THE INFLUENCES OF MIDDLE SCHOOL MATHEMATICS TEACHERS' PRACTICAL RATIONALITY ON INSTRUCTIONAL DECISION MAKING REGARDING THE COMMON CORE STATE STANDARDS FOR MATHEMATICAL PRACTICES

A dissertation submitted to the
Kent State University College
of Education, Health, and Human Services
in partial fulfillment of the requirements
for the degree of Doctor of Philosophy

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August 2017

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The purpose of this study was to examine the influences of various facets of middle school mathematics teachers' practical rationality on their instructional decision making as they plan to enact the Common Core State Standards for Mathematical Practice, CCSS-MP1 (perseverance in problem solving) and CCSS-MP3 (communicating and critiquing). The study expands and confronts some of the literature that lacks specifics to instructional decisions made by middle school mathematics teachers, particularly with regards to their disposition, the operationalization of their MKT, and the connection to the institutional obligations affecting their practical rationality.

This study provides insight into three facets impacting middle school mathematics teachers' instructional decision making with regards to CCSS-MP1 and CCSS-MP3. First with regards to teacher disposition, a facilitative role using a problem solving approach is preferred. Secondly, curricular choices are made directly tied to the teachers' MKT. Finally, although the teachers recognized that they had certain obligations to the institution, they also held the belief that the institution was obligated to them as well. The two main obligations required from the institution were the need for professional

development provided by the district and appropriate resources that promote problem solving and communication.

These results suggest the need for professional development for in-service and preservice teachers in the facilitative approach to mathematics instructions, more time for teachers to work collaboratively in professional learning communities (PLCs), professional development for district administrators, board members and parents with regards to a more rigorous and investigative approach to mathematics instruction.

ACKNOWLEDGMENTS

I would never have been able to complete this journey without the support of the people in my life. God has blessed me with a network of amazing people.

I would like to extend a special appreciation for my advisor, Dr. Karl Kosko, who took time to "hangout" with me each week providing endless guidance, caring, words of wisdom (even a few not related to the research), and extreme patience. The road has been rough at times. Thanks for helping me navigate it. I would also like to thank my "external" committee member, Dr. Jay Jahangiri. You always seemed to know the right supportive things to say and provided a bit a humor when I needed to laugh the most. Also, thanks to my co-advisor, Dr. Joanne Caniglia who pushed me to go where I may not have thought to travel.

I would like to thank my critical friends, Drs. Peggy Slavik, Marcella Isacco-McConnell Keri Stoyle, and Jen Loudon who encouraged me to stay the course and dodge every obstacle thrown my way.

Thanks to my three participants, "Mary," "Fred," and "Jen." Without your honesty and willingness to take time from your busy lives, I would never have been able to complete this journey. Hopefully, I will be able to return the favor one day.

And finally, thanks to my family and the special man in my life. My parents who were never too tired to listen and offer encouragement. You believed in me more than I believed in myself. To my three children, Shane, Cameron, and Elyse. When I needed encouragement the most, you three were always there telling me how proud you were of my hard work. You truly are my inspiration. To Tim who came into this journey midway but stuck around to see the finish line. Your support will always be appreciated.

I know I may not have always been the easiest to live with during this journey. Thanks for helping me stay the course.

TABLE OF CONTENTS

LIST OF FIGURES

Figure Page

LIST OF TABLES

Table Page

CHAPTER I

INTRODUCTION

Statement of the Problem

Some of the more relevant topics being investigated in recent mathematics research include research on how teachers help promote mathematical thinking within the classroom, how teachers help students to communicate their mathematical understanding, and what are some of the differences in mathematics environments. Imbedded in all of these research studies is the relationship between teaching and learning (Carpenter, Dossey, & Koehler, 2004; Davis, Maher, & Noddings, 1990; Sowder & Schappelle, 2002). As one reads this research, one should recognize how the findings can be used in light of the Common Core State Standards for Mathematics, CCSSM from here on out, content and practice standards. This is not to say that classical research does not serve a purpose. Research that has been endorsed by the National Council of Teachers of Mathematics (NCTM), the National Science Foundation (NSF), and other reputable organizations is more than likely based on similar teaching and learning principles as those found in the CCSSM. However, due to the fact that the research was conducted prior to the creation of the CCSSM, it becomes the burden of the reader to make the connections between these previous research studies and the CCSSM. There is little existing research that indicates whether or not middle school mathematics teachers are making this critical connection.

At the time of this study, 43 states, the District of Columbia, four territories, and the Department of Defense Education Activity (DoDEA) have adopted a national set of mathematics standards, the CCSSM. The CCSSM contain the Standards for Mathematical Practice and the Standards for Mathematical content. The focus of this research is on the Standards for Mathematical Practice (MP), as the focus of these standards crosses grade levels K–16 indicating the mathematical skills and expertise that educators should strive to develop in their students ("Standards for Mathematical Practice," 2015, introduction section, para. 1).

The eight Standards for Mathematical Practice, referenced as CCSS-MP from here on, deal with key components of previously developed standards. The NCTM process standards of problem solving, reasoning and proof, communication, representation, and connections are woven throughout the practice standards. The second set is the strands of mathematical proficiency outlined in the National Research Council's report *Adding It Up*: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (Kilpatrick, Swafford, & Findell, 2001). When teachers include CCSS-MPs in their instructional decision making and subsequent mathematical instruction, students will develop practices that will increase student engagement as the students grow in their mathematical expertise. It is important that teachers not only include the content standards but also the mathematical practices in their instructional decision making as the connections made between the practice standards and the content standards help students grow in their mathematical understanding.

This study intends to focus on middle school mathematics teachers' instructional decision making with regards to CCSS-MP1: *Make sense of problems and persevere in* *solving them* and CCSS-MP3: *Construct viable arguments and critique the work of others.* These two practice standards were chosen based on a critical conversation between middle school mathematics teachers participating in a summer academy focusing on the mathematics reform changes connected to Ohio's New Mathematics Learning Standards that are founded on the CCSSM (L. McMahon, personal conversation, June 17–18, 2015). These teachers clearly indicated that perseverance and argumentation are important components in developing mathematical understanding and promoting future acquisition of mathematical knowledge. As these teachers work to unpack Ohio's New Mathematics Learning Standards, they also see the importance of providing the students with opportunities to engage in solving rigorous problems. These conversations also indicate that teachers are bound by other factors as they attempt to include CCSS-MPs in their instructional decisions. Concern was expressed regarding the probable enactment of these practices with all students in the middle school classroom.

Although research exists regarding the impact of teachers' disposition with regards to instructional decision making, research is lacking specific to middle school mathematics teachers with regards to CCSS-MPs. Several studies indicate that teachers bring many personal attributes to the instructional situations, which directly influence their instructional decision making (Bourdieu, 1998; Chazan & Ball, 1999a, 1999b; Herbst & Chazan, 2003, 2006, 2011; Lampert, 1985). Herbst and Chazan (2003) asserted that teachers must draw on their practical rationality to build their own mathematics teaching practices in conjunction with their personal commitments and demands of the instructional situation as relevant in the individual classrooms (p. 2). Although this research outlines the components of teachers' dispositions regarding mathematical instructional decision making, it fails to address the CCSS-MP specifically.

This study focuses on the discrepancy between professional beliefs and enacted practices. As evident in the conversation between the middle school mathematics teachers mentioned earlier, there may be non-mathematical influences that impact the exchange of mathematical knowledge between participants in the instructional settings. Research studies have indicated that professional norms and obligations connected to the instructional situation may affect the planned instructional decisions as well as the decisions made in the moment within an instructional situation (Herbst & Chazan, 2012). One must recognize that once placed in an instructional situation, a teacher must decide what is the most probable and suitable action that may result in one that is contradictory to the instructional norms. The conversation during the summer professional development among the middle school teachers implied that their professional obligations, such as their obligation to the students and institution as a whole, influenced the decisions that they made regarding the CCSSM.

Significance of the Study

The CCSS-MPs are designed as an outline of what students should know and be able to do in order to demonstrate an understanding of the mathematics at stake ("Ohio's new learning," 2010). In order to determine if the student understands the mathematics, it is the teacher's responsibility to make an assessment. One way to assess students' understanding is to require the students to provide justification, in a way that is appropriate for the students' level of mathematical progress, of why something is mathematically true or why a rule works in the manner that it does (“Ohio’s new learning,” 2010, p. 4). Further, “there is a world of difference between a student who can summon a mnemonic device to expand a product such as (a + b) (x + y) and a student who can explain where the mnemonic comes from” (p. 4). The student who can justify the rule has a better understanding of the mathematics and is more likely to show success when encountering a task that involves expanding on the newly acquired knowledge. This is not to discredit procedural skills but rather recognizes that in combination with mathematical understanding the student is better equipped to engage with rigorous mathematical tasks. This is another reason why providing students with opportunities to employ CCSS-MP3 is so important and rationalizes why it was chosen in this study.

The CCSS-MPs are a roadmap for developing student practitioners of mathematics to become active participants in the acquisition of the subject matter in order to grow in mathematical maturity and expertise (“Ohio’s new learning,” 2010, p. 7). As an instrumental player in development of the curricula, teachers need to incorporate these mathematical practices in their instructional decision making to ensure the desired student growth. The ability to combine the content knowledge with the practices will lead to better understanding. When working on CCSS for mathematical content, teachers can readily recognize a connection to the practices if the standard looks to develop understanding (“Ohio’s new learning,” 2010, p. 8). A student who lacks mathematical understanding may not look to find analogous problems, evaluate their progress and change the course of their engagement when faced with problems that require perseverance, in other words, they are incapable of employing CCSS-MP1 which as mentioned earlier is one of the practices seen as essential in developing mathematical understanding. Similarly, the absence of understanding makes it difficult for students to explain the mathematical knowledge and skills to others or to argue the validity of their mathematical solutions and knowledge, showing a lack of employment of CCSS-MP3, the other practice being investigated.

As teachers fully implement Ohio's New Mathematics Learning Standards, the content standards seeking understanding become the junction of the Standards for Mathematical Content and the Standards for Mathematical Practice ("Ohio's new learning," 2010, p. 8). Research used to justify CCSSM places the mathematical practices at the forefront indicating that these junctions are essential in the development of mathematical understanding and subsequently are the catalyst toward student achievement in mathematics. This being said, instructional decision making should warrant considerable time, resources, and focus toward inclusion of the mathematical practices in curriculum, instruction, and assessment. But in order for this to be realized, the teacher must see the inclusion as probable and sustainable. This study focuses on the factors that influence teachers' ability to include these mathematical practices in their instructional decision making.

Research Goals and Questions

The goal of this study is to consider the role of middle school mathematics teachers' practical rationality in their instructional decision making with regards to CCSS-MP1 and CCSS-MP3. The data can be used to help determine specific professional development opportunities for middle school mathematics teachers. Often professional development opportunities are a "one size fits all" format making it less likely that some of the teachers will actually use the skills and knowledge in their own instructional situations. By investigating what interferes or promotes the inclusion of the mathematical practice standards in the instructional decision making of the teachers, a better understanding of the professional needs can be assessed.

Effectively implemented, professional development leads to four important accomplishments (Doerr, Goldsmith, & Lewis, 2010). Through professional development, the teacher should gain mathematical knowledge for teaching. Historically at the elementary and middle school levels, mathematics teachers were not highly qualified in their discipline (United States National Commission on Excellence in Education, 1983). After *A Nation at Risk* recommended that teacher preparation programs make improvements toward this end, states began to require that teachers at the middle school level become highly qualified in their discipline (U.S. National Commission on Excellence in Education, 1983). This is slowly starting to filter into the middle schools as districts and states are recognizing that the rigor of the CCSSM will require that teachers have a deeper understanding of the content and processes involved not only at their grade level but at the grade levels above and below their own (CCSSI, 2010). The Conference Board of Mathematical Sciences (2010) asserted that teachers can increase their mathematical knowledge for teaching by collaborating with mathematicians and mathematics educators at the universities on the development of instructional strategies and curricular issues ("The mathematical education of teachers," 2010). The Partnership for Mathematics and Science established by the National Science

Foundation (NSF) and the United States Department of Education indicates that this type of collaboration will lead to better mathematical teaching practices, increase mathematics knowledge for teaching, and increase student learning (Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2009). Enrollment in mathematics organizations at all levels and attendance at conferences can also promote acquisition of mathematical knowledge (Loucks-Horsley et al., 2009). The CCSSM content and practice standards are designed with more rigor, focus, and coherence than past standards. As professionals, it is our responsibility to understand this intent and implement these standards within our classrooms. It is imperative to keep student learning and mathematical thinking at the heart of our professional endeavors. A professional is a lifelong learner who should constantly be looking to improve. Collaboration is one way to help with the demands of the new CCSSM standards. Teachers need to experience, design, and implement instruction and assessment that meet the demands of the CCSSM. Afterwards, they need the opportunity to reflect on the impact on their own mathematical learning and students' learning (Courtney, 2014).

Data were gathered from four sources: the Mathematics Teaching Efficacy Beliefs Instrument, MTEBI from here on; reflective journals after participants viewed video lessons where CCSS-MP1 and CCSS-MP3 have been incorporated in the middle school mathematics instructional setting; videotaped classroom observations of instructional lessons determined by each participant to be a lesson where CCSS-MP1 and CCSS-MP3 are incorporated; and individual interviews with each participant. The videos were chosen from *Inside Mathematics*, an online professional resource "for educators passionate about improving students' mathematics learning and performance" (Noyce Foundation, n.d., para. 1). Participants responded to the videos revealing their interpretation of the instructional decision making practices of the middle school teachers featured in each of the videos. Each participant videotaped two classroom interactions, demonstrating his or her own implementation of CCSS-MP1 and CCSS-MP3. These observations were followed by stimulated recall sessions to ensure that I correctly recorded the intent of the instructional decision making that led to the instruction observed. The last source of data was individual interviews with each of the participants. During these interviews, I focused on each participant's practical rationality with regards to his or her instructional decision making with regards to the CCSS-MP1 and CCSS-MP3. These data were used to address the following three research questions:

1. What role does the teacher's professional disposition have on middle school mathematics teachers' instructional decisions regarding CCSS-MP1 and CCSS-MP3?
2. What role do environmental and societal influences have on middle school mathematics teachers' instructional decisions regarding CCSS-MP1 and CCSS-MP3?
3. What role does Mathematical Knowledge for Teaching have on middle school mathematics teachers' instructional decisions regarding CCSS-MP1 and CCSS-MP3?

Chapter 2 highlights the research related to the influences on teachers' instructional decision making with the main emphasis being on practical rationality.

Research includes the Common Core State Standards for Mathematical Practices, specifically focusing on CCSS-MP1 and CCSS-MP3, the two practices in this study. The literature also reviews the mathematical knowledge for teaching utilized by teachers as part of their instructional decision making and the role that it plays when focusing on the mathematical practices.

Chapter 3 discusses the rationale for using a case study in this investigation. It also addresses the choices for educational settings in light of the existing research and the focus of the study. The four sources of data collection and analyses are described.

Key Terms

The following terms were used throughout this study and warrant being defined to ensure that the readers share a common understanding of how I use them within the research.

Appreciation: the doctrine and conditions which teachers use to create a mindset toward people, occurrences, objects, or ideas (Bourdieu, 1998).

Didactical contract: Expectation for the teacher to give students work to do that create opportunities to learn a body of knowledge at stake and the expectation for the students to engage in work assigned (Herbst & Chazan, 2011).

Dispositions: Regulations that a participant is subjected to based on one's position in the situation; tendencies coming from the individual that causes them to act in a certain way (Herbst & Chazan, 2003; Lampert, 1985).

Instructional decision making: Decisions made by teachers that impact behavior in the classroom and ultimately influence the learning process utilized and the outcomes produced by students (Shavelson, 1983; A. G. Thompson, 1992).

Instructional norms: Central habit around which actions in certain parts of a situation tend to disseminate (Herbst & Chazan, 2006).

Mathematical Knowledge for Teaching (MKT): Essential knowledge and activities needed to deal with the day-to-day, moment-to-moment, demands of teaching specific to mathematics instruction; essential knowledge and activities needed to establish a classroom where mathematics is handled with integrity; students' ideas are valued and mathematical explorations are done collaboratively (Ball, Thames, & Philips, 2008).

Pedagogical content knowledge: Most useful ways of representing and formulating the subject that make it comprehensible to others; what makes the learning of specific topics easy or difficult; conceptions and preconceptions that students of different ages and backgrounds bring to learning (Shulman, 1986).

Perception: Shared ways in which teachers identify people, occurrences, objects, and idea shared within an instructional setting (Bourdieu, 1998).

Practical rationality: Way of doing an activity that makes sense to the practitioner while at the same time keeping the activity steady and workable; specific to the instructional situation; what practitioners consider probable and suitable actions within their classroom interactions; helps practitioners notice and justify (or else denounce) departures between actual actions and (implicit) norms (Herbst & Chazan, 2006, 2011).

Professional obligations: Links the practitioner to the position of mathematics and regulates the decisions toward actions; used to explain why actions that depart from situational or contractual norms are justified or refuted (Herbst &Chazan, 2011).

Teacher efficacy: A teacher's view or opinion regarding the power to affect how well students learn including those who are challenging or apathetic (Guskey & Passaro, 1994).

CHAPTER II

REVIEW OF THE LITERATURE

The literature review highlights research regarding influences on teachers' instructional decision making with primary focus on practical rationality. Recent mathematics reform centered around the Common Core State Standards includes the standards for Mathematical Practice, CCSS-MP from here on out but there is little research regarding the instructional decision making done by middle school mathematics teachers to ensure that these practices will be enacted. The intent of the CCSS-MPs is to provide teachers with a blueprint for the type of competencies that should be developed at all levels to enable students to grow in their mathematical understanding (Standards for Mathematical Practices, n.d.). Although the intentions are founded on the important historical relevant ideas from such documents as the NCTM process standards and the National Research Council's *Adding It Up* report, the standards are meaningless unless valued and prominent in the decision making of the classroom teacher. It is my contention that the teacher's instructional decision making is impacted by their own personal disposition, societal and environmental influences on his or her practical rationality, and the teachers' mathematical knowledge for teaching, thus the study investigates the role each of these influences have on teachers' decision making.

This chapter focuses specifically on the role of practical rationality as described by various researchers. Included in this review is the impact of instructional situations, the role of perceived professional obligations, the role of mathematical knowledge for teaching, and the impact of teachers' belief systems as directly linked to teachers' instructional decision making. This literature frames my research regarding middle school teachers' instructional decision making regarding CCSS-MP1 and CCSS-MP3.

Early Research on Teachers' Instructional Decision Making

Many important elements are involved in instructional decision making. The decisions made during the planning process impact teachers' future behavior in the classroom and ultimately influence the learning process utilized and outcomes produced by the students (Shavelson, 1983; A. G. Thompson, 1992). Shavelson and Stern (1981) asserted that focusing solely on teacher behavior without capitalizing on teacher intent does not allow one to fully realize the conceptual goals, judgments, and decisions behind the instructional planning. Also, the association between teachers' intentions and subsequent behaviors can be used as a predictor of future implementation of educational innovations (Shavelson & Stern, 1981). It is important then to look at the research regarding teachers' decisions made regarding instructional practices.

Jackson (1968) was one of the first to strive to understand teachers' instructional decision making process as related to effectiveness. He described the decision making process as being linear where decisions are pre-active, interactive, and post-active. Yinger (1980) disagreed claiming that the relationship between planning, teaching, and reflecting were cyclic rather than linear. Yinger conjectured that teaching is not about the sequence of plans and teaching experiences for a single event but rather is the direct results of previous plans and teaching experiences. This implies that the post-reflections from a teaching sequence can have an effect on future planning and instruction. Ball and Forzani (2009) described the core tasks that teachers must enact in order for students to learn. Included in these tasks is the planning which leads to the creation and maintenance of an orderly and productive environment for learning. Ball and Forzani recognized that effective practice involves rigorous and imaginative work by the teacher. Skillful teaching is the direct result of specific planned activities based on teacher knowledge and understanding of the students and on the professional decision making and judgment of the teacher. Herbst and Chazan (2003, 2006, 2011) recognized that teacher planning, whether prior to instruction or in the moment within the instructional situation, is driven by the practical rationality of the instructional situation. They made the claim that practitioners have an obligation to the discipline of mathematics, the individual and collective group of students within their classroom, and the institution where they teach. The decisions made by the teacher are not based on personal reasons but rather are based on the instructional situation.

Early researchers' findings on teachers' instructional decision making assumed that teachers' behaviors are the direct results of their thoughts, judgments, and decisions (Fenstermacher, 1980; Nisbett & Ross, 1980; Shavelson & Stern, 1981). Without this assumption, teachers must be seen as machines with built in automatic response systems. Research conducted by the National Institute of Education (1975) reaffirms that teachers' behaviors are the direct result of their thought processes and further, if viewed as a thoughtless reaction then teachers' most unique attributes are ignored. Nisbett and Ross (1980) asserted that the inability to bridge the gap between cognition and behavior is one of the shortcomings of cognitive psychology. In order to understand teaching, this research suggests that one must attempt to understand how a teacher's cognition is carried out in one's behaviors.

Early researchers found that characteristics possessed by teachers have an impact on their judgments, decisions, and subsequent behaviors. Shavelson, Cadwell, and Izu (1977) found that when applicable information was available, teachers used it in their decision making process. If the information was not available, then the teachers relied on their own beliefs about education and teaching to make uninformed but rational decisions. The behaviors displayed by the teacher would be a direct result of these decisions.

Through careful planning involving rational decision-making, teachers strive to optimize student learning through goal-oriented planning (Shavelson & Borko, 1979; Shavelson & Atwood, 1977; Shavelson, Atwood, & Borko, 1977; Shulman & Elstein, 1975). This is reaffirmed by McNair (1978-79) in a study in which a method of stimulated recall studied teachers' thoughts and decisions while teaching. McNair indicated that teachers were most influenced by their concern for their students and based their pedagogical decisions on what they perceived to be happening to individual students during the instruction. Content attributed to the remainder of their decision-making. The teacher is equipped with a multitude of instructional strategies to help students reach their goals. It becomes the teacher's responsibility to select the correct one based on the information gathered about the individual. This information is combined with the teacher's own beliefs and goals and other environmental forces (McNair, 1978-79).

During daily instruction, teachers are required to make decisions oftentimes without formal time to reflect on their responses (Shavelson & Stern, 1981). The need for a quick response often leads to an inability to make informed judgments or decisions. The ability of individual teachers to reason through difficult problems as presented in the daily classroom experiences is best approached when the teacher responds rationally to a self-created reduced model of the situation, which Shavelson and Stern referred to as "bounded rationality" (p. 456). This enables the teachers to act rationally within the boundaries of their information-processing potential oftentimes based on their mathematics belief systems.

Instructional planning is one of the actions that teachers generally do in the absence of the students; however, the decisions made during this planning have a tremendous impact on teachers' classroom behaviors and on the attributes and results of the education that the students receive (Shavelson, 1983). This planning involves course of actions for the lesson that day, over a unit, semester, or the entire school year. The significance of this planning should not be overlooked when considering teachers' instructional decision making.

Teachers' instructional plans act as a roadmap for the implementation of interactive teaching (Borko & Livingston, 1989; Ethell & McMeniman, 2000; Griffey & Housner, 1991; Shavelson & Stern, 1981; Smith & Sendelbach, 1979). Yinger (1979) inferred that "teacher planning is the major tool by which teachers manipulate the environments that later shape and control their own behavior" (p. 164). Planning seems to be a tool that links curriculum to instruction; therefore, influencing what happens in the instructional environment (Byra & Coulon, 1994). Once established, teachers do not tend to deviate from their plans once they have begun teaching an instructional activity (Shavelson & Stern, 1981). Shavelson and Stern found that knowing a teacher's instructional plan became a good predictor of teacher's behavior in the classroom during instruction.

Shavelson (1983) described interactive decision making as the decisions made during interactions with students such as lectures, discussions, and tutoring sessions. These decisions are done in the moment, meaning that the teacher does not have the time to reflect on the decision or obtain additional information before deciding on an appropriate action. These decisions are usually made when the interactive teaching is not going as planned (Clark & Yinger, 1979). Clark and Yinger focused on the basic psychological processes employed in the teachers' minds that shape and focus their behaviors. Teachers are faced with complex situations which require the teacher to simplify the situation in a reasonable and modified way. This is done by splitting the environment of the complex task into a defined smaller part that is viewed as the problem space within which the teacher works. How the teacher performs this simplification is affected by the teacher's judgment, decision making, attention, and memory (Clark & Yinger, 1979, p. 3).

Clark and Yinger (1979) recognized that the above mentioned basic processes do not operate in a vacuum. Clark and Yinger indicated that the basic processes used for teacher judgment and decision making exist within both a psychological and ecological context. The psychological context is composed of the teacher's implicit theories, beliefs, and values about teaching and learning. The ecological context is comprised of the resources, external circumstances, administrative requirements, and others that inhibit, facilitate, and form teachers' and students' thoughts and behaviors (p. 4).

Teacher decision making is removed from the instructional planning when teachers use commercially produced textbooks or learning systems (Clark & Yinger, 1979). The planning is often scripted by the publishers and authors of these materials. When a teacher veers from these prescribed materials, planning allows teachers to clarify their ideas, try them out mentally, implement their ideas in the classroom, then reflect on the activity in order to revise, reject, or convert them into routines. Tasks that are not inhibited by routines, prescribed materials, and procedures allow for the most opportunities for teacher decision making and cognitive processing (p. 5).

In the data rich environment that teachers presently operate, one cannot ignore the effects of data on teacher pedagogical decision making. The prominence of technology, political driven financial support, and greater accountability for student outcomes has led to an increased focus on datum use for educational improvement across the globe (Hamilton et al., 2009; Marsh & Farrell, 2015; Wayman & Stringfield, 2006). Research indicates that although educators are surrounded by a wide range of datum from formative assessments, cross grade level common assessments, statewide assessments, and student work, teachers are not always equipped to use the data to inform their decisions to change instruction that can result in improved student outcomes (Heritage, Kim, Vendlinski, & Herman, 2009; Olah, Lawrence, & Riggan, 2010). It is also challenging for teachers to use the data to inform their practice while holding true to their personal pedagogical beliefs and expectations (Young, 2006).

Role of Practical Rationality on Instructional Decision Making

Herbst and Chazan (2003) recognized that since mathematics teaching is viewed as part of the practice of teaching, it must be based on a practical rationality upon which individual practitioners can build their own mathematics teaching practices in conjunction with their personal commitments and the demands of the institution where they practice (p. 2). This practical rationality influences practitioners to perform actions that are deemed to be relevant in the classroom. Herbst and Chazan defined practical rationality as follows:

> Practical rationality not only enables practices to reproduce themselves over time as the people who are the practitioners change, but also regulates how instances of the practice are produced and what makes them count as instances. (p. 2)

To better be able to describe the practice of mathematics teaching, one must understand the practical rationality that directs it.

Before reformers can design and enact improvements that are viable and worthwhile, reformers need to be able to recognize and understand the mathematical work that teachers and students generally do as they work together in instructional situations (Herbst & Chazan, 2011). Herbst and Chazan defined rationality as a way of doing the activity that makes sense to practitioners while at the same time keeping the activity steady and workable (p. 213). They further defined practical rationality as being specific to the instructional situation. Practitioners bring a sense of what they consider to be probable and suitable actions into their classroom interactions. Practical rationality influences the decisions of mathematics teachers as they encounter different instructional situations.

A norm is a central habit around which actions in certain parts of a situation tend to disseminate (Herbst & Chazan, 2006). Since the norms are enacted by individuals who can act with any degree of variance from what is expected, the norm must only be viewed as the central tendency and may not necessarily predict the most frequent set of actions during any given instance of that instructional situation. According to Herbst and Chazan:

> Instructional situations are sets of norms that identify similarly regulated phenomena but not necessarily regularities in behavioral manifestation; teachers operating under the same norms may produce different actions . . . The notion of practical rationality helps us make sense of that apparent contradiction. Practical rationality is the system that helps practitioners notice and justify (or else denounce) departures between actual actions and (implicit) norms. The empirical datum that justifies the existence of a norm is the frequency of observations of similar ways of noticing and valuing different behaviors. Thus the operational definition of practical rationality calls for uncovering the categories of perception and appreciation that actors of a given practice invest in noticing and negotiating the status of specific, problematic actions. (p. 214)

Practical rationality then allows us to explain the breeches from these mathematical norms.

In Herbst and Chazan's (2011) research using vision sketches, teachers were asked to respond to classroom stories presented using three different media sources: animation, slide shows, and comic books. Their goal was to engage participants in thought experiments about the way that teachers were presenting different geometry proof problems. Each situation was intended to display a breech from the mathematical norm. Herbst and Chazan described three customary ways that practitioners respond to the vision sketches. The first approach, the vision of conceivable mathematical work in classrooms, has the teacher acting as a social critic of the current educational system. The teacher acknowledges and analyzes the forces that make the vision not realistic in the present educational system. Drawing on the conceivable vision, the teacher then advocates for a new education system, which brings the vision to realization. In the second approach, the teacher acts as a social engineer, working tirelessly to make the vision happen. To realize the vision, the teacher uses persuasive discourse, puts effort into the design, and organizes all resources even when it is unlikely that the vision will work. The teacher believes that the only thing preventing the conceivable vision from happening is the lack of effort needed. The final approach, the one that Herbst and Chazan (2011) advocated, combines the two previously mentioned by making improvements to the second by using the organized characteristics of the first. The teacher poses questions that rely on theory and research, not critiquing and engineering. Recognizing that teachers' actions in the classrooms do not only reflect their free will and individual resources but are also the result of the adaptation to conditions and restrictions created by the environment where they work. This does not mean that the teacher must accept the vision as status quo; rather, the vision can be used to promote improvements in "viable, incremental, and sustainable ways" (Herbst & Chazan, 2011, p. 407).

One way that researchers explain the perplexities and dynamics that teachers need to manage is through the concept of disposition (Chazan & Ball, 1999; Herbst & Chazan, 2011, Lampert, 1985). Bourdieu (1998) described dispositions as having two sides like a coin. On one side, dispositions can be seen as regulations that a participant is subject to based on one's position in the situation. At the same time, dispositions can be seen as the tendencies coming from the individual that causes them to act in a certain way (Herbst & Chazan, 2003; Lampert, 1985). Teachers bring a collection of dispositions to each instructional situation, which comes from the collective unit such as a set of algebra teachers who work in a similar setting (Herbst & Chazan, 2011). A teacher within this collective unit abides by these dispositions with regards to the norms of the instructional situation such as algebraic manipulations while at the same time honoring the obligations of the profession of mathematics teaching (Herbst & Chazan, 2011, p. 430).

Referencing the work of Bourdieu (1998) regarding dispositions, one must look at what he referred to as categories of perception and appreciation, which inspire practitioners to act in a specific way. The category of perception is used to describe the shared ways in which teachers identify people, occurrences, objects, and ideas shared within an instructional setting. The category of appreciation encompasses the doctrine and conditions which teachers use to create a mindset toward people, occurrences, objects, or ideas. Most often, these dispositions are unspoken but the teacher is able to draw upon them when faced with an opportunity that requires one to justify to other stakeholders why one might or might not choose to do something in the instructional situation (Herbst & Chazan, 2011, p. 431).

The title of teacher does not just describe a part of an individual's identity but rather is a role given to a person who is part of the educational institution (Herbst & Chazan, 2011). The teacher brings many personal attributes to the instructional situation, which is likely to influence what he or she decides to do. Ball et al. (2008) asserted that mathematical knowledge for teaching (MKT) and skills needed to perform the task are some of the assets. Their research indicates that the teachers who possess these assets may be able to perform tasks and reason out things that others lacking these assets may not be able to do. Although causes and rationale for doing the things may be founded on personal assets, it does not really give justification for why these actions are being done. A way to justify the actions is through practical rationality (Herbst & Chazan, 2003, 2006, 2011).

It becomes necessary to provide justification for one's actions when teaching departs from what is considered the norm or desired action. This deviation should not be seen as indicative of lack of knowledge but rather as reflecting the possibility of some knowledge of what action should be performed which is akin to a practical rationality that justifies it (Herbst & Chazan, 2011, p. 429). Without an understanding of this practical rationality, it is unfair to evaluate teachers' action or attempt to regulate their instruction. This may be one reason why reform initiatives fail in certain instructional situations. Teachers and students are driven by a unique knowledge of what needs to be done; this knowledge may not be recognized by outsiders to the instructional situation even though they are knowledgeable about the mathematical domain being taught and learned. In order for improvements in instruction to become viable, it must be able to deal with the established drive from existing practices and the possible resistance. To do this, the improvement must provide innovative and superior resources. One way to hedge the possibility of the acceptance of the new reform improvement is to gain knowledge of what is considered the norm and what practical rationality grounds the usual actions prior to the design (Herbst & Chazan, 2011, p. 433).

The Impact of Instructional Situations on Teachers' Decision Making

Although each mathematics content course may draw on general sets of norms, there are also specific norms within each course, which are dependent upon what knowledge is at stake (Herbst & Chazan, 2011). Use of core content vocabulary such as prove, construct, and conjecture allow practitioners to be aware of which norms are needed in particular classroom interactions by calling up select reciprocated norms indicating who can do what and when. Herbst and Chazan (2011) referred to each of these frames as instructional situations. They defined instructional situations as "specialized, local versions of the didactical contract that frame particular exchanges of work for knowledge, obviating the need to negotiate how the contract applies for a specific chunk of work" (p. 435). Didactical contracts rely on the notion that student and teacher have basic roles and responsibilities, which are akin to the knowledge at stake. The knowledge must transfer between teacher and students through some form of communication. It is considered to be at stake because this transfer may or may not occur. Herbst and Chazan (2011) asserted that:

> The didactical contract is a tacit assignment of rights and responsibilities between the teacher and students vis-a-vis the communication of that knowledge. These responsibilities include the expectation for the teacher to give students work to do that is supposed to create opportunities to learn elements of that body of knowledge and the expectation for the student to engage in the work assigned, producing work that can be assessed as evidence of having (or not yet having) acquired that knowledge. (p. 431)

The design of the instructional situations becomes important in driving the acquisition of knowledge.

Each classroom has a didactical contract that can be recognized by its norms. The teacher acts as the manager of the didactical contract enacting the exchange of knowledge between the players (Herbst & Chazan, 2011, p. 432). This exchange is characterized by the work intended for, allocated to, and finalized by the students and the knowledge presented which is authorized by the curriculum at stake in the instruction, ultimately then incorporated in the students' finished work. Not only must the teacher manage these exchanges with his or her students but is also responsible for sorting out the results of the work to make sure that it reflects the knowledge at stake. A didactical contract consists of any mathematics teaching that satisfies the goals of the contract inside the educational setting. There are many ways to accomplish the fulfillment of the contract, which may vary not only across different courses due to the different content being presented but also within the same coursework. Different contracts could require unique roles and responsibilities of the teacher and students. In other words, the contract might include the assumptions that every new task would necessitate deliberations about how the general norms of the contract apply. This includes what is needed for the teacher to enable students to work on a certain task and what it means for students to do the work on these tasks. Often, the contract relies on a variety of instructional situations that deem these deliberations unnecessary. The instructional situations include unspoken specific norms that specify how the didactical contract works for a multitude of tasks and the specialized items of knowledge that must transfer between teacher and students as the students work on these tasks. When focusing on the instructional situations rather than on the individual practitioners, an explanation can be provided for why an individual practitioner may display contradictory actions when working in differing instructional situations.

Through practical rationality, teachers are able to invoke their acceptance or rejection of courses of action in their teaching (Herbst & Chazan, 2011). Herbst and Chazan did not attempt to understand the participants but rather investigated the participants' reactions to the instructional situations presented to them using different media sources. They looked to reveal parts of the teachers' practical rationality that justified breaches of the instructional situations that might produce a more authentic kind of mathematical work (Weiss, Herbst, & Chazan, 2009). The role being enacted by the teachers and the position where they play that role requires the teachers to hold true to the specific professional obligations that are instrumental in the formation of their decisions (Herbst & Chazan, 2011, p. 437). When placed in an instructional situation where one of the norms has been breached, teachers can engage in repair strategies thus acknowledging that the norm exists thereby choosing to either provide more details about how the norm influences the instructional situation or choose to reject it in order to establish a more desirable educational environment or response.

The Role of Perceived Professional Obligations on Instructional Decision Making

Although the decisions made by the teachers are motivated by the didactical contract, the instructional situation, and the nature of the task itself, the professional obligations that links the practitioner to the position of mathematics also regulates the decisions toward actions (Herbst & Chazan, 2011). Herbst and Chazan contended that four obligations can be used to explain why actions that depart from the situational or contractual norms are justified or rejected. These four obligations are disciplinary, individual, interpersonal, and institutional (Ball, 1993; Herbst & Balacheff, 2009; Herbst & Chazan, 2011).

The disciplinary obligation indicates that a teacher should be compelled to provide students with a valid representation of the discipline of mathematics (Herbst & Chazan, 2011, p. 450). This includes representations of mathematical knowledge, mathematical practices, and mathematical applications. The individual obligations state that the teacher is responsible for the whole child as student. This includes recognizing the students as individuals with their own "behavioral, cognitive, emotional and social needs" (p. 450). The interpersonal obligation recognizes that the teacher is obligated to organize the interactions between all members of the instructional situation. This encompasses the "needs and resources of shared discursive, physical, and social spaces within shared time" (p. 451). The institutional obligation, also referenced as the schooling obligation, indicates that the teacher must attend to the various details of the school as a whole. This includes managing "school policies, calendars, schedules, examinations, curriculum, extracurricular activities, and so on" (p. 451).

The obligations described hold true for all mathematics courses. The obligations combine to give grounds for contracts and the corresponding instructional situations, which in turn may be used to justify unusual actions when combined with norms of contract, situation or task (Herbst & Chazan, 2011, p. 451). These obligations combined with the norms of contracts, instructional situations, and instructional tasks compose the practical rationality of the mathematics teaching. Herbst and Chazan asserted

> That the justifications for actions in teaching, either those actions that are usual or those that are unusual but viable, can be found by combining norms of the contract and situations that the teacher is enacting with obligations that teacher has to the profession of mathematics teaching. (p. 451)

When looking at the decisions made by teachers, one cannot ignore these obligations.

Within the practical rationality, the didactical contracts and corresponding instructional situations create a sociohistorical construction that endures by fusing with the professional obligations (Herbst & Chazan, 2011). At times, these obligations are contradictory to the each other making it difficult to believe that teaching is able to establish reliable didactical contracts and stable instructional situations (Herbst, 2002). Herbst and Chazan's (2011) description of practical rationality can be used to explain how this stabilization is possible:

> To the extent that our interest in improving practice stresses the need for improvements to be responsible, incremental, and sustainable, it is appropriate for us to try to understand what justifies the norms of stable contracts and situations, even if we might want to modify or do away with some of them: Understanding stable systems of practices as well as understanding how those systems react to perturbations is fundamental for the design of new practices. Indeed, since improved practices will need to subject themselves to similar grounds for justification, practices that are close to those that are normal in existing instructional situations (as gauged by how many norms of a situation a practice breaches) may be easier to justify than others. (p. 452)

It is imperative that the teacher be able to provide this justification for new educational practices to be realized.

Practical rationality combined with the professional obligations can also give insight to how a teacher may respond in different instructional situations. Herbst and Chazan (2011) alleged that anticipating how a teacher may react to breaches in the norms as the instruction proceeds is useful in determining:

> . . . potential derailments in the implementation of new practices in the classrooms. That anticipation may also be useful in the examination of teachers' responses to assessment or development, or their reactions to instructional interventions. Teachers' responses to representations of breaching (but arguably valuable) instances of an instructional situation can help us understand not only

> what justifies teaching as it exists today but also whether and how proposed new practices could be justified in ways that practitioners find compelling. (p. 453)

The decisions teachers make correlate directly with their ability to notice actions in their teaching, their interpretations of these actions, their contemplation of alternatives to these actions, and their ability to justify these alternatives. Throughout the decision making processes, professional obligations, especially institutional obligations, impact the teachers' decisions whether they agree with the components of the institutional obligation or not.

Webel and Platt (2015) recognized that professional obligations often hinder teachers from enacting mathematics reform changes. Handal and Herrington (2003) contend that:

> If the mathematics teachers' beliefs are not congruent with the beliefs underpinning an educational reform, then the aftermath of such a mismatch can affect the degree of success of the innovation as well as the teachers' morale and willingness to implement further innovation. (p. 60)

Webel and Platt (2015) alleged that one must not only acknowledge teachers' knowledge and beliefs as they work to implement mathematics reform changes but should also focus on teachers' perceived obligations. Often these obligations are seen as obstacles but should be recognized as potential motivators for reform changes (p. 214). They see teaching as "a cultural activity that includes implicit constraints on how teachers can change. Their professional obligations . . . tended to 'trump' the teachers' goals in the moment, and teaching practices . . . showed a lack of progress in attaining stated goals"

(p. 214). The teachers' decisions may need to be evaluated in light of their perceived professional obligations.

The classroom environment also impacts teachers' judgments and decisions and is also influenced by the teachers' decisions (Cohen, 1980; Everhart, 1979; Janesick, 1978; Joyce, 1978-79). The classroom environment consists of both the social and physical conditions of the classroom. Although the teacher has primary control of the classroom environment, there is a continual negotiation process conducted between the teacher and students regarding the goals established (Cohen, 1980; Everhart, 1979; Janesick, 1978).

The same holds true for the school environment. The school environment includes the imposed pressures from administration, politics, and the community including parents (Barr, 1980). These pressures have a direct impact on teacher instructional decision-making. Floden, Porter, Schmidt, Freeman, and Schwille (1980) contended that one of the most demanding decisions affecting student learning is the choice of content for instruction. Floden et al. claimed certain individuals within the school environment make mindful efforts to influence teachers' decisions with regards to content such as providing the teachers with lists of objectives. At other times, the unintended influences may be a result of imposed requirements such as state mandated assessments which result in teachers' decisions to only focus on the topics covered on these assessments (Floden et al., 1980).

One must also be cognizant of the role of the student in teachers' judgments and decisions. Individual students have long term goals and personal learning preferences toward the acquisition of certain knowledge over others (Cohen, 1980). The individual will work to further his own agenda whether it is consistent with the teacher's goals or not. At the same time, the teacher has his or her own goals with the intent to achieve changes in students' understanding which have a direct impact on teacher's decisions and behaviors. Cohen (1980) suggested the importance of keeping these dualistic goals in mind when assessing the decisions and behaviors of the teacher.

Role of Mathematical Knowledge for Teaching on Instructional Decision Making

Knowledge of the content being taught is necessary in teaching; however, research shows that it goes beyond just subject knowledge involving what Shulman (1986) termed pedagogical content knowledge (Ball et al., 2008). Shulman defined pedagogical content knowledge as knowledge unique to teaching, which connects content knowledge to the practice of teaching. Shulman also recognized that content knowledge and curricular knowledge must be coupled with pedagogical content knowledge to fully understand the instructional situation.

With regards to content knowledge, the teacher must also be able to distinguish between content that is essential to learning and that which is specific prior supporting knowledge. This involves knowing more than just the concepts and facts regarding the intended content. Shulman (1986) noted that a teacher must understand the arrangement of principles and structures in teaching while understanding what is allowable to say and do in the professional setting. The teacher must do more than understand that something is so, when it is appropriate to argue its foundation and when it necessitates weakening or denying its justification (Shulman, 1986, p. 9).

According to Shulman (1986), curricular knowledge is:

> Represented by the full range of programs designed for teaching of particular subjects and topics at a given level, the variety of instructional materials available in relation to the programs, and the set of characteristics that serve as both the indications and contraindications for the use of particular curriculum or program materials in particular circumstances. (p. 10)

Shulman subdivided curricular knowledge into two categories: lateral curriculum knowledge and vertical curriculum knowledge. Lateral curriculum knowledge is used to link the curriculum being taught to the curriculum in other subject areas. Similarly, vertical curriculum knowledge links the curriculum of the present to the topics, issues, and materials of both previous and subsequent curricular years in order to make connections (p. 10).

Although the above mentioned categories are essential to teaching, pedagogical content knowledge might be considered to be most influential in teaching (Ball et al., 2008). Shulman (1986) asserted that pedagogical content knowledge is composed of:

> The most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations—in a word, the most useful ways of representing and formulating the subject that makes it comprehensible to others . . . Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult; the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons. (p. 9)

Shulman further claimed that the “pedagogical content knowledge is the category most likely to distinguish the understanding of the content specialist from the pedagogue” (p. 8).

Ball et al. (2008) expanded on Shulman’s (1986) notion of pedagogical content knowledge by examining what is involved in dealing with the “day-to-day, moment-to-moment demands of teaching” (p. 395) specific to mathematics instruction. They looked to define the essential knowledge and activities, the mathematical knowledge for teaching, MKT here on out, needed to establish a classroom where mathematics is handled with integrity, students’ ideas are valued, and mathematical explorations are done collaboratively. Ball et al. asserted that MKT is concerned with the tasks of teaching and the associated mathematical demands involved. It involves such tasks as demonstrating how to solve problems, giving answers to related students’ questions, and checking to make sure the students’ work reflects the correct solution strategies (p. 395). Teaching is the culmination of all that teachers must do to contribute to the learning of their students. Kilpatrick et al. (2001) *Adding It Up* research summarized the tasks and roles of teachers in the learning process as being comprised of the following:

- interactions among teachers and students around content
- knowledge, beliefs, decisions, and actions of teachers about what is taught and ultimately learned
- the way that students’ expectations, knowledge, interests, and responses shape what is taught and learned

- students' role in the acquisition, perception and use of opportunities to learn
- students' different interpretations and responses to mathematical tasks, different questions asked, and different ways to complete the work on what becomes the enacted lesson
- whether teachers may or may not notice how students are interpreting the content, whether they do or do not investigate further, and if they respond with their own interpretation
- instruction takes place in contexts involving educational policies, assessments of students and teachers, school organizational structures, school leadership characteristics, the nature and organization of teachers' work, and the social matrix in which the school is embedded which subsequently produce the teaching and learning. (pp. 313-315)

Ball et al. (2008) came to two main conclusions about the knowledge needed to teach mathematics. First, most of the work needed is mathematical in nature with important mathematical demands. This work imparts knowledge for teachers' choices and actions with students while revealing the specific mathematical thinking that teachers perform and realize while promoting learning. Mathematical skill, habits of mind, and judgment are required drawing from a specific mathematical knowledge that "stands on its own as a domain of understanding, disposition, and skill needed by teachers for their work" (p. 398).

The second conclusion made is that mathematical knowledge has importance in understanding teaching but is often not included in the research regarding mathematics teaching (Ball et al., 2008). Connecting the mathematics to specific tasks that teachers do in the classroom gives significance to the role of the teacher. Shulman's (1986) pedagogical content knowledge provides a connection between subject knowledge and the practice of teaching by identifying the combination of knowing the content with knowing the students and pedagogy. Ball et al. (2008) used content knowledge for teaching to show another way that the content knowledge and pedagogical knowledge combine. They defined knowledge in inclusive terms centered around skill, habits of mind, and insight that surround knowledge based on its use for specific actions of mathematical teaching (pp. 398-399).

Ball and Cohen (1999) suggested that the interactions between teachers and students centered on educational material are the catalyst behind the instructions rather than the curriculum or teachers in isolation (p. 2). Although they recognized that each component is essential to instruction, in order for the instruction to be complete, all three must be fully functioning. The ability to produce worthwhile and long lasting learning requires the interactions among the three elements. The Instructional Triangle shown in Figure 1 shows the relationship between the three elements.

The teacher has an impact on instructional interactions based on intellectual and personal resources that the teacher draws upon to understand, interpret, and respond to both the curricular materials and the students (Ball & Cohen, 1999b). The way that teachers "notice, interpret, and adapt to differences among students" varies based on their:

> Conceptions of knowledge, understanding of content, and flexibility of understanding, acquaintance with students' knowledge and ability to relate to, interact with, and learn about students; and their repertoire of means to represent and extend knowledge, and to establish classroom environments. (p. 3)

It is the responsibility of the teacher to make decisions on how to use the students and materials as resources to promote learning

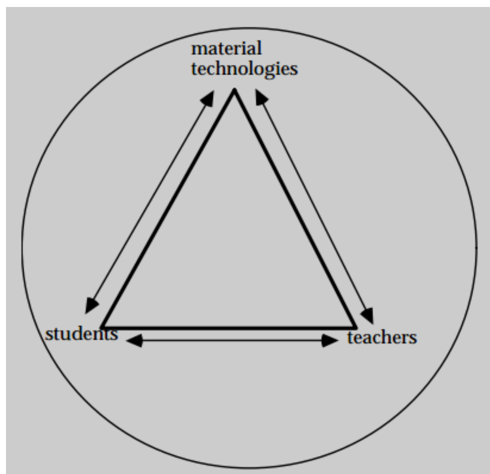

Figure 1. Ball and Cohen's Instructional Triangle. Arrows represent constant exchanges between students, teachers, and material technologies during instructional situations. Reprinted from "Instruction, Capacity, and Improvement" by D. L. Ball and D. K. Cohen, 1999, *CPRE Research Report Series, RR-43.* Consortium for Policy Research in 1999 by the Consortium for Policy Research in Education. Reprinted with permission.

Ball and Cohen (1999b) suggested that "students' experiences, understandings, interests, commitments, and engagement" (p. 3) are key factors in instruction. The ability for the teacher to impact learning is dependent on the resources that students possess. "Students bring experience, prior knowledge, and habits of mind, and these influence how they apprehend, interpret, and respond to materials and teachers" (p. 3). Further, when teachers imply that students are incapable of doing certain instructional tasks, they are not recognizing the ways that students might learn or change.

Instructional materials include everything the students interact with including items presented in texts and other media which includes the problems, tasks, and items given to students (Ball & Cohen, 1999b, p. 4). The choice of instructional materials can affect students' ability to embrace the content to be learned. With regards to instructional materials, Ball and Cohen (1999b) noted that the decisions made regarding the choice of technologies, complexity, and design intended to evoke students' engagement, the nature of the problems, and the variety of representations offered help to shape what teachers and students can do and learn (p. 4). The way that the instructional materials are used in the interactions with both teachers and students are essential components of learning.

Instructional interactions will vary depending on the capacities of all three of these elements. Learning is dependent on what each component brings to the instructional tasks (Ball & Cohen, 1999b). Different teachers can create different student responses depending on teachers' knowledge, beliefs, and capabilities which are molded by their perceptions of what students are capable of doing, the opportunities they provide for the students, and their interpretations of the students' resulting work (p. 4). The way that teachers interpret and use the instructional materials affects the potential and usage within the curriculum. Again, this shows the importance of the interactions between the three elements of the instructional triangle.

Herbst and Kosko (2014) expanded on Ball et al.'s (2008) ideas of MKT by focusing on the decisions and actions of high school geometry teachers as a composition of individual attributes of the teachers while recognizing the norms of the instructional situations and professional obligations connected to the teaching event. They described how "individuals' MKT combines with their recognition of professional obligations and norms of an instructional situation in accounting for the decisions they make in classroom events framed by those norms" (p. 26). Herbst and Kosko asserted that the past teaching experiences have more impact on the instruction than academic knowledge (p. 36). Their research findings suggest that MKT may need to be differentiated within its domains to address the content specifics of the courses of mathematics. This is especially true when referencing common content knowledge.

Herbst and Kosko (2014) further claimed that awareness of the specifics of teaching involved is essential for understanding the instructional situations. They argued that specific elements of MKT should be pinpointed from the mathematics instruction within a given course of studies rather than focusing on the general features from a list of mathematical topics from the given domains (p. 36). Herbst and Kosko also focused on the actions of teaching that were influenced by course specificity, which subsequently constructed the way the tasks evolved. Drawing on the idea of instructional situations (Herbst, 2006), to frame the exchange of mathematical knowledge during mathematical tasks, Herbst and Kosko made the claim:

> That while some of those exchanges of work for knowledge may be done ad hoc (e.g., negotiated), many exchanges go without saying because they are framed by instructional situations (i.e., participants abide by the norms of the situation). These instructional situations are course specific, which means more than

> mathematics specific. The roles of teacher and students in regard to exchanges of work for knowledge vary depending on whether the exchanges happen in one or another course, though the work done or the knowledge at stake may exist in both courses. (p. 38)

Thus, it is important to be aware of the instructional situation when viewing the decisions made regarding the implementation of teaching tasks.

The role that the teacher plays in the instructional situations is instrumental in the choices made regarding the instructional tasks. Herbst and Kosko (2014) made the following observations:

> The teacher's management of instructional situations includes, in particular, the choosing of the various mathematical tasks that students are to do, the observation of the proceeds (what students actually do), and the effecting of exchanges between such observed actions and the knowledge at stake (identifying at least for himself/herself, but possibly also publicly to the class, how what students have done indicates that they know the ideas at stake). While the definition of these tasks of teaching is general, the mathematical knowledge called forth in doing them would be different across different courses, as long as the specific exchanges were different. We expect that these differences between exchanges may ensue from different kinds of knowledge at stake, different kinds of students' mathematical work being transacted for such knowledge, or even different ways of effecting those transactions. (p. 38)

While the content standards are apparent, the implementation of the instruction varies based on the instructional situations.

Herbst and Chazan (2012), in line with the research of Herbst and Kosko (2014), suggested that teaching is "an activity system involving positions, roles, and relationships, where individual choice is possible, but not cost-free" (p. 1). Using Ball and Cohen's (1999b) instructional triangle as a framework, they added the element of justification of instructional actions and decisions as well as indicating the role of the teacher in setting up students' work to encourage engagement and exchanging of knowledge at stake as indicated in Figure 2. Herbst and Chazan acknowledged the existence of a didactical contract indicating that the instructional system does not just transpire or arise from bringing together individuals and allowing them to exercise their free will (Herbst & Chazan, 2012, p. 6). The teacher is responsible for the students acquiring the knowledge at stake by organizing activities that enable the students to become engaged in the learning activities and demonstrate the acquisition of the intended knowledge at stake (pp. 6-7). As indicated in Figure 2, certain norms must be followed by both the teacher and students during this exchange which can then be used as justification for actions in teaching (p. 7).

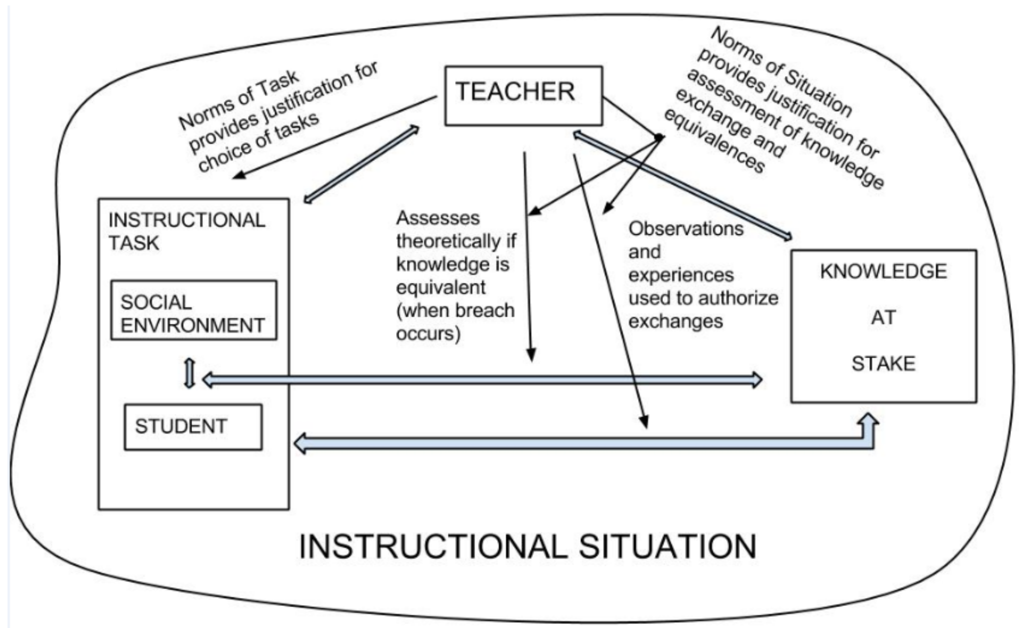

Figure 2. Herbst & Chazan's description of adaptations made to Ball and Cohen's Instructional Triangle (see Figure 1). Drawn according to "On the Instructional Triangle and Sources of Justification for Actions in Mathematics Teaching" by P. Herbst and D. Chazan, 2012, *ZDM: The International Journal on Mathematics Education, 44*(5). Copyright 2012 by Springer. Drawn with permission.

Herbst and Chazan (2012) also showed that the teacher is responsible for orchestrating the instructional exchanges within the instructional system (p. 8). An instructional exchange is defined as the teacher engaging in "(1) Deploying mathematical objects of study in the form of work for students to do and (2) Interpreting work (being) done by students in light of a mathematical object of study" (p. 8). Although the knowledge at stake is explicitly stated, it is up to the teacher to ensure that the exchange takes place through the choice of tasks and the interpretation of students' reactions and evidence of the acquisition of the knowledge at stake.

As students work on the instructional tasks, the teacher is responsible for providing constructive feedback, shown as social environment in Figure 2 (Herbst & Chazan, 2012). The social environment, also referenced as the milieu, includes the goal students need to obtain and the resources that students have to reach this goal. The teacher's actions during the instructional situation must support the function of the milieu and can subsequently be used as justification based on the instructional norms (p. 10).

The final responsibility of the teacher in the instructional system is to choose appropriate instructional tasks that allows students to study and show evidence that the knowledge at stake is acquired and the teacher must continually observe the students' work in order to gather this evidence of demonstrated learning (Herbst & Chazan, 2012). The choice of one action over another must be justified by the instructional norms of the given instructional situation.

The Role of Teachers' Individual Belief Systems on Instructional Decision Making

Research has shown that teachers' beliefs along with other factors will influence their instructional practices (Fennema & Franke, 1992; Forgasz & Leder, 2008; Lloyd & Wilson, 1998; Porter & Brophy, 1988; Putnam, Heaton, Prawat, & Remillard, 1992; Thompson, 1984, 1992). According to Thompson (1992), teachers' conceptions of mathematics teaching is defined as:

> What a teacher considers to be desirable goals of the mathematics programs, his or her own role in teaching, the students' role, appropriate classroom activities, desirable instructional approaches and emphases, legitimate mathematical procedures, and acceptable outcomes of instruction. (p. 135)

Although some of the research has also shown that teachers' content knowledge directly impacts student achievement (Ball & Cohen, 1999a; Kazemi & Franke, 2004; Shulman, 1986; P. S. Smith & Esch, 2012; Stein, Smith, & Silver, 1999; C. L. Thompson & Zeuli, 1999), the research is less compelling regarding the impact of teachers' beliefs on student achievement due to the inconsistencies between intended beliefs and actual enacted instruction connected to these beliefs (Empson & Junk, 2004; Leatham, 2006).

Ernest (1989) recognized three conceptions of mathematics because of their implications in the philosophy of mathematics and their repeated appearance in empirical studies of mathematics teaching. He described them in the following way:

> First of all there is a dynamic, problem-driven view of mathematics as a continually expanding field of human creation and invention, in which patterns are generated and then distilled into knowledge. Thus mathematics is a process of enquiry and coming to know, adding to the sum of knowledge. Mathematics is not a finished project, for its results remain open to revision (problem-solving view).
>
> Secondly, there is the view of mathematics as a static but unified body of knowledge, a crystalline realm of interconnecting structures and truths, bound together by filaments of logic and meaning. Thus mathematics is a monolith, static immutable product. Mathematics is discovered, not created (the Platonist view).
>
> Thirdly, there is the view that mathematics, like a bag of tools, is made up of an accumulation of facts, rules and skills to be used by the trained artisan

> skillfully in the pursuance of some external end. Thus mathematics is a set of unrelated but utilitarian rules and facts. (the instrumentalist view; Ernest, 1989, p. 10).

A teacher's conception of the nature of mathematics becomes his or her belief system about the nature of mathematics as a whole (Ernest, 1989).

Thompson (1992) claimed that individual teacher's conception of mathematics inevitably will include facets of more than one of the views described by Ernest even those that are seemingly contradictory. The clustering of belief systems or the integration of conceptual systems, as described by Thompson (1992), can account for the appearance of conflicting beliefs when held in isolation but be well integrated when put into practice. It is only when one views the entire individual's conceptual system that the characteristics described above are seen.

A Lens for Studying Middle School Mathematics Teachers' Practical Rationality With Regards to CCSS-MP

This literature review highlights research regarding influences on teachers' instructional decision making. Although several research studies have been highlighted here, the literature is lacking with regards to middle school mathematics teachers' instructional decision making regarding the Common Core State Standards for Mathematical Practices (CCSS-MP). Teachers' decisions for instructional tasks should focus on making connections between the practice and content standards in mathematics instruction (Mathematical practice, 2012). To stay current with best practices, educators need to be cognizant of the CCSS-MP as these standards are forefront in the CCSS document due to the fact that these standards reflect what students engaged in mathematical learning should be doing in all grades K–16.

The eight Standards for Mathematical Practice, CCSS-MP, deal with key components of previously developed standards. The NCTM process standards of problem solving, reasoning and proof, communication, representation, and connections are woven throughout the practice standards. For example, Mathematics Practice 1 (CCSS-MP1), *Make sense and persevere in solving them*, encourages students to start by explaining the meaning of the problem and look for starting points toward a solution (Mathematical practice, 20124) similar to the NCTM process standard of *problem solving* which encourages students to apply and adapt a variety of appropriate strategies to solve problems (Process standards, 2000). Mathematics Practice 3 (CCSS-MP3), *Construct viable arguments and critique the reasoning of others,* promotes the construction of arguments using prior knowledge of definitions, assumptions and results while encouraging students to justify conclusions, communicate them to others (Mathematical practice, 2012), and respond to the arguments of others which is similar to NCTM process standard of *communication* which promotes sharing of mathematical thinking coherently and clearly to peers, teachers and others and analyzing the mathematical thinking of others (Process standards, 2000). The second set are the strands of mathematical proficiency outlined in the National Research Council's report *Adding It Up,* conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition (National Research Council, 2001). For example, CCSS-MP1 mentioned above encourages students to make sense of the problems (Mathematical practice, 2012) while the *strategic competence* strand references students' ability to formulate mathematical problems, represent them and solve them (National Research Council, 2001, p. 124). CCSS-MP3 encourages the students to make viable arguments, which are similar to the *adaptive reasoning* strand, which provides justification for conclusions (National Research Council, 2001, p. 129). The practice standards when integrated throughout mathematics instruction will aid in developing student practices that will increase student engagement as the students grow in their mathematical expertise. Development of curricula and assessment should focus on making connections between the practice and content standards in mathematics instruction (Mathematical practice, 2012). To stay current with best practices, educators need to include CCSS-MP in their instructional decision making as it is forefront in the CCSSM document due to the fact that these standards reflect what students engaged in mathematical learning should be doing in all grades K–16. Using previous research can help the participants in this study and myself as the researcher accomplish this by making us aware of our own practical rationality as it connects to the CCSS-MP1 and CCSS-MP3.

This study focuses on middle school mathematics teachers' instructional decision making regarding instructional tasks involving CCSS-MP1 and CCSS-MP3. Courtney, Kosko, and McMahon (2015) suggest that instruction that provides students with opportunities to engage in mathematical habits of the mind requires that teachers have an understanding of what the mathematical practices entails and how to elicit evidence of the practices in students' written work and verbal communication. The two practices under investigation in this study, CCSS-MP1 and CCSS-MP3, were selected because when conversing with both my colleagues and those at the summer professional development activity mentioned earlier referenced the importance of this type of teacher and student engagement.

This study concentrates on several facets of the teachers' practical rationality: instructional situations, professional obligations, and teachers' individual belief systems. For the theoretical framework of this study, I have created the *Instructional Decision Making Triangle, IDMT* from here on, as shown in Figure 3, a subcomponent of Ball and Cohen's (1999b) Instructional Triangle (see Figure 1) and Herbst and Chazan's (2012) modifications to the Instructional Triangle (see Figure 2), both described earlier. Although one must recognize the student as being a key stakeholder in any given instructional situation as evident in both of the figures just mentioned, the *IDMT* is only concerned with the teachers' influential part in instructional decisions. The *IDMT* focuses on three key components that impact the educational decisions made regarding the planning and implementation of mathematical practices, specifically CCSS-MP1 and MP3. One can view this as "a triangle within both figures" being able to replace the label of teacher in both previously mentioned figures.

The *IDMT* suggests that middle school mathematics teachers do not teach in a vacuum. Their decisions are affected by several facets, which may cause a discrepancy between their professional beliefs and their enacted practices. It suggests that there is a continual exchange as indicated by the double sided arrows between teacher's disposition, societal and environmental influences on practical rationality, and mathematical knowledge for teaching, MKT. While each instructional exchange is intended to promote optimal acquisition of mathematical knowledge, several non-mathematical influences affect the exchange.

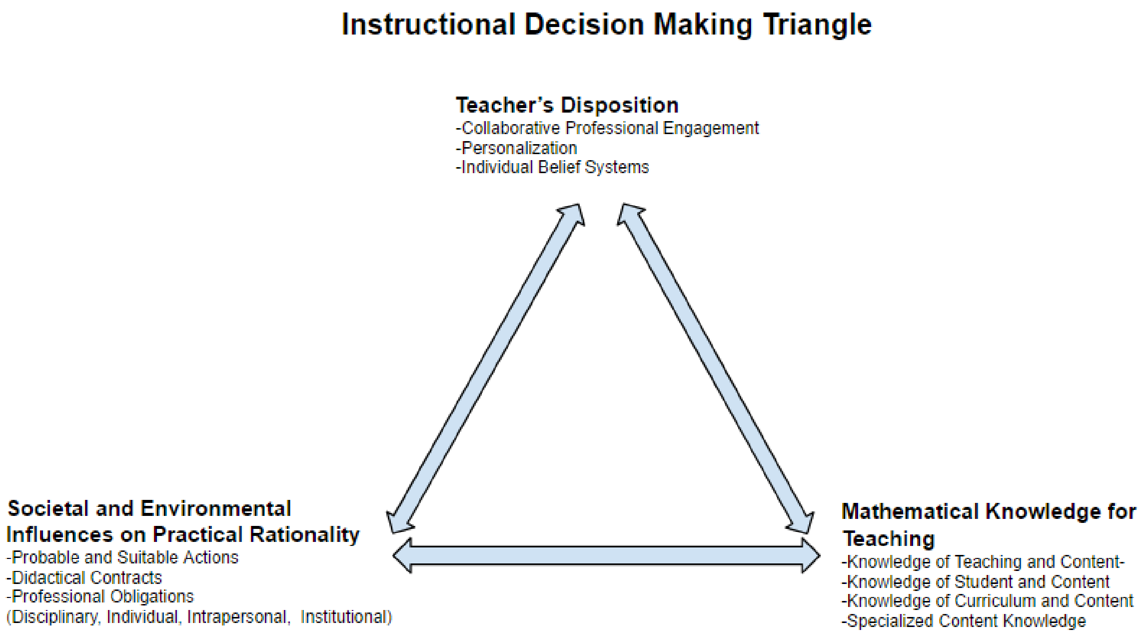

Figure 3. Instructional Decision Making Triangle. This is the *Instructional Decision Making Triangle* I designed which is a microscopic view of the teacher components of both Ball and Cohen's *Instructional Triangle* and Herbst and Chazan's adapted *Instructional Triangle* described earlier.

At the top of the *IDMT* is the individual teacher's disposition. The teacher's individual belief system includes the teacher's conceptions of mathematics as described earlier by both Ernest (1989) and A. G. Thompson (1992). These beliefs can be a combination of a problem solving view (a dynamic view of mathematics as involving a continual changing and expanding problem solving approach of mathematics), a Platonist view (a static view where mathematics is discovered not created), and an instrumentalist view (an accumulation of facts, rules and skills that are used by the trained artisan) as well as other views that may not have been described by these researchers.

Another aspect of the teacher's disposition, as described earlier (Bourdieu, 1998), is the regulations based on one's position in the instructional situation. These are the tendencies of the individual teacher that cause him or her to behave in a certain way. The teacher's perceptions allow the teacher to identify people, occurrences, objects, and ideas within an instructional situation in a personal way. The teacher's appreciation is the doctrine and conditions that the teacher uses to create a mindset toward the people, occurrences, objects, and ideas within the instructional situation. Both perceptions and appreciation can be unspoken but are the catalyst used by the teacher to justify why he or she might or might not choose to do something within the instructional situation.

Although much of the teacher's disposition is the result of internal beliefs, it is my belief that they are often formed during both personal reflection and professional engagement within instructional situations. I propose that the beliefs that one possesses are the direct results of personal educational experiences as well as professional exchanges with individuals with whom the teacher engages. These experiences may or may not be positive experiences but either way will impact the teacher's belief systems. I reference these experiences at the top of the *IDMT*.

On the left side of the *IDMT*, I have included the idea of societal and environmental influences on teachers' practical rationality. As addressed earlier in Herbst and Chazan's (2012) adaptation of the instructional triangle (Ball & Cohen, 1999b), the teacher is influenced by the professional norms and obligations connected to the instructional situation which affect the instructional decisions both planned and in the moment. The teacher is placed in the instructional situation but the decisions are not exercised via free will (Herbst & Chazan, 2012). As evidenced by the above mentioned conversation between practicing middle school mathematics teachers, societal and environmental influences impact the ability to enact personal professional beliefs regarding instructional activities. Although these teachers appeared to share the belief the CCSS-MP were important, the actual inclusion of these practices in instructional decision making appeared to vary depending on the demographics of the instructional situations. This is what I reference as probable and suitable actions meaning that the teacher must determine what tasks and actions are practical within the instructional situation while staying within the realm as acceptable under the particular environmental and societal influences.

The left side also includes the didactical contract employed by the teacher. As described in detail earlier (Herbst & Chazan, 2011), the teacher is responsible for enacting the exchanges with his or her students to ensure the acquisition of the knowledge at stake. The teacher's actions may vary based on the instructional situation which can then account for what may appear to be contradictory actions when referenced to the instructional norms. I believe that the middle school teachers referenced earlier were referring to such enactments.

The teacher is also bound by certain professional obligations (Herbst & Chazan, 2011). The teacher must accurately represent the discipline of mathematics. The teacher needs to recognize students as individuals composed of cultural, intellectual, social, behavioral, and emotional influences that may directly impact the acquisition of knowledge. Interpersonal obligations recognize the teacher as the master orchestrator responsible for organizing the interactions between all members. The resources available will vary across instructional situations, which again are referenced in the above mentioned conversation amongst the middle school teachers. Finally, the institutional obligation references the school as a whole influenced by school policies, curriculum, assessments, and other school wide activities and resources. Within the school environment, the teacher must acknowledge the pressure from administrators, politics, and the community of stakeholders such as parents and the school board. These are often items that the teacher may not be able to alter or control.

On the right side of the *IDMT*, the teacher is continually drawing on MKT, a key component in Cohen and Ball's instructional triangle, specifically in this study, that which is concerned with CCSS-MP1 and CCSS-MP3. Although the majority of the teachers showed awareness of the CCSS-MP, when asked to describe CCSS-MP specifically, the conversation varied among the teachers regarding meaning of each standard. This knowledge may or may not affect inclusion in the instructional decision making with regards to inclusion of the standards in instructional task choice.

I have included four subcomponents of the MKT, which I believe directly impact teachers' instructional decision making with regards to CCSS-MP1 and MP3 (Ball, 2011). Firstly, the knowledge of teaching and content includes teachers' choice of problems and representations needed to portray the knowledge at stake. The teacher is responsible for facilitating the whole class discussions, choosing which solutions to present, and making decisions regarding the order to present the information. Secondly, the knowledge of students and content include knowledge of common errors, students' past experiences that are directly linked to the new knowledge. These choices may determine if the knowledge is obtained or led to future confusion or common difficulties. Thirdly, knowledge of content curriculum is essential. This is not limited to the present grade level curriculum but must also be cognizant of prior grade level knowledge. The teacher must orchestrate the sequencing of knowledge from one grade level to another relying on appropriate past and present mathematical models. Lastly, specialized content knowledge is that which is beyond what is expected of an educated adult outside the instructional situation. The teacher must be aware of and employ this specialized content knowledge, which becomes a key component of the instructional decision making.

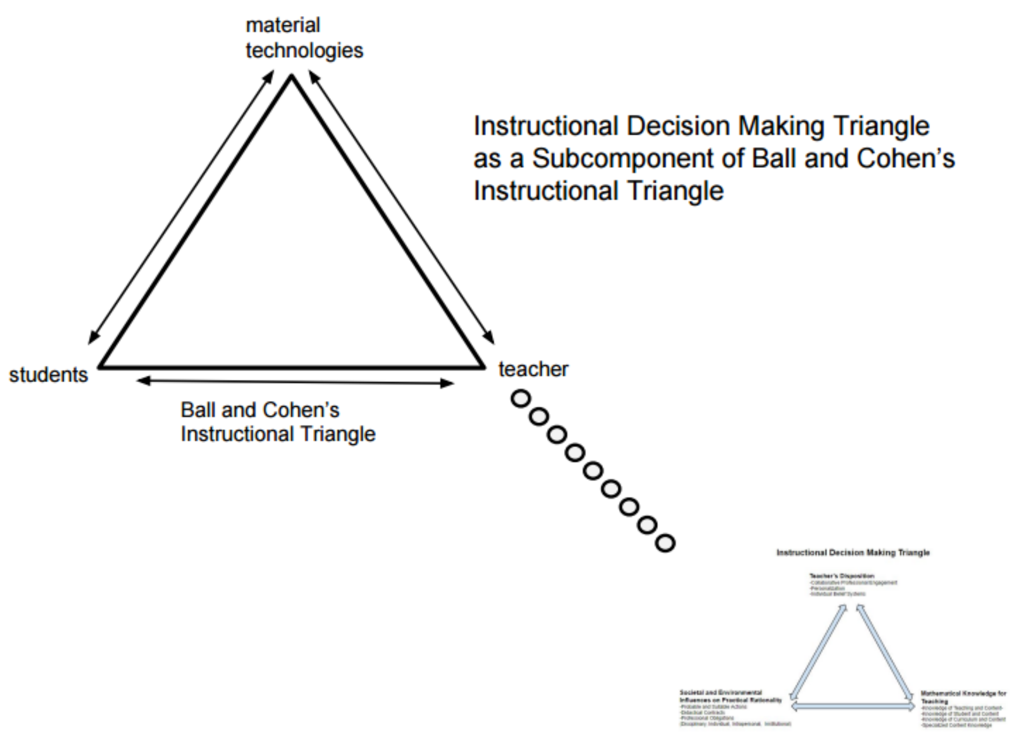

Figure 4. Instructional Decision Making Triangle as a Subcomponent of Ball and Cohen's Instructional Triangle. I designed it to show how the teacher component of Ball and Cohen's figure is further defined by the figure being used as the framework of this study.

As indicated by the double arrows on the connectors, these exchanges are never stagnant, continually moving back and forth between the stakeholders. Again it is important to recognize that this is a "triangle within the Instructional Triangle" (Ball & Cohen, 1999b), which should be viewed separate from the influences of students and materials and technologies employed in the instructional situation (See Figure 4). By better understanding the specific influences on the teacher in the instructional decision making, I conjecture that a teacher will have better insight into the other two key components of the *Instructional Triangle* although this is not within the realm of this study. It is the intent of this research to only directly gain insight into middle school mathematics teachers' instructional decision making as they move to make reform changes regarding the CCSS-MP1 and CCSS-MP3. The *IDMT* was used to frame the study as a way to address the following research questions:

1. What role does the teacher's professional disposition have on middle school mathematics teachers' instructional decisions regarding CCSS-MP1 and CCSS-MP3?
2. What role do environmental and societal influences have on middle school mathematics teachers' instructional decisions regarding CCSS-MP1 and CCSS-MP3?
3. What role does Mathematical Knowledge for Teaching (MKT) have on middle school mathematics teachers' instructional decisions regarding CCSS-MP1 and CCSS-MP3?

It is important to note that each of these three areas under investigation are what encompass the participants' practical rationality.

CHAPTER III

METHODOLOGY

In this chapter, the research methods and the design of this qualitative case study are described. The purpose of this case study is to examine the influences of various facets of middle school mathematics teachers' practical rationality (teacher's disposition, societal and environmental influences, and mathematical knowledge for teaching) on their instructional decision making as they plan to enact CCSS-MP1 and CCSS-MP3. Teachers' instructional decision making includes all that is involved during the planning process and in the moment situations in the classroom that influence the learning processes employed and resulting student outcomes. This chapter includes the theoretical framework, research design, participants, setting, role of the researcher, data collection, data analysis, and trustworthiness and credibility.

Theoretical Framework

Qualitative research is a way of looking at activities within a given situation that places the observer within the world of the observed (Denzin & Lincoln, 2011). Qualitative researchers study participants doing things that they normally do in the setting where they normally do it. Denzin and Lincoln explained this as "qualitative researchers study in their natural settings, attempting to make sense of or interpret phenomena in terms of the meanings people bring to them" (p. 3). In order to explore middle school mathematics teachers' instructional decision making, a qualitative method is the most appropriate choice.

Research Perspective

Qualitative research investigates the natural setting where the study develops (Creswell, 2003). Through this type of investigation, the researcher is able to obtain a feeling of the experiences of the participants. Data collections through interviews, observations, and documents require active participation by the members of the study. Collection of open-ended, emerging data revealed developing themes (p. 18). The data in this study included a minimum of two individual interviews with each participant, one before viewing the experiments videos and one after the viewings. A qualitative study is emergent requiring that the researcher interpret and formulate conclusions about individual participants' meaning from various data sources. As the researcher analyzes the various sources, it is important to "reflect on who he or she is in the inquiry and (be) sensitive to his or her personal biography and how it shapes the study" (p. 182). The process of collecting multiple forms of data, analysis of the data, and drawing conclusions needs to be repeated until apparent themes are revealed.

Constructivist

Looking at the research through the constructivist paradigm, it is important to recognize that the multiple, abstract, mental constructions are dependent on the individual holding the construction even though elements may be shared among groups of individuals and even within culture (Guba & Lincoln, 1994, p. 111). Constructions are not absolute truths but are informed or experienced realities of the participants. Creswell (2003) noted that our established engrained beliefs drive our actions. Through interactions between the researcher and the participants, individual constructions are elicited and refined bringing forth the personal and varied nature of the social constructions. It is the role of the researcher to interpret these constructions and create a construction that is more informed and advanced than previous constructions (Guba & Lincoln, 1994, p. 111). Constructivists recognize that people view events through different lens and bring different meanings to situations (Rubin & Rubin, 2012). As the primary researcher in this study, my intent was to develop a deeper self-knowledge of my own lens as I tried to interpret the meaning of the middle school teachers' experiences with making meaning of their instructional decision making as they interpret and enact the CCSS-MP. Trying to make meaning of their experiences added to the theory that I had begun to formulate as described in Chapter 2.

Research Design: Multi-Case Study

Merriam (2009) asserted that the first tasks when designing a case study is to identify the case. Stake (2006) indicated that when a researcher feels that by studying a particular case, he will be able to answer a research question, figure out something that is puzzling, or develop a general understanding, then a case study should be the method of choice. Yin (2013) indicated that case study research is relevant when one wants to understand "complex social phenomena (p. 4). Further, Yin recognized that investigating an individual case allows one to keep a holistic and real world perspective. There is agreement among these experts that the case study has bounds and that there are limits to the number of participants, the extent of time, and the collection of data that can be studied through this paradigm. Merriam (1998) described a multi-case study as one that involves collecting and analyzing data from several cases, which is differentiated from a single case, which may have subgroups such as teachers within one school. Merriam further recognized that cross-analyses of the cases can enhance the interpretation of the data. As already indicated, this multi-case study is interested in the instructional decision making of middle school mathematics teachers from three different demographic middle schools. The three participants are each considered a case. Through in-depth interviews, I was able to listen to what my participants were trying to tell me as I was truly curious about their instructional decision making processes as they interpret and enact the CCSS-MP (Rubin & Rubin, 2012). This study will add to my own understanding of the process used when making instructional decisions, which is pertinent as reform change regarding CCSS-MP is lacking in the present literature.

Merriam (1998) asserted that "insights gleaned from case studies can directly influence policy, practice and future research" (p. 19). This multi-case study will attempt to gain deep understanding of the situations and meaning behind the participants' decision making. By exploring the case within the real world contextual settings and recognizing that the phenomena of instructional decision making being bounded to the contextual setting makes a multi-case study the only choice for this study (Yin, 2013).

Participants

I chose three middle school mathematics teachers who teach in different school districts in Northeast Ohio. Two of the teachers from these districts were specifically chosen as they were identified as teachers willing to change and improve their teaching practices as evident by their attendance at a summer academy focused on mathematics best practices. The last participant was chosen specifically because of the demographics of the school district. Each of the participants is actively employed at districts with varying academic demographics. This purposeful sampling allowed me to maximize what I can learn about the influences on middle school mathematics teachers as they employ instructional decision making processes as they interpret and enact the CCSS-MP (Merriam, 1998; Stake, 1995).

Setting

The three different school districts in this study were chosen based on demographic information as reported on the Ohio Department of Education website. Data were collected from information provided for the 2013–2014 school year. Table 1 shows the achievement demographics used in choosing the districts (Ohio school, 2014). My hypothesis is that student demographics may also play a role in the instructional decision making as related to societal and environmental factors in the *IDMT*.

The performance indicators show the number of students who have a minimum, or proficient, level of knowledge. They are based on 24 state tests that measure the level of achievement for each student in a grade and subject. To get credit for the corresponding indicator, 80% of students must score a minimum of proficient in that area. The performance index measures the achievement of every student and districts receive points for every student's level of achievement. The A-F grade on the state report card is calculated by the number of indicators met out of the total possible indicators. The ranges for these grades are shown in Table 2.

The Gap Closing rating is calculated based on the academic performance of specific groups, such as racial and demographic groups compared against the

Table 1

School Academic Demographics of Selected Sites

School	District Rating Performance Index/ Indicators Met	Middle School Achievement Ratings		Middle School Mathematics Indicators Scores		
		Performance Index	Gap Closing	6th	7th	8th
1	D/F	D	F	49%	47.7%	59.8%
2	B/C	C/B	C	77.9%	84.7%	83.6%
3	A/A	A	B	93.3%	94.4%	94.4%

Table 2

Ohio State Report Card Grading

Score	Letter Grade
90%-100%	A
80%-89.9%	B
70%-79.9%	C
50%-69.9%	D
Below 50%	F

performance of all students in Ohio. The goal is to bring all students up to the same high level of achievement displayed by all groups ("Ohio Department of Education," 2014). When compared to the 610 Ohio school districts in the reported data, School 1 is low performing as indicated by being 1 of 24 districts earning a D performance index score and 1 of 63 schools earning an F rating for indicators met. School 2 would fall in the average range indicated by being 1 of 115 to earn a C rating on the performance index. School 2 earned a B score for indicators met being 1 of 114 districts to earn that rating. School 3 would be considered a high performing district earning an A rating in both categories, 1 of 37 to earn that rating with regards to performance index and 1 of 188 for indicators met. The teachers' and district stakeholders' awareness of these ratings are part of the environmental factors that may have an impact on teachers' instructional decision making. It is my belief that how a school performs on state report cards directly impacts how the teachers select instructional tasks, view their students, and make decisions regarding how to close the achievement gaps.

Table 3 summarizes the school's profile that may be factors affecting teachers' instructional decision making. Ohio Department of Education (2015) identified the purpose of the District Profile Report as

> To provide a user friendly and easy to use analytical tool to evaluate statistical characteristics of each public school district in the context of its similar school districts and the state as a whole to show how a typical public school district in the state fairs with respect to each statistic. (p. 1)

Table 3

Ohio District Profile Data

Schools	Year End Enrollment	Racial Profile of Student Population (as % of Total)							Other Demographics (% of students)		
		Asian	Pacific Islander	Black	American-Indian Alaskan Native	Hispanic	White	Multi-racial	In Poverty	With Limited English Prof.	With Disability
1	3442.53	0.40	0.03	92.71	0.01	1.49	2.22	3.15	94.16	0.14	14.03
2	2115.13	1.25	0.21	13.76	0.00	2.30	79.08	3.41	37.49	1.38	13.10
3	4449.71	5.01	0.02	1.05	0.08	1.74	89.51	2.58	5.60	0.86	15.04

School 1 has a large population of minority students and a high level of students living at the poverty level. School 2 has about 25% minority students and a third of the population at the poverty level. School 3 has about 10% minority students and the smallest level living at the poverty level (about 5%). It is my belief that these demographics impact the instructional decision making regarding CCSS-MPs.

Role of the Researcher

I have been a teacher for 28 years, 19 years teaching middle school mathematics. Through those 28 years, I have seen many reform movements come and go with some teachers embracing the changes while others seeing the improbability of being able to fully enact the changes due to many facets of the teaching profession. When I questioned my colleagues, not the subjects in this study, about the mathematical practice standards, only one of the 11 within my department was aware of the standards and could not readily recall all eight standards. While in attendance at a summer academy for mathematics teachers K–16 in 2015, I again brought up the CCSS-MP during one of our critical conversations regarding the recent shift to implementing national standards. Again, these practices did not appear to be a “critical” issue for most in attendance (L. McMahon, personal conversation, June 17–18, 2015). This led me to wonder if these practices were at the forefront of their instructional decisions and if not, I wondered what was preventing the CCSS-MP from entering the teachers’ instructional decision making.

I hope that an in-depth analyses of the experience of the participants will help me to develop ways to better help myself, my colleagues, and other middle school educators, including the preservice teachers in the middle school mathematics courses I teach, come to a better understanding of the meaning of these practice standards, and subsequently make them an integral part of their instructional decision making. As I discover new meaning about my own instructional decision making through the experiences of the participants, I can apply the realizations to my own experiences within my own instructional practices. I recognize that teachers have the tendency to focus primarily on the content within their discipline; I have always found it puzzling as to why few teachers incorporate the practice standards in their lesson planning. As the department chairperson, this is a personal concern. The heuristic research approach is centered on an attempt to solve a problem that has been a personal challenge or one that has been puzzling to the researcher. Although the researcher looks at a situation other than his own, the research helps the researcher to understand himself and his own life. The topic is personal in nature but the knowledge gained can have social or universal significance (Moustakas, 1994, p. 17). I am looking for that personal understanding.

Data Collection

Good case studies draw from many sources of datum in order to capture the complexity of the cases under study (Merriam, 1998, 2009; Stake, 2006; Yin, 2012). Using multiple data sources will enable the triangulation of the data to confirm the findings and recognize agreement among the outcomes of the participants (Merriam, 1998; Yin, 2012). Data for this study was collected through documented response entries, direct observations, and in-depth interviews. The first piece of datum collected was responses to the MTEBI. The second piece of datum was teachers' response entries to videos of lesson enactment of CCSS-MP1 and CCSS-MP3 by other teachers. The third piece of datum was participants' self-selected recordings of their implementation of lessons that they recognize as involving instructional decisions involving these mathematical practices. The final piece of datum was two in-depth interviews: the first interview prior to viewing the videos and classroom observations and the second after these two datum collections.

Mathematics Teaching Efficacy Beliefs Instrument

The participants completed the MTEBI (see Appendix A). The results gave both a personal mathematics teaching self-efficacy score (SE) and a teaching outcome efficacy score (OE). These self-reported SE responses indicate the participants' perceptions of their ability to teach mathematics as well as their knowledge of the mathematics content. The self-reported OE responses reflect the participants' beliefs regarding the effects of their teaching on student learning.

Videos of Middle School Classroom Lessons Involving CCSS-MP1 and CCSS-MP3

The participants watched a minimum of two videos of middle school mathematics teachers engaged in lessons intended to demonstrate CCSS-MP1 and CCSS-MP3 within middle school classrooms. After viewing these videos, the participants wrote reflective journal responses about the instructional tasks and interactions seen. This gave insight into what the participants perceive as the practical rationality of the teacher shown as it impacts the enactment of the CCSS-MP. Their reflective responses gave an idea of what they saw as necessary for enactment and how it could or could not be enacted in their own classroom. The participants also reflected on the interactions between the teacher and students which is reflective of two key elements of the *IDMT*.

The videos were chosen from *Inside Mathematics*, an online professional resource designed with the intent to help teachers improve students' mathematics learning and performance (Noyce Foundation, n.d.). The videos used were those that were indicative of classroom practices for CCSS-MP1 and CCSS-MP3. The sixth grade video involving Joe Condon employing CCSS-MP1 and CCSS-MP3 and the seventh grade video involving Jacob Disston doing the same were chosen. The participants were then asked to write reflective response entries that asked them to connect what they saw in the video to their own instructional decision making. The participants were asked to assess whether the implementation of similar lessons was realistic in their own instructional situations. They were asked to assess whether or not the teachers in the video were demonstrating the intended mathematical practices. Prompts were given to aid in the teachers' responses, which encouraged the participants to be specific about what they saw concerning the intended mathematical practice (See Appendix B). The intent of this data collection was to ascertain the teachers' views of other teachers' enactment in relationship to their own understanding of the practices.

Classroom Observations

A minimum of one observation per mathematical practice implementation of each participant was conducted. The classroom observations were chosen by each participant from self-recorded videos of classroom lessons where they included CCSS-MP1 and CCSS-MP3 in their instructional decision making. I followed these observations with a simulated recall discussion with each participant to ensure that the field notes accurately reflect the observed classroom interactions. The intended purpose of these observations was for me to get a better understanding of the teacher's perceptions of his or her own enactment of the CCSS-MP1 and CCSS-MP3 since the chosen classroom observations are indicative of the instructional decision making to include the intended practices. This relates to the MKT aspect of the *IDMT* as it gives insights into the teacher's understanding of the CCSS-MP.

These classroom observations also revealed components of the teacher's disposition by displaying aspects of his or her belief systems within the lesson planning. The follow up interviews exposed results of collaboration during professional engagement. This is consistent with the top of the *IDMT*.

Individual Interviews

Since the participants were also middle school educators, I needed to establish a conversational partnership, making sure the participants knew that I would be honest and open with them throughout the process as I hoped to get open and honest responses in return (Rubin & Rubin, 2012). I wanted to make sure that they knew that I would not be establishing any type of evaluator role during the entire process nor would I be sharing their responses with any of their administrators unless mutual consent was established.

I used an in-depth interviewing process to obtain thick descriptions of times when the participant employ instructional decision making with regards to CCSS-MP1 and CCSS-MP3. The semi-structured interview consisted of guiding questions (see Appendix C), which were not always read verbatim. The following example of an interview question illustrates the descriptive nature of the questions (especially in the initial interview):

> The Common Core State Standards for Mathematical Practices "describe varieties of expertise that mathematics educators at all levels should seek to develop in their students." These practices rest on important "processes and proficiencies" with longstanding importance in mathematics education ("Standards for Mathematical Practice," 2015). The *Ohio's New Learning Standards: Mathematics Standards* (2010) places these practices first in the document indicating that the CCSS-MP "describe ways in which developing student practitioners of the discipline of mathematics increasingly ought to engage with the subject matter as they grow in mathematical maturity and expertise" (pp. 7-8). **Based on this description, why do you think the CCSS-MP are forefront in the document?**

The rationale behind inclusion of a common descriptor is so that the participants have a shared context when providing an answer. I did not want teachers to inadvertently share a response, which may be reflective of different mathematical practice or component of Ohio's New Mathematics Learning Standards which is not under investigation in this study.

These questions attempted to reveal the participants' personal dispositions, their perceptions of societal and environmental factors that play into their instructional decision making, and their MKT. It also shows the interactions between them and their students as they make decisions regarding these practices. All of these are a part of the *IDMT*.

During the interviewing process, I adjusted the questions several times based on the conversation. This included rephrasing the question to make them clearer and coming up with more specific questions at times in order to make sure that I was not missing any of the details of instructional decision making experiences incorporating the practice standards (Rubin & Rubin, 2012, p. 96). I avoided questions that required only a “yes” or “no” response or a hypothetical in order to elicit more rich descriptions of the experience. As suggested by Merriam (1998), hypothetical questions and ideal position questions are especially useful in eliciting more detailed responses from the student participants. Immediately following the interviews, I wrote journal entries to try to capture as much as I could remember regarding any body language, which might indicate anything with regards to their experiences with making meaning.

Data Analysis

The focus of the analysis of the data was on the responses to the items on the MTEBI, the text gathered from the video observation reflections, the classroom observation field notes, and the interview transcripts. The MTEBI responses gave a baseline understanding of the participants’ beliefs regarding their ability to teach mathematics and the effects on student learning. Through the analyses of these transcripts, I focused on understanding what the participants really think and feel about their instructional decision making as it relates to CCSS-MP1 and CCSS-MP3. I attempted to understand why the participants chose to do what they did during the classroom observations as related to instructional decision making. Understanding was also gleaned from how the participants viewed the teachers in the videos enacting and making instructional decisions regarding CCSS-MP1 and CCSS-MP3.

The participants were instrumental in the analyses. Staying true to a hermeneutic perspective (Schutt, 2012), I recognize that the interpretations made cannot be judged to be true or false but rather should be negotiated among the interpreters, the participants and me, leading to a consensual community validation (p. 321). The results are a rich interpretation of the instructional experiences of the participants. This is the direct result of categorizing the data to discover patterns and relationships within. The analysis of data from the video viewing, classroom observations, and individual interviews was used to draw conclusions.

Mathematics Teaching Efficacy Beliefs Instrument

First, I separated the MTEBI item responses into two categories; self-efficacy responses (SE) and outcome expectancy responses (OE). Using the responses, I calculated a mean score for each category, recognizing when a negative response required a reverse scoring. I then looked for a connection between these self-reported beliefs and the participants' teacher dispositions as indicated in the interview responses and simulated recall session responses as related to their instructional decision making regarding CCSS-MP1 and CCSS-MP3.

Videos of Middle School Classroom Lessons Involving CCSS-MP1 and CCSS-MP3

Analysis began with coding of the reflective journal entries provided by each participant after watching the selected classroom video lessons mentioned above. During the initial coding process, I looked for descriptive tags or labels that I could use to index the data for storage and subsequent retrieval. I looked for indicators of the participants' reflection of the influences affecting the teachers in the videos enacting of CCSS-MP1 and CCSS-MP3. The primary focus was on the participants' interpretation of the societal and environmental influences and the MKT of the teachers shown in the video. I then repeated the coding process, this time looking for patterns and higher-order concepts regarding the above mentioned aspects of the *IDMT* illustrated in the videos (Creswell, 2003).

Memoing was also utilized as I reviewed the reflective journals of each participant. This allowed me to begin to formulate propositions regarding the participants' ideas of key components involving instructional decision making as related to CCSS-MP1 and CCSS-MP3 as evident in the videos. The memoing took the descriptive to the conceptual level as it involved the formulation of ideas regarding the research questions involved in this study (Creswell, 2003, p. 180). It is important to note that the coding and memoing occurred simultaneously allowing me to stop the coding and record ideas as they formulated.

The use of these documents provides preserved documentation of the participants' interpretations and can be used for ongoing conceptualization.

Classroom Observations

Similarly to methods employed with the video lessons described above, I used a similar process of coding and memoing for the classroom observations of the participants. I transcribed the videos as well as created field notes during the stimulated recall session, recording non-verbal observations that may have been relevant to the study as well as an attempted to reconstruct the feelings of the participants during the classroom interactions (Schutt, 2012). In order to create an accurate account of the observations, I met with each of the participants to share my field notes and transcriptions to assure it was reflective of the actual observation. Again, I focused on several aspects of the *IDMT* but the main focus this time was on the participants' teacher dispositions and MKT.

Individual Interviews

I transcribed the initial and final interviews. After transcribing the first interviews, I used coding to analyze the data with the goal of identifying missing information, revising data collection methods as needed, and refining the questions for the second interview. I coded the data to see if I noticed any categories within the data, which would lead to the discovery of emerging themes (Merriam, 1998). I then conducted the final interview to continue to expand on propositions, which had emerged at this point from the video reflective journal analyses, the stimulated recall analyses and the initial interview analyses. This led to my conclusions that were verified by the repetition of questioning in the final interviewing process.

Trustworthiness and Credibility

Lincoln and Guba (1985) indicated that trustworthiness can be established through credibility, transferability, dependability, and confirmability. Credibility establishes that the researcher's finding indicate the truthfulness. Transferability indicates that the findings can be applied to similar contexts. Dependability is established when the findings can be replicated in other studies. Finally, confirmability is closely related to bracketing because it indicates that the findings are based on the data collected not the biases of the researcher.

I used member checks as indicated above. The participants had full access to my journaling and data analyses and I was encouraged to clarify and add descriptions to my findings so that the description accurately reflects their experiences. I also employed triangulation and ensured confirmability by bracketing my preconceptions and biases as indicated.

I used memos to record thoughts and experiences throughout the study. This was a way to bracket any of my preconceptions and biases regarding the experience. It is important for a researcher to be able to set aside any biases and knowledge of the topic under study to be able to be fully receptive the responses given during the interview process (Moustakas, 1994). I also included reflections on future questioning in order to develop a holistic view of the experience and to be able to go beyond the descriptive to meaning making of the essence of the experience.

I worked hard to try to reflect the experience of the teachers as they attempted to make meaning of their instructional decision making practices. I became an integral part of the study by diligently reflecting on the data and using member checks to make sure that it is truly reflective of the participants' experiences. I provided the participants with a copy of the findings and made sure to allow for input at the conclusion of the study to again make sure that the meanings I have developed are reflective of the participants' experiences.

CHAPTER IV

ANALYSIS OF THE FINDINGS

This section gives a detailed analysis of the data collected from each participant. The analysis is centered around the facets of *Instructional Decision Making Triangle:* teacher disposition, mathematical knowledge for teaching, and societal and environmental influences on practical rationality.

Review of Research Questions

In this study, I explored how three participants' instructional decision making regarding CCSS-MP1 and CCSS-MP3 is influenced by their teacher's disposition, societal and environmental influences, and Mathematical Knowledge for Teaching (MKT) as each are a facet of the Instructional Decision Making Triangle. The participants in the study taught in three different educational settings (high, average, and low performing with regards to academics), which allowed for examination of how the setting may or may not impact their instructional decision making. By investigating what interferes or promotes the inclusion of the mathematical practice standards in instructional decision making of the teachers in each of these settings, a better understanding of the professional needs of middle school teachers can be assessed.

I examined aspects of participants' practical rationality regarding CCSS-MP1 and CCSS-MP3. This analysis was facilitated through data collected from responses to the MTEBI, dialogue during interviews with each participant, participants' reflection responses to videos of peers' classroom interactions where CCSS-MP1 and CCSS-MP3 were employed, and interviews utilizing stimulated recall of the participant's own teaching. The following research questions were addressed:

1. What role does the teacher's professional disposition have on a middle school mathematics teacher's instructional decisions regarding CCSS-MP1 and CCSS-MP3?
2. What role do environmental and societal influences have on a middle school mathematics teacher's instructional decisions regarding CCSS-MP1 and CCSS-MP3?
3. What role does Mathematical Knowledge for Teaching have on a middle school mathematics teacher's instructional decisions regarding CCSS-MP1 and CCSS-MP3?

Each research question focused on one of the three facets: teacher's disposition, societal and environmental influences, and MKT. The objective of the study is to explore and understand how the decisions made by the teachers, as they attempted to incorporate CCSS-MP1 and CCSS-MP3 into their instruction, are influenced by the three facets. Differences in teachers' instructional contexts allowed for comparisons based on the average academic performance levels of the students (high, average, and low) at each participant's school as evidenced from the state school report cards. Analysis across the three participants allowed for the construction of cases that describe specific instances of mathematics teachers' practical rationality in regards to the Standards of Mathematical Practice. As is customary with case study, I recognize that the data collected will reveal components of the participants' instructional practices as revealed through the various modes of collection (responses to the MTEBI, responses from interviews, viewing of video of other teachers enacting the practices, and stimulated recall interviews following videotaping of participants' classroom instruction) giving partial insight into the core of their instructional decision making.

Contextual Themes

During my interactions and correspondences with each participant, several themes emerged with regards to the three facets of the *IDMT* (teacher's disposition, Mathematical Knowledge of Teaching (MKT), and societal and environmental influences, see Figure 5). The double arrows between the three facets in the *IDMT* indicated the connected influences on the instructional decision making as is described across all three participants.

Adaptation as a Component of Teacher Disposition

Adaptation emerged as a theme situated in the teacher disposition portion of the *IDMT* (See Figure 5). *Adaptation* is defined here as the perception that mathematics involves continual change and differential approaches to problem solving. It is the teacher perceived need to adapt lessons based on student interactions and work. Bourdieu (1998) described a teacher's disposition as the perception and appreciation that inspire practitioners to act a specific way. It is the shared ways in which teachers identify people, occurrences, objects, and ideas shared within an instructional setting. Participants holding this belief view the mathematics teacher as the facilitator, the individual in the classroom whose role is to drive the instruction while allowing the students in the classroom time to develop the understanding in distinctive ways.

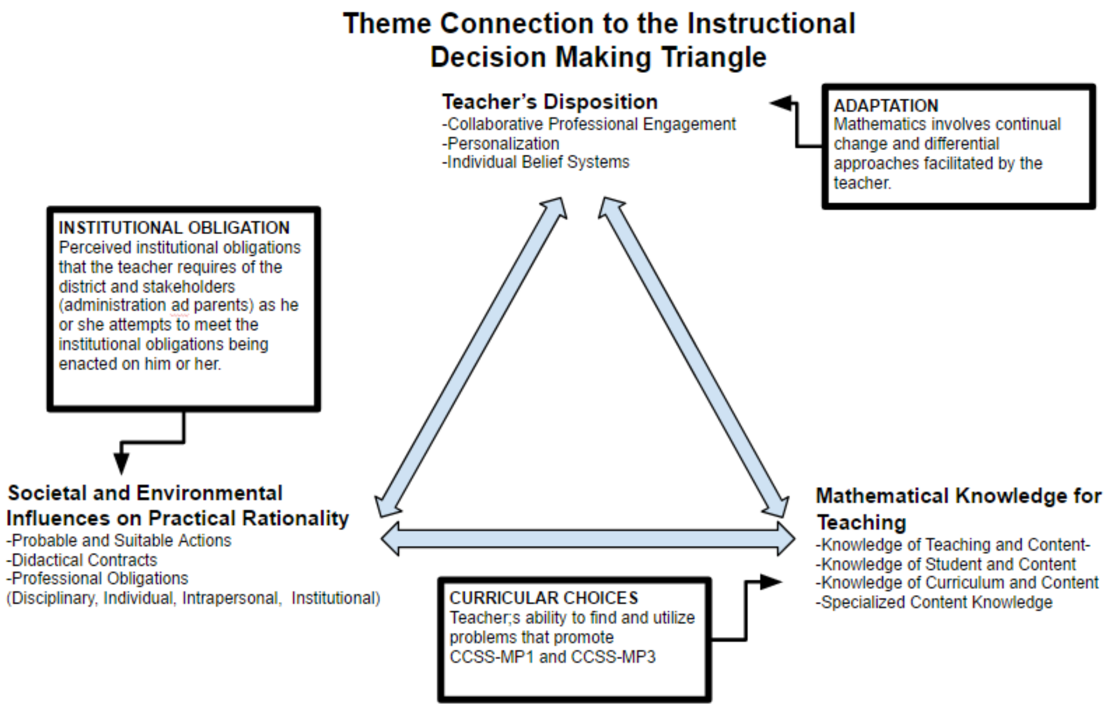

Figure 5. Instructional Decision Making Triangle with themes. This is the *Instructional Decision Making Triangle* I designed with the themes revealed by the participants indicated as they connect to the components of the triangles.

One of the shifts within the Common Core Mathematics standards is to provide students with more rigorous problems. In order for students to demonstrate success with these problems, teachers are tasked with instilling in their students the ability to persevere. The participants in this study conveyed that this requires teachers to make adaptations in instructional decisions to provide students with the best chance to realize the mathematics within these rigorous problems. This disposition is also described by participants as being open to ideas that may differ from how teachers may approach a mathematical task and to recognize that students may have different entry points to solving the task. Further, a teacher demonstrating adaptation describes a willingness to adapt the lesson when misconceptions arise. Instructional decisions may be made during the lesson that change what was initially planned. Although primarily situated with Teacher's Disposition in the *IDMT*, the double sided arrows recognize that adaptations in instructional decisions may also be influenced by MKT and societal and environmental influences such as professional obligations. Such descriptions were evident across all three participants.

Curricular Choices as a Component of Mathematical Knowledge for Teaching

Curricular choices emerged as a theme as part of a teacher's mathematical knowledge for teaching, MKT (right side of *IDMT*, see Figure 5). Ball et al. (2008) described MKT as the "day-to-day, moment-to-moment demands of teaching" (p. 395) specific to mathematics instruction. It includes the essential knowledge and activities needed to establish a classroom where mathematics is handled with integrity, students' ideas are valued, and mathematical explorations are done collaboratively. Specifically, this is the teacher's perceived ability to find and utilize problems that provide opportunities for students to engage in the mathematical practices.

Teachers' perceived ability may be framed by the curricular materials available within the instructional setting including resources provided by the district as well as material found by the teacher that may or may not meet the mathematical practice and content standards, seen by the double sided arrow between MKT and societal and environmental influences in the *IDMT* (see Figure 5). Within the instructional triangle, Ball and Cohen (1999b) asserted that MKT involves the teacher utilizing personal and intellectual resources in order to understand, interpret, and respond to the curricular materials and the students. The teacher is tasked to make instructional decisions that include the students and resources in an effort to promote learning. The teacher's disposition toward a certain mode of instruction, coupled with MKT, may result in specific curricular choices made by the teacher.

In the present study, *curricular choices* emerged as a theme situated in the *Knowledge of Content and Teaching* (KCT), *Knowledge of Curriculum and Content* (KCC), *Knowledge of Content and Students* (KCS), and *Specialized Content Knowledge* (SCK) domains of the MKT portion of the *IDMT* (see Figure 5). Curricular choices are defined here as the teacher finding and then utilizing problems that may (or may not) promote students' employment of the CCSS MP-1 and CCSS MP-3. The participants in this study described making curricular choices involving the mode of instruction and choice of problems to use in order to promote student perseverance in solving problems and communicating mathematical understanding. Participants described such decisions in terms of their understanding of appropriate pedagogy, which aligns well with Ball et al.'s (2008) description of KCT. The participants also conveyed making curricular choices based on student demonstrated present and past knowledge, which aligns with Ball et al.'s (2008) descriptions of KCS. Lastly, participants described their curricular choices as situated within their own grade level curriculum, the curriculum of grade levels above and below theirs and the curriculum of other content areas. Such descriptions align with Ball et al.'s (2008) descriptions of KCC and SCK. All four types of descriptions aligned with MKT-based justifications were evident across the three participants.

Institutional Obligations as a Component of Societal and Environmental Influences on Practical Rationality

Institutional obligations emerged with regards to the environmental and societal influences on practical rationality (left side of *IDMT*, see Figure 5). *Institutional obligations* are defined as the schooling obligations requiring the teacher to attend to such details as "school policies, calendars, schedules, examinations, curriculum, extracurricular activities and so on" (Herbst & Chazan, 2011, p. 451). Within this particular study, the participants revealed perceived institutional obligations that they require of the district and stakeholders (administration and parents) as they attempt to meet the institutional obligations being enacted on them. Although all three participants indicated their obligation to both the students and the institution at large, they also indicated required supports needed, returned institutional obligatory resources. These institutional obligations are framed by the support and non-support given to a teacher by administration and parents within the school district, which may (or may not) help the teacher realize the enactment of the CCSS MP-1 and CCSS MP-3.

The participants in this study described influences of both administration and parents as being both positively and negatively present in their instructional decisions. The participants' descriptions of their actions in the classroom and instructional decisions did not always imply free will choices but often seemed to reflect the restrictions created by the environment where they taught (Herbst & Chazan, 2011). Their decisions also seemed to reveal variances based on the different instructional situations.

The institutional obligations required were also driven by the teacher's perceived notion of continually being held to certain standards. The teacher perceived an obligation to accept responsibility for instructional decisions and actions while making the decisions transparent to the stakeholders. The participants described the desire to be transparent in their instructional decision making as not only a belief but a professional obligation often dictating their course of actions. The *instructional obligation* theme was evident across the three participants as is illustrated.

These themes reveal a picture of the practical rationality participants utilized in making instructional decisions regarding CCSS-MP1 and CCSS-MP3. This picture aided in a deeper understanding of how the participants' practical rationality, and components of it, contributed to the development of classroom interactions incorporating the mathematical practices.

Context: Teacher Participants

This section gives an overview of the three participants followed by a detailed analysis of each case. Each case is divided according to the three facets of the *Instructional Decision Making Triangle.*

The participants in this study were distinctive, hardworking individuals who showed a high level of professionalism and dedication to their practice. Their differences in ages, experiences, and teaching environments all contributed to their practical rationality and was reflected in their teaching styles and revealed in their decision making. The participants taught in vastly different school districts in Northeast Ohio (high, average, and low academic performing districts), the selection of which was purposely chosen to examine potential variations in the effect of the environmental and social aspect of the *IDMT*.

The three participants in this study were Mary, Fred, and Jen (pseudonyms). All three are middle school teachers in public schools in Northeast Ohio. Mary taught in a low academic achieving district, Fred in an average academic achieving school district, and Jen in a high academic achieving school district. Mary teaches regular sixth grade mathematics in a school that has been placed on state academic emergency in previous years as the result of state assessment scores and presently has earned a below average score on the state report card. Fred teaches both regular sixth grade mathematics and accelerated sixth grade mathematics in a school district with an average state report card score as indicated by results of state assessments. Jen teaches regular seventh grade mathematics and accelerated seventh grade mathematics in a school district with an above average state report card score. The participants range in age and experience, from 36 to 45 years old with 14 to 20 years of teaching experience. All three participants have had experience teaching in more than one school district.

I chose to include quotes from their interviews to allow the reader to capture some of the participants' personal experiences while expressing the complexities involved in their instructional decision making. I follow these excerpts with my interpretation of the participant's meaning making and experiences with his or her practical rationality. I also describe influences on participants' instructional decision making as he or she described CCSS-MP1 and CCSS-MP3 in context with classroom interactions. By exploring the case within the real world contextual settings of the districts where the participants teach and recognizing that the phenomena of instructional decision making is bounded to the contextual setting, this is an effective approach to glean meaning about participants' instructional decision making (Yin, 2013).

Mary's Case

This section gives a brief description of Mary's instructional decision making as she attempts to enact CCSS-MP1 and CCSS-MP3. Components of her decision making, such as Mary's disposition toward investigative problem solving, her MKT leading to student engagement, and the institution's obligations to provide professional development and resources are examined. These connections to the *Instructional Decision Making Triangle* are discussed in detail.

Background

Mary has been teaching for 15 years, all 15 years in a public school setting. Mary has taught both mathematics and language arts but indicated that her preference is mathematics. Mary has primarily taught at the intermediate and middle school level, mainly fifth and sixth grade. Although she teaches in a low academic achieving school district, Mary did not mention this during either of the interviews or simulated recall sessions. Mary described spending countless hours, both during and after the school day, preparing materials and lesson plans to reach the academic needs of her students. Mary has earned a master's degree in education and is working toward a second licensure degree. Thus, Mary conveys a high degree of dedication and professionalism as indicated in our interactions. Confirmatory evidence for this disposition comes from descriptions of Mary by the curriculum director and superintendent in her district.

Specifically, when identifying a teacher from their district for participation in the study, both described Mary as a teacher who gives her best effort in all endeavors within the profession. Another aspect of Mary's professionalism is her ability to get along with her colleagues, as evident in the description of collaborative efforts made with at least two others in her building during the final interview.

When I approached the administration within in her district about participation in this study, Mary's name was the first given. I emailed Mary and she eagerly agreed to be a part of the study. One thing I noted about Mary was that she was not always timely in her responses to my emails. Oftentimes, it took several repeated emails to get a response, each time containing an apology from Mary stating that she was sorry but school work and home life had detained her from responding sooner. After my interactions with Mary, I was soon made aware of the validity of this apology. During our initial interview Mary referenced the amount of time she spent preparing her lessons indicating that this was something she felt she needed to do. "You know not everybody is willing to make sacrifices I give up. I get up at 2 o'clock. That's just me." When I contacted Mary in the spring to finalize our data collection, Mary indicated that she would not be able to meet again until May as she was in professional development classes every Saturday from 8:30 until 4 and she needed to spend time with her family on Sunday. When figuring out how to manage her time, Mary seemed to prioritize her work as a teacher alongside her family. This did not demonstrate a lack of interest in the present study but rather her commitment to the profession and her family.

Throughout the recording of her classroom teaching, Mary constantly demonstrated a good rapport with her students. For example, students responded well to her questioning and were attentive throughout. When Mary approached a group, it did not matter who she asked to respond at the table, the students were willing participants. Oftentimes, Mary and her students shared laughter, even when an error was discovered. All of her students seemed to welcome these interactions with Mary.

Her dedication to her students was apparent in the responses to the interviewing questions and is shown in context with the narrative that follows. Mary appeared comfortable during our interactions. She was open about her own teaching and was willing to express both positive and negative aspects about her professional experiences. Her openness in our interactions was demonstrated by consistent follow-up questions in which she would ask if there was anything else I needed from her response. Additionally, Mary always ended our interactions stating that I should contact her if I needed any additional material or had any further questions for her.

Adaptation as a Component of Mary's Teacher Disposition

Teacher's efficacy beliefs include both outcome expectancy beliefs and self-efficacy beliefs, which may influence instructional decision making (Gibson & Dembo, 1984) and may be connected to teacher disposition. The results of the MTEBI survey (see Appendix A) for Mary indicate that she has an above average personal mathematics teaching efficacy belief (SE) with a composite score of 4.08. Several of the statements seem to suggest Mary's belief the she is effective in helping students to understand math (See Table 4). On the other hand, Mary's outcome expectancy score (OE) is lower with a

Table 4

Mary's MTEBI Responses Related to Teacher Disposition

Personal Mathematics Teaching Efficacy Belief (SE)	**Score**
I will continually find better ways to teach mathematics.	5-Strongly Agree
I understand mathematics concepts well enough to be effective in teaching mathematics.	4-Agree
I find it difficult to use manipulatives to explain to students why mathematics works.	
I am typically able to answer students' mathematics questions. When teaching mathematics, I usually welcome student questions.	
When a student has difficulty understanding a mathematics concept, I am usually at a loss as to how to help the student understand it better. (Opposite scoring)	
Outcome Expectancy (OE)	**Score**
If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.	5-Strongly Agree
When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.	4-Agree
The teacher is generally responsible for the achievement of students in mathematics.	
When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.	
Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.	
When a student does better than usual in mathematics, it is often because a teacher exerted a little extra effort.	2-Disagree

score of 3.875, falling just below the "agree" level, indicative of an implied belief that students play some role in their own learning. Despite the fact that she is confident she has the ability to teach mathematics successfully, Mary's responses imply that student success depends on the role of the teacher (See Table 4). This may seem contradictive to her SE score but throughout the study, Mary revealed a teacher disposition toward the role of teacher as facilitator as important to student success, which may correlate to her belief that teachers have a direct impact on student learning. These belief statements seemed to be upheld in her responses throughout this study with regards to her teacher disposition.

Inclination toward a problem solving approach. In the initial interview, when asked why she thinks the CCSS-MP are forefront in *Ohio's New Learning Standards,* Mary demonstrates strong convictions with regards to her role in student understanding and engagement (see Appendix C, prompt 1). Mary immediately referenced the need to make her students 21st century learners, those who can problem solve in various way when presented problems differing from previously encountered. This follows a problem solving view of mathematics (Ernest, 1989; A. G. Thompson, 1992). Mary clearly indicates that she does not want her students following a pre-established method crediting her math textbook as one that pushes her students "beyond just the rote memorization of a step by step process of finding and solving a math problem." Mary describes what she wants her students doing when problem solving. "I was thinking of problem solving right now with my students being able to picture what does it look like, maybe, what does it sound like in the real world." Through communication, Mary recognizes the problem solving view of mathematics as students make changes in their thinking and self-correct when errors are made. Mary further describes communication as an important component, stating that "(problem solving) forces them [the students] to be able to talk with one another to get their ideas across of their understanding and kind of just to justify if they're even correct." Mary's disposition toward mathematics as involving continual change and allowance for expanding problem solving approaches shows a double arrow connection between her teacher disposition and her mathematical knowledge of teaching and content, KCT (right side of *IDMT*, see Figure 6, bullet 1), as she makes choices in the type of problems that will allow for persevering opportunities.

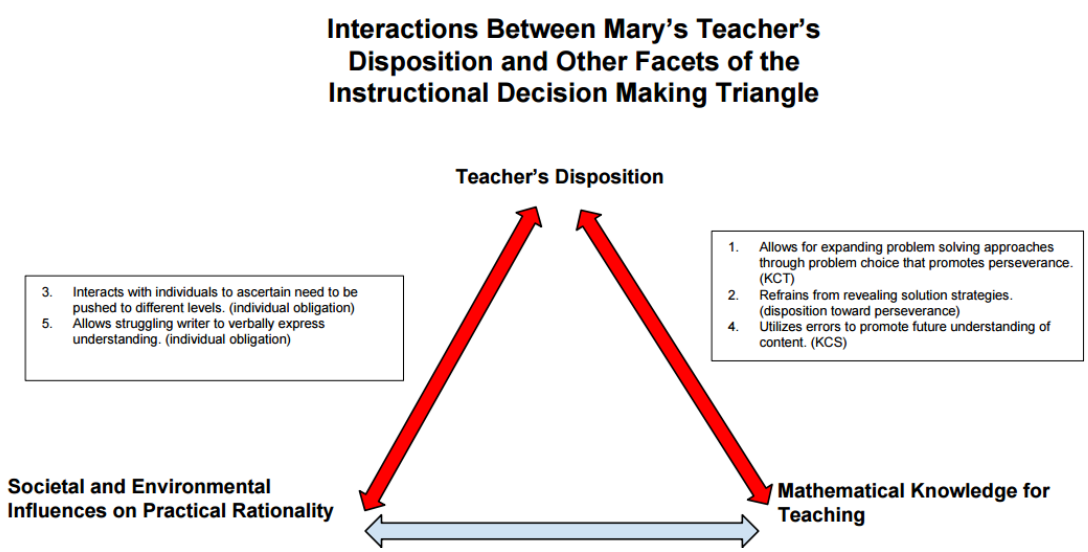

Figure 6. Mary's teacher disposition. This highlights the interactions between Mary's teacher disposition and the other facets of the *Instructional Decision Making Triangle.*

An additional indicator of Mary's disposition toward the problem solving approach to mathematics instruction is further evident in Mary's response to why the mathematical practices are in the forefront of the Common Core State Standards (see Appendix C, prompt 1). Mary describes an evolution in her instructional approach from a demonstrative method toward a constructive and collaborative instructional approach. Mary describes her previous instructional decisions as a beginning teacher, showing the students a step-by-step approach to the problem as something problematic when the students are then faced with a word problem.

> They're just memorizing the step by step and when they forget the step by step, it's like, "Oh shoot, what do I do next?" And then you throw a word problem into it, and they're really like, "Wow, I don't get it because you said do step by step and now I got this word problem and I don't know what to do."

In comparison, Mary refers to her present experience with her students as being collaborative and constructive in nature with her role being more facilitative than demonstrative. "I think this really hones in to what they need to do. Being able to collaborate. Being able to discuss with other people their thinking process to solving the problem. And then finding out on their own ways to solve the problem before I just tell them."

Facilitator of student learning. In this light of her teacher disposition toward her role as facilitator, Mary acknowledges that she is not the only teacher in the classroom as evident in her response to what is needed for a teacher to engage students in CCSS-MP1 and CCSS-MP3 (see Appendix C, prompt 3). Mary describes allowing her students to discuss their individual approaches to the same problem indicating that these interactions between her students enhances understanding of the mathematics content of focus. When referencing the construction of mathematical arguments, Mary illustrates how exposure to different students' views and methods for solving problems may help students who are unable to understand the content when she presents the content. Mary also recognizes the importance of communication as ways for students to justify the accuracy of their work (see bolded text).

> I think it [conversation] gives **justification within themselves, if they're on the right track or if they're not versus me always telling them**. A lot of times, I notice also within them **communicating with one another, it allows them to see it another way**. Let's say **I already taught it** and **maybe they didn't get it** and **them hearing how somebody else does it or is looking at it**, a lot of times, **they are able to quickly get it** like "Oh, I get it now." Like their 'ah ha' moment.

Mary seems comfortable in a facilitator role, encouraging these types of interactions and seeing the positive results. The allowance for adaptation to student approaches emerges as a theme within Mary's teacher disposition (top of *IDMT*, see Figure 6).

Another example of her adaptive nature in her instructional decisions is demonstrated by Mary recognizing that her lessons need to be fluid, not static. She is willing to make adjustments after seeing her students interact with the mathematics. Mary knows that students bring different prior knowledge and experiences to the classroom interactions and she makes changes as the need arises. An example of this is evident in the response to what influences the professional obligations have on her enacting the mathematical practices (see Appendix C, prompt 4).

> I always **reflect on my lesson every day**. I don't always jot it down but a lot of times I will jot it down. A lot of times in my lesson plan book **my ideas for the week are going to change**. You know they're going to change **based upon what you're going to see the students are getting, lacking background knowledge, maybe pushing them further because they got it**. So I'm always thinking **what could I have done differently** to have that person engage more than what they were because the other day they were engaged. What was it that I did or said that got them interested? So **all that goes through my mind throughout the day.**

This reflects Mary's knowledge of curriculum and content, KCC (right side of *IDMT*, see Figure 6, bullet 2), as she is able to ascertain the misconceptions that her students have in their own mathematical understanding in order to make the necessary adjustments in her instructional decisions. Mary also describes "pushing them further" not because it is part of the curriculum but because it reflects a student need. This ability to adapt instruction to meet students' needs supports the adaptation theme within teacher disposition as well as her individual obligation to her students.

During the simulated recall session, Mary reveals how she makes adaptations during her interactions with groups based on the group's dynamics and the needs of individuals within the groups, which shows the double arrow connection between her professional obligation to the individual students (left side of *IDMT*, see Figure 6, bullet 3). Mary describes daily checking in during group work to make sure that students are accurate in their problem solving. Mary further explained that these personal interactions with the groups enables her students to make adjustments when they are not understanding the material prior to placing them in a situation where they are presenting to the entire class.

As seen in the video, upon approaching a group that seems to struggle with the concept, Mary does not give the students the answer directly. Mary is seen working with the group to help them figure out an appropriate strategy by asking them questions rather than showing them how to do the problem. Staying true to the individual obligation, Mary starts the discussion with this group by pointing out what the students had done correctly. Mary explained that this helps the students feel more confident about arriving at a correct final solution enabling her to provide the students with strategies to move forward without sounding critical of their work. In a similar way Mary adjusts her instructions with a student who has not written down any of his work. Rather than reprimanding the student, she chooses a different approach, asking the student to orally communicate his understanding. When asked about this approach, Mary explained that she was most concerned about her students' understanding of the mathematics and would do whatever it took to find out what they knew, revealing her knowledge of content and student, KCS (right side of the *IDMT*, see Figure 6, bullet 4). Mary also indicated that this would allow her to make changes in the facilitation of her student's understanding because she knew this particular student was a reluctant writer due to academic struggles in language arts, reflective of her obligation to the individual (left side of *IDMT*, see Figure 6, bullet 5). If Mary had chosen to focus on the fact that the student had not written down his work, the student would have lost the opportunity to grow in his mathematical understanding, another example of Mary's willingness to adapt.

Error friendly environment. Mary describes wanting her students to feel comfortable with making adjustments to their work and their approaches to problem solving. Mary has established a climate in her classroom where students are not afraid to make mistakes. The students know that Mary will not be judgmental, instead allowing the students to continue to work at the problem until they feel confident in their solution. When asked if the students were permitted to question the presenters, Mary explained the nature of student interactions. The student-to-student feedback during group presentations provides for additional adaptation to instruction and learning as emphasized with the bolded text from the simulated recall discussion below.

> They provide them [presenters] feedback so I usually say, “Class **do you agree or disagree?”** Sometimes they agree**. If anyone disagrees** I usually say, “**What do you see is incorrect?”** Sometimes **they explain why** and then they’re like, “Oh, never mind. They’re right.” Usually **if everybody agrees**, then I might call on someone from the **audience** and say, **“How did you do it differently? What’s another way?”** So **we’re not [just saying], “Sure we agree.”** Because then they just tune me out. Then the **audience** is supposed to always **check to see if** they [presenters] are **correct.**

Mary has shared her adaptive nature through student interactions, which results in the students also making changes to their work when they discover errors. During the simulated recall viewing of classroom interactions, Mary is seen questioning the groups she visits which conveys her role as a facilitator requiring students to justify their solutions. Later in the video, students are seen doing their own justifications without

Mary's prompting. Throughout the viewing, students were seen communicating their ideas and making adjustments to the problems until they felt confident that they had done it accurately both in small group discussions and whole class presentations.

Mary describes making instructional decisions that allow students to be able to make errors without being judged, ultimately resulting in furthering student learning. Mary's teacher disposition toward her role as the facilitator of learning results in instructional decisions that allow for collaboration both in small group and large group interactions. Mary allows for adaptations in her instructional decisions based on her KCS ascertained during group interactions both student to student and teacher to student. Mary conveys the adaptations throughout her instructional decision making.

Curricular Choice as a Component of Mary's Mathematical Knowledge for Teaching

Ball et al. (2008) described the teaching and content subcomponent, KCT, of MKT as the teacher's role in demonstrating how to solve problems, giving answers to student questions, and checking to make sure that students' work reflects the correct solution strategies. Mary describes several classroom interactions that seem to reflect this view. Her curricular choices regarding the problems chosen and the mode of instruction as described by Mary are intended to promote perseverance and open communication as indicated in the bold text in her response in the initial interview (see Appendix C, prompt 1).

> **Thinking about problem solving** with my students being able to picture what does it look like, maybe what does it sound like in the real world. They struggle a

> lot with that and just being able to persevere through the concepts because a lot of times they give up so quick or so easily but **our math curriculum** allows them or I shouldn't say allows but it **kind of forces them to try to persevere through the concepts**. We **do a lot of hands on activities within my math lessons** so it forces them, you know every day to kind of look at **what is it that I plan on teaching**, **how does it correlate to what it is they're supposed to learn and how does it look like in the real world**. So it **forces them to be able to talk with one another** to get their ideas across of their understanding and kind of just to **justify if they're** even **correct**. Our **math series** does a really good job of you know **pushing them**.

Mary's comments reflect a personalization disposition towards hands-on learning of mathematics (top of *IDMT*, see Figure 7, bullet 1), but her tone conveys not only a belief in this form of mathematics instruction, but a knowledge, from past experience both as a learner and as a teacher, that it is indeed effective pedagogy for teaching concepts of focus. This provides one instantiation of Mary's enactment of the curricular choices theme.

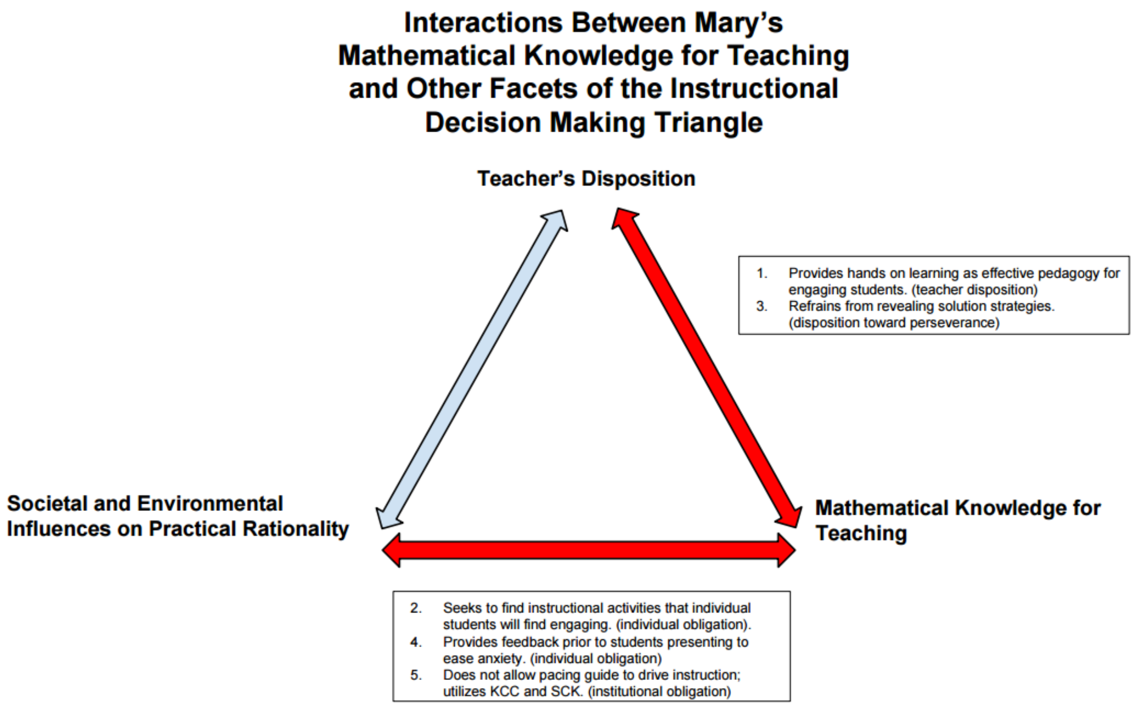

Figure 7. Mary's MKT. This highlights the interactions between Mary's MKT and the other facets of the *Instructional Decision Making Triangle.*

Mathematical knowledge of appropriate motivational tasks. Mary further describes the changes she has made from when she initially began teaching. Reflective of her teacher disposition toward investigative learning, Mary describes the exploratory nature of her lesson as effective pedagogy for enabling her students to make meaning for the concepts under study (top of *IDMT*, see Figure 7, bullet 1). Mary portrays her thinking process as she plans her instruction as one that has the students in the forefront, reflective of KCS. When making instructional decisions, KCS employs teachers to make predictions about what students will find appealing and motivating (Ball et al. 2008). When asked what exists in her instructional decision making that lends itself to the implementation of the two practices under investigation (See Appendix C, prompt 2), Mary illustrates her KCS involved in her choice of instruction.

> I think I always try to look at **how to get them engaged**. How they're going to be engaged 100% of the time. So pulling in things or **concepts** that I know that are **relevant** to them **in their world** really helps me adapt my lesson to **fit their needs**. As well as making sure that it is always **engaging** with them, getting up, they're **moving**, they're **socializing** because there's so many times where they're in the classroom and they're not allowed to socialize. They just sit and take notes or listen to the instructions. So, whenever I'm designing my lessons, I'm **always thinking** how can I **engage them**, how can I **involve movement**, how can I **involve communication to still get my point across**.

Mary's remarks on her choice of problems being situated in her students' world, as a means for making content relevant, demonstrate a combination of knowing about her students and knowing about the mathematics. Her final statement, "to still get my point across," seems to convey that her instructional decisions stay true to the mathematical content while allowing for curricular choices based on students' interests. Mary cites students' needs which indicates the double arrow connection between MKT and her individual obligation (left side of *IDMT*, see Figure 7, bullet 2) with regards to making instructional decisions leading to "moving" and "socializing," a perceived student need.

As just described, Mary's continual awareness of her students leads to instructional decisions based on previous classroom interactions. When questioned about which norms within her instructional system lend themselves to the enactment of CCSS-

MP1 and CCSS-MP3 (see Appendix C, prompt 5), Mary describes choosing past concepts to model that will promote learning the new concepts under investigation. KCT recognizes the importance of sequencing of mathematical content, determining which examples to start with and which examples to give to students that will provide the opportunity to delve deeper into the content (Ball et al., 2008). Mary's disposition to encourage perseverance in problem solving by avoiding revealing solutions too soon to her students informs Mary's choice to model previous learning to set the stage. In her response, Mary describes modeling without giving the students a direct solution (top of *IDMT*, see Figure 7, bullet 3).

> Before I turn them loose in their groups or independent work, [I] always **remind them of what we did whole group. We kind of always act it out before they do it on their own**. So they act it out and they talk about it to figure it out. So I try **never to give them the straight forward answer.** Like when they first started learning about the number line and I said, "You and we talked about where the positive and negative numbers went." I **didn't really tell them** where the fractions were. I said, "**Where do you think** they go? Now if we put these little lines in between, what does that mean?" I always kind of **try to lead** it to them telling me because they have sort of **background with it in previous grades**. And then I always **try to bring that back to them** when they're doing it independently or in a whole group or small group.

Mary describes how she attempts "to lead it to them" telling her by choosing to model concepts that they already have "background with it in previous grades" which is indicative of her KCC. The curricular choices of how she models the new content are based on what she already knows the students have from previous grades that will directly impact the acquisition of the content of focus.

Teacher feedback as student motivator toward mathematical understanding. During the simulated recall, Mary revealed another curricular choice to utilize whole class discussion on a daily basis as a way to enact CCSS-MP3, communicating understanding and critiquing the work of others. The emphasis on this as a daily activity seems to convey knowledge from past experiences that this pedagogical curricular choice promotes the communication between not only Mary and her students but between the students themselves. Mary further describes the whole class discussion platform as a way for students to check their own understanding while also having the opportunity to be exposed to other approaches to the problem. As part of the individual obligation (left side of *IDMT*, see Figure 7, bullet 4) prior to these whole group discussions, Mary interacts with each group, putting them at ease prior to presenting as indicated in the bolded text.

> With all classes I try to do that because to get to this portion, getting in front of the class, they get very nervous. I try to **give them feedback** so that when they go up they're not like, "Well I don't know if I'm right or not." It more or less **puts them at ease**.

Mary anticipated that this may be hard for some students, being able to explain their mathematical thinking in front of their peers, reflects her KCS.

Mary describes the importance of knowing her students, consistent with both her KSC (right side) and individual professional obligations (left side) in the *IDMT*. In the initial interview, Mary responds to the second prompt (see Appendix C), what exists in your instructional decisions that lend itself to implementation of CCSS-MP1 and CCSS-MP3, by describing one way for helping low academic performing students persevere during problem solving. Mary draws on pedagogical content knowledge of low academic performing students coupled with her knowledge of the mathematics (KSC) to group these students with students she believes have the ability to successfully access the content which will ultimately allow all students access as described in the bolded text in the following quote.

> They do **give up quickly**, not everybody, as many of my ones who are really, really **low in mathematics** and trying to **get them to persevere,** I do have them in **group stations** in a sense, **putting them with somebody** that I know is going to be, you know, **slightly above their level**, **somebody** that is going **to push them** you know **to the fullest**. "Like come on I want to get this. I want to do this." **Getting them recognition in class.** "Oh, yes that was such and such got it, table such and such got it. Yay!" Also, **me** going around, **giving them feedback**, **gives them** more of a **drive**. "She says we're on the right track so I know what to do." Like you'll hear them having that conversation. So the **consistent feedback from me**.

Mary describes finding out which students need the constant feedback and then she provides it regularly by listening and interpreting where they are in their mathematical thinking (KCS). This is also evident in the first interview when responding to prompt three (see Appendix C), what do teachers need to get students to engage in CCSS-MP1 and CCSS-MP3. "I think that just really knowing your students, that really knowing, that wanting to get to know them. Wanting to get to know their likes and dislikes." Mary uses KCS to predict what students will find interesting to promote acquisition of the mathematical understanding of the concepts of focus (Ball et al., 2008).

Flexibility with curricular content. During the initial interview (See Appendix C, prompt 4), when asked about the influences professional obligations have on her curricular choices regarding CCSS-MP1 and CCSS-MP3, Mary describes the importance of knowing her subject content which is reflective of both KCC and SCK (right side of *IDMT*, see Figure 7). Ball et al. (2008) described KCC as the content of the curriculum but not specific to a particular curriculum, the content that a well-educated adult should know. It is the knowledge that the teacher possesses that enables him or her to use the terms and notations when speaking to the students or in written material. SCK is the content of the curriculum that goes beyond that expected of any well-educated adult, specific to the concepts of focus (Ball et al., 2008). Mary conveys how her lesson design involves not only knowing the curriculum for the grade she is teaching but also the grades that follow reflective of her SCK as well as the overarching KCC. Mary describes the need to be flexible with the curriculum based on student demonstrated needs, not getting caught up in staying with the district pacing guide, moving away from one of her institutional professional obligations. The following description from the initial interview is evidence of these connected vertices of the *IDMT* (left side of *IDMT*, see Figure 7, bullet 5).

> You really need to **know your subject** a lot. . . . Knowing your subject matter you know as best you can **helps your students** because they realize, oh you know, this is not the way Miss [last name] said. Miss [last name] has us do it this and this way. **She's always organized. She's always prepared**. When **students** notice that, they **realize** that **you take time in creating and designing lessons based upon things that you are doing.** They're more **willing to meet your expectations** and that's with any type of subject regardless if its math or what have you . . . I tell them every day, "My **main goal** is not only for you to **understand the sixth grade content** but **also to push you ahead to seventh grade content."** So I always tell them since the first day of school, always remind them on an everyday basis, and I do not try to pull out problems because you know no matter what . . . grade level mathematics you are in, there's always going to be that **spiraling review section** but they don't look at it like that, and so I **pull** those things **from** the book from the **seventh grade** and I'm like, "Look I got this out of the seventh grade book." Or like, "Look, you just did a problem out of seventh grade." That excites them like I have **meaty expectations**. "You know she said she pulled this out of the seventh grade book. She knows her stuff. I know my stuff. I'm catching on to things." So your **obligations** as an instructor is to **know your material inside and out**, **know who your students are, know what you expect of them, and make sure they know what you expect of them**

> and be flexible. Just **be flexible** on what there is to teaching because you're not **going to be able to stay with the pacing guide**. You're not or you're going to have **too many people left behind**.

Further, Mary's portrayed drive to know the curriculum above grade level reflects Mary's belief that knowledge of the content is important for her to be able to facilitate her students' ability to do the work that she is assigning (Ball et al., 2008). The fact that Mary not only assigns at grade level tasks but also those that take her students beyond the present grade level curriculum reflects not only her KCC but as her KCT regarding choice of tasks that will enable students to delve deeper into the concepts of focus. This seems to reflect the theme of curricular choice. Mary conveys incorporating MKT throughout her instructional decision making.

Institutional Obligations as a Component of Societal and Environmental Influences on Mary's Practical Rationality

Herbst and Chazan (2012) recognized the influences of professional norms and obligations within instructional situations having an impact on instructional decisions. Mary identified her obligation to the institution at the same time expressing that the institutions should be obligated to help her in her instructional decision making.

Institution's obligation to provide instructional resources. As part of her disciplinary obligation (left side of *IDMT*, see Figure 8), Mary described the immense amount of time she invested within the school setting and during her own personal time searching for resources that would provide her students with valid representations of the mathematics discipline (Herbst & Chazan, 2011). When questioned in the initial

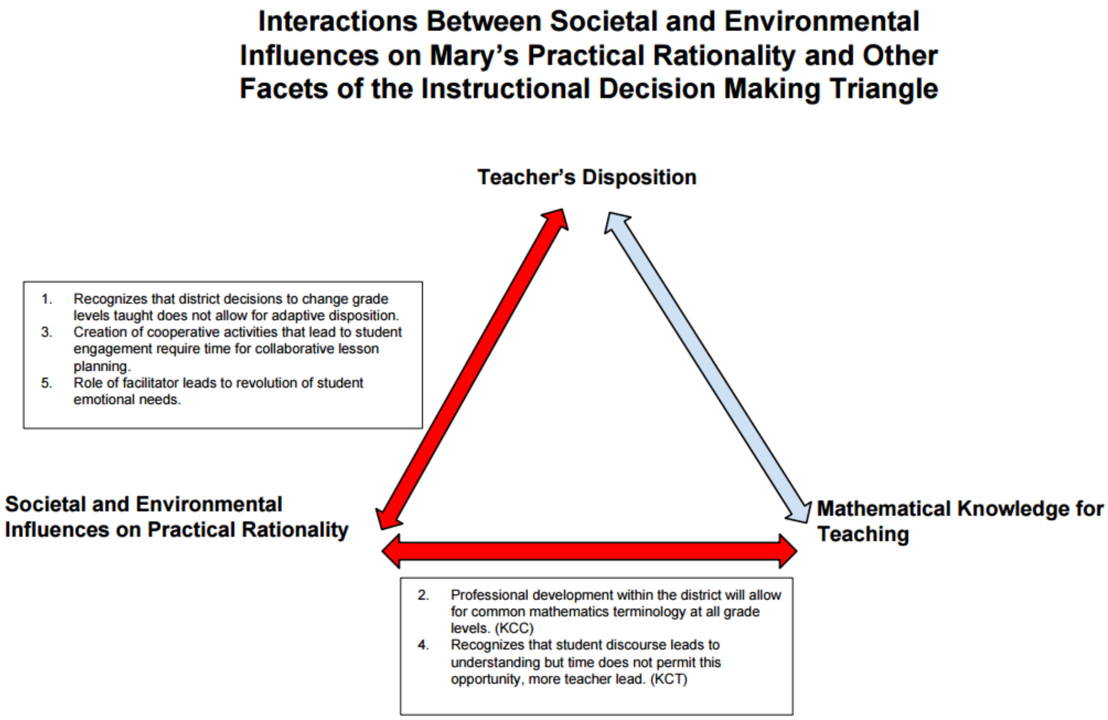

Figure 8. Influences on Mary's practical rationality. This highlights the interactions between societal and environmental influences on Mary's practical rationality and the other facets of the *Instructional Decision Making Triangle.*

interview about what would be necessary to be able to implement the CCSS-MP1 and CCSS-MP3 (see Appendix C, prompt 3), Mary reflected on what appeared to be a frustration she encountered with her district's choice to move teachers from existing positions to others at a different grade level. Mary's response seemed to connect the fact that the choice did not give teachers the needed support to be able to enact the mathematical practices effectively. Mary's tone implied that she felt the pressure to follow the curricular choices made by the district, but with the grade level changes being made, she did not feel supported. Mary references having "to start all over from scratch" making it difficult to move forward implementing the mathematical practices when the resources are not readily available (see bolded text).

> **Jumping grades doesn't help** either. So a lot of teachers are jumping grades. So then **you have to start** all **over from scratch**. You know you might have to **look online** at *Teachers Pay Teachers* and find stuff but **not everything** on those websites is going to be **geared toward your students** because you've got to **make it adaptive and for them**. We all need more time. You know and the fact that you're willing to **do those extras** because it **isn't** just **outlined in the curriculum**.

Although Mary's teaching disposition is to allow students to make adjustments in their thinking which often requires in the moment adaptations to her own instruction (top of *IDMT*, see Figure 8, bullet 1), Mary's response seems to reflect whole grade level adjustments as being counterproductive in making sound instructional decisions. Mary also shows recognition that the curriculum resources provided at the district level do not have complete outlines of what needs to be provided so Mary chooses to "do those extras." Mary expresses a need for support from the district; a necessary obligation of the institution, to allow teachers to remain at the same grade level for consecutive years which she implies will enable the teachers to become knowledgeable in their discipline.

Institution's obligation to provide professional development. During the final interview (see Appendix D, prompt 2), Mary suggests that it is the responsibility of the district to provide professional development with regards to the CCSS-MPs. Mary not only expresses a personal desire for professional development but suggests the same for her colleagues, a reflection of her interpersonal obligation (left side of *IDMT*, see Figure 8, bullet 2) to the members within her district as shown in the bolded text.

> At the **district level providing training** to all math teachers **on what the mathematical practices should look and sound like in the classroom** because **we don't know** all of the time **if it is looking like or it sounds like** it type of thing. **We don't know**. We're just going with the flow. I feel that it is. The **lesson book says that it is** but is it really? So I think **more training** to math teachers. Maybe **administrators or curriculum person coming in** and kind of **telling us what practices they** kind of **see** because that just **lets us know** if **we are meeting them**. I think those would be the **supports** I know **I** would **need**. I would like. I know that for my children who are in the same district at a **lower elementary level** you know I would like to see that so that when I am **able to converse** and I **talk to them about math** you know I could hear that like 'Oh you guys did do that." Because **I don't think we all know what it looks like and sounds like at every grade level**.

Mary's acknowledgment of the need for professional development for all teachers including those at the elementary level shows the double arrow connection between professional obligations and her KCC (right side of *IDMT*, see Figure 8, bullet 2). Mary recognizes the need for students to share a common mathematical vocabulary across grade levels (KCC) so that all teachers and students are "able to converse" and "talk to them about math," reflective of her interpersonal obligation. While the institution places the obligation on Mary to know her curriculum and prepare students for state level assessments, Mary sees the district having the obligation to the teachers to provide the appropriate training.

Mary also discloses her reliability on administration to validate her instructional decisions regarding the enactment of the mathematical practices. Mary expresses the desire to have administrators or curriculum people come in to observe and tell her if she is enacting the mathematical practices correctly. Although Mary thinks her lessons have the mathematical practices embedded, she wants validation for her actions from the stakeholders to whom she feels accountable. Once again, Mary sees this as an obligation of the institution to hold the teachers accountable by validating the instructional decisions are staying true to the mathematical practices.

Institution's obligation to provide instructional time. Part of the institutional obligations (left side of *IDMT*, see Figure 8) is the teacher's responsibility to follow the district established schedules and pacing guides (Herbst & Chazan, 2011). Mary again struggles with the established inequities between the amounts of minutes allotted for her mathematics instruction. In the final interview when asked what she needs to enact the CCSS-MP1 and CCSS-MP3 (see Appendix D, prompt 1), Mary describes the need for more time. Mary describes the vast difference between her ability to enact the mathematical practices when the time frame is shortened by 24 minutes (see bolded text).

> Within a **ninety minute block**. I'm quite **confident** that I used **all those practices** even though they weren't really talking about them during that time period but I am quite confident during that 90 minute block because there is **a lot of conversation** going on **between the students versus me** [doing all the

> talking]. Whereas with the **66 minutes** per se I feel like **I am doing more talking** and I **want them to do more of the talking**. So I just feel like time and I think all teachers would feel that you **just need more time** to give them that time **to correspond with one another** on **what they're getting** and **what they're not** so you know where to **stop and adjust versus stopping midway** through or **not getting through the whole thing**. Picking back up the **next day**, I mean yeah you **have those that remember but the vast majority of them do not.**

Mary's teacher disposition toward cooperative activities where students are engaged in mathematical discussions (top of *IDMT*, see Figure 8, bullet 3) is jeopardized when Mary is lacking the class time needed to allow for these conversations. Mary implies that she must do "more talking" in order to stay within the district established pace set forth for the curriculum but she implores for "more time" so she can allow for the interactions between the students which her KCT (right side of *IDMT*, see Figure 8, bullet 4) has shown to be the most appropriate way to establish student understanding. Mary recognizes the allotment of more time being provided by the district as an institutional obligation she desires, one she believes necessary for good instructional decisions to be enacted.

Similar to her teacher disposition as the facilitator during cooperative discussions (top of *IDMT*, see Figure 8, bullet 5), Mary describes a conversation with a parent leading to deeper understanding of the individual student's emotional needs, an individual obligation (left side of *IDMT*). During the parent meeting, Mary is able to assess the situation to ascertain why this particular student is upset about a particular situation within the classroom interaction. Mary is transparent about her academic expectations of her students at the same time explaining to this particular parent that her comments were not specifically directed at this parent's daughter (see bolded text).

> I just got out of a **parent meeting** with this parent. Her **daughter** always **wants to please me** and she came home **one day, kind of upset** because she **didn't get a particular grade** on an assignment. She was **frustrated** based upon **a comment I said to the class** but it **wasn't directly to her** but she **took it personally** though because she **felt** that **she was disappointing [me].** It had **nothing to do with her**. I made a **general comment** like they **know my expectations** and they **want to meet them**. So your **obligations** as an instructor is to **know your material inside and out**, **know** who **your students** are, **know what you expect of them**, and **make sure they know what you expect of them** and be **flexible**. Just be flexible on what there is to teaching because you're not going to be able to stay with the pacing guide. You're not or you're going to have too many people left behind.

Although Mary's tone implies that she has high expectations of her students, her individual obligation to insure the emotional wellbeing of her students is demonstrated in her recognition of the need to be flexible. Mary is accountable to parents and students, making "sure they know" what she expects of the individuals in her classroom.

Mary describes her professional obligations to her students, to the district, and to the parents acknowledging that she is always thinking about what she can do to ensure that she knows the content and prepares her students accordingly. Mary also recognizes the district's institutional obligation to her to provide the appropriate professional development, curricular materials, and necessary time to implement best practices. These duel obligations are what Mary describes as ideal for implementing CCSS-MP1 and CCSS-MP3, indicative of the theme.

Fred's Case

This section gives a brief description of Fred's instructional decision making as he attempts to enact CCSS-MP1 and CCSS-MP3. Components of his decision making, such as Fred's disposition toward problem solving, his MKT of directive problem solving, and the institution's obligations to acknowledge best practice are examined. These connections to the *Instructional Decision Making Triangle* are discussed in detail.

Background

Fred has been working in the educational field for 20 years, all 20 years in a public school setting. Fred initially had a license to be an educational aide but chose to earn an elementary teaching license, allowing him to teach all subjects, grades one through eight. He has taught both Social Studies and Mathematics at the middle school level but the majority of his teaching experience has been with mathematics. All of his experience has been at the intermediate and middle school level.

Fred shows dedication to the teaching profession as indicated by his involvement in professional activities within his district as well as experiences with other districts. Fred has worked with local university professors creating professional development activities in the area of middle school mathematics, which he presented at a summer academy. He has also been instrumental in curriculum development work within his own district.

Fred has a master's degree in education and is continually seeking to stay current in the field. Throughout the interview process, Fred described the amount of time he devoted to researching present educational practices in an effort to provide his students with rich learning experiences.

Fred has a good working relationship with his colleagues. I had the opportunity to witness Fred interacting with several of his colleagues as they worked together to try to find appropriate curricular material that they could use to meet the new state mathematics standards. During this observation, Fred showed evidence of a goal to find materials that would provide his students with opportunities to engage in rich and rigorous mathematical problem solving. This would also come to light in the interviews as one of his personal educational goals for his students.

Fred has a good rapport with his students as evidenced in the videos of his teaching. The students were attentive and responded to each of his questions. Fred was able to redirect his students when they were off task and the students appeared to be engaged in the learning activities that were provided. Fred seems comfortable with the teaching at the middle school level and made no indication that he intended to switch to another level. He has taught primarily at the sixth and seventh grade level.

Fred seemed confident and relaxed during our interactions. He was quick to respond to most of the questions and rarely needed clarification. Fred indicated that he had spent some time over the past several years trying to make sense of all of the mathematical practice standards, but he did feel that he still had some work to do to ensure that he was implementing them correctly. This is revealed in the following narrative. Fred made sure I knew that I could contact him at any time if I needed further information from him.

Adaptation as a Component of Fred's Teacher Disposition

The results of the MTEBI survey for Fred indicates that he has a strong personal mathematics teaching efficacy belief (SE) with a composite score of 4.83. Several of the statements seem to suggest Fred's belief the he is effective in helping students to understand math (See Table 5). Similarly Fred's outcome expectancy score (OE) is a strong belief score of 4.5, falling just below the "strongly agree" level. Responses from the MTEBI indicate that Fred strongly agrees that there is a correlation between improvement in student grades and the teacher finding a more effective teaching approach (See Table 5).

Despite this correlation, Fred is uncertain if underachievement is due to ineffective teaching, which may be seen as contradictory. However, during both the initial interview and the stimulated recall conversation Fred often commented when referring to his students that they were performing "where you would expect them to be." This may indicate that Fred does not see his *own* students as underachieving so may not have a reference to comment on the cause of the underachievement in *other* teachers' classes. These belief statements seemed to be upheld in his responses throughout this study with regards to Fred's own teacher disposition.

Table 5

Fred's MTEBI Responses Related to Teacher Disposition

Personal Mathematics Teaching Efficacy Belief (SE)	**Score**
I will continually find better ways to teach mathematics.	5-Strongly Agree
When teaching mathematics, I usually welcome student questions.	
When a student has difficulty understanding a mathematics concept, I am usually at a loss as to how to help the student understand it better. (Opposite scoring)	
I understand mathematics concepts well enough to be effective in teaching mathematics.	4-Agree
I find it difficult to use manipulatives to explain to students why mathematics works.	
I am typically able to answer students' mathematics questions.	
Outcome Expectancy (OE)	**Score**
When a student does better than usual in mathematics, it is often because a teacher exerted a little extra effort.	5-Strongly Agree
When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.	
When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.	
Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.	
The teacher is generally responsible for the achievement of students in mathematics.	4-Agree
If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.	3-Uncertain

Struggles with mathematical discourse. During the initial interview when questioned about his instructional decisions regarding CCSS-MP3 (See Appendix C, prompt 1), Fred conveyed that he was not confident in his ability to engage students in rich mathematical conversations, acknowledging that this was an area in his teaching that he needed to continue to work at improving. Fred recognizes that he needs to make adjustments but does not indicate any immediate solutions. Fred also recognizes that communicating mathematical thinking is something with which students struggle, which may be a direct result of his own struggles. "I've often had students who when they're given the directive that they have to communicate in some way, whether that's verbally, whether it's demonstrating, they struggle." Although Fred admits the difficulty he finds in facilitating the communication, he does see the value in promoting it as indicated by his recognition that students are able to find "errors in their thinking." Fred implies that the students are then able to change their thinking because their "approach isn't necessarily working." Fred recognizes the value in having the students share their thinking because "it's important that other students hear" but it is not something that Fred acknowledges as an instructional strength. Fred implies that he needs to adapt his lessons so that the students have opportunities to openly communicate their thinking but he is unsure of the necessary steps needed to actually make the changes.

At times Fred referred to his frustration with some of his classes with regards to the students' willingness to engage in mathematics. Again indicating that it is something that he struggles with. Fred asserts that the ability to have good mathematical discussions is dependent on the nature of the students in the classroom, showing the double arrow between his teacher disposition and the societal and environmental influences on practical rationality (left side of *IDMT*, see Figure 9, bullet 1). Fred references this dependence in his response to what exists in his instructional decisions that lends itself to the implementation of CCSS-MP1 and CCSS-MP3 (see Appendix C, prompt 2).

> You know **sometimes you have great classes and great discussion** and sometimes you know we **often see our students just kind of going through the motions**. You know when they're **not listening**. You know that when they're **not really hearing each other**. We ask for feedback and questions or comments for those that are presenting and often times there's none.

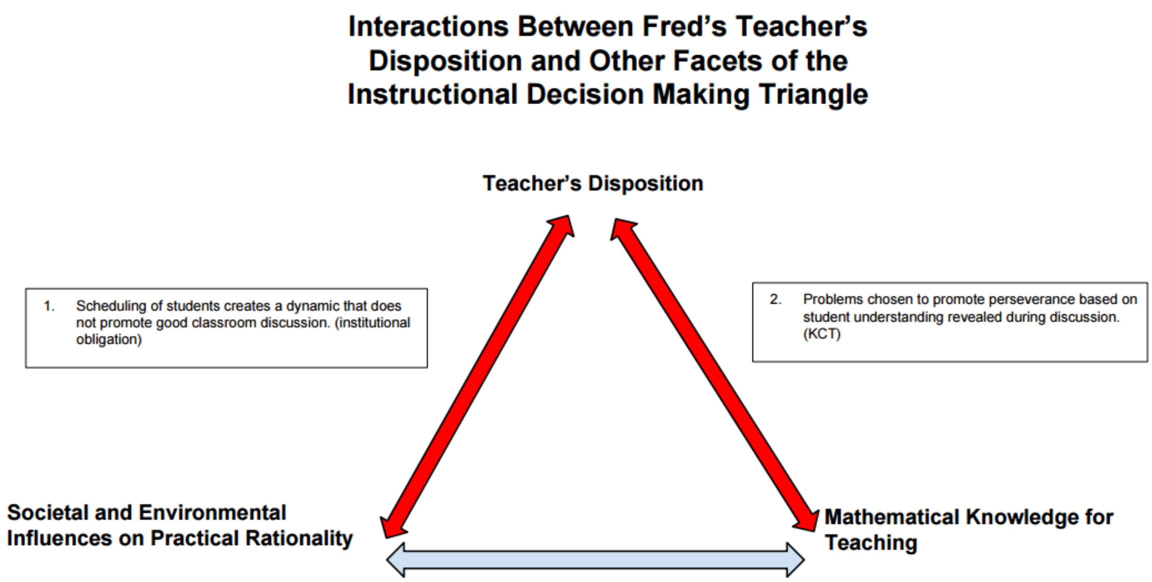

Figure 9. Fred's teacher disposition. This highlights the interactions between Fred's teacher disposition and the other facets of the *Instructional Decision Making Triangle.*

Fred describes prompting the students, at the same time implying that it is not always successful because the students are more focused on getting time to begin work on their homework.

> So it **requires a lot of prompting** but I think it's really important to take students beyond that just (clicks fingers) we're just going 60 minutes. **We're just getting through the period**. The sooner we get through this demonstration, the more time we're going to have for our homework, etc. But it's really **so important to their understanding.**

Although Fred gives recognition to the importance of critiquing and communication in student understanding, he implies that if the students choose not to engage then he will not be successful in promoting the discussion. Fred does not reference any adjustments to his instructions even though he recognizes that the discussions are often non-existent. Fred reveals his convictions about what needs to occur to ensure the enactment of the mathematical practices, keeping the demonstration going, but does not always believe that he has the power to facilitate its occurrence. This indicates that Fred knows he needs to adapt his instructional decisions but is not quite sure what those adaptations need to be.

Problem selection to bolster students' confidence. Fred attaches importance to bolstering his students' beliefs in their problem solving reflective of a problem solving view of mathematics (Ernest, 1989; Thompson, 1992). Fred does this by choosing questions that pushes his students to persevere even when they openly state that they are unable to understand the material. Fred does not allow his students to rely on him to give them the solution rather he adjusts his instructions based on what the students reveal to him that they know indicative of Fred's KCS (right side of *IDMT*, see Figure 9, bullet 2). He pushes them to realize their abilities even when the students are unable to see it themselves (see bolded text).

> We often **talk** with our kids **about** those very **common phrases of 'I don't get this' and you know 'I'm not good at math.' 'I don't understand math.'** But I'm trying to get them to **rephrase** some of that thinking and some of those questions and try to get them to question themselves. **'What do I understand? What is confusing me about this?'** and **trying to get those entry points, to persevere more and get to a solution** we know that they can get to. But it's because we've seen them demonstrate that those skills that they need to maybe solve a particular problem but they just need to be able to get to it and to access that.

By adapting his instruction to get his students to look for aspects of mathematics where they are already proficient, Fred is utilizing his KCS to build the confidence vital to enable them to persevere in their problem solving.

Although Fred holds a disposition toward problem solving as the correct pedagogical choice, Fred is not confident that he has the ability to help them achieve high levels of understanding. During the simulated recall videotaping viewing, Fred commented on the students open ended responses to the analysis of their data as being "where you kind of expect them to be" which seems to indicate that Fred desires a higher level of response. Fred describes his students as being "pretty concrete about it." Although Fred indicates that this is "fine," his tone suggests that it is below where Fred would really like his students' responses to be. Again, Fred knows that adjustments need to be made to get his students to look beyond the concrete but does not offer how he will make the necessary adaptations to his instruction.

Fred describes making instructional decisions with the desire to get students to be better problem solvers and become better at communicating as ways to develop mathematical understanding indicative of a problem solving view of mathematics. Although Fred's KCS helps him to recognize how students will react to the mathematics, he describes lacking the confidence to move students to a higher level of engagement. Fred frequently described the need for adaptations in his instructional decisions but Fred lacked the knowledge of what those adaptations needed to be.

Curricular Choice as a Component of Fred's Mathematical Knowledge for Teaching

Ball et al. (2008) described the MKT as knowledge that a teacher utilizes to establish a classroom incorporating mathematical explorations that are done collaboratively. Further, they described an environment where student's ideas are valued and mathematics is handled with integrity. Teachers are seen answering students' questions and encouraging reflection about the strategies leading to correct solutions (p. 395). During the interviews and simulated recall sessions, Fred describes his MKT in conjunction with his instructional decision making.

Task and problem selection influenced by students. Staying true to his teacher disposition toward student ownership of learning, Fred describes the pedagogical decision to have students engage with the content of focus. In response to why the mathematical practices are forefront in the CCSS (see Appendix C, prompt 1), Fred describes a curricular choice toward an exploratory mode of instruction, part of his KCT, as intended to promote perseverance and peer modeling. "I guess our goal is to have that [problem solving] be driven from the students themselves." Drawing on his teacher disposition toward promoting problem solving, Fred describes facilitating learning by using the students' conversation to ascertain their prior knowledge, indicative of his KCS.

> As teachers when we see that there are gaps, it's intuitive to do those things like [ask], "Ok well what is a similar scenario that we've seen that's similar to this problem? What is a simpler way to model this problem? What's something that's an entry point?"

As Fred further thinks about the prompt, he describes the pedagogical choice to allow for collaborative learning to enable students to interact with the content of focus.

> It's the beauty of being in a classroom of learners as opposed to here's the content. You know we can all access that content by ourselves and we could take a course online and still be presented with the material but if you don't have others that are modeling for you, that you're kind of engaged with, then you're never going to think of other ways to approach things. So I think it is [CCSS-MP-1] important for having, you know, mathematical understanding because we're just not learning things by rote.

Fred communicates his teacher disposition toward peer learning stating that without peer-to-peer modeling of thinking, the students are "never going to think of other ways to approach things." Ball et al. (2008) described knowing when to ask questions that will promote further learning as a part of KCT. Fred describes asking his students questions as something that he does intuitively when he sees gaps in the students' understanding. This is an example of Fred's enactment of the curricular choice theme.

When Fred was asked to reflect on his thinking process as he plans a lesson (See Appendix C, prompt 1), he describes seeking problems and tasks that allow students an accessible entry point based on their prior learning experiences and content understanding, KCS. Fred illustrates the importance of choosing examples that "build on previous context whether it's previous as in last week, last year, or the beginning of the period just something that's going to build some confidence but give some context for understanding." This exemplifies the curricular choice theme with regards to KCT, as described earlier with regards to Mary, sequencing particular content for instruction, deciding which examples to start with and which examples to choose that allow for immediate student access to the necessary prior skills and understanding used to take students deeper into the content (Ball et al. 2008). Further, Fred describes task but acknowledges that "it's sometimes a fine line between stretching those that need stretched and frustrating some that can be easily frustrated." This shows the double arrow connection between Fred's KCT and his individual obligation to his students (left side of *IDMT*, see Figure 10, bullet 1). Thus, Fred's remarks demonstrate a combination of curricular decision driven by what students are likely to do with the task and whether they will find it hard or easy (KCS) and knowing the content of the curriculum (KCC).

As indicated earlier, Fred describes listening to his students who lack the confidence in their ability (See Appendix C, prompt 1). "I definitely have some students that already come in with some preconceived notions about their ability mathematically. Those are the kids that I think it's more of a challenge to get to persevere." Consistent with his teacher disposition to facilitate the learning of all his students, Fred describes how he interprets his students' resistance to complete the task and how he pushes his students' thinking through questioning intended to encourage them to persevere through the mathematical task.

> I'm trying to **get them to rephrase** some of that thinking and some of these questions and try to **get them to question themselves** and trying to **get to those entry points** to persevere more and **get to a solution we know that they can get to**. We've **seen them demonstrate those skills** that they need to maybe solve a particular problem but they just need to be able to get to it and to access that. So **a lot of confidence** will **or a lack of confidence** will certainly **affect them**.

The comments do not only reflect his teacher disposition toward problem solving but also his individual obligation to his students (left side of *IDMT*, see Figure 10, bullet 2) and Fred's KCS regarding whether students will find the tasks difficult or easy (Ball et al., 2008). Through listening and interpreting their emerging thinking while at the same time helping them to access the skills they have already demonstrated they know reflects the relations between specific mathematical knowledge (SCK) and Fred's awareness of his students' mathematical thinking (KCS). This is indicative of the curricular choice theme within MKT.

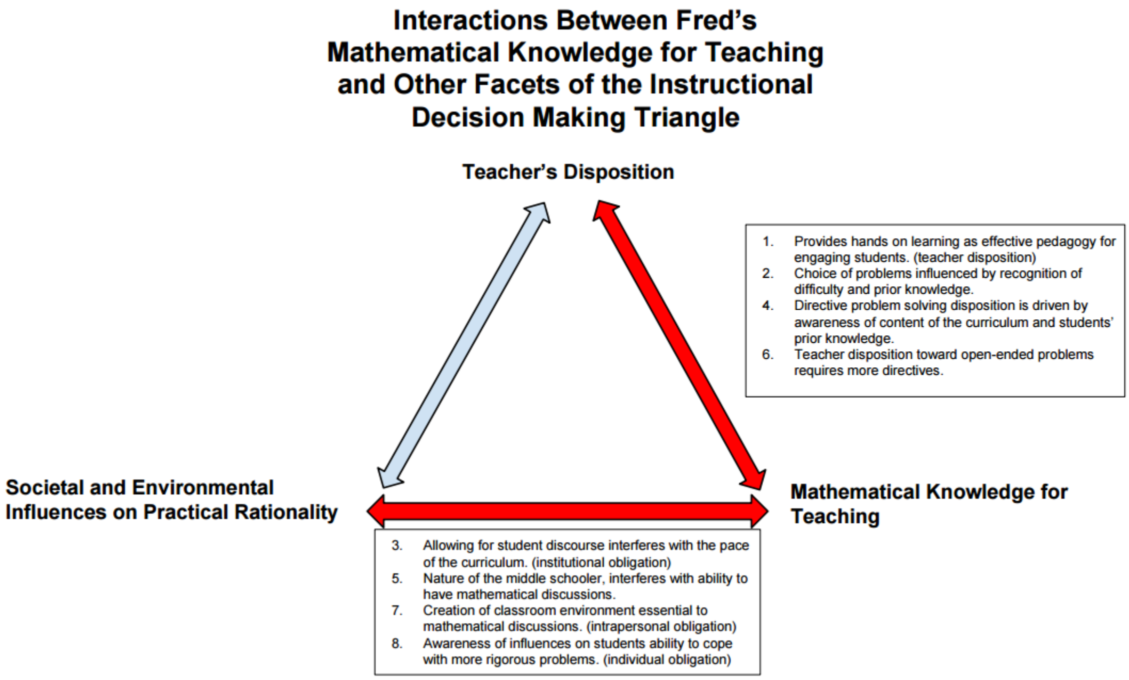

Figure 10. Fred's MKT. This highlights the interactions between Fred's MKT and the other facets of the *Instructional Decision Making Triangle.*

Benefits from peer interactions with teacher directives. Fred reflects on his thought process when making curricular choices regarding how he will have his students communicate their mathematical understanding. Fred illustrates the struggle between his institutional obligation to follow a pacing guide (left side of *IDMT*, see Figure 10, bullet 3) and what his past experiences have shown as a good pedagogical curricular choice, allowing students to visually communicate their understanding. Although Fred explicitly states that this mode of communicating will "take them inevitably three times as long as you think it's going to take," his tone implies that Fred sees this as a good pedagogical decision.

> I think about **which particular tasks**, which components of tasks, are **more appropriate for certain forms of communication**. What's that communication going to be? Who's the audience? Is the audience just me reading their work? Is the audience truly the audience in the classroom as groups are presenting? Are individuals representing their groups or themselves? I think about whether it's **worth the time** to have individuals or partners or groups **present** a portion of their thinking on a big piece of chart paper which is going to **take them inevitably three times as long** as you think it's going to take to prepare. You know and **a lot of times it is worth it** because they're **not only verbally explaining** but they're **working with each other** to **show that visual communication** as well.

Fred recognizes that this curricular choice takes time, which may result in a sense of discord with the institutional obligation to stay true to the pacing guide, but he also sees the benefit of providing students time to visually and verbally demonstrate their understanding. Fred further describes the interactions that occur during the class presentations of the large chart displays as another beneficial way to demonstrate student understanding. These interactions with his students are indicative of Fred's KCT as described by Ball et al. (2008), knowing the right questions to ask and when to comment on student remarks as a way to further student thinking.

> In regards to being able to **critique each other**, I think about some of **the questions** that I want **to prompt them with**. I think when they're listening, I **don't think** that they are **always necessarily asking the right questions** of each

> other or asking any questions of each other. As I have said “Do you have any questions or comments?” and [I get] “Nope. Great job.” [Fred claps]. You know that they’re certainly **being polite**. They’re listening but are they really **listening to the mathematical communication? Not always** so a lot of times I’ll **think about what I want them to be looking** for when they’re hearing each other communicate, like they were listening but we know that they’re probably not.

I interpret Fred’s espoused disposition toward his role as teacher-facilitator, interacting with his conveyed KCS, as affecting Fred’s curricular choices regarding the questions that he asks. On the one hand Fred voices recognition of his students being polite, but his tone implies that this will not lead to student understanding. This is followed by Fred drawing on his role as facilitator to provide the students with explicit directives of what to look for during the communication.

In his reflective journal responses to video of a sixth grade teacher’s classroom instruction with regards to MP-1, Fred seems to assign emphasis to the teacher providing the students with reference to previous learning as catalyst for students to persevere. “I liked the fact that the instructor gave students a reference point to this new problem by pointing out the work they did on a previous task.” Ball et al. (2008) referred to KCC as the content of the curriculum that may not be particular to the present curriculum but is necessary in order for the students to be able to do the work. Fred states that it is important to have students reflect on previous work but reprimands the teacher viewed in video for being directive. “I feel that he was too prescriptive in his directions for the learning task. He asks students to solve this problem using all “3 ways” and seems to be leading students to use all three methods." When responding to what he would do differently (see Appendix B, prompt 4), Fred stays true to his student directive problem solving disposition (top of *IDMT*, see Figure 10, bullet 4).

> I would have presented the problem, asked my students to **refer to their previous work and the strategies they presented to each other**, asked them to **find similarities between the tasks**, and asked them to **defend their position and solutions with specific evidence**.

By having students do their own reflecting on the previous tasks rather than providing them with the scripted "3 ways," Fred is applying his KCS to anticipate what the students will be able to do with the content of focus based on what he has seen them do with previous tasks. Fred's own awareness of the content of the curriculum (KCC) leads to these types of curricular choices to allow the students to take initiative in their own learning.

Connecting new tasks to previous learning and experiences. During the stimulated recall interview, while viewing his own teaching, Fred reflected on task choice as being an important curricular choice for him. Fred commented on the task choice as being one that required application of previous concepts. "They had had experience with understanding vocabulary, parts of a graph, where it comes from, why we use it, but very little application of actually using data to create it." This seems to convey Fred's sequence choice as indicative of his KCT, starting with basic content introduction followed by what he implies as a higher skill, application. Again, this seems to be reflective of his pedagogical choice of his role as facilitator of his students investigating the content of focus while making sure that his students have the necessary content knowledge to do the work they are being assigned (KCC).

Further, Fred describes the deliberative choices he made regarding the cereal boxes used as data.

> We had some boxes of cereal that were **deliberatively chosen** so that they (his students) could see a range of data, be it sugar or calories. So that was the idea that when you use that kind of graph (box and whisker plot) to see some outliers and see the spread of the data.

By referencing this curricular choice, Fred seems to convey his knowledge of the type of data display leading to his choice of data to be included, evidencing his KCC.

Another specific example of his teacher disposition toward his role of facilitator is his choice of application that followed his students collecting data from the cereal boxes Fred had provided in class. Fred describes the application problem, an imaginary cereal box with three times as much sugar or calories, as one that pushed his students to persevere while allowing students to communicate their understanding to their group as well as other groups within the class. Although the nature of the question allowed for student choice, “Which statistic would you choose, median or mean, to try to convince somebody that this was a healthy cereal being added to the data?” Fred was more directive in what he wanted the students to do with the data once they were done with the collection as he indicated that being pretty concrete about their findings “is where you kind of expect them to be” which reflects his own KCS. Fred wants his students to be more analytical but his statements convey that he does not have much confidence in this coming to fruition. To help facilitate this, Fred made a list on the board of what he "recommended they do with their data" and leaving it there for them to reference, again reflecting his anticipation of what his students would find hard and what they would find to be easy (KCS).

Establishment of teacher expectations and classroom environment. With regards to student communication (CCSS-MP3), Fred illustrates an example of a curricular choice he made to employ a new strategy he had seen during a professional development experience. His catalyst behind the choice was prior experience with students presenting their findings to the entire class and losing interest, ultimately missing opportunities to learn from their peers.

> So I was really **trying to find a way** for them to present the data that they collected on cereal and the conclusions that they came to, to each other **without truly having everyone sit there and listen** because there's only so much of that you can do because **most kids just tune out**.

This reveals the double arrow connection between individual obligations to his students (left side of *IDMT*, see Figure 10, bullet 5) and choice of representations, KCT. Although Fred saw the curricular choice as leading to the better listening, Fred once again felt he needed to do a better job at facilitating the communication staying true to that ever present role (top of *IDMT*, see Figure 10, bullet 6). Fred seems to suggest that when the task is open-ended, his students are not as successful, needing more directives from him.

> Their **feedback** that they gave to each other **wasn't at the level that I wanted it to be.** I think I could have **given some more specifics** you know things like **requirements** of the feedback like, you could give any feedback but you have to say something about their graph construct or give them one comment about one of their statements. It was **pretty open ended.**

Although Fred's teacher disposition is toward student empowerment in problem solving, his KCT requires a more directive role. This provides one instantiation of Fred's enactment of the curricular choices theme.

During the final interview when reflecting on what he could do right now in his instructional decision making (See Appendix D, prompt 3), Fred parallels his instructional decisions in his mathematics instruction to his pedagogical choices made when he taught elementary language arts. When suggesting what he can do in regards to CCSS-MP3, Fred sees opportunities for more collaboration in a group setting, as well as communicating with the whole class (KCT). Fred implies that this requires the establishment of a classroom environment that has well-known expectations of student roles during these exchanges, an interpersonal professional obligation (left side of *IDMT*, see Figure 10, bullet 7). Part of this curricular choice seems to be driven by his past experiences with literature circles used in previous classroom interactions as a language arts teacher.

> A lot of the **foundational little pieces and structure** [math group roles] are really kind of related to **literature circles** in a lot of ways. I really see that **parallel** right away with the roles and the **tasks and how things are organized**

> and it's really what I have done in the past. I'm elementary certified so I've taught literature before and it's something I investigated at a time but really the idea of **creating a classroom environment** that is **teacher facilitated but student led** truly and that takes work but I think those things are important because you want them to be able **to drive their learning and not always come from you** and not just be kind of watching the clock and waiting **until you're done talking** and you know **"What do you want me to do next?"** and **"Is this answer right?"** You know etcetera. You know where you want them to be **engaged in that learning with each other** but truly kind of **setting up the foundation** for that.

Fred interpersonal obligation to organize the interactions between the students as well as with him (Herbst & Chazan, 2011) lead to these pedagogical decisions to provide students with numerous opportunities to work in collaborative groups and tasks that allow for delving deeper into the content of focus (KCT).

Responding to the same prompt, Fred explains his instructional decisions when choosing tasks that will promote CCSS-MP1, perseverance and problem solving. Ball et al. (2008) acknowledged that a teacher must draw on his or her KCS in order to anticipate what students will be able to do with a task and the level of difficulty of the work involved with regards to the individuals within the instructional setting. Fred describes his curricular choices as part of this component of KCS.

> In regards to MP1 just continue to search for things that are **truly stretching them**, you know, that are **more complex tasks but are truly reachable for the**

> **wide variety of learners** that we have. That **open-endedness** of your task, those are good ones too because it **gives them some leeway**. You know **knowing when it's too hard**, what's a **healthy struggle versus struggling**. It is **hard not to pick up their pencil and get them started.** That just takes classroom experience. Knowing that you can do that, it may **make it easier for you right now** and this **kid** is going to walk out maybe **not as frustrated but in the long run**, they're going to **continue to be that frustrated**. That's just **understanding how much help is truly helpful**.

Fred conveys his pedagogical choice to provide tasks that are challenging but "truly reachable" reflective of the double arrow between his individual obligation to his students with varying cognitive and emotional needs (Herbst & Chazan, 2011; left side of *IDMT*, see Figure 10, bullet 8) and his choice of which examples to start with and which examples to use to take the students deeper into the content, KCT, without leaving them "frustrated in the long run."

Fred utilizes his individual obligation to his students to make curricular choice that will enable students to delve deeper into the content of focus (KCT). Fred also predicts what students will find difficult and easy, oftentimes erring on the easier side due to his lack of confidence in his students' abilities. Fred draws on his prior experience as a language arts teacher to create opportunities for his students to share their thinking, part of his teacher disposition toward student directive problem solving, in order to ascertain what examples to use to promote further understanding (KCT). Fred depicts the curricular choice theme in conjunction with MKT throughout his instructional decision making.

Institutional Obligation as a Component of Societal and Environmental Influences on Fred's Practical Rationality

Herbst and Chazan (2011) describe four obligations that can be used to explain why a teacher's actions may depart from the situational norm. Although all three obligations may influence a teacher's decision, Fred primarily focused on the institutional obligation as being influential in his decision making.

Institution's obligation to provide professional development. Like Mary, Fred describes the desire to be given more time to plan appropriate instructional activities that would provide students with the opportunity to engage in the employment of CCSS-MP1 and CCSS-MP3. In the initial interview when questioned about what is needed to engage students in the practices (see Appendix C, prompt 3), Fred expressed his frustration not only with the district's choice to have teachers teaching mathematics at different grade levels but also having teachers teach classes in different content areas.

> You know some of us are **teaching more than just math** even and we are **teaching a variety of different levels** and I think the **less experience you have with your content and your curriculum** the **less you know what you're looking for, what math you are trying to pull out** of whatever the task may be.

Fred reflects that these district choices do not enable teachers to gain the necessary experience needed to improve their instruction making it difficult to enact the mathematical practices well. Fred describes the necessity to work through the problems being assigned, at the same time recognizing the impracticality of actually doing the work. Fred recognizes that working through the problems will allow teachers to see where students will struggle, a connection to his KCS (right side of *IDMT*, see Figure 11, bullet 1).

> So I think the **more engagement** you can have **with the math the better** you know [the content] and we'd love to say we are all **working through every problem we assign** but we know that that's **not the case** but I think that's **really important** because we're able to kind of **foresee some of the shortcomings** and to **see what we really want them to [do], where they are going to have difficulty persevering** to solve those particular problems as well as **what we want them to like pull out of it and communicate to each other**.

Fred also notes that the district should provide more professional development opportunities and allow teachers to make classroom observations of other teachers who are teaching the same content, a type of reversed institutional obligation (left side of *IDMT,* see Figure 11, bullet 2).

> What does that mean? I don't know if that's just **more professional development**. If it's the **opportunity to view other teachers teaching the same content**. You know I think **it's important**. Those are things that we **don't really have the opportunity**. Where as much as we **want to collaborate** we're still pretty much, it's **kind of a one person show**.

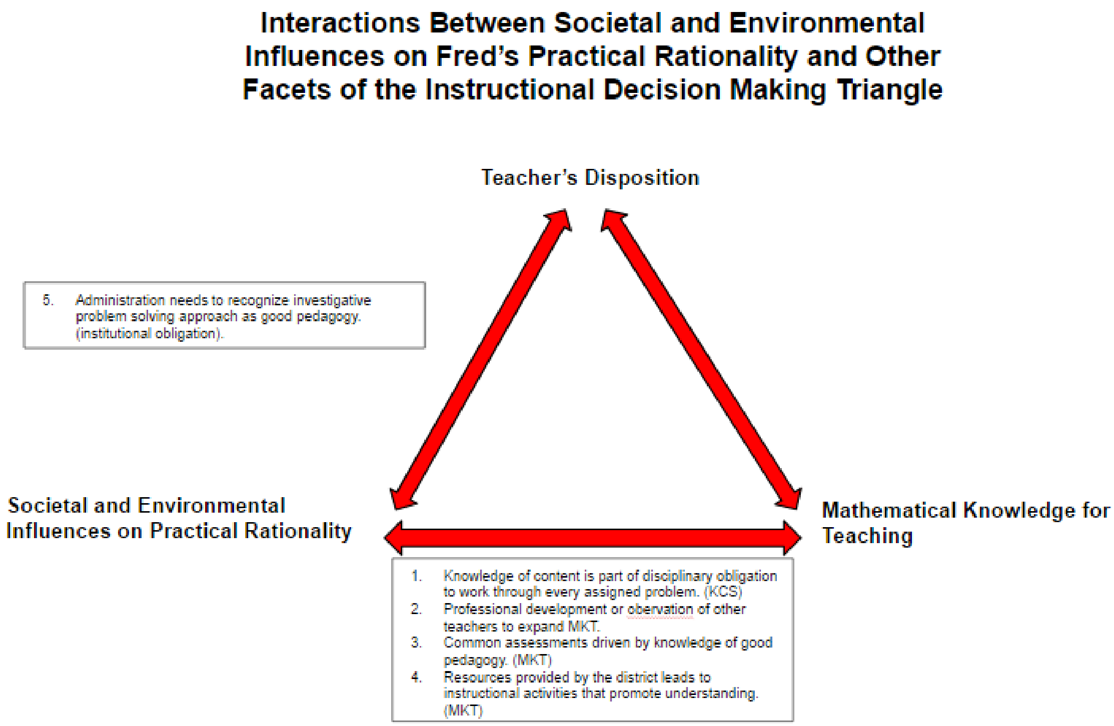

Figure 11. Influences on Fred's practical rationality. This highlights the interactions between societal and environmental influences on Fred's Practical Rationality and the other facets of the *Instructional Decision Making Triangle.*

Fred's acknowledgment of his own feeling of being "kind of a one person show" seems to reflect what he sees as a lack of opportunities provided by his district to collaborate with his colleagues, a practice that Fred implies would be beneficial at least for his instructional decisions. Fred also sees the need for professional development so that he is able to know what he needs his students to be able to do with regards to the mathematical practices. Again, Fred implies that this should be an institutional obligation afforded to him.

Joint decision making between institution and teacher. In the initial interview when asked about the influence that the professional obligations have on his instructional decisions regarding CCSS-MP1 and CCSS-MP3, Fred reflects on his MKT (right side of *IDMT*, see Figure 11, bullet 3) with regards to knowing the content but he also reflects on the institutional obligations with regards to schoolwide environment and common assessments (See Appendix C, prompt 4).

> What do we need to understand and do to truly benefit the people that we're serving, our students? It is truly you know having the **understanding of your content**, creating an **appropriate learning environment**, which is going to be conducive to those particular mathematical practices that you're focusing on. I know a lot of those other things, the **schoolwide setting**, how we're **scheduling students**, what are our **school policies on assessment** whether it is you know a **departmental decision** whether it's something that's **coming from our administration** that you know we **need to have common assessments at each grade level**.

Although Fred recognizes that the district is ultimately the one enforcing the schoolwide decisions, he makes sure to note that it should also be a result of consultation with the teachers who are obligate to enforce them, again a double arrow connection between the teacher and the institution.

> I think some of those things are **maybe outside of what's going on in the classroom**. I think a lot of hopefully we're **placing kids appropriately** if we have **different levels of mathematics.** So those are **decisions we need to constantly make**. Are our **kids in the right place** to truly get out of them what

> they need to get out of each class? There is a lot that we **do have control** on and **control with the common assessments** hopefully are **teacher driven**.

Fred recognizes that some of the district decisions are "outside of what's going on in the classroom," but he acknowledges that the teacher should still be the one driving the schoolwide decisions. Institutional obligations although imposed by the district ultimately are the responsibility of the teacher who is working with those who they serve, the students. Fred seems to consider this as part of the tasks that he must attend to in order to ensure correct placement of his students which ultimately leads to student understanding, reflective of his interpersonal professional obligation.

Institution's obligation to provide instructional resources. Further in his response, Fred describes the limitations he feels with regards to the curricular materials provided by the district. Fred acknowledges that the district has allowed him the "freedom" to find his own resources, but his laughter following this comment implies that this was not a benefit but rather a burden he had to face. Fred suggests that the choice of resources during these searches in the long run impacts the classroom interactions regarding CCSS-MP1 and CCSS-MP3. The institutional obligation (left side of *IDMT*, see Figure 11, bullet 4) to choose the appropriate curricular resources without much support may prevent Fred and his colleagues from enacting the mathematical practices (see bolded text).

> So I think that's a **big factor**. It is **limiting**? Maybe it can be. If you **figure out** what those **limits** are and you **find** things that are **better** you know as in regards to **curriculum**. We're in a transition right now that **everything** that we have used

> **in the past**, maybe not everything, but a **good portion of it** just **doesn't work** anymore. So we've been kind of **on our own to pull resources** from a variety of places but we've had the **freedom to do that (laughs)** because we have to but I think those things are going to **influence how our classroom's going to run** and the **type of learning that's happening** whether we're **looking for rich mathematics** or whether it's pretty much **rote skill work**. Whether the classroom is **structured** in a way **where we're communicating** or **thinking about those rich problems or not.** I think **one thing influences the other** and likewise you know.

Fred further references the need for curricular materials when asked in the final interview to describe the ideal instructional system (See Appendix D, prompt 1).

> I think the ideal instructional system in regards to MP-1 is to truly have a **great selection of resources and rich problems** that are **sequenced** in a way that is always going **to keep kids confident** yet **pushing towards something achievable** yet takes some work, **truly takes some work** is **stretching their thinking**. I think I have some of those problems but I **don't feel like I have them sequenced in good ways** sometimes as well as I just **don't have enough of them** truly. I think there are a lot of **tasks** I know it that it's **truly too easy for a lot of kids** and **overwhelming for others** so it's really trying to find that sweet spot. I **don't think that we will find that truly in every lesson and every task for every kid** but I think if we're **sequencing things well and problems are rich** enough we can **truly stretch some kids and no matter where they're at**.

Fred does not feel that he has enough resources to provide the necessary tasks needed to stretch kids to the level that he knows they need to be stretched as described in his KCT (right side of *IDMT*, see Figure 11, bullet 4). Given the appropriate resources from his district, Fred implies that he would be able to make better instructional decisions regarding the implementation of CCSS-MP1 and CCSS-MP3. This seems to reflect an obligation of the institution toward Fred, reflective of the theme.

District's public acknowledgment of best practices. When questioned about the supports needed to be able to include CCSS-MP1 and CCSS-MP3 in his instructional decision making (See Appendix D, prompt 2), Fred immediately responds by describing the lack of parental support or understanding. Fred suggests that part of the problem is the lack of outward support from the administration both at the building level and central office level. Fred seems to imply that parents will support his instructional decisions if the administration makes it clear to the community that his disposition toward an investigative problem solving approach is best practice, reflective of the double arrow (top of *IDMT*, see Figure 11, bullet 5). Fred sees the need to educate parents as an institutional obligation at the administrative level. Fred also desires from the institution more time for his mathematics instruction, once the district recognizes that his instructional decisions really are best practice.

> I think really just sometimes it's hard to believe that were still kind of **battling parental objections or confusion to truly inquiry based collaborative work** in the math classroom and **not just teaching formal algorithms** right from the get go but it still is there. So I really think one of the **biggest supports** is just having

> **an administration at the building level all the way up to the central office** that really **believes in good math instruction** and how that takes place and really just the **support** there **from knowing what we are doing and understanding that its research based** as well as truly **best practice**. I think those are important but as well as continuing to have **good chunks of time to teach** you know in the sense of how we are **constructing the schedule**.

Fred does not seem to object to having the institutional obligations imposed on him, often recognizing that some of the decisions are outside of what he does in the classroom. Rather, Fred implores for more support from the district with regards to professional development opportunities which might include observations of others enacting the mathematical practices. He also requests support from the district in outward recognition of the instructional decisions being made as best practices and providing the teachers with the necessary curricular resources to enact CCSS-MP1 and CCSS-MP3.

Jen's Case

This section gives a brief description of Jen's instructional decision making as she attempts to enact CCSS-MP1 and CCSS-MP3. Components of her decision making, such as Jen's disposition toward a growth mindset, her MKT allowing for student errors, and the institution's obligations to provide investigative resources are examined. These connections to the *Instructional Decision Making Triangle* are discussed in detail.

Background

Jen has been teaching for 14 years, at three different neighboring public school districts. She has been in her present teaching position for five years. She has taught primarily regular seventh grade mathematics and accelerated seventh grade mathematics. Jen has also worked in an inclusion setting, co-teaching with an interventionist specialist. Her experience with these different levels of mathematics has given her a vast knowledge of the mathematics content standards as she has had to adjust her learning modes to meet the diverse needs of her students. Without a deep content knowledge, this would be a difficult task.

Jen shows a deep sense of collaboration as she co-plans with the interventionist specialist, allowing her colleague to take the lead role at times and dividing the work in the instructional planning. She has a strong devotion to the teaching profession, working as a lead presenter at a summer workshop for middle school mathematics educators. Jen has a master’s degree in education. During several of her responses during the interviewing process, Jen revealed that she spends time reading current educational literature not only with regards to mathematics teaching but education in general. She is not afraid to test out these practices in her classroom as will be show in the following narrative.

Jen is dedicated to all students learning and has a great rapport with her students as revealed in the videos of her classroom interactions. Students are eager to respond to her questions and will seek her assistance when needed. This shows that the students respect her knowledge of mathematics as well as demonstrating her establishment of a learning environment that encourages collaboration and problem solving.

Jen was hesitant at times to response to the interview questions, taking time to re-read the questions after I had read it aloud. Other times, she requested clarification, asking for my assistance in making meaning of the intent of the question. At the conclusion of several responses, Jen would comment that she was unsure of whether or not she had given me what I needed for my study. On the other hand, once she grasped the direction of the questions, Jen was confident in sharing her opinion and even displayed a tone of excitement in her voice as she responded. It was apparent that Jen had a passion for teaching and enjoyment in her students' successes with the mathematics content. Jen thanked me often for our discussions and indicated that she would be willing to meet again if I needed additional information.

Adaptation as a Component of Jen's Teacher Disposition

The results of the MTEBI survey for Jen indicate that she has a high personal mathematics teaching efficacy belief (SE) with a composite score of 4.75. Responses to several of the statements seem to suggest Jen's belief the she is effective in helping students to understand math (See Table 6). On the other hand, Jen's outcome expectancy score (OE) is lower with a score of 3.75, falling just below the "agree" level, indicative of an implied belief that students play some role in their own learning. Her scoring of some of the response questions seems to signify her uncertainty with regards to her sole role in the mathematical outcomes of her students despite the fact that she is confident she has the ability to teach mathematics (see Table 6). Throughout the study, Jen described the dual responsibility between teacher and students with regards to learning which seems to correlate to her MTEBI responses. These belief statements seemed to be upheld in her responses throughout this study with regards to her own teacher disposition.

Promoting problem solving in an error friendly environment. Jen is a teacher who openly expresses her passion for her profession. During the initial interview, it became apparent that Jen valued her students and was excited when she was able to see her students succeed. Part of her students' successes came from making changes in her instruction in order to push her students beyond their comfort zones. In order to push them beyond their comfort zone, it is important first to get students to believe in their ability to problem solve, reflective of a problem solving view of mathematics. When asked why she believed the mathematical practices were placed at the forefront of the standards documents (See Appendix C, prompt 1), Jen turned to the desire to have her students feel confident in their abilities**.**

> I love that **persevering** because sometimes we are just so quick to go and give up. Go to the teacher and ask. But that **kind of pushes them for solving it themselves before they give up**. So why do I think this practice is important? Because it starts kids out with the **belief that they can solve the problem themselves or the belief that they can use any strategy to solve a problem**.

Jen does not place the emphasis on her role in student learning but rather places the onus on the student. Jen makes adjustments to the instructions based on what the students are demonstrating when she interacts with them, a double arrow relationship to her KCS (right side of *IDMT*, see Figure 12, bullet 1). Jen creates a classroom environment where students are able to make mistakes and learn from them. The emphasis is not just on the answer but on the justification of the solution. Jen wants to move the focus away from striving to find the one right answer to the process and the learning that precedes the final result.

Table 6

Jen's MTEBI Responses Related to Teacher Disposition

Personal Mathematics Teaching Efficacy Belief (SE)	**Score**
I will continually find better ways to teach mathematics.	5-Strongly Agree
I understand mathematics concepts well enough to be effective in teaching mathematics.	
I find it difficult to use manipulatives to explain to students why mathematics works.	
I am typically able to answer students' mathematics questions.	
When teaching mathematics, I usually welcome student questions.	
When a student has difficulty understanding a mathematics concept, I am usually at a loss as to how to help the student understand it better. (Opposite scoring)	
Outcome Expectancy (OE)	**Score**
When a student does better than usual in mathematics, it is often because a teacher exerted a little extra effort.	4-Agree
When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.	
The teacher is generally responsible for the achievement of students in mathematics.	
If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.	3-Uncertain
When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.	
Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.	

> The **process is more important than the end**. That's what we're trying to teach this year, that **how I solve something, the steps that I need to take**, it's **ok** to have a **different strategy than someone else you know or it's ok to just not have the right answer**. I want them to find the answers but **I want to be one that's supporting them**.

Due to her belief that a teacher must adapt instruction to meet the needs of the individual, Jen provides support to students to allow them to become confident in their ability to develop mathematical understanding and differing strategies which can be employed in various situations, related to her KCT (right side of *IDMT*, see Figure 12, bullet 2). Jen describes this as a vital part of CCSS-MP1 and also difficult.

> You want to **lead them in the right direction**. You want to **ask them questions**. That I found hard. **That's hard**. How do I **know when to let them go** and when do I **need to instruct a lesson**? Like when do I **provide the rich problems** but then **just let them go?**

Jen also struggles with knowing exactly what the students need to take away from the instruction. "I'm thinking what do I want the kids to get out of this and sometimes you don't know." In a sense, this reveals Jen desire to adapt lessons to meet the needs of her students but not always knowing exactly what those adjustments need to be.

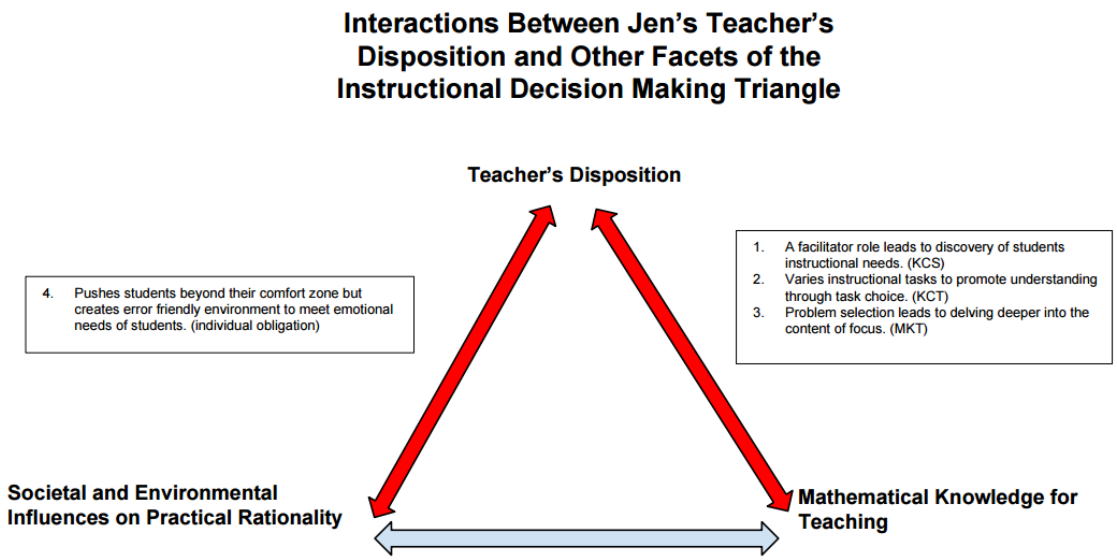

Figure 12. Jen's teacher disposition. This highlights the interactions between Jen's teacher disposition and the other facets of the *Instructional Decision Making Triangle.*

Inclination toward a growth mindset. Although Jen worries about her own mistakes, she creates an error friendly environment for her students. Jen knows that it is difficult for students to feel comfortable sharing their mistakes so she works hard to establish a rapport with her students that allows for a growth mindset. A growth mindset, as described by Dweck (2006), is the belief held by an individual that basic abilities can grow through hard work and dedication and that intelligence and the talent you are born with are just the starting points. Jen's teacher disposition in this growth mindset philosophy is coupled with her view that we learn more from our mistakes than we do from the right answer.

> I think sometimes when in pairs, it's the kids **comfort level** in the classroom with **sharing their mistakes and knowing it's ok that you have mistakes**. That you have to set right off the bat. It's so **hard to let them know that it's okay**. **Our**

> **brain learns more from mistakes than it does when we do it right**. And then I try to give examples too about how many times you have to fail to succeed. You know, look at some of the inventions that we've created and how many times have said 'Oh, that's terrible. This is a better idea.' So how many times that takes to go there? So we are really **trying to get that mindset going**.

Students are confident that Jen will make sure that they get it right but that it is acceptable to struggle along the way, promoting teacher disposition toward perseverance in problem solving. Her willingness to adapt the lesson as she goes promotes this environment.

Jen lives her professional life in a growth mindset, constantly looking for professional development opportunities and reading professional literature. It was always apparent in our conversations that Jen believed that she could be doing it better. I think that had a direct correlation with Jen's conviction that the students in her classroom had high academic abilities and needed to be challenged. Driven to provide these higher level problem solving opportunities, Jen continually looked for ways to provide instruction that pushed them to new levels.

> They're very smart kids. They want to learn but then **maybe I'm not challenging them**. Like maybe **I need to go about different ways of teaching them** you know than I'm used to. They're very good at listening and regurgitating but I **want them to be active thinkers and listeners and problem solvers**. So get them out of that zone. You know it's just **easy to do it this way**

> **so I'm going to keep doing this**. You know it's comfortable. But I continue to **try to get them out of that comfort zone**.

Although it is hard to do this with her students, Jen wants her students to grow so she keeps pushing them to new levels. Jen adapts her instruction, giving her students suggestions without giving solutions, to enable them to persevere through the problem. Jen utilizes her KCT to find rich problems that will enable her students to delve deeper into the content of focus, reflective of the double arrow connection between her teacher disposition and MKT (right side of *IDMT*, see Figure 12, bullet 3).

Jen's teacher disposition toward a facilitator role that pushes her students beyond their comfort zone requires Jen to be flexible in her instructional decisions. Jen's main goal seems to be to allow every student in her classroom to develop a growth mindset, building confidence in their mathematical abilities. One way that Jen promotes this is through an error-friendly environment, encouraging students to learn from their mistakes rather than feel defeated by them, staying true to her obligation to the individuals (left side of *IDMT*, see Figure 12, bullet 4). Jen uses her MKT to find ways to promote understanding directly connected to the interactions she has with her students during collaborative group interactions.

Curricular Choice as a Component of Jen's Mathematical Knowledge for Teaching

The mathematical tasks of teaching require mathematical knowledge that interacts with the design of instruction (Ball et al., 2008). Jen utilizes her MKT in her instructional decisions, always cognizant the individuals in her classroom.

Student empowerment and reflection. Like Mary, Jen illustrates the importance of her role during classroom discussions especially during questioning when she utilizes students' remarks to make a mathematical point or seeks clarity indicative of her KCT (Ball et al., 2008). Staying true to her teacher disposition toward student empowerment, Jen describes the pedagogical decision to allow students to have different entry points and strategies for arriving at a solution.

> They're just worried about **getting to the end point instead of the process** and the **process is more important than the end**. That's what we're trying to teach this year. That **how I solve something**, the steps that I need to take, it's okay to **have a different strategy than someone else**.

In response to the why the mathematical practices are in the forefront in the CCSS (see Appendix C, prompt 1), Jen describes the importance of her curricular choice to accept student errors as a way to promote perseverance and critiquing. Jen explains how her students approach a problem, often searching for the right answer, at the same time being accepting of wrong answers. "It's okay to just not have the right answer. You know they're so caught up sometimes in just having the right answer." Although recognizing that her students focus more on the right answer than the process, Jen places the emphasis on the explanation of the process through reflection to promote further learning indicative of her MKT (right side of *IDMT*, see Figure 13, bullet 1).

> I don't know if it's just in the district that I teach in but the **answer is the upmost thing for them instead of the process** you know in knowing how to solve a problem. I love the reflection. The **reflection piece** or **how did we solve this**

> **one before** and then in the way that the problems like spiral back is so great. Just little things like that. **It's about the process**. How we get there. That **showing and persevering**, **making sense**. Those things come into every problem. That's what we're trying to do this year, to embed that a little bit more.

Jen's comments reflect a personalization disposition towards a non-rigid student approach to learning mathematics (top of *IDMT*, see Figure 13, bullet 2) but her tone conveys not only a belief in this open-ended strategic approach but a knowledge, based on her own research and observations in her classroom and other teachers' classrooms, that it is an effective pedagogy for promoting perseverance and good mathematical discussion. Jen's recognition that students often focus on finding the right answer while ignoring the process, leads to the instructional decision to emphasize reflection by the students on the strategy they choose, evidence of the curricular choice theme within MKT (right side of *IDMT,* see Figure 13, bullet 1).

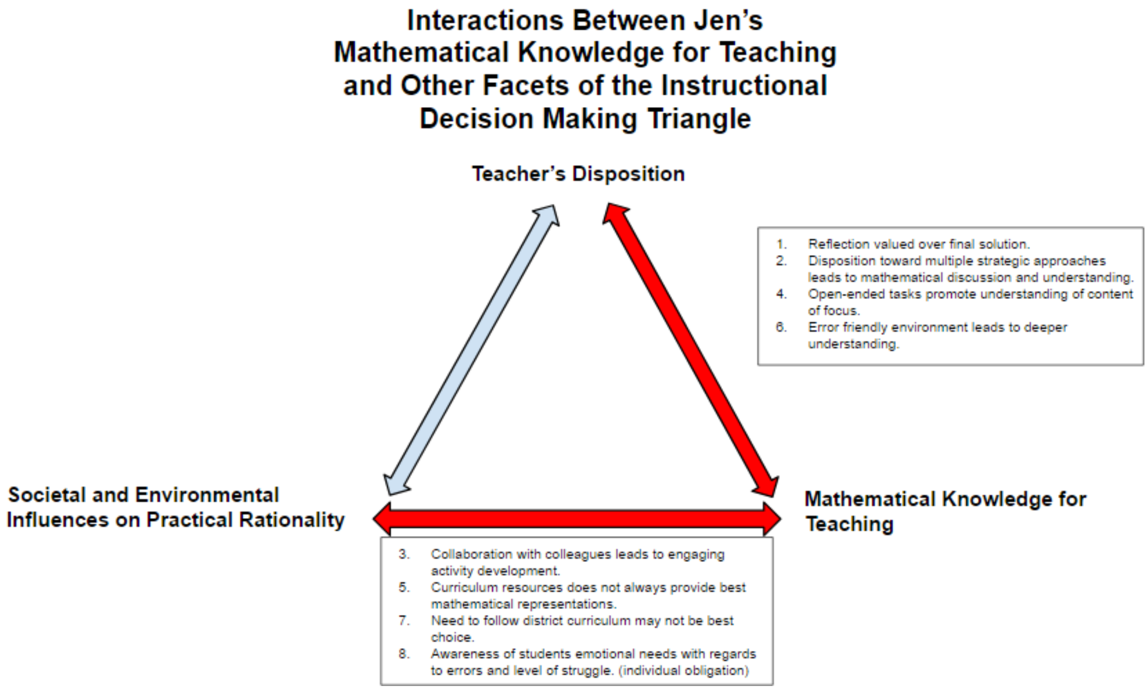

Figure 13. Jen's MKT. This highlights the interactions between Jen's MKT and the other facets of the *Instructional Decision Making Triangle.*

Lesson development through collaboration. Similarly to Mary, Jen conveys a desire to find tasks that students will find interesting and motivating which is an aspect of KCS (Ball et al., 2008; right side of *IDMT*, see Figure 13). On more than one occasion during the initial interview when asked why she thought these two practices, CCSS-MP1 and CCSS-MP3, were in the forefront of the standards (See Appendix C, prompt 1), Jen describes her instructional decision on how she chooses problems that relate to real contexts in order to establish both interest and motivation. In conjunction with the interpersonal obligation (left side of *IDMT*, see Figure 13, bullet 3), Jen works with teachers from other disciplines to create these instructional activities that incorporate the content of focus while engaging the students as described in the bolded text.

> We can cross team things now. Like my science teacher works on things and he's **doing mathematical practices**, I think that's vital because we're getting all those things then together. We're working on an **engineering project** right now. One of our teachers wrote a grant for and she asked the **math teachers, the science teachers,** down to **social studies**. We're all doing like an **interdisciplinary unit** on Rome but they're having to find scale factor for it and they're building the Rome cities and they're figuring out how, you know. But all that's math and science and social studies.

Jen not only sees the value in the rich mathematics embedded in the interdisciplinary unit (scale factor) but her tone implies that connecting it to other content is an effective pedagogy and part of her interpersonal obligation, connecting to all members in the instructional situation. This is evidence of the curricular choice theme within KCS.

Exposure to multiple strategies. Part of KCT requires the teacher to make instructional decisions regarding the sequencing of the content of focus for instruction (Ball et al., 2008). The teacher needs to choose examples to start with and then provide problems that will take the students deeper into the content. In the initial interview when asked about which of her instructional norms enable her to enact CCSS-MP1 and CCSS-MP3 (See Appendix C, prompt 5), Jen describes how her knowledge of the content sometimes requires her to intervene when students are selecting their own strategy. Jen struggles with staying true to her teacher disposition toward allowing students to make mistakes and have choice in their approaches and having to provide them with a prescribed strategy.

> **I love how they go solve their own strategies but sometimes I have to teach them a strategy** and have to get them used to that before they actually put it into use. So I found a balance of this a little bit. Like let me **keep practicing** this way a little bit and **then** go try to **use** that. Like for example proportions. They just wanted to divide or just wanted to (pause), they didn't set it up in a proportion but sometimes that set up, they don't go to that because maybe it looks too much like mine you know so they're **trying to use** like **basic strategies** to solve something **instead of** take it to the **next level** and set up a proportion and understand what that proportion means. I think it's **critical** to get them **to understand**, to try **to persevere** in **looking at other's reasoning** because to me if they start **seeing other people solving** them some way, **I** as the **teacher pointing the ways out** as they solve them because maybe **another kid** will **pick up on that way**. Sometimes they're **reluctant**, they **go back to the same way** that they've always done it and they **don't** get out there and **try to solve it in different ways**. In some respects, I understand how they have to like, "This is the step. This is the next step. This is the next step." But **listening to other people's steps** I think is **critical**.

Jen describes a struggle between her teacher disposition toward allowing for student strategic choice and knowing when to intervene to provide the mathematical strategy. Jen appears to promote exposure to multiple strategies as good pedagogy but does not always know how to engage her students in the enactment of these strategies. A curricular choice appears to be the repeated exposure to other students' mathematical processing of the content of focus. This seems to go along with Jen's beliefs responses that indicate that the teacher is responsible for student achievement (see Table 3). Her curricular choice to allow for student choice, whether that be using the old strategy or finding a new strategy, is reflective of her KCT, deciding which representations to use.

Further evidence of Jen's instructional decision to provide multiple exposure to different strategies as being a good pedagogical decision is revealed in her journal response after viewing the video of a seventh grade teacher enacting CCSS-MP1 (see Appendix B, prompt 4). When asked how she would have implemented the lesson differently to promote CCSS-MP1, Jen responded that she would provide more interaction with new strategies as seen in the following quote. "I think the students need more interaction and to see other cards and make more connections, build their prior knowledge and new knowledge before getting into the large group discussion and manipulating the large cards on the front board." Her response seems to imply that having the whole group discussion too early could actually hinder student individual learning that could result from students seeing other students' responses first. Jen suggests a second instructional strategy that allows groups to sort their own cards into appropriate categories followed by a representative from the group, the traveling salesman, to go to another group to "sell" their group's categorizing of the cards. This strategy again evidences her pedagogical choice to allow for multiple exposure to other's thinking. Similarly, after viewing the video enactment of MP-3, Jen describes how she would allow students to share their strategies.

> I would **allow students to visit each group** to share ideas, since I **believe students learn best from peers**, then they could **report back to the group with new ideas** and they have owned the ideas and questions and have critiqued the reasoning of others.

As part of her instructional decisions, Jen appears to see exposure to student's emerging and incomplete thinking (Ball et al., 2008) both by her and the other students in the class as valuable instructional interactions that promote mathematical understanding. Jen's espoused familiarity with her student's mathematical thinking seems to promote specific mathematical understanding reflective of the curricular choice theme.

Choosing open-ended tasks. During the stimulated recall viewing of Jen's teaching, Jen reflects on her teacher disposition towards open-ended tasks (top of *IDMT*, see Figure 13, bullet 4) as effective pedagogy for promoting understanding of the content of focus. Parallel to both Mary and Fred, Jen describes looking for tasks that will enable students to delve deeper into the content, reflective of her KCT (right side of *IDMT*, see Figure 13, bullet 4), choosing the progression of the content of focus (Ball et al., 2008). A connection between the bottom vertices of the *IDMT*, societal and environmental influences on practical rationality and MKT (left side of *IDMT*, see Figure 13, bullet 5), emerges as Jen describes her institutional obligation to use the provided curriculum and her KCT with regards to the advantages and disadvantages of certain representations used to teach a certain topic (Ball et al., 2008). The bolded text highlights her instructional decision to use a list of vocabulary to elicit prior knowledge rather than the lessons from the "traditional" textbook.

We have a **traditional book** so we had to **think outside of the box**. We took the **list of vocab that comes in the book** and we said "Turn around and talk to your neighbor about that. List any words that you noted." We **didn't** like **cut the list down**. We just put the list out there. **What they know and don't know**. We tried to **use** that **prior knowledge**. That's how we introduced the lesson. We did the whip around strategy and then they started **sharing** some of their **strategies**. We had a criteria. It was more **open-ended** like a PBL, **project based**. In a bucket, we put the shapes from the 3-D blocks so they had to observe something that was practical to touch and to feel. They each picked one out of the bucket and then they had to create a poster and they got to put **whatever vocabulary words** onto their poster that they could put together. We **didn't tell them which ones**. We just had that **list** which was at the **beginning of the chapter**. **Instead of doing the workbook pages**, we just had that list there. They started using edges and faces and vertices and they were coming up with that **on their own**. They could put together **whatever they wanted** on their poster. Then we had them walk around, do a walk-around, as like a culminating [activity] and then they got to **add stuff** to their poster that maybe **somebody else had** that they did not. So then we got into these **great discussions** about what makes something a prism because that was like a **huge discovery** for them. You can see that **all they had was that book page** so we just used that but they **could use their resources** like **anything** that **they could find in there**. We said if you wanted to find something in your book and to use that **to explain it** you can.

Jen's tone when expressing the way that students utilized a single page of vocabulary to make discoveries and develop understanding about prisms in a non-traditional way, suggests not only a belief in the use of open-ended tasks but a knowledge that this type of approach is effective pedagogy that will lead to understanding of the content of focus. When Jen describes this instructional decision resulting in "great discussions about what makes something a prism" leading to a "huge discovery for them," Jen communicates her observation of the outcomes that these open-ended tasks provide as being significant in the emerging thinking of her students. These comments are instances of the curricular choice theme related to KCT in the *IDMT*.

Learning from mistakes and asking questions. During the stimulated recall session, Jen repeatedly reveals her teacher disposition (top of *IDMT*, see Figure 13, bullet 6) toward the allowance of student errors being embedded in class interactions as effective pedagogy for further development of understanding. Jen describes her comfort level with allowing for students error as a focus of her instruction this year because "we are all about that **learning from your mistakes** stuff right now. We're really into that and that **it's okay**." Jen's comments reveal her KCS with regards to her familiarity with her students and the knowledge of errors with respects to the content of focus. By allowing the students to struggle with the mistake and Jen not intervening, the students are seen discovering their own error in thinking which Jen believes will lead to a deeper understanding, indicative of her KCT.

> So then **they made a mistake.** They said, "**We made a mistake**. This is not rectangular (prism)," and that **some of their feedback** said that and we went

> around too and gave feedback. We **didn't know if it was any good** but we were like let's try this because it's so much **more interesting** than making and classifying and sorting.

Jen's description reflects her belief that allowing for mistakes in students' reasoning is a "really good" curricular choice as students learn from the exposure not only to their own mistakes but also through critiquing the work of their peers. Jen's self-admission to not knowing "if it was any good" seems to reflect her struggle with her role and responsibility to the mathematical knowledge at stake, the didactical contract (left side of *IDMT*, see Figure 13, bullet 7). However, Jen also admits that this curricular choice, the open-ended task, was "much more interesting than making and classifying and sorting," recognition of the curricular choice theme as she predicts what will motivate her students to persevere despite initial mistakes in their emerging thinking (right side of *IDMT*, see Figure 13, bullet 6).

As revealed in her MTEBI SE response, Jen is not only confident in answering her students' questions but also welcomes questions as part of her regular classroom interactions (See Table 3). Staying faithful to her teacher disposition toward a facilitative role, Jen describes how she uses student questioning, sometimes asking questions where she herself may be unaware of the response as revealed during the stimulated recall session (see bolded text).

> Maybe **during** their **discussion, I don't know the answer**. I'm **just questioning them** on different things. You can see that they're **not used to being questioned** all the time but that's what we **try to do this year a lot**. I don't know. **Half the**

> **time** when I ask a question, you know, **it's just like questions**. So they're like "We don't know. Could there be?" So that's when they're like, "The feedback!" So they had made three-dimensional views so the **feedback suggested** that all the views [should be] two-dimensional. So that was caught. So **some of it we didn't even like figure out**. I went around and did some [questioning].

Jen's comments suggest a mutual questioning relationship between her and her students that may or may not lead to a definitive response but does ultimately lead to inquiry into the content of focus. This is indicative of the curricular choice within the KCT subcomponent of MKT, a knowledge of questions that further student understanding (Ball et al., 2008).

During the stimulated recall, Jen comments on part of the video of her teaching which shows a student struggling during one of these questioning sessions described in the previous paragraph. Although Jen maintains the belief that allowing for errors will further student understanding as previously described, Jen struggles with her individual professional obligation (left side of *IDMT*, see Figure 13, bullet 8) to this particular student and her instructional decision to allow for student errors as a way to promote understanding (see bolded text).

> See this kid **hates making mistakes**. He's **pissed right now** because he **doesn't like to be wrong** and his **group was wrong** and they **have to cross** that thing **off** at the top and they're **not happy about it.** You can see how **clammed up** he is and he's **usually** like you know **[talkative]** because he **doesn't like to be [wrong]** he isn't [talkative]. He thinks he is **right all the time. Not that we**

> **want to prove him wrong** but you know sometimes you **learn from this** you know. It's **hard for him**. You can **see him struggle** because these girls, like he **thinks he's smarter** than them. I'm **sure they're all good** but like he does **not like to be wrong**.

Although Jen conveys empathy toward this student as he struggles to deal with the recognition that he may not always be right, she maintains her belief that allowance for student errors is an effective approach toward student understanding. She references this same student two other times, at the end of the stimulated recall and during the final interview when asked about needed support (see Appendix E, prompt 2). This supports the struggle between Jen's KCS and her individual professional obligation to this student (left side of *IDMT*, see Figure 13, bullet 8). Jen describes the interactions between this student and the others in his group as promoting perseverance (CCSS-MP1) as the students develop their own questions and discover the errors in their thinking (see bolded text).

> I think **persevering** because they had to **go back and fix their mistakes** and you know they were wrong like **that one boy was wrong** and I just watched him. Then the **questioning** that they are **creating on their own**. I thought was **good** too because **they're** the ones that are **thinking of the questions**. I will throw things out there. **Sometimes it's wrong**. **Sometimes, it's right**. **What I say even [is wrong]**. Even so, I thought **it was good**.

Jen's experiences during classroom interactions like described in the previous response seem to support her curricular choice to allow for student error followed by discussion, both between students and those between teacher and students even if not received well by all students. The following response during the final interview continues to provide evidence of this belief (see bolded text).

> This one girl, her **conversations for persevering**, we were like floored. Like I mean she had the **best conversations about why it was and why it wasn't** and she was **proving** that other **little guy wrong** that **thought he was always right**. She was like, "No. No. Remember what they said?" And like **she was afraid to speak up at first** but then she **got** like you know **[confident]**. It was **very good**. I was really floored.

Jen's teacher disposition toward allowing students to drive the conversation through her role as facilitator paired with choice of questions and tasks that promote investigating further into the content allowed for the student interactions described within this one student learning group. Jen needed to make a curricular choice based on both KCT and KCS that it is beneficial to allow for some student struggles when the final outcome is further mathematical understanding.

Jen's descriptions illustrate a classroom where students' ideas are important and open-ended mathematical tasks are done collaboratively. Her MKT coupled with her teacher disposition toward the teacher's role as facilitator appears to promote student questioning as well as allowance for student errors that ultimately lead to correct solution strategies (Ball et al., 2008). Jen KCC allows for identification of student errors and correct usage of terms during classroom interactions in a way that empowers students to discover the accuracies and inaccuracies in their reasoning. Jen's instructional decisions described seem to support the curricular choice theme.

Institutional Obligation as a Component of Societal and Environmental Influences on Jen's Practical Rationality

Jen describes her actions as being influenced by many environmental and societal factors. Herbst and Chazan (2011) asserted that classroom and instructional decisions are not always free will choices but are often influenced by restrictions created by the environment where one teaches. Jen describes several environmental and societal factors influencing her instructional decisions.

Institution's obligation to support PLCs. Similar to both Mary and Fred, Jen describes the need for additional time to plan the instructional activities, which will engage the students in the usage of CCSS-MP1 and CCSS-MP3. In the initial interview when asked about what exists in her instructional decision making that lends itself to the implementation of the two practices, Jen reflects on the time she spends with her professional learning community, PLC (see Appendix C, prompt 2). Although Jen recognizes this as an important component in her instructional decision making, her desire is for additional planning time, commenting on the need to meet "in the hallway" and during "lunch" because the once per week district provided meeting time is not enough. Jen has an institutional obligation to honor the established schedule of once a week, but implies that the institution has an obligation to her to provide more time in order to support her instructional decision making (see bolded text).

> We have **every Friday** we meet as a **PLC for about 45 minutes**. We meet as a PLC which that's on Fridays. We have **a team meeting every week** but it's **still not [enough]** I mean we do **a lot of outside talk** a lot of like just **in the hallway, in lunch using our other times as our time for planning.** It's just constantly **every day we got our planning** and every day we have and then or once a week is our team meeting, a common planning. **Vital.** I think that's **critical**, that **common planning** and things like that. There's **not enough** [time]. We're **constantly working outside the classroom texting each other at home**.

Although Jen has her colleagues to help her in her instructional decision making, she seems frustrated with the necessity to meet outside the allotted district provided planning time. Jen sees this shared planning as instrumental in implementation of CCSS-MP1 and CCSS-MP3 but her tone implies that the district is not supportive toward this end. Jen implies that the institution obligation to her would be to provide more time for common planning, supporting a mutual exchange within the institutional obligation theme.

The need for additional time is reinforced by Jen's response to her perception of what is needed to create the ideal instructional system to fully enact CCSS-MP1 and CCSS-MP3 in her classroom lessons (See Appendix D, prompt 1). Once again, Jen draws on support from her PLC as a way to create the ideal instructional system. This reflects her interpersonal obligation to organize the interactions between her and her colleagues as Jen attempts to implement the mathematical practices. Jen also reflects on the district support, allowing her to observe best practices implemented by other teachers and providing the opportunity to work with her PLC (see bolded text).

> I think it **takes time to think of these things** and like go for it. I think that's another big **problems with instructional systems today**. Maybe **a lot of us are just afraid** or **we don't have enough time**. I think it's really important for us. Like **this** one **took time to think about** it but **all the teachers did it**. Like all my friends did it too **that I teach with** so then we were like "Oh, we really like that." Or you know **we take ideas. PLC is critical**. Like I thought like even **getting her on board** [the interventionist specialist] started to **make me think more**. Like **seeing someone else do it** too like **don't be afraid to take someone else's ideas**. It's so **good to see other teachers**. I think that piece it's **got to be** somehow be **in our schools** now because that **working together piece** and **going out and seeing other people** because think like watching my student teacher teach that lesson, she had an idea but I think that, like not that I'm a master teacher, but just saying, "**How can I now change that idea** to make it more like the PBL projects or something you know like where I know education is going or trying to go."

Jen not only insinuates the appropriateness of taking "someone else's ideas" but almost insists that this is something that all teachers should be doing. The only way for this to occur is for teachers to go out and see other teachers, something that her district allows her to do.

Jen proposes that instructional systems work best when the members have shared beliefs about best practices. Jen credits shared professional development as promoting this shared belief system, something she is thankful that her district provides. Jen sees this as district support necessary for schoolwide enactment of CCSS-MP1 and CCSS-MP3 (see Appendix D, prompt 2). Jen implies that instructional decisions can only be made when the system is composed of members with shared beliefs, such as the importance of the mathematical practices (see bolded text).

> I think that you need to have a **system of people** that are **on board** like you. So I think that you need to have really **good PLC**. So like **if** you're kind of **split on your thinking** realistically you're **not going to get it**. You're going to be in your class. They're going to be in theirs but if **everybody** is **on board**, the **ideas** just **flow**. Like we had the **book study**, Jo Boaler *Mathematical Mindset*. **All** of the **7th grade** went to the meeting. I mean **did** the whole **book study** together. We're **all in,** you know. So like when we think of a **project, we share it** with each other. Then this person adds something. This person is like "I'll do the next project." I love how they're **[district] giving us more time**. You know they gives us a **lot of in-service** you I think that's important because it's so much **easier to do with peers rather than fight a peer**. I think that too is another battle. If you can **find someone** to work with you know that **has these same ideas.**

Jen seems to believe she is fortunate because the colleagues with whom she has been grouped share common beliefs regarding the mathematical practices as well as are willing to continue to grow in their understanding through professional development activities such as the book study on which they embarked. Jen not only recognizes the professional obligation to the discipline of mathematics but knows that it is easier to accomplish when surrounded by individuals who share the same beliefs about best practice. Jen acknowledges that the professional developments opportunities afforded to her by her district promote the shared beliefs amongst her colleagues.

Institution's obligation to provide instructional resources. In the final interview (see Appendix C, prompt 3), Jen's response seems to indicate that Jen agrees with both Fred and Mary that it is easier to implement CCSS- MP1 and CCSS-MP3 when provided with curricular resources. Jen reflects on the difficulty in creating her own materials or making faulty instructional decisions based on prescribed lesson plans in a district provided textbook. Although Jen would more than likely not fall subject to use of workbook activities in her own classroom because it would go against her teacher disposition toward investigative student activities (top of *IDMT*, see Figure 14, bullet 1), Jen comments on the ease of using this approach (see bolded text).

> I think we **need good curriculum** too. I think that's another one because like **thinking of this stuff is hard**. I don't think everyone can think of it. **If you have that book, it's so easy to just open that workbook** and say go. We're all busy. I mean busy parents you know. So I think that part is critical [good curriculum].

Jen does not place the blame on the teacher who chooses to use the curricular materials provided by the district, actually attributing the usage to lack of time to think of the appropriate activities. Jen reflects on the difficulty associated with coming up with appropriate tasks. Jen insinuates that is the obligation of the institution to provide "good curriculum," reflective of the institutional obligation theme.

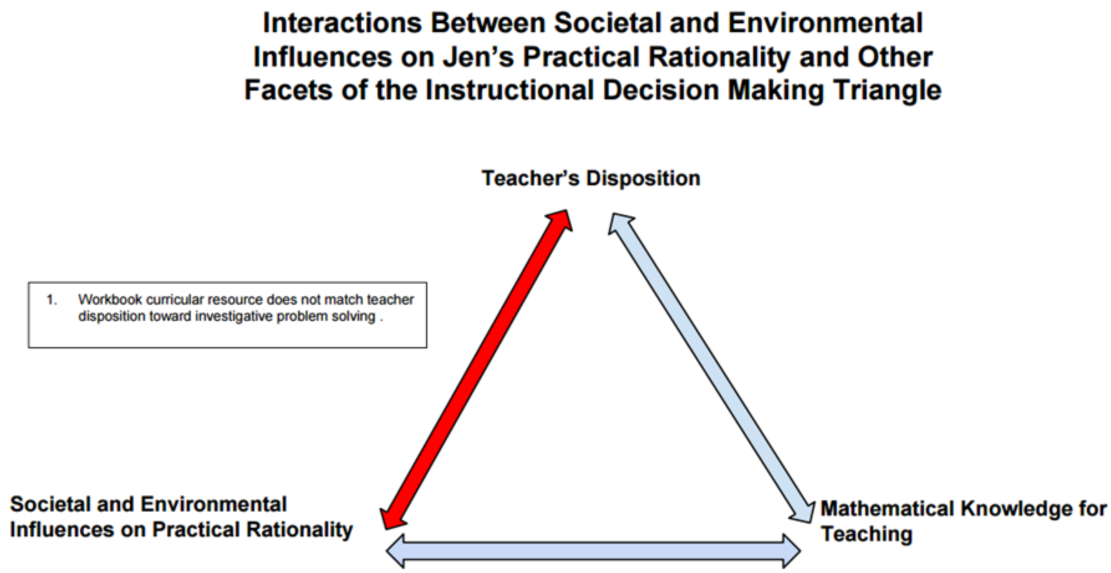

Figure 14. Influences on Jen's practical rationality. This highlights the interactions between societal and environmental influences on Jen's practical rationality and the other facets of the *Instructional Decision Making Triangle.*

Exposure to examples of best practices. When questioned about the supports needed to be able to include CCSS-MP1 and CCSS-MP3 in her instructional decisions (See Appendix D, prompt 2), Jen again looks for help from her PLC as well as the district at large. Jen suggests that her instructional decisions are enhanced by seeing how others interpret and implement the mathematical practices. When provided the opportunity to visit other classrooms, Jen describes the growth experience in her own instructional decisions. Jen also desires support from the parents, once again implying that it is better when everyone is on board with her instructional decisions (see bolded text).

> I think what we talked about **the professional learning communities, PLCs are critical**. I think getting out there. I think part of our system I think it shouldn't just be principals evaluating us I think we should **evaluate each other**. I think

> that's where you **get a lot of ideas** not even evaluation. I think it should just be like **growth opportunities**. Just **walking through people's classrooms**. I think you **learn so much** even just watching people. Like me just going **into that other school** and getting to see that for the day. I was like floored. I'm like **exploding with ideas** because we get to pilot it this year. I think you also **need community support**. I think you need to **educate the parents** on what it is because I think **they're a little worried that we're not teaching**. I think that the **hard part is getting the parent support**. I think our **schools** are starting to get **on board** with it. I think just the parent piece. We need to educate them.

Jen seems to suggest that the best learning opportunities are found at the classroom level rather than at the administrative level. Rather than having evaluative measures from the principal, Jen's suggestion that her colleagues observe her shows the value she places on day to day experience as the best means for enhancing her instructional decisions. Jen also desires parental support through education about the instructional decisions made so that all community members are on board with the mathematical practices. Jen seems to imply that parents may not understand the instructional mode in her classroom and may not see it as teaching. Although Jen chooses a role as facilitator as best practice, she is "worried" that parents will not see the value of these learning opportunities and may even view it as not teaching. She implies that the district should be obligated to educate the parents to get them on board, evidence of the duel institutional obligation theme.

Jen describes the institutional environment as one that is collaborative. Jen sees the interactions with her PLC as vital in being able to enact the mathematical practices and recognizes that district support through professional development as essential for this to occur. Jen also desires everyone being on board with the instructional decisions to ensure the implementation of best practice.

Summary

During my interactions with the three participants across this study, several aspects of their instructional decision making with regards to CCSS-MP1 and CCSS-MP3 were revealed with regards to the three facets of the *IDMT*, teacher's disposition, MKT, and societal and environmental influences. Although each had unique instructional experiences, several common themes emerged. The participants demonstrated the continual exchanges between the three facets, indicative of the fluid nature between the components of the *IDMT*, represented by the double arrows.

The three participants, although working within their own belief systems, described how they needed to make adaptations in their instructional decisions due to the continual changing nature of the students' understanding of mathematics. This was driven by each of the participants taking on the role of facilitator of the learning, allowing for students to make changes in their approaches and utilization of mathematics strategies. The need to make adaptation was evident across the teacher disposition of all participants.

Mary describes her continual effort to allow students to learn from their errors without fear of judgment. Mary's teacher disposition toward her role as the facilitator of learning is continuously evident in the daily collaborative interactions amongst the students in her classroom. Mary uses her KCS during the discussions with each collaborative group as she listens to the mathematical discourse within each group.

In a similar light, Fred recognizes the need for students to engage in mathematical discussions while interacting during problem solving activities. Fred's teacher disposition toward the facilitation of problem solving that pushes the students beyond the reenacting of strategies he demonstrates shows his adaptive nature. However, Fred revealed his lack of confidence in his ability to do this daily, often expressing a desire to do more but lacking the tools and knowledge to implement this daily.

Jen describes a teacher disposition toward a growth mindset, recognizing that all students have the ability to grow in their mathematical understanding. This requires that Jen is able to adjust her mathematics instruction often based on her interactions with her students. Jen creates an error friendly classroom, allowing students to learn from their mistakes as they grow in their mathematical understanding. Jen utilizes her MKT to find ways to connect the mathematical understanding developed during collaborative activities to future learning interactions. Jen's individual obligation to her students is revealed through recognition of a growth mindset, building confidence in individuals' mathematics abilities.

The three participants made curricular choices which were driven by their MKT. This included the daily decisions made during student to student and teacher to student interactions as well as during instructional planning. All participants described awareness of student ideas, both individual and within cooperative learning groups. Problems were chosen that lead to student engagement.

Mary describes a desire to know the curriculum at the grade level above the level she teaches as a way to help her students delve deeper into the content of focus. The fact that Mary looks for rigorous mathematical tasks reflects a choice of curriculum she believes will enhance her students' perseverance opportunities. Her KCC and KCT regarding choice of tasks includes student investigations and mathematics discussions, staying true to her disposition toward cooperative investigative problem solving.

Fred describes his interactions with his students as enabling him to make curricular choices that will allow students to persevere in their problem solving and delve deeper into the content of focus (KCT). Fred recognizes that his students have differing knowledge bases and skills (KCS) allowing him to predict areas of difficulty and ease. Often, Fred's curricular choices appear to err on choosing problems that may not be as challenging as the other participants in the study, often implying that he does not expect his students to reach the higher levels. Fred encourages his students to share their thinking (KCS), part of his disposition toward student directive problem solving.

Jen's classroom interactions are driven by the students. Jen depicts a classroom where students' ideas are valued and mathematical tasks are open-ended. Investigations are done collaboratively, true to Jen's disposition toward a growth-mindset, allowing Jen to utilize her KCC to identify student error which Jen believes leads to enhanced understanding. Her disposition toward an error friendly environment empowers students to grow in understanding without fear of being judged. Curricular choices with regards to tasks provide numerous opportunities for students to discover various strategies to approach problems, allowing for individual differences, part of Jen's individual obligation.

The participants in this study described the obligations they had to institutions as being influenced by the administration and parents. Oftentimes the participants seemed to describe their instructional decisions as being limited by societal and environmental factors, sometimes preventing them from enacting what they described as best practices. The instructional decisions were also uniquely influenced by the instructional settings. Although all three participants described institutional obligations that they were obliged to follow, they also described obligations they felt entitled to from the district and other stakeholders.

Mary seemed to be ever cognizant of what she needed to do to ensure student understanding. She describes working endless hours to learn the content and to prepare activities that will promote student engagement and understanding. Mary desires that the district provide professional development opportunities, curricular materials, and instructional time to implement the standards in an effort to prepare her students for future learning.

Fred seems to believe that the institutional obligations are something that is a necessary component of his profession. Fred often expressed that most of what he was obligated to do was outside of his control. Fred described a desire for more support from the district with regards to professional development opportunities. Fred described not always knowing how to bring his students to the level they needed to be, often indicating that it was a direct result of student scheduling and course development, again outside of his control.

Jen describes the support that she receives from her district with regards to professional development as something that is essential for the development of instructional activities that will lead to student understanding and growth. Jen seems to value the interactions with her PLC again crediting the institution for allowing these experiences. Jen desires more time for these activities as an obligation of the institution to her.

In the next chapter, discussions and implications of the findings are related to the literature. I also make recommendations for further investigation regarding the themes across the facets of the *IDMT*.

CHAPTER V

DISCUSSIONS, IMPLICATIONS, AND RECOMMENDATIONS

This chapter gives an overview of the emergent themes regarding the instructional decisions made by middle school mathematics teachers in three instructional settings. I position the findings presented in Chapter 4 within the related research. Implications for teacher and administrator education and professional development are discussed in the contexts of instructional decision making and the teaching profession in general. Finally, the chapter identifies the study's limitations and makes recommendations for practice and future research.

This study examined three middle school mathematics teachers' instructional decision making regarding the Common Core Student Standards for Mathematical Practices, CCSS-MP1 (perseverance in problem solving) and CCSS-MP3 (communicating and critiquing). The study was specifically interested in the influences impacting instructional decisions. The study expands and confronts some of the literature that lacks specifics to instructional decisions made by middle school mathematics teachers, particularly with regards to their disposition, the operationalization of their MKT, and the connection to the institutional obligations affecting their practical rationality. The findings support Herbst and Chazan's (2003) findings that teachers draw on their practical rationality to build their own mathematics teaching practices in conjunction with their personal commitments while upholding the demands of the instructional situation. The findings also substantiate Ball et al.'s (2008) claims that the decisions made within the daily demands of teaching require essential mathematical knowledge and activities, the mathematical knowledge for teaching (MKT), in order to establish an environment where students' ideas are valued and collaboration is encouraged. The teacher's disposition, specifically the conception of mathematics as described by Ernest (1989) and Thompson (1992), was evident in the findings with regards to instructional decisions made by the three participants in this study. The cases analyzed in this study suggest that it is relevant to consider all three of these facets in light of instructional decision making.

Findings Situated Within Literature

The review of literature was structured with the view that teachers' instructional decisions are influenced by several factors. The literature review developed a framework to study middle school mathematics teachers' instructional decision making grounded in a case study approach. The theoretical framework (Figure 15) for this study was based on three facets impacting instructional decisions. In particular, the study pulled from research regarding teacher's disposition (Bourdieu, 1998; Ernest, 1989; Thompson, 1992), the mathematical knowledge for teaching (MKT; Ball, 2011; Ball & Cohen, 2009; Ball & Cohen, 1999b), and societal and environmental influences on practical rationality (Ball & Cohen, 1999b; Herbst & Chazan, 2011, 2012).

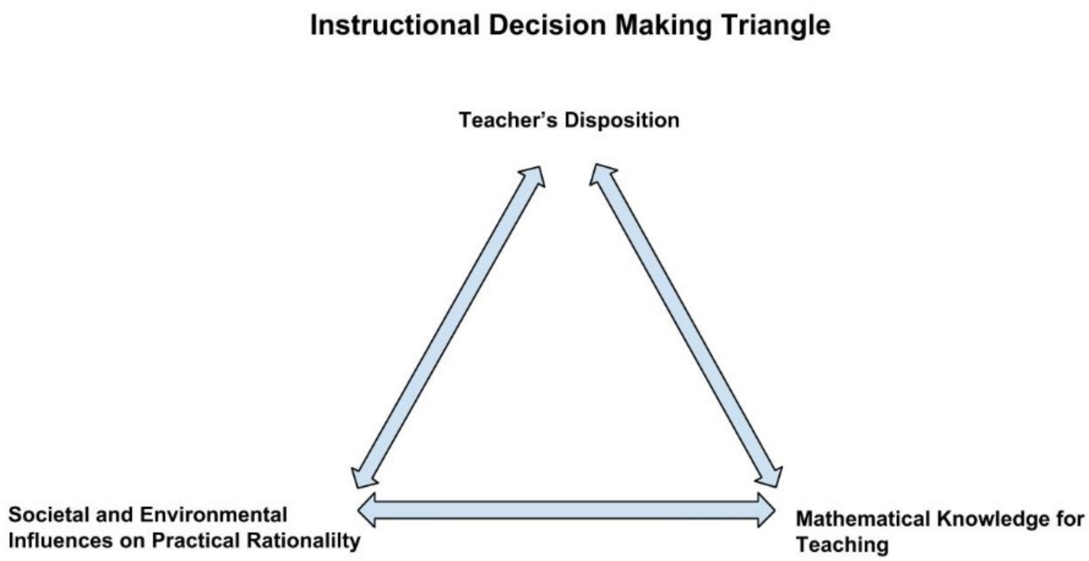

Figure 15. Instructional Decision Making Triangle. This is the *Instructional Decision Making Triangle* I designed to show the teacher component of both Ball and Cohen's Instructional Triangle and Herbst and Chazan's adapted Instructional Triangle used throughout this study.

Through reflective journaling, stimulated recall interviews, and conversational interviews, the middle school mathematics teachers in this study described (a) their teacher dispositions during mathematics instruction as being adaptive in nature, (b) the curricular choices they needed to make based on their MKT, and (c) the impact of institutional obligations on their practical rationality. Exploring and organizing these three facets of the *IDMT* enabled me to investigate what influences their instructional decisions with regards to CCSS-MP1 and CCSS-MP3.

Adaptation as a Component of Teacher Disposition

According to Bourdieu (1998), practitioners act according to their perceptions and appreciation of ideas, occurrences, and objects within instructional settings. Those who hold this belief view their position as one who facilitates, taking on the role as one who drives the instruction but allows for the individuals in the classroom to develop the understanding in unique ways. Central to this study was the participants' recognition that being adaptive during classroom interactions was important in developing student understanding and promoting perseverance in problem solving encounters. In this section, I highlight the participants' teacher dispositions toward their role as the facilitators of mathematical investigations ultimately leading to understanding. The section also includes a description of a disposition toward collaboration as a way to promote student communication and critiquing of each other's mathematical reasoning, CCSS-MP3.

Facilitating students' mathematical understanding. As described by Gibson and Dembo (1984), teacher's efficacy beliefs include both outcome efficacy beliefs and self-efficacy beliefs. While having slightly different scores on the MTEBI, all three participants in the present study held a belief that they could be effective in helping students to understand mathematics. They all saw some correlation between improvement in student grades and the teacher's ability to find a more effective teaching approach. Jen described a dual responsibility between the teacher and the student in the development of mathematical understanding, relying on her role as the facilitator. She did not see her role as holding sole responsibility for the outcomes as her disposition toward a problem solving approach to mathematics resulted in instructional decisions toward investigative and collaborative learning activities. Fred described his role as the facilitator but his efficacy beliefs were impacted by his belief that his students performed "where you would expect them to be" causing Fred to be uncertain about the impact of ineffective teaching on student learning. Mary held a strong belief that effective teaching directly impacted the students' ability to develop understanding. Mary described her endless preparation, always looking for better ways to facilitate student learning.

Part of the adaptive nature theme within the teacher's disposition facet of *IDMT* (top) is demonstrated in the fluid nature of the mathematical interactions within each teacher's instructional settings. All three participants describe a classroom dynamic that includes students working in collaborative groups, communicating their mathematical thinking to each other. These interactions are not based on a scripted communication but rather include in the moment conversations based on revealed student understanding and misconceptions.

Mary describes making changes based on students' prior knowledge and experiences which she ascertains during her interactions with the individual students during the daily classroom activities. Mary expresses that "I always reflect on my lesson every day" recognizing that her ideas can change in the moment based on what she sees students getting and filling gaps where she sees students missing background knowledge.

Fred illustrates his facilitation of learning being based on the conversations he has with his students as a means for discovering their prior knowledge. "As teachers when we see that there are gaps, it's intuitive to do those things like (ask) "Ok well what is a similar scenario?" Fred references wanting the problem solving to be driven by the students themselves, at the same time recognizing that he must be a part of the process, assisting in acquisition of the understanding.

Jen's teacher disposition toward her role as a facilitator of the learning is illustrated throughout the data collected. Her belief that the teacher must adapt instruction based on demonstrated student needs lends itself to her supportive role throughout the student interactions she describes. Jen holds the belief that *all* students have the ability to grow in their mathematical understanding and it is her job as the leader in the classroom to promote confidence in her students' abilities to develop in their mathematical understanding. "You want to lead them in the right direction. You want to ask them questions."

Problem-driven view of mathematics. All three participants seemed to hold a teacher disposition toward a dynamic, problem-driven view of mathematics as described by Ernest (1989). Based on patterns generated through exploration, students develop knowledge of the mathematics of focus. The mathematics is a process of investigation and acquisition of knowledge that adds to prior mathematical understanding. This view recognizes that mathematics is not static but rather is open to revisions.

Mary describes the individual approaches displayed by her students as they approach the same problem. Mary acknowledges that when students are able to communicate their approach to a problem within collaborative groups, all benefit with those who may be struggling with identifying an approach to a problem benefitting the most. Mary gives her students credit as peer facilitators of understanding, indicating that "it gives justification within themselves, if they're on the right track or if they're not versus me always telling them." Staying true to her outcome efficacy beliefs, Mary recognizes that her students' voices may be just as important as her voice. "A lot of times I notice also within them communicating with one another, it allows them to see it another way . . . hearing how somebody else does it or is looking at it, they are able to quickly get it."

Fred acknowledges the importance of strengthening his students' abilities to persevere in problem solving. Fred describes how he looks for problems that will push his students beyond their comfort zone even when his students openly admit that they are incapable of solving the problems. Fred does not allow his students to rely on him for the solutions but rather he looks for a way to adjust the instruction, hoping to facilitate the understanding. Fred describes pushing his students even when they do not believe in their own abilities. "I'm trying to get them to rephrase some of their thinking and some of those questions and try to get them to question themselves." Fred helps his students by pointing out where they have already demonstrated their understanding in an effort to get them to persevere, always staying true to his disposition toward a problem solving mathematical approach.

Jen's disposition toward a problem solving mathematical approach is grounded in a classroom environment that values learning from one's mistakes. By creating an error friendly environment, Jen believes that students are more likely to persevere, again based on her growth mindset belief (Dweck, 2006). Jen describes how we learn more from mistakes than we do from getting it right the first time. Jen has made it acceptable in her classroom to struggle along the way, adjusting her instruction in order to promote that type of environment. As a result, Jen has seen growth in *all* of her students.

Curricular Choice as a Component of Mathematical Knowledge for Teaching (MKT)

Knowledge of the mathematical content is an important part of teaching but research reveals that it is more than just subject knowledge including pedagogical content knowledge, the mathematical knowledge of teaching (MKT; Ball et al., 2008; Shulman, 1986). Shulman defined pedagogical knowledge as knowledge specific to teaching that connects the content knowledge to the art of teaching. Ball et al. (2008) furthered this notion by including the “day-to-day, moment-to-moment demands of teaching” (p. 395) specific to mathematics instruction. They made the claim that MKT needs to establish a classroom where students’ ideas are valued and collaborative mathematical explorations are the norm. Within this study, participants described the curricular choices that they made being based on their own MKT in order to promote perseverance in problem solving and communication of mathematical thinking. In this section, I highlight the participants’ curricular choices with regards to mathematical interactions and problem selection used to promote CCSS-MP1 and CCSS-MP3. Ball et al. (2008) concluded that connecting mathematics to specific tasks that teachers do in the classroom gives significance to the role of the teacher in the development of student mathematical understanding. The teacher has an impact on the instructional interactions based on intellectual and personal resources utilized by the teacher to understand, interpret, and respond to the curricular materials and the students (Ball & Cohen, 1999a). This section highlights the purposeful curricular choices made by the participants in response to their students in an effort to promote the mathematical practices of focus.

Collaboration to promote mathematical communication. One curricular choice that seem to be prevalent across all three participants is collaborative activities that promote communicating mathematical thinking. As described in *Adding It Up* (Kilpatrick et al., 2001), the role of the teacher in the learning process involves providing tasks where students can demonstrate different interpretations and responses to mathematical tasks, ask different questions, and utilize varying ways to complete the work which then becomes the enacted lesson (Kilpatrick et al., 2001). Kilpatrick et al. noted that teachers may or may not notice how students are interpreting the content or whether or not the students investigate the content further which may or may not promote mathematical understanding. All three participants in this study describe instances of noticing and acting upon the investigative activities amongst the collaborative groupings within their classroom. This also demonstrates an instantiation of their teacher dispositions toward a facilitative role as they respond to these interactions, a connection to the top of the *IDMT*. Herbst and Kosko (2014) recognized that the teacher's choice of instructional tasks followed by the classroom observations and the teacher's effects on the exchanges between the actions and knowledge of content of focus will directly impact students' acquisition of knowledge. It can vary based on the role played by the teacher.

Mary describes her choice of hands on activities as effective pedagogy for teaching concepts of focus keeping her focus on students' demonstrated needs reflective of her KCS. When making instructional decisions based on KCS, the teacher predicts what students will find appealing and motivating (Ball et al., 2008). In her response in the initial interview, Mary describes seeking to find activities that the students will find engaging and relevant to their world as a way to implement CCSS-MP1 and CCSS-MP3. "How they're going to be engaged 100% or the time. So pulling things or concepts that I know that are relevant to them in their world really helps me adapt my lesson to fit their needs." Mary situates the lesson within her students' world as a way to make the content relevant, demonstrating a connection between the knowledge of her students and knowledge of the mathematics. Mary is constantly interacting with the students, describing how finding out what students need and providing constant feedback enables her to interpret where they are in their mathematical thinking (KCS). Ball et al. (2008) defined KCS as a way to predict what students find interesting in order to promote the acquisition of the mathematical understanding of the mathematical content. Mary is continually accessing her students' thinking through conversations during collaborative group work and whole class discussions.

Fred describes his curricular choice to have students engage in exploratory activities as a way to promote CCSS-MP1 and CCSS-MP3. In the initial interview when asked why the practices were forefront in the CCSS, Fred describes a goal to have his students drive the problem solving while he maintains his teacher disposition toward a facilitative role. Drawing on his KCS, Fred describes facilitating the learning through student conversations where he ascertains their prior knowledge. "As when we see that there are gaps, it's intuitive to do those things like (ask) 'Ok, well what is a similar scenario that we've seen that similar to this problem?'" By drawing on prior knowledge, Fred is making the curricular choice to help students find an entry point without being totally directive in the instruction. Fred also describes the collaborative nature of his classroom as important for modeling different approaches to understanding the content of focus. "It's the beauty of being in a classroom of learners as opposed to here's the content. If you don't have others that are modeling for you, then you're never going to think of other ways to approach things." Ball et al. (2008) described how asking questions at the right time can promote further learning, part of KCT, which is something Fred described as important in his interactions with his students.

Similar to Mary and Fred, Jen describes the importance of student empowerment, allowing her students to have different entry points and strategies when searching for a problem solution. Ball et al. (2008) described the use of questioning to seek clarity or make a mathematical point as essential for students' development of mathematical understanding. Jen illustrates the importance of making sure that her students are aware that "it's okay to have a different strategy than someone else" and that "the process is more important than the end." Her choice of tasks that encourage collaboration and investigation allows for the development of these different strategic approaches (KCT). Jen describes the creation of an error friendly environment as another way to promote perseverance (CCSS-MP1) and critiquing (CCSS-MP3). "It's okay to just not have the right answer." Jen promotes reflection as a way to explain one's process, indicative of her MKT. "The reflection piece or how did we solve this one before. It's about the process. That showing and persevering, making sense." Through a collaborative environment, students are able to explore the different approaches to the content of focus.

Problem and task choice. The way that the instructional materials are used in classroom interactions is an essential component of learning. Ball and Cohen (1999a) illustrated that the nature of the problems and the variety of representations have an impact on what students are able to do with the content. Further, Ball and Cohen recognized that how teachers interpret and use the instructional materials affects the students' responses to the materials. All three participants describe the choice of tasks and problems as essential to promoting both CCSS-MP1 and CCSS-MP3.

Mary describes the need to be flexible with the curriculum, once again based on students' demonstrated needs. SCK is the content of the curriculum that is specific to the content of focus (Ball et al., 2008). Mary makes sure to know not only the curriculum at her grade level but also the curriculum of the grades that are above hers. "My main goal is not only for you [her students] to understand the sixth grade content but also to push you ahead to seventh grade content." Mary's curricular choice to assign tasks above grade level reflects not only her KCC but also her KCT regarding choice of tasks that will enable her students to delve deeper into the mathematical content.

Fred chooses tasks that will allow for student presentations, at the same time struggling with his institutional obligation to stay true to the pacing guide. Fred recognizes that allowing students the time to visually and verbally demonstrate understanding is important in promoting student communication of ideas as well as providing the opportunity to critique the work of their peers. "I think about whether it's worth the time to . . . present . . . their thinking . . . a lot of times it is worth it because they're not only verbally explaining but they're working with each other to show that visual communication." Fred describes task choice as being important, reflecting on selection of tasks that require application of previously learned concepts. Indicative of

KCT, Fred recognizes that the sequencing of problems, starting with content that students have already been exposed, followed by “higher skill, application,” enables him to facilitate the students’ acquisition of the necessary content knowledge to the do the work tasked (KCC). Ball et al. (2008) acknowledged that the teacher must employ KCS in order to anticipate what students will be able to do with a task and whether the individuals will be able to access the level of difficulty. Fred seeks tasks that he anticipates will stretch his students’ thinking. “[I]search for things that are truly stretching them, that are more complex tasks but are truly reachable for the wide variety of learners.” This allowance for keeping the task within reach for the majority of students seems to reflect Fred’s professional individual obligation in conjunction with his KCS.

On more than one occasion during the initial, final interview and simulate recall session, Jen referenced her instructional decision making involving the search for tasks and problems that established both student interest and engagement. One way that Jen does this is by choosing problems that have real world connections, often connecting to other academic content areas. “We can cross team things now. I think that’s vital because we’re getting all those things then together.” Ball et al. (2008) acknowledged the importance of anticipating what students will find interesting and motivating (KCS).

Institutional Obligation as a Component of Societal and Environmental Influences on Practical Rationality

Herbst and Chazan (2011) described the connection between the didactical contract as consisting of the instructional situation and the nature of the mathematical task and the professional obligations that links the practitioner to the position of mathematics as what regulates the instructional decisions toward the task. Research identifies four obligations, disciplinary, individual, interpersonal, and institutional, as influential in instructional decision making (Ball, 1993; Herbst & Balacheff, 2009; Herbst & Chazan, 2011). The analysis of the data in this study implies that although all four obligations play a factor in decision making, the institutional obligations posited on middle school mathematics teachers may be most influential in their instructional decisions with regards to CCSS-MP1 and CCSS-MP3. In this section, I highlight the participants' descriptions of the obligations being placed on them by the institution which may or may not promote enactment of the mathematical practices of focus. Additionally I focus on the obligations that the participants describe as being something they require of the institution as they attempt to include CCSS-MP1 and CCSS-MP3 in their instructional decisions.

Lack of curricular resources. Floden et al. (1980) argued that one of the most arduous decisions impacting student learning is the choice of content for instruction. Further, administrators and other stakeholders attempt to influence teachers' decisions with regards to the content through the creation of list of objectives (Floden et al., 1980). All three participants reference the curricular materials provided, or not provided, by the district as impacting the ability to engage students in tasks that encourage perseverance (CCSS-MP1) and promote communication of their thinking (CCSS-MP3).

Mary describes the lack of curriculum resources at the district level as hindering her ability to enact the mathematical practices without searching for materials on her own. "You know you might have to look online . . . but not everything on those websites is going to be geared toward your students . . . it isn't just outlined in the curriculum." Recognition of the extra work needed to find the necessary materials and ideas is also obstructed by the fact that her district moves teachers to new grade levels frequently. "Jumping grades doesn't help either. So a lot of teachers are jumping grades. So then you have to start all over from scratch." Mary expresses that the district should be obligated to provide the necessary resources and allow teachers to remain at a grade level in an effort to become knowledgeable in their discipline.

Similarly, Fred expresses frustration with regards to the district decision to have teachers teaching multiple academic content areas and mathematics at different grade levels. Fred implies that this district choice impedes teachers from knowing their curriculum and the content standards. "The less experience you have with your content . . . the less you know what you're looking for, what math you are trying to pull out." Fred desires more professional development which he expresses as being an obligation of the district, including time provided by the district to observe his peers who teach the same content. Fred also describes the limited curricular materials available from the district at the same recognizing that the district allows him the "freedom" to find his own. "We're kind of on our own to pull resources from a variety of places but we've had the freedom to do that (laughs) because we have to." Although freedom is usually conceived as something desirable, Fred implied that it was problematic because the teachers may not look for "rich mathematics," choosing "rote skill work" instead. In an ideal instructional system, Fred describes the district's obligation to provide a "great selection of resources and rich problems that are sequenced in a way that . . . keeps kids confident yet pushing towards something achievable." Fred does not believe that he has enough of those kind of resources.

Jen also describes the obligation for the district to provide curricular resources, indicating the difficulty in creating or finding your own resources. "I think we need good curriculum too . . . because like thinking of this stuff is hard. I don't think everyone can think of it." Jen does not find fault in her colleagues who choose to "just open that workbook and say go," rather implying that the district is obligated to provide that teacher with better resources so that the teacher does not have to find the materials on his or her own. Although the teacher is following the institutional obligation to use the curricular materials provided, Jen expresses a responsibility for the district to be more cognizant of the choices of the resources. Webel and Platt (2015) recognized that professional obligations often deter teachers from enacting mathematics reform.

Desire for additional planning and instructional time. The school environment includes the imposed pressures from stakeholders, including the institutional obligations such as the requirement to follow pacing guides and use common assessments (Barr, 1980; Floden et al., 1980). All three participants in this study described a desire for additional time in order to fully enact CCSS-MP1 and CCSS-MP3. This included the desire to have more classroom time to allow students to engage in the rich mathematical tasks which encourage perseverance (CCSS-MP1) and to allow students to communicate their emergent mathematical thinking (CCSS-MP3). Mary expresses concern with the district's decision to cut mathematics instructional time by twenty-four minutes. "With the 66 minutes . . . I am doing more talking and I want them to do more of the talking . . . I think all teacher would feel that you just need more time." Fred also describes the need for "good chunks of time to teach" which he conveys as something the administration needs to consider when "constructing the schedule." Fred does not object to the institutional obligations imposed on him with regards to things he sees as "outside of the classroom" but he expresses the desire for them to do a better job at providing professional development and allowing him and his colleagues to help in the decision making, an obligation Fred feels the district should provide.

Jen also references the need for additional time but her focus is on professional development and common planning. Jen credits her district's support of professional development opportunities both within and outside of the district. Effectively implemented professional development allows teachers to gain mathematical knowledge, which can be utilized in their teaching (Doerr et al., 2010). Reflecting on the difficulty in creating or finding appropriate rigorous tasks and problems, Jen implies that it is appropriate to utilize other's ideas and encourages others to do the same. "Like seeing someone else do it too . . . don't be afraid to take someone else's ideas. It's so good to see other teachers." Jen's conviction that all members of the institution share common beliefs about what constitutes good practices can only be achieved if the district holds an obligation to the teachers to provide the necessary professional development.

Limitations

One limitation of this study is the transferability of results. The results may only be transferable and generalizable in similar middle school settings with similar state achievement scores. Although the themes found in this study were derived after extensive analysis, they cannot be transferred to other populations. Another reason for limited replication is the use of only three participants, one from each setting. Merriam (2009) indicated that studies are less transferable when the sample size is small.

The participants' awareness of the study may have influenced the study by the participant giving more attention to the students during the videotaping of the lessons. This type of Hawthorne effect may have resulted in different reactions to group interactions than normally present within classroom interactions. The presence of an observer, even if just a video camera, may influence the participant to react in an unnatural way, skewing the observable behaviors. Also, my prior professional relationship with two of the participants during a summer workshop may have influenced them to participate in the study rather than their participation being due to a personal choice. Similarly, the third participant was selected by an administrator to participate, again indicating that the choice to be a part of the study may have been extrinsic rather than intrinsic.

Another limitation may have been the choice to have the participants do their videotaping near the end of the school year. All three participants indicated that they waited until after state achievement testing which may have limited the choice of topics to include in the videotaping session. At this point in the school year, most of the mathematical standards required for the grade level would have already been covered. The students may have also been aware of this fact which may or may not have resulted in students being less engaged in the investigation. At this point in the school year, the participants may not push their students in the same way that they do prior to state assessing as indicated by Fred's comment, "it is where we expect them to be."

Implications and Recommendations for Professional Practice

Prior research indicates that there are many important elements that impact instructional decision making. The decisions made during the planning process may impact teachers' behavior in the classroom which can influence the learning strategies chosen and ultimately the student outcomes (Shavelson, 1983; Shavelson & Stern, 1981; Thompson, 1992). The findings from this study imply that incorporating CCSS-MP1 and CCSS-MP3 is impacted by three primary facets: teacher disposition, mathematical knowledge for teaching (MKT), and societal and environmental influences on practical rationality. Each facet is unique but interrelated, working in conjunction as teachers make instructional decisions about promoting mathematical understanding.

Developing a Facilitative Role Through Education

One implication of this study is the suggestion that middle school teachers make adaptations within their instructional decisions as a result of their teacher disposition toward a role as the facilitator of mathematical understanding. All three participants describe listening to students' conversations, focusing on discovering prior knowledge and misconceptions while assisting in students' acquisition of mathematical understanding. Further, the participants emphasized the importance of allowing students the freedom to investigate different approaches to problem solving, providing the students with multiple opportunities to be exposed to differing strategies through collaboration and investigation. In conjunction with their individual obligations, the participants describe the interactions as based on the students' needs and interests. As a result of the interactions with their students, the participants indicated that students were more likely to persevere when faced with more challenging problems and communicate their mathematical thinking. It appears that a teacher disposition toward a facilitative role, which allows for adaptations in instructional decisions may enhance the enactment of CCSS-MP1 and CCSS-MP3. It should be noted that this is not necessarily the case with all practitioners with some teachers being less proficient in taking on a facilitative role during classroom interactions.

Although the focus of this study was on the teacher, another implication of the study is recognition of the impact that the facilitative role has on the students. Noddings (1988) stated that the student is more important than the content of focus, ultimately in control of his or her own learning. The teacher may persuade the student to respond to the content, which may result in the student choosing against himself or herself (p. 176). Although all three participants describe pushing their students to persevere, they also demonstrate their caring natures, often reflecting on the students' emotional wellbeing. Mary describes a meeting with a parent where she assures the parent that a class comment made was not reflective of this parent's daughter. "She was frustrated based upon a comment I said to the class but it wasn't directly to her." Jen recognized that sometimes even when she tries to get a student to persevere, the student may choose not to. "You can see how clammed up he is and he's usually like you know [talkative]." Although this may be the case, as manager of the didactical contract, Jen does not give up and continues to work with this student. As discussed earlier, the teacher is the manager of the didactical contract, driving the exchange of the knowledge at stake between the teacher and students (Herbst & Chazan, 2011, p. 432). During these exchanges, it may be important to be also cognizant of the role the student has in the exchange.

Based on these findings, it is my suggestion that preservice teachers be given more opportunities to be exposed to this type of pedagogy throughout their education program. Unfortunately, this may not be evident in the field experiences where they are being placed. Although live observations of this type of instruction is preferred, one way to compensate for this is to make videotapes of teachers using this approach part of the core middle school mathematics methods courses. Previous research has shown that video-based activities support preservice teachers' attention to student thinking and instructional decisions regarding student learning (Santagata, Zannoni, & Stigler, 2007; Sherin & van Es, 2008). Also, those at the university responsible for placement of preservice teachers might consider this as they make connections with local school districts for placement. Perhaps, the individuals responsible for the placement could observe the cooperative teachers themselves, noting which are more closely aligned with the facilitative role in the mathematics classroom in order to provide preservice teachers the opportunity to witness this type of instruction as one possible mode of instruction.

The findings also imply that veteran teachers need additional professional development in the facilitative approach to mathematics instruction. Although the participants in this study saw the benefits of this type of instruction, they also mentioned that not all of their colleagues were implementing the approach. All three participants noted the benefits of shared beliefs amongst their colleagues. Both Fred and Jen suggested that observations of their peers using good pedagogy would be beneficial to them, with Jen going so far as suggesting that teachers be the ones to do the observations rather than administrators. This would require administrative support, requiring that the administration place trust in the teachers to be critical and supportive in the role as observers. Mary made the suggestion that teachers be given time either during the school year or in the summer to develop these common beliefs about what best practices look like when making instructional decision about the mathematical practices. McDonald, Kazemi, and Kavanagh (2013) suggested that teachers work collaboratively with other educators who are focused on observing other teachers teaching in an effort to understand student learning.

Collaborative Instructional Decision Making

The findings suggest that more time needs to be given for teachers to work collaboratively in professional learning communities, PLCs, to develop these types of tasks. Previous research has shown that student learning increases when teachers participate in PLCs (Andrews & Lewis, 2002; Bambino, 2002; Louis & Marks, 1998; Vescio, Ross, & Adams, 2008). All three participants described the benefits of being able to work with colleagues when creating investigative tasks, including working with colleagues teaching other content areas as described by Jen. This would require the administration to provide the time for the teachers to collaborate. The findings suggest that preservice teachers also be exposed to these type of tasks, requiring that the university professors provide them with these experiences.

All three participants describe the benefits of a shared beliefs system. Lortie (1998), in reflecting on his research findings in *Schoolteacher,* stated that the norms about sharing information as well as a teacher's feelings will impact classroom experiences. When colleagues are given the opportunity to do the same work, Lortie indicated that teachers are able to make comparisons about their instructional decisions. Fred makes a similar observation when he reveals his frustration with the lack of time for collaboration with other teachers. "You know I think it's important. Those are things that we don't really have the opportunity . . . we want to collaborate." Jen notes that she does not have enough time to meet with her colleagues even though she is given shared time with her colleagues once a week. "We have a team meeting every week, but it's still not [enough]." This suggest that more opportunities be given to teacher to share their beliefs about best practices.

Another implication of this study is that curricular choices regarding problems chosen and the mode of instruction, based on teachers' MKT, have a direct impact on the implementation of CCSS-MP1 and CCSS-MP3. As described with respect to teacher disposition, the choice of problems that promote mathematical understanding may or may not promote perseverance and communication. All three participants describe a classroom where students' ideas are valued and mathematical investigations are done collaboratively with students benefitting from exposure to differing strategical approaches. The participants illustrated choosing problems that pushed students beyond their comfort level, even though the participants recognized that the students would struggle and make errors along the way. In conjunction with individual obligations to the students, the participants emphasized the importance of establishing a classroom where students felt comfortable and success was always at the forefront. The study implies that a healthy struggle is essential for promoting perseverance, CCSS-MP1.

The participants in this study discussed wanting support both from the district and the parents. The study suggests that making the stakeholders aware of the research behind the instructional decisions being made will make the implementation more productive, ultimately leading to student understanding. (It was suggested by both Fred and Jen that the district openly express their support of the teachers' choices of tasks and problems as best practices, recognizing that this mode of instruction is different than what teachers and administrators were exposed to when they were in middle school. With regards to preservice teachers, it is important to assist in the development of MKT through the mathematics methods courses.

Recommendations Future Research

Another component of teacher disposition that emerged is that a problem solving approach to mathematics promotes perseverance and communication. All three participants noted that tasks that allowed students to approach problems in unique ways encouraged students to continue to work through the problems, not requiring the teacher to provide them with a strategy or list of skills to use. When given an investigative collaborative activity, the students were described as being immersed in mathematical discussions and debates, encouraged to defend and justify their thinking. Although these activities required additional time in the planning process and the resources with these type of activities are not always available, the participants indicate that students benefit from these type of investigations. Fred describes students as just going through the motions when the activity is more traditional, evidence of the necessity for more problem solving based instruction.

Research Regarding Choice of Tasks and Problems

This suggests that more research regarding what constitutes a rigorous and relevant task is needed. Although Ball and Forzani (2011) recognized the need for a common core for learning to teach, little research exists regarding what constitutes the appropriate resources to implement the mathematical practices at the middle school level. Although Ball and Forzani acknowledged that reliable instruction requires the selection of content appropriate for a wide range of learners from different backgrounds (p. 20), the existing research is lacking on how to make those selections. This study suggests the need for research regarding the appropriateness of tasks meeting CCSS-MP1 and CCSS-MP3 at the middle school level.

Research on Institution's Obligations to the Teacher

All three participants referenced schooling obligations placed on them by the district administrators as well as the parents as impacting their ability to enact or not enact CCSS-MP1 and CCSS-MP3. Past research describes institutional obligations as the obligations of the school as a whole, acknowledging the pressures from administrators, politics, and the community of stakeholders (i.e., parents and school board) which the teacher may not be able to alter or control (Herbst & Chazan, 2011). Although the participants in this study acknowledged the existence of some institutional obligations such as pacing guides, curricular materials, and student class placement, all three participants expressed obligations they felt the institution was responsible to provide.

Jen expressed the need for additional curricular materials that moved from the traditional textbook she was presently using to a more problem solving based program which she was piloting. Jen also voiced the need for teachers to be able to observe colleagues in instructional situations in order to gain additional instructional strategies rather than being observed by administrators who are not as familiar with the mathematical content and standards. Mary articulated a need for in-district professional development so that all teachers at all grade levels could develop a shared vocabulary and understanding of the new mathematical standards. Mary was also clear that the administration needed to allow teachers to stay at the same grade level in order to become experts in their field. Similarly, Fred desires additional professional development to learn more about the mathematical practices and describes how observations of teacher who teach the same content, whether in his own district or another, would be beneficial in planning to incorporate the standards in his own classroom. Fred also conveyed that the district is at fault when it has teachers teaching more than one content. He implies that it is difficult for teachers to be good at what they do when their planning time crosses content. This study suggests that institutional obligations are not only enacted on the teachers by the district and stakeholders but are also required of the institution by the teachers.

This indicates the need for further research regarding the institutions' stakeholders' recognition of these obligations. Perhaps a similar instrument to the PROB surveys could be created to measure this recognition. Herbst and Ko (2017) have measured the validity of instruments, the four PROB surveys: PROB-MATH, PROB-INDV, PROB-INTP, and PROB-INST, used to measure high school teachers' recognition of four professional obligations as described by Herbst and Chazan (2011). Similarly, Herbst, Chazan, Kosko, Dimmel, and Erickson (2016) have created a suite of four scenario-based instruments, one for each of the professional obligations, used to measure teachers' recognition of these obligations. Each scenario describes a situation in which the teacher deviates from a norm in order to stay true to one of the professional obligations. The teachers' responses indicate the degree to which a teacher should (or should not) deviate from the normative responses due to the perceived professional obligation.

This study not only suggests the need for research regarding similar measurement of middle school teachers' recognition of the professional obligations but seems to indicate the need for instruments to measure the institution's recognition of its obligation to the teacher. The instrument could be used to ascertain what the teachers see as the obligation of the institution to them, which may or may not be the same as those described by the participants in this study. Another instrument could be used with the administrators and board members to determine the degree of recognition of these teacher perceived obligations. Perhaps, a separate instrument could also be developed to include the parents, another institutional stakeholder.

These findings appeared to indicate the necessity for professional development for district administrators and board members as the shifts in mathematics instructional decisions move to a more rigorous and investigative mode. It also suggests the importance of open communication between the teachers and the administration with student learning at the forefront. The findings suggest that parents be educated with regards to the CCSS-MPs revealed when the participants in this study implied that parents do not understand the shifts in mathematics defined by the CCSSM. Although the teachers are required to implement certain institutional obligations, the findings suggest that the institution also holds certain obligation to the teachers who are the implementers of the instructional decisions. It is my recommendation that further research be conducted to ascertain if the stakeholders find validity in meeting these institutional obligations.

If I were to replicate this study, I could address each of the limitations described earlier. I might have the participants videotape their lessons earlier during the school year. I could do multiple tapings or randomize the taping in order to try to minimize the Hawthorne effect. Finally, I could increase the sample size to enhance transferability of the study.

Conclusion

This study was initiated with the intent to develop an understanding of how middle mathematics teachers make instructional decisions regarding CCSS-MP1 and CCSS-MP3. Although the full extent of what impacts the instructional decision making process is beyond the realm of this study, this study provides insight into three facets, teacher disposition toward a facilitative role using a problem solving approach, the curricular choices tied directly to the teachers' MKT, and the impact of institutional obligations on practical rationality. Although the participants in this study were already middle school mathematics teachers, implications were discussed regarding the instruction provided to preservice teachers with regards to instructional decision making.

In conclusion, the participants in this study identified two obligations they required of the institution if enactment of CCSS-MP1 and CCSS-MP3 is to be realized. First, all three participants described the value of working collaboratively with teachers who have a shared belief in the practices needed to promote perseverance (CCSS-MP1) and communication of students' thinking (CCSS-MP3). In order for this collaboration to occur, this study indicates that the district has the obligation to provide the teachers with professional development time, both during the school year and summer. Another proposal is for additional opportunities for teachers to observe others, both inside and outside of the district, who are implementing the mathematical practices. Secondly, the participants advised that the district be obligated to provide resources that include tasks and problems that promote perseverance and communication. The participants expressed frustration in having to find materials on their own, often indicating that they were uncertain if the materials were appropriate for implementing CCSS-MP1 and CCSS-MP3. It is suggested that the institution provide the teachers with resources based on the intent of the two mathematical practices of focus.

APPENDICES

APPENDIX A

MATHEMATICS TEACHING EFFICACY BELIEF INSTRUMENT (MTEBI)

INSERVICE TEACHERS

Appendix A

Mathematics Teaching Efficacy Belief Instrument (MTEBI)

Inservice Teachers

Developed by Larry G. Enochs and Iris M. Riggs, used with permission

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

	Strongly Agree	**Agree**	**Uncertain**	**Disagree**	**Strongly Disagree**
1. When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.	**A**	**B**	**C**	**D**	**E**
2. I will continually find better ways to teach mathematics.	**A**	**B**	**C**	**D**	**E**
3. Even if I try very hard, I do not teach mathematics as well as I do most subjects.	**A**	**B**	**C**	**D**	**E**
4. When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.	**A**	**B**	**C**	**D**	**E**
5. I know the steps necessary to teach mathematics concepts effectively.	**A**	**B**	**C**	**D**	**E**
6. I am not very effective in monitoring mathematics activities.	**A**	**B**	**C**	**D**	**E**

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
7. If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.	**A**	**B**	**C**	**D**	**E**
8. I generally teach mathematics ineffectively.	**A**	**B**	**C**	**D**	**E**
9. The inadequacy of a student's mathematics background can be overcome by good teaching.	**A**	**B**	**C**	**D**	**E**
10. The low mathematics achievement of some students cannot generally be blamed on their teachers.	**A**	**B**	**C**	**D**	**E**
11. When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.	**A**	**B**	**C**	**D**	**E**
12. I understand mathematics concepts well enough to be effective in teaching mathematics.	**A**	**B**	**C**	**D**	**E**
13. Increased effort in mathematics teaching produces little change in some students' mathematics achievement.	**A**	**B**	**C**	**D**	**E**

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
14. The teacher is generally responsible for the achievement of students in mathematics.	**A**	**B**	**C**	**D**	**E**
15. Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.	**A**	**B**	**C**	**D**	**E**
16. If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.	**A**	**B**	**C**	**D**	**E**
17. I find it difficult to use manipulatives to explain to students why mathematics works.	**A**	**B**	**C**	**D**	**E**
18. I am typically able to answer students' mathematics questions.	**A**	**B**	**C**	**D**	**E**
19. I wonder if I have the necessary skills to teach mathematics.	**A**	**B**	**C**	**D**	**E**
20. Given a choice, I would not invite the principal to evaluate my mathematics teaching.	**A**	**B**	**C**	**D**	**E**

	Strongly Agree	**Agree**	**Uncertain**	**Disagree**	**Strongly Disagree**
21. When a student has difficulty understanding a mathematics concept, I am usually at a loss as to how to help the student understand it better.	**A**	**B**	**C**	**D**	**E**
22. When teaching mathematics, I usually welcome student questions.	**A**	**B**	**C**	**D**	**E**
23. I do not know what to do to turn students on to mathematics.	**A**	**B**	**C**	**D**	**E**

MTEBI October 2002

APPENDIX B

REFLECTIVE JOURNAL WRITING PROMPTS FOR TEACHER VIDEO LESSONS

Appendix B

Reflective Journal Writing Prompts for Teacher Video Lessons

1. How does the teacher seen in the video promote the intended CCSS-MP?
2. What evidence do you see indicative of the intended CCSS-MP? Be specific.
3. What instructional tasks or interactions, if any, did you witness that prevented the CCSS-MP from being enacted?
4. How would your own implementation of the lesson differ? Include all facets of the instructional situation that might impact the implementation.

APPENDIX C

INITIAL INTERVIEW QUESTIONS

Appendix C

Initial Interview Questions

1. The Common Core State Standards for Mathematical Practices "describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important "processes and proficiencies" with longstanding importance in mathematics education" (practices, 2014). The *Ohio's New Learning Standards: Mathematics Standards* (2010) places these practices first in the document indicating that the CCSS-MP "describe ways in which developing student practitioners of the discipline of mathematics increasingly ought to engage with the subject matter as they grow in mathematical maturity and expertise" (pp. 7-8). Based on this description, why do you think the CCSS-MP are forefront in the document?

    a. CCSS-MP1 *Make sense of problems and persevere in solving them,* describes mathematically proficient students as those that "start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution" (Ohio, 2015, p. 6). Why do you think this practice is important in promoting mathematical understanding?

b. CCSS-MP3 *Construct viable arguments and critique the reasoning of others,* describes mathematically proficient students as those that "understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose… (They) are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and- if there is a flaw in an argument- explain what it is" (p. 7). Why do you think this practice is important in promoting mathematical understanding?

2. What exists in your instructional decision making that will lend itself to implementation of CCSS-MP1 and CCSS-MP3? (Additional prompting may include ideas mentioned above regarding teacher disposition, societal and environmental influences, and mathematical knowledge for teaching).

3. What do you perceive is needed for a teacher to be able to engage students in CCSS-MP1and CCSS-MP3?

4. Professional obligations include but are not limited to obligations to the discipline whose knowledge is the subject of instruction, to the individual students who are there to learn, to the classroom space and community as a public channel of interaction and to the instructional setting and process of schooling (schedules, assessments, curricula, etc.; Herbst & Chazan, 2011). What influences do these obligations have on your instructional decision making regarding CCSS-MP1 and CCSS-MP3?
5. An instructional norm is the demands or controls that affect the way the teacher's role is played in an instructional situation (Herbst & Chazan, 2011). The norm is attributed if the teacher acts as if accountable to what the norms say. What norms exist in your instructional system that enable you to enact CCSS-MP1 and CCSS-MP3?

APPENDIX D

FINAL INTERVIEW

Appendix D

Final Interview

1. If you could create the ideal instructional system to fully enact CCSS-MP1 and CCSS-MP3, how would it look similar to and different from the classroom lessons shown in the videos? How would it be similar to and different from your own instructional system?
2. What supports are needed to be able to include CCSS-MP1 and CCSS-MP3 in your instructional decision making?
3. What instructional decisions can you realistically include in your present instructional system as you attempt to enact CCSS-MP1 and CCSS-MP3?

REFERENCES

REFERENCES

"A Nation at Risk." (n.d.). Retrieved from https://www2.ed.gov/pubs/NatAtRisk/risk.html

Andrews, D., & Lewis, M. (2002). The experience of a professional community: Teachers developing a new image of themselves and their workplace. *Educational Research, 44*(3), 237–254.

Bakewell, L. L. (2008). Writing use in the mathematics classroom. *Studies in Teaching 2008 Research Digest*, 7.

Ball, D. L. (1993). With an eye on the mathematical horizon: Dilemmas of teaching elementary school mathematics. *Elementary School Journal, 93*(4), 373-397.

Ball, D. L. (2011). Knowing mathematics well enough to teach it. Presentation for the Initiative for Applied Research in Education expert committee at the Israel Academy of Sciences and Humanities. Jerusalem, Israel: January 30, 2011. Retrieved from http://www-personal.umich.edu/~dball/presentations/013011_IASH.pdf.

Ball, D. L., & Cohen, D. K. (1999b). Instruction, capacity, and improvement. *CPRE Research Report Series, RR-43.* Consortium for Policy Research in Education.

Ball, D. L., & Cohen, D. K. (1999a). Developing practice, developing practitioners: Toward a practice-based theory of professional education. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 3-32). San Francisco, CA: Jossey-Bass.

Ball, D. L., & Forzani, F. M. (2009). The work of teaching and the challenge for teacher education. *Journal of Teacher Education*, *60*, 497–511. doi: 10.1177/0022487109348479

Ball, D. L., & Forzani, F. M. (2011). Building a common core for learning to teach and connecting professional learning to practice. *American Educator, 35*(2), 17-21.

Ball, D. L., Thames, M., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education, 59*(5), 389-407.

Bambino, D. (2002). Critical friends. *Educational Leadership, 59*(6), 25–27.

Barr, R. (1980). *School, class, group and pace effects on learning.* Paper presented at the annual meeting of the American Educational Research Association, Boston, MA.

Borko, H., & Livingston, C. (1989). Cognition and improvisation: Differences in mathematics instruction by expert and novice teachers. *American Educational Research Journal, 26*(4), 473-498. doi:10.3102/00028312026004473

Borko, H., & Livingston, C. (1989). Cognition and improvisation: Differences in mathematics instruction by expert and novice teachers. *American Educational Research Journal, 26*, 473-498.

Bourdieu, P. (1998). *Practical reason.* Palo Alto, CA: Stanford University Press.

Byra, M., & Coulon, S. C. (1994). The effect of planning on the instructional behaviors of preservice teachers. *Journal of Teaching in Physical Education, 13*, 123-139.

Carpenter, T. P., Dossey, J. A., & Koehler, J. L. (2004). *Classics in mathematics education research.* Reston, VA: National Council of Teachers of Mathematics.

Chazan, D., & Ball, D. (1999). Beyond being told not to tell. *For the Learning of Mathematics, 19*(2), 2-10.

Clark, C. M., & Yinger R. J. (1979). *Three studies of teacher planning.* East Lansing, MI: The Institute for Research on Teaching.

Cohen, M. (1980). *Policy implications of an ecological theory of teaching: Toward an understanding of outcomes.* Paper presented at the annual meeting of the American Educational Research Association, Boston, MA.

Common core state standards initiative: Standards for mathematical practices. (2010). Retrieved February 2, 2014, from http://www.corestandards.org/Math/Practice/

Conference Board of the Mathematical Sciences (2010). *The mathematical education of teachers II*. Providence RI and Washington DC: American Mathematical Society and Mathematical Association of America.

Courtney, S. (2014). Do we need to show our work through our meanings and reasoning? *National Teacher Education Journal, 7*(1).

Courtney, S. A., Kosko, K. W, & McMahon, L. (2015). *In the eye of the beholder: Mathematics teacher educators' interpretations of Standards for Mathematical Practice.* American Educational Research Association 2015 Annual Meeting (AERA). Chicago, IL.

Creswell, J. W. (2003). *Research design* (2nd ed.). Thousand Oaks, CA: Sage.

Davis, R., Maher, C., & Noddings, N. (1990). Introduction: Constructivist views on the teaching and learning of mathematics. In R. Davis, C. Maher, & N. Noddings

(Eds.), *Constructivist views on the teaching and learning of mathematics* (pp. 7-18). Reston, VA: National Council of Teachers of Mathematics.

Denzin, N. K., & Lincoln, Y. S. (2011). *The handbook of qualitative research* (4th ed.). London: Sage.

Doerr, H. M., Goldsmith, L. T., & Lewis, C. C. (2010). *Mathematics professional development.* National Council of Teachers of Mathematics Professional Research Brief. Reston, VA: NCTM.

Dweck, C. S. (2006). *Mindset: The new psychology of success*. New York, NY: Random House.

Empson, S. B., & Junk, D. L. (2004). Teachers' knowledge of children's mathematics after implementing a student-centered curriculum. *Journal of Mathematics Teacher Education, 29,* 306-333.

Enochs, L. G., Smith, P. L., & Huinker, D. (2000). Establishing factorial validity of the mathematics teaching efficacy beliefs instrument. *School Science and Mathematics, 100*(4), 194-202. doi:10.1111/j.1949-8594.2000.tb17256.x

Ernest, P. (1989). The knowledge, beliefs and attitudes of the mathematics teacher: A model. *Journal of Education for Teaching, 15*(1), 13-33.

Ethell, R. G., & McMeniman, M. M. (2000). Unlocking the knowledge in action of an expert practitioner. *Journal of Teacher Education, 51*, 87-101.

Everhart, R. B. (1979). The fabric of meaning in a junior high school. *Theory Into Practice, 18*, 152-157.

Fennema, E., & Franke, M.L. (1992). Teachers' knowledge and its impact. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 147-164). New York, NY: Macmillan.

Fenstermacher, G. D. (1980). What needs to be known about what teachers need to know? In G. E. Hall, S. M. Hord, & G. Brown (Eds.), *Exploring issues in teacher education: Questions for future research* (pp. 35-49). Austin, TX: Research and Development Center for Teacher Education.

Floden, R. E., Porter, A. C., Schmidt, W. H., Freeman, D. J., & Schwille, J. R. (1981). Responses to curriculum pressures: A policy capturing study of teacher decisions about content. *Journal of Educational Psychology, 73*(2), 129-141.

Floden, R. E., Porter, A. C., Schmidt, W. H., Freeman, D. J., & Schwille, J. R. (1980, April). *Responses to curriculum pressures: A policy capturing study of teacher decisions about content* (Research Series No. 74), Institute for Research on Teaching, Michigan State University.

Forgasz, H. J., & Leder, G. C. (2008). Beliefs about mathematics and mathematics teaching. In P. Sullivan & T. Wood (Eds.), *Handbook of mathematics teacher education: Vol. 1 Knowledge and beliefs in mathematics teaching and teaching development* (pp. 173-192). Rotterdam, the Netherlands: Sense Publishers.

Gibson, S., & Dembo, M. (1984). Teacher efficacy: A construct validation. *Journal of Educational Psychology*, 76, 569-582.

Griffey, D. C., & Housner, L. D. (1991). Differences between experienced and inexperienced teachers' planning decisions, interactions, student engagement, and instructional climate. *Research Quarterly for Exercise and Sport, 52,* 196-204.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105-117). Thousand Oaks, CA: Sage.

Guskey, T. R., & Passaro, P. D. (1994). Teacher efficacy: A study of construct dimensions. *American Educational Research Journal, 31,* 627-643.

Hall, T. J., & Smith, M. A. (2006). Teacher planning, instruction and reflection: What we know about teacher cognitive processes. *Quest, 58,* 424-442.

Hamilton, L., Halverson, R., Jackson, S. S., Mandinach, E., Supovitz, J. A., Wayman, J. C., . . . & Steele, J. L. (2009). Using student achievement data to support instructional decision making. United States Department of Education. Retrieved from http://repository.upenn.edu/gse_pubs/279

Handal, B., & Herrington, A. (2003). Mathematics teachers' beliefs and curriculum reform. *Mathematics Education Research Journal*, *15*(1), 59-69.

Herbst, P. (2002). Engaging students in proving: A double bind on the teacher. *Journal for Research in Mathematics Education*, *33*(3), 176-203.

Herbst, P. (2006). Teaching geometry with problems: Negotiating instructional situations mathematical tasks. *Journal for Research in Mathematics Education*, *37*, 313–347.

Herbst, P., & Balacheff, N. (2009). Proving and knowing in public: What counts as proof in a classroom. In M. Blanton, D. Stylianos, & E. Knuth (Eds.), *Teaching and learning of proof across the grades: A K–16 perspective* (pp. 40-63). New York, NY: Routledge.

Herbst, P., & Chazan, D. (2003). Exploring the practical rationality of mathematics teaching through conversations about videotaped episodes: The case of engaging students in proving. *For the Learning of Mathematics, 23*(1), 2-14.

Herbst, P., & Chazan, D. (2006). Producing a viable story of geometry instruction: What kind of representation calls forth teachers' practical rationality? In D. Alatorre, J. L. Cortina, M. Saiz, & A. Mendez (Eds.), *Proceedings of the 28th Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education.* Merida, MX: Universidad Pedagogica Nacional, 2, 213-220.

Herbst, P., & Chazan, D. (2011). Research on practical rationality: Studying the justification of actions in mathematics teaching. *The Mathematics Enthusiast*, *8*(3), 405-462.

Herbst, P., & Chazan, D. (2012). On the instructional triangle and sources of justification for actions in mathematics teaching. *ZDM: The International Journal on Mathematics Education, 44*(5), 601-612.

Herbst, P., Chazan, D., Kosko, K., Dimmel, J., & Erickson, A. (2016). Using multimedia questionnaires to study influences on the decisions mathematics teachers make in instructional situations. *ZDM: The International Journal on Mathematics Education, 48*(1), 167-183.

Herbst, P. & Ko, I. (2017). *Measuring recognition of the professional obligations of mathematics teaching: The PROB surveys.* Paper presented at the 2017 Annual Meeting of PME-NA, Indianapolis, IN. Retrieved from http://hdl.handle.net/2027.42/136788

Herbst, P., & Kosko, K. (2014). Mathematical knowledge for teaching and its specificity to high school geometry instruction. In J.-J. Lo, K. R. Leatham, R. Van Zoest, L. R. Leatham (Eds.), *Research trends in mathematics teacher education* (pp. 23-45). Switzerland: Springer International Publishing.

Heritage, M., Kim, J., Vendlinski, T., & Herman, J. (2009). From evidence to action: A seamless process in formative assessment? *Educational Measurement, 28*(3), 24–31. Retrieved on July 7, 2015 from http://www.insidemathematics.org/common-core-resources/

Jackson, P. W. (1968). *Life in classrooms.* New York, NY: Holt, Rinehart & Winston.

Janesick, V. J. (1978). *An ethnographic study of a teacher's classroom perspective: Implications for curriculum* (Research Series No. 33). Institute for Research on Teaching, Michigan State University.

Joyce, B. (1978). Toward a Theory of information processing in teaching. *Educational Research Quarterly, 3*(4), 66-77.

Kazemi, E., & Franke, M. L. (2004). Teacher learning in mathematics: Using student work to promote collective inquiry. *Journal of Mathematics Teacher Education, 7*(3), 203-235. doi:10.1023/BJMTE.0000033084.26326.19

Kilpatrick, J., Swafford, J., & Findell, B. (Eds.). (2001). *Adding it up: Helping children learn mathematics.* Mathematics Learning Study Committee, Center for Education, Division of Behavioral and Social Sciences and Education. National Research Council. Washington, DC: National Academy Press.

Lampert, M. (1985). How do teachers manage to teach? *Harvard Educational Review*, *55*(2), 178-194.

Leatham, K. R. (2006). Viewing mathematics teachers' beliefs as sensible systems. *Journal of Mathematics Teacher Education, 9,* 91-102.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage.

Lloyd, G. M., & Wilson, M. (1998). Supporting innovation: The impact of a teacher's conceptions of function on his implementation of a reform curriculum. *Journal for Research in Mathematics Education, 29*(3), 248-274, doi: 10.2307/749790

Lortie, D. C. (1998). Unfinished work: Reflections on schoolteacher. In *International handbook of educational change* (pp. 145-162). Netherlands: Springer.

Loucks-Horsley, S., Stiles, K. E., Mundry, S., Love, N., & Hewson, P. W. (2009). *Designing professional development for teachers of science and mathematics.* Thousand Oaks, CA: Corwin.

Louis, K. S., & Marks, H. M. (1998). Does professional learning community affect the classroom? Teachers' work and student experiences in restructuring schools. *American Journal of Education, 106*(4), 532–575.

Marsh, J. A., & Farrell, C. C. (2015). How leaders can support teachers with data-driven decision making: A framework for understanding capacity building. *Educational Management , Administration & Leadership, 43*(2), 269-289.

Mathematical practice. (2012). Standards for mathematical practice. Retrieved February 2, 2014 from http://www.corestandards.org/Math/Practice

McDonald, M., Kazemi, E., & Kavanagh, S. S. (2013). Core practices and pedagogies of teacher education. *Journal of Teacher Education, 64*(5), 378-386. doi: 10.11177/0022487113493807.

McNair, K. (1978-79). Capturing inflight decisions: Thoughts while teaching. *Educational Research Quarterly, 3*, 26-42.

Merriam, S. B. (1998). *Qualitative research and case study applications in education.* San Francisco, CA: Jossey-Bass.

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation* (3rd ed.). San Francisco, CA: Jossey-Bass.

Moustakas, C. (1994). *Phenomenological research methods*. London, England: Sage.

National Institute of Education. (1975), *Teaching as clinical information processing.* Report of Panel 6, National Conference on Studies in Teaching, Washington DC: National Institute of Education.

National Research Council. (2001). *Adding it up: Helping children learn mathematics.* Washington, DC: The National Academies Press. Doi: https://doi.org/10.17226/9822

Nisbett, R. E., & Ross, L. (1980). *Human interferences: Strategies and shortcomings of social judgment.* Englewood Cliffs, NJ: Prentice-Hall.

Noddings, N. (1986). *Caring, a feminine approach to ethics & moral education*. Berkeley, CA: University of California Press.

Noyce Foundation. (n.d.). *Inside mathematics.* Santa Cruz, CA: Silicon Valley Initiative. Retrieved on July 7, 2015 from http://www.insidemathematics.org/common-core-resources/

Ohio Department of Education: FY2014 district profile report. (2015). Retrieved on July 23, 2015 from http://education.ohio.gov/Topics/Finance-and-Funding/Finance-Related-Data/District-Profile-Reports/FY2014-District-Profile-Report

Ohio department of education: FY2014 district profile report. (2014). Retrieved on July 23, 2015 from http://education.ohio.gov/Topics/Finance-and-Funding/Finance-Related-Data/District-Profile-Reports/FY2014-District-Profile-Report

Ohio school report cards (2014). Retrieved on July 19, 2015 from http://education.ohio.gov/getattachment/Topics/Data/Accountability-Resources/

Ohio's new learning standards: Mathematics standards. (2010). Retrieved on July 13, 2015 from http://education.ohio.gov/getattachment/Topics/Ohio-s-New-Learning-Standards/Mathematics/Math-Standards.pdf.aspx

Olah, L., Lawrence, N., & Riggan, M. (2010). Learning to learn from benchmark assessment data: How teachers analyze results. *Peabody Journal of Education 85*(1), 226–245.

Porter, A. C., & Brophy, J. (1998). Synthesis of research on good teaching: Insights from the work of the Institute for Research on Teaching. *Educational Leadership, 45*(8). 74-85. Retrieved from http://www.ased.org/ASCD/pdf/journals/ed_lead/el_198805_porter.pdf.

Process standards. (2000). Retrieved February 2, 2014 from http://www.nctm.org/standards/content.aspx?id=322

Putnam, R. T., Heaton, R. M., Prawat, R. S., & Remillard, J. (1992). Teaching mathematics for understanding: Discussing case studies of four fifth-grade teachers. *Elementary School Journal, 93*(2), 213-228. doi: 10.1086/461723

Rubin, H. J., & Rubin, I. S. (2012*). Qualitative interviewing: The art of hearing data* (3rd ed.). Los Angeles, CA: Sage.

Santagata, R., & Guarino, J. ZDM Mathematics Education. (2011). 43, 133-145. doi: 10.1007/s11858-010-0292-3

Santagata, R., Zannoni, C., & Stigler, J. (2007). The role of lesson analysis in pre-service teacher education: An empirical investigation of teacher learning from a virtual video-based field experience. *Journal of Mathematics Teacher Education, 10*(2), 123-140.

Schutt, R. K. (2012). *Investigating the social world: The process of research.* Thousand Oaks, CA: Sage.

Schwille, J., Porter, A., & Gant, M. (1980). Content decision-making and the politics of education. *Educational Administration Quarterly, 16*(2), 21-40.

Shavelson, R. J. (1983). Review of research on teachers' pedagogical judgments, plans, and decisions. *The Elementary School Journal, 83*(4), 392-413.

Shavelson, R. J., & Atwood, (1977). Teachers' estimates of student "states of mind." *British Journal of Teacher Education, 5*, 131-138.

Shavelson, R. J., & Borko, H. (1979). Research on teachers' decisions in planning instruction. *Educational Horizons, 57*, 183-189.

Shavelson, R. J., Atwood, N., & Borko, H. (1977). Experiments on some factors contributing to teachers' pedagogical decisions. *Cambridge Journal of Education, 7*, 51-70.

Shavelson, R. J., Cadwell, J., & Izu, T. (1977). Teachers' sensitivity to the reliability of information in making pedagogical decisions. *American Educational Research Journal, 14*, 83-97.

Shavelson, R. J., & Stern, P. (1981). Research on teachers' pedagogical thoughts, judgments, decisions, and behavior. *Review of Educational Research, 51*(4), 455-498.

Sherin, M. G., & Van Es, E. A. (2008). Effects of video club participation on teachers professional vision. *Journal of Teacher Education, 60*(1), 20-37. doi: 10.1177/0022487108328155

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2). 4-14. doi: 10.3102/0013189X015002004

Shulman, L. S., & Elstein, A. S. (1975). Studies of problem solving, judgment, and decision making: Implications for educational research. In F. N. Kerlinger (Ed.), *Review of research in education* (pp. 3-42). Itasca, IL: F. E. Peacock.

Smith, E. L., & Sendelbach, N. B. (1979). *Teacher intentions for science instruction and their antecedents in program materials.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Smith, E. L., & Sendelback, N. B. (1979, April). *Teacher intentions for science instruction and their antecedents in program materials.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Smith, P. S., & Esch, R. K. (2012, April). *Identifying and measuring factors related to student learning: The promise and pitfalls of teacher instructional logs.* Paper presented at the annual meeting of the American Educational Research Association. Vancouver, British Columbia, Canada. Retrieved from http://www.horizon-research.com/atlast/wp-content/uploads/Promise-and-Pitfalls-of-Logs.pdf.

Sowder, J., & Schappelle, B. (2002). *Lessons learned for research.* Reston, VA: National Council of Teachers of Mathematics.

Stake, R. E. (2006). *Multiple case study analysis.* New York, NY: Guilford Press.

Standards for Mathematical Practice. (n.d.). Retrieved May 28, 2015, from http://www.corestandards.org/Math/Practice/

Stein, M. K., Smith, M. S., & Silver, E. A. (1999). The development of professional developers: Learning to assist teachers in new settings in new ways. *Harvard Educational Review, 69*(3), 237-270.

The mathematical education of teachers II. (2010). Retrieved May 13, 2014 from http://www.cbmsweb.org/MET2/met2.pdf.

The strands of mathematical proficiency. (2001). Retrieved February 2, 2014 from http://www.nap.edu/openbook.php?record_id=9822&page=116

Thompson, A. G. (1984). The relationship of teachers' conceptions of mathematics and mathematics teaching to instructional practice. *Educational Studies in Mathematics, 15*(2), 105-127.

Thompson, A. G. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 127-146). New York, NY: Macmillan.

Thompson, C. L., & Zeuli, J. S. (1999). The frame and the tapestry: Standards-based reform and professional development. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 341-375). San Francisco, CA: Jossey-Bass.

United States. National Commission on Excellence in Education. (1983). *A nation at risk: The imperative for educational reform: A report to the Nation and the Secretary of Education, United States Department of Education.* Washington, DC: The Commission: [Supt. of Docs, U.S. G.P.O. distributor].

Vescio, V., Ross, D., & Adams, A. (2008). A review of research on the impact of professional learning communities on teaching practice and student learning. *Teaching and Teacher Education, 24*(1), 80-91. doi:10.1016/j.tate.2007.01.004

Wayman, J., & Stringfield, S. (2006, August). Using computer systems to involve teachers in data use for instructional improvement. *American Journal of Education 112*, 463–468.

Webel, C., & Platt, D. (2015). The role of professional obligations in working to change one's teaching practices. *Teaching and Teacher Education*, *47*, 204-217.

Weiss, M., Herbst, P., & Chazan, C. (2009). Teachers' perspectives on mathematical proof and the two-column proof. *Educational Studies in Mathematics*, *70*(3), 275-293.

Yin, R. K. (2012). *Applications of case study research* (3rd ed.). Washington DC: Sage.

Yin, R. K. (2013). *Case study research: Design and methods* (5th ed.). Thousand Oaks, CA: Sage.

Yinger, R. J. (1979). Routines in teacher planning. *Theory Into Practice*, *18*(3), 163-169.

Yinger, R. J. (1980). A study of teacher planning. *The Elementary School Journal*, *80*, 107-127.

Young, V. (2006). Teachers' use of data: Loose coupling, agenda setting, and team norms. *American Journal of Education, 112*(4), 521–548.