PERCEPTIONS ON ENACTMENT OF THE EFFECTIVE MATHEMATICS TEACHING PRACTICES BY TEACHER CANDIDATES: A REPLICATION STUDY

by
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Dedication

To my parents, Marian and Ken, for always supporting and encouraging my love of learning. Dad, thank you for so lovingly proofreading this paper. Thank you both for distracting my kids during the most intense part of this process and providing emotional support through the challenges. I am truly blessed to be your daughter, and I hope I am able to pass along all I've learned from you to my own children.

To my children, Hannah, Lilia, and Evan, I love you more than you'll ever know. I'm proud of you, and I love you all just the way you are. I'm so grateful that I get to be your mom.

Finally, to my husband, Dan, thank you for encouraging me to get started, for prodding me along when I felt like giving up, and for being there to cheer with me at the end. Your unwavering support and love make me a better person. I'm so grateful to have you in my life, and I love you.

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Finally, thank you to the four participants in this study. I am so grateful for the time you invested in this project, and I'm proud of the teachers you have become. I hope you are able to receive empowering support that will keep you in education for many years to come.

Abstract

Background: Teacher candidates are encouraged in their teacher preparation programs to enact instructional practices that support equity and access for all students. Learning to teach is complex and challenging, and teacher candidates are influenced by factors both internal and external to the teacher preparation program and their school setting. As a result, teacher candidates may not always enact practices they have learned in their teacher preparation program. **Purpose:** This study explored teacher candidates' perceptions of their enactment of the National Council of Teachers of Mathematics effective mathematics teaching practices (EMTP); this served as a means of understanding teacher preparation program outcomes. The study addressed the following research questions: 1. Which of the EMTP do secondary mathematics teacher candidates rank most characteristic of their teaching? 2. Which of the EMTP do secondary mathematics teacher candidates rank least characteristic of their teaching? 3. How do teacher candidates' perceptions of their use of the EMTP change between the first and second years of their teacher preparation? 4. How do teacher candidates describe influences on their prioritization of the EMTP within their instructional practice? **Methods:** A Q-sort, a methodological tool developed by Stephenson (1953), was used to gain insight into how teacher candidates prioritized enactment of the EMTP which are emphasized in the teacher preparation program. A questionnaire consisting of open-ended questions and a group interview served as data sources to capture candidates' rationale for their prioritization of practices. Descriptive statistics were used to analyze quantitative data from the Q-sort; the constant comparative method was used to analyze data from the questionnaire and group interview. **Findings:** On average, participants ranked the

EMTPs, *supporting productive struggle* and *posing purposeful questions,* as most characteristic of their teaching. They ranked *establish mathematical goals to focus learning* and *facilitate meaningful mathematical discourse* as least characteristic of their teaching. The practice, *use and connect mathematical representations,* increased the most in rank from the first year to the second year, and *build procedural fluency from conceptual* understanding, decreased the most. Findings included influences on teacher candidates' perception of their practice in four broad categories: 1. formal teacher preparation coursework, 2. beliefs about teaching and learning, 3. lived experiences, and 4. school-based setting. **Conclusions:** The findings suggest that teacher candidates may be better prepared to facilitate discussion and use goals to promote learning if the teacher preparation program further decomposes the instructional actions. Opportunities for reflection were shown to be effective and could be expanded to address EMTP that teacher candidates are less comfortable enacting. Finally, an increased focus on advocacy for equitable practices is necessary to empower teacher candidates to persist with the EMTP when faced with the pressure of accountability policy at the school level.

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Chapter I

Introduction

Statement of the Problem

The state of mathematics education and trends in urban schools today point to a need for well-prepared teachers who enact practices that benefit culturally and linguistically diverse students. In response to this need, the Association of Mathematics Teacher Educators (AMTE, 2017) published a set of standards for mathematics teacher education programs that guide what learning should be included in a teacher preparation program with acknowledgement that continued growth is necessary once teachers are in service. Among these standards include the skills and dispositions to enact equitable teaching practices by building on students' interests and cultural knowledge, selecting appropriately challenging tasks that support development of deep mathematical reasoning and understanding, and attending to the identities' of students as learners of mathematics (AMTE, 2017). Additionally, the standards stipulate that new teachers should be able to plan for and execute effective mathematics lessons, including the use of Effective Mathematics Teaching Practices (EMTP), which were outlined by the National Council of Teachers of Mathematics (NCTM, 2014) in the seminal work, *Principles to Actions: Ensuring Mathematical Success for All*.

These eight EMTP are supported by a wealth of research that indicates that the use of the EMTP improve student outcomes. Establishing a mathematical goal, as well as eliciting and using student thinking serve as foundational practices that help a teacher focus on the needs of their students (Hiebert et al., 2007). Additionally, selecting appropriately rigorous tasks that emphasize conceptual understanding as the conduit

through which procedural fluency is promoted reach toward equity by leveling the playing field. When content is taught conceptually, memorization and previous experiences become less important (Boston et al., 2017). With conceptual understanding, students are able to use their funds of knowledge to make sense of the mathematics using multiple representations when given the opportunity to productively struggle. Communities of learners support one another through engaging in discourse, and teachers provide support throughout the learning process with purposeful questioning (NCTM, 2014). While much of the research on the EMTP focus on their impact on student learning, some research has focused on how teachers learn to enact the EMTP.

In one such study, Wilburne et al. (2018) used a Q-sort to explore experienced teachers' perceptions of their use of the EMTP and to promote reflection on practice. This study replicated the Wilburne et al. (2018) study in a different setting and expanded on the methods to determine whether the Q-sort process could be used to provide insight into how teachers' perceptions and prioritization of the EMTP change as they progressed through a teacher preparation program.

Purpose of the Study

The purpose of this study was to explore the priorities and perceptions of secondary mathematics teacher candidates with respect to implementation of the EMTP. The participants in the study were completing the second year of a two-year Master of Arts in Teaching program that leads to teacher licensure. Gaining insight into what influences teacher candidates' enactment of the EMTP has provided several concrete suggestions for programmatic improvements in the teacher preparation program.

This study also asked teachers to reflect on how their practice changed during their time in a teacher preparation program, which is an expansion on the original Wilburne et al. (2018) study. Findings from the expanded methods suggested the data collection process may be used to capture meaningful change in teachers' perceptions of their practice over time. Teacher preparation programs that adopt these methods could promote reflection in their teacher candidates while also gaining information about how the teacher preparation program is functioning.

Research Questions

The first two research questions parallel those of Wilburne et al. (2018). The third and fourth research questions deviate from Wilburne et al. (2018) to explore the influences on teacher candidates' perceptions of their prioritization of the ETMP along with how teacher perceptions of their practice changed during their time in a teacher preparation program.

1. Which of the EMTP do secondary mathematics teacher candidates rank most characteristic of their teaching?
2. Which of the EMTP do secondary mathematics teacher candidates rank least characteristic of their teaching?
3. How do teacher candidates' perceptions of their use of the EMTP change between the first and second years of their teacher preparation?
4. How do teacher candidates describe influences on their prioritization of the EMTP within their instructional practice?

Significance of the Problem

Between 2016 and 2018, I taught math methods coursework to teachers-in-residence in an urban Master of Arts in Teaching program in Southeast Texas. My students entered the classroom as teachers of record after they spent a year observing and gradually taking on more teaching responsibilities. As they engaged in coursework in core and content pedagogy, they also worked full-time in urban schools, learning to build relationships with culturally and linguistically diverse students, engage and communicate with parents, and plan, teach, and assess student understanding.

In my instruction in the secondary math methods course, I focused on supporting teacher candidates in learning and practicing the EMTP, so they could begin their career equipped with a skill set that supports an equitable environment for student learning of mathematics. However, through classroom observations of the teachers I supported, I noticed that enactment of the EMTP were often not present in classroom instruction. In observation debriefs and classroom discussions, teacher candidates voiced a variety of factors that influenced their lesson design and execution. Many teachers shared that the practices were not supported by their campus instructional leaders or that the teacher they were paired with in the first year of the program did not use the practices. Some of the other teachers shared that when they used what they learned in their math methods courses, students disengaged. Yet a small group of teachers regularly used at least a subset of the EMTP and reported feeling more confident in supporting students in problem solving and discourse in their classes.

As a teacher educator, I began to wonder whether I could be doing something differently to support more teachers to enact the EMTP. On a larger scale, I considered

whether advocating for change in the core pedagogy classes in the teacher preparation program would make a difference. I wondered how much the teacher preparation program influences teacher practice compared to their school setting and mentor teacher.

After reading the literature in preparation for this study, I have concluded that the process of becoming a teacher is exceptionally complex. Teacher preparation is likewise very complex, which makes continuous improvement a challenge. This study gave me insight into what factors support (or inhibit) enactment of the EMTP in the local context in which I work. Findings from this study are valuable for the teacher preparation program in this study which is revising its curriculum in order to better promote equity and preparation for teaching culturally and linguistically diverse students.

In addition to personal and context-specific significance, this study holds value as a replication study. This replication is consistent with constructive replication, which is a type replication that extends beyond the original study in some way, rather than mimicking the exact procedures (Lykken, 1968; Makel & Plucker, 2014; Ostrum, 1971). Specifically, the method of data collection and analysis have been replicated in a different contextual setting. While Wilburne et al. (2018) explored the perspectives of teachers from a wide range of experience levels, this study focused exclusively on the perspectives of teachers who are still completing a teacher preparation program. Using the same Q-sort with teacher candidates expanded on the answers to questions from the original study. A comparison of the findings from both studies suggest that some practices may be more characteristic of teachers' practice regardless of level of experience. This points to a need for further research to determine why those practices are ranked more characteristic than others.

While replication of research is important, this study is significant for another reason. By comparing teachers' perceptions of their practice at two different points during their time in the teacher preparation program, valuable insight was gained about the influences that shape new teacher practice. Intuitively, it seems a teacher's practice may shift during this critical time in a teacher's career. This study identified elements of formal teacher preparation coursework, beliefs about teaching and learning, lived experiences, and the school-based setting as categories of influences that shaped teacher candidates' perceptions of their practice throughout their time in the teacher preparation program. The deeper understanding of how knowledge and enactment have emerged from the complex system of teacher education is useful for adjusting coursework and teacher candidate support.

Definitions

Teacher Candidate and Resident Advisor

In this study, teacher candidate is used to refer to the students in the teacher preparation program. During the first year in the teacher preparation program in this study, the teacher candidates were not yet teaching their own classroom of students as a teacher of record. Rather, they were teachers-in-residence, meaning they spent the whole school year learning and practicing teaching in an experienced teacher's classroom. The experienced teacher who mentors the teacher candidate is referred to as a resident advisor.

The experience of the teacher candidate in the first year is similar to student teaching, except the duration of the experience is longer than a typical student teaching assignment, and the teacher-in-residence is fully employed by the school. Employment

results in full immersion into campus-based responsibilities, including substitute teaching, parent conferences, and various duties. During the second year in the teacher preparation program, the teacher candidate assumes a teacher of record role, and no longer works under the supervision of the resident advisor.

Simplex Systems

Simplex systems are representations of complex systems that are reduced to simpler structures by the individuals attempting to understand the complex system. Simplex systems include "beliefs, knowledge, and practices orientated around how something works (such as improving student learning, or learning to teach)" (Ell et al., 2017, p. 330). According to Van Geert and Steenbeck (2014) a simplex system is defined as "a connected whole of beliefs, representations, values, emotions, habits, practices and material tools that serves as a simplifying representation of the overarching complex system in which a person participates and that organizes the participants' actions" (p. 23). Because simplex systems are thought to be important influences on how individuals act (Ell et al., 2017), eliciting information about teachers' simplex systems may provide insight into the functioning of the whole system of teacher preparation.

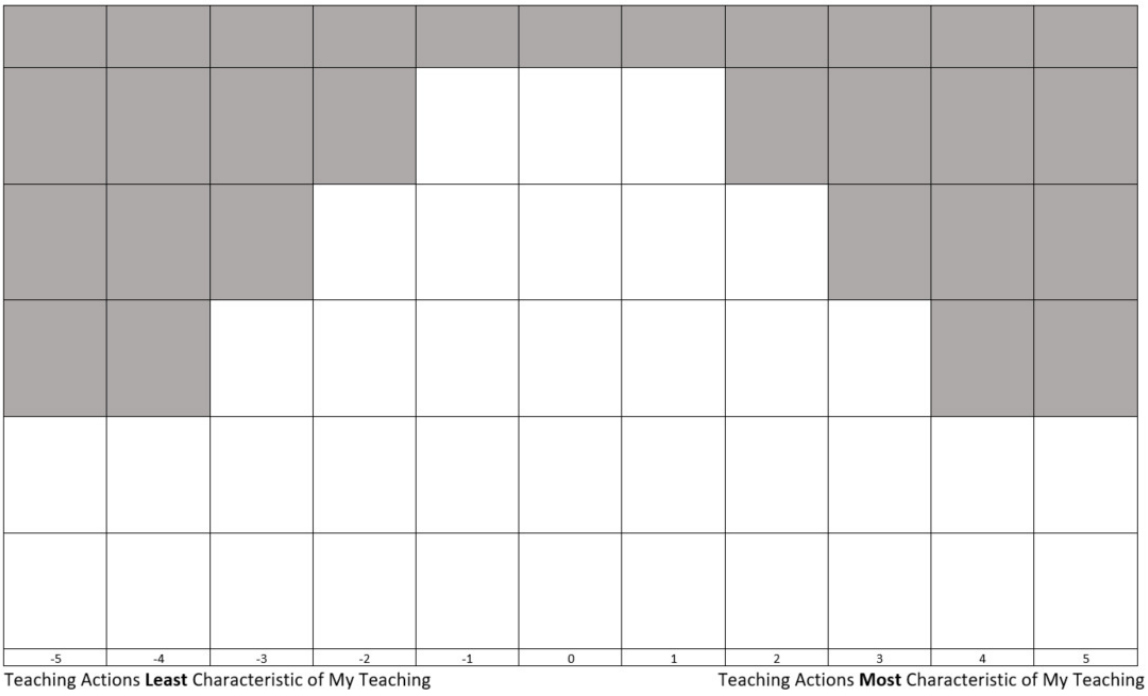
Q-sort

A Q-sort is a ranking process involving statements or pictures that are collectively referred to as the Q-set. The Q-set items are placed on the Q-grid by participants as they use their frame of reference to represent their view or perspectives on each of the items in the Q-set (Ramlo & Newman, 2011). Figure 1 shows a Q-grid in which the white boxes on the far-left side are for items in the Q-set that are selected as least characteristic of the person sorting, and the white boxes on the right are reserved for items in the Q-set that

are selected as most characteristic by the sorter. The remaining items are sorted along the continuum from least characteristic to most characteristic. Only the white boxes may be filled, which forces the sorter to make choices about how they want to represent the items in the Q-set.

Figure 1

A Q-Grid



Note. From "Mathematics teachers' implementation of high-leverage teaching practices: A Q-sort study," by J. Wilburne, D. Polly, D. Franz, & D. A. Wagstaff, 2018, *School Science and Mathematics, 118*(6), p.242 (https://doi.org/10.1111/ssm.12293). Copyright 2018 by Wiley.

Methodology

This study used the data collection tool from Q-methodology to assess teacher candidates' perceptions of their use of the EMTP in their instruction. Q-methodology

combines qualitative and quantitative methods to explore and summarize the subjective views of participants (Coogan & Herrington, 2011; Ramlo & Newman, 2011), which in this study was the teacher candidates' perceptions of their enactment of the EMTP. The Q-sort data collection tool is appropriate as it allows for insight into individual perceptions while still including a means for whole group analysis that can be used to identify patterns (Damio, 2018).

The first part of the study replicated the Wilburne et al. (2018) study using the same Q-sort with teacher candidates as participants instead of teachers with varying years of experience. Teacher candidates ranked the practices that make up the EMTP on a scale from "least characteristic of my practice" to "most characteristic of my practice". This ranking allowed teachers to reflect on their use of what they learned in their math methods class. This process also allowed trends to be identified in reported practices within the cohort.

Following the Q-sort, participants completed a questionnaire with demographic information and open-ended questions about which statements were easiest/hardest to place on the Q-grid, providing rationale for their responses. The questionnaire was also in direct replication of Wilburne et al. (2018). After the questionnaire, the methods in this study deviated from the study on which it is based, which is typical of constructive replications that seek to build onto existing research (Makel & Plucker, 2014).

The second part of the study embraced complexity theory to examine the influences within a teacher preparation program, which shaped participants' priorities for enacting the EMTP. A semi-structured group interview of the four participants was used to probe participants' thinking around their simplex systems. The patterns that emerged in

participants' Q-sort and reflection in the focus group provide some explanation as to how the complex system of teacher preparation was functioning. The group interview was selected to reflect the stance of situated learning theorists who argue group discussion spurs new observations and insight for teachers who are developing their schema around instructional practices (Korthagen & Lagerwerf, 1996). In the group interview, participants discussed how they completed the Q-sort and what influences they identified as shaping their instruction. The group interview was audiotaped, transcribed, and analyzed using the constant comparative method (Glaser, 1965).

After the group discussed their Q-sort and influences, they received their Q-sort from the first year in the teacher preparation program. They compared their first year Q-sort with their second year Q-sort and identified similarities and differences in the two. As they analyzed similarities and differences between the two Q-sorts, they completed an individual reflection form. Finally, participants discussed the changes in their practice along with the reasons for the changes.

Summary

By replicating Wilburne and colleagues' study on teachers' perceptions of their enactment of the EMTP, I sought to gain insight that will lead to stronger enactment of practices for teacher candidates in the future. Findings from this study provided insight into adjustments that can be made in the complex system of teacher preparation. With stronger teacher preparation that leads to enactment in the classroom, an equity-based model of instruction can become the norm in math classes. The study includes: (1) a review of relevant literature; (2) methods of the study; (3) findings; and (4) discussion.

Chapter II

Review of Literature

This study explored the preferred teaching practices of secondary mathematics teacher candidates and the influences that most impacted their instructional practices while in the teacher preparation program. The proposed study also explored how teachers' perceptions of their practices changed between the first and second years in the teacher preparation program. This chapter will review the relevant literature regarding teacher preparation and the evolution of teachers' perceptions and practices. The literature review will include the following sections: (1) theoretical framework; (2) teacher preparation; and (3) effective mathematics teaching practices.

Theoretical Framework

The proposed study will be grounded in situated learning theory (Lave & Wenger, 1991) and complexity theory (Mason, 2008) as the literature suggests teacher preparation programs have little impact on the enactment of practices (Grossman, 2008; Korthagen, 2010; Papay et al., 2012; Wideen, Mayer-Smith, & Moon, 1998). One potential explanation for these findings stems from the apprenticeship of observation phenomenon (Borg, 2004).

The apprenticeship model of learning is widespread in teacher preparation, sometimes as an intentional design of the learning process for preservice and early career teachers (Lloyd, 2018; Williamson & Hodder, 2015). However, the term "apprenticeship of observation" has been used for decades to describe not an actual apprenticeship, but instead the phenomenon of novice teachers drawing from thousands of hours of teacher observations from the time they are a student to the time they begin teaching (Borg, 2004;

Mewborn & Tyminski, 2006). Research shows a tendency for teachers to resort to practices they observed as students as a means of feeling comfortable in their instruction, rather than enacting more innovative methods learned in their teacher preparation program (Borg, 2004; Borko & Livingston, 1989; Smagorinsky & Barnes, 2014; Tomlinson, 1999). The theoretical framework that follows will outline situational theory (Lave & Wenger, 1991) and complexity theory (Mason, 2008) as perspectives through which teacher preparation may be viewed to learn more about how a novice teacher's lived experiences as a student, formal teacher preparation coursework, and school-based settings interact to frame a teacher's practice over time.

Situated Learning Theory

Situated learning theory was first introduced by Lave and Wenger (1991) as a means of understanding learning and behavior. Specifically, they view learners as experiencing legitimate peripheral participation as a stepping stone to full participation in practitioner communities (Lave & Wenger, 1991). Legitimate peripheral participation is a positive, connected way for novices to interact in the sociocultural space that defines a community of practice. In their analysis of legitimate peripheral participation, Lave and Wenger (1991) emphasize that all learning requires legitimate peripheral participation as a means of developing a participant's identity as a practitioner within a community.

Other situated learning theorists have taken up teacher preparation from a situative perspective (Borko et al., 2000). Borko and colleagues see learning as occurring within a specific context that cannot be separated from the knowledge or skills gained from the activity or situation (2000). In the case of teacher preparation, contexts that are inseparably tied to teacher learning include the teacher's coursework, field experiences,

mentor interactions, and the school(s) of employment during the induction years. Exploring teacher learning from a situative perspective allows consideration of individual cognitive processes in addition to that of a social experience, or legitimate peripheral participation within a learning community of beginning teachers (Borko et al., 2000).

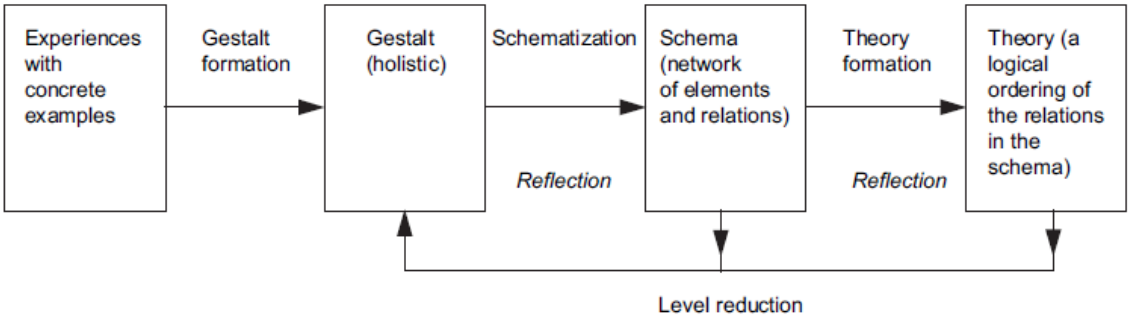
Situated learning theory, much like many modern learning theories, counters the idea that knowledge can be transmitted from one who already holds it to another who does not (Korthagen, 2010). Rather, knowledge is socially constructed from actions and relationships to the actions of others (Lave & Wenger, 1991). For preservice and novice teachers, knowledge and pedagogy develop as a social practice within school settings, influenced by the specific contexts in which they are placed. While the transfer of learning to new contexts is not fully understood, more consensus has been built around the general progression of knowledge-building from a situative perspective (Korthagen, 2010). In the next section, a model of knowledge-building will be shared to illustrate how experiences and reflection support learning.

Three Levels of Knowledge-Building

Situated learning theory and Piaget's (1936) cognitive development theory are reconciled in Korthagen and Lagerwerf's (1996) three level model of knowledge-building that elaborates on mathematics learning theory (Van Hiele, 1986). Figure 2 shows the three levels of learning: gestalt formation, schematization, and theory formation along with the interactions and learning processes that move understanding from one level to the next.

Figure 2

Three Levels of Learning including Learning Processes



Note. From "Situated Learning Theory and the Pedagogy of Teacher Education: Towards an Integrative View of Teacher Behavior and Teacher Learning," by F. Korthagen, 2010, *Teaching and Teacher Education, 26*(1), p. 100 (https://doi.org/10.1016/j.tate.2009.05.001). Reprinted with permission.

The first level, gestalt formation refers to the combination of thoughts, emotions, and motivation that form tendencies toward actions depending on the context or environment (Lunenberg & Korthagen, 2009). Gestalts are formed in reaction to a need of some kind that requires the mind to focus on some aspect of the situation. This focus highlights certain aspects of a situation, and ignores other aspects, depending on what serves to satisfy the need (Korthagen & Lagerwerf, 1996).

As shown in Figure 2, gestalts are formed through concrete experiences, which hearkens back to the apprenticeship of observation as an early gestalt for preservice teachers. As teachers gain experience, the opportunity for more complex and differentiated gestalts emerges, which allows teachers to grow in what Lunenberg and Korthagen (2009) describe as practical wisdom moving toward full participation in practice.

In level two of the model, a teacher grows in experience and practical wisdom and reflection allows him or her to examine gestalts that have previously resided in the unconscious mind (Lunenberg & Korthagen, 2009). Reflection facilitates schematization, or the process of forming a conscious conception or understanding (Korthagen & Lagerwerf, 1996). In teacher education, the theory supports providing ample opportunities for preservice and novice teachers to experience concretely the target pedagogy and practices. When supported with opportunities for reflection, novice teachers may be able to build a schema around a new conception of teaching to counteract gestalts from earlier experiences that may tend toward transmission-ist teaching (Korthagen & Lagerwerf, 1996).

Reflection that promotes schematization can include discussion of observations related to what is seen, heard, and done within a lesson (Korthagen & Lagerwerf, 1996). Participants in the discussion, building on their lived experiences and using informal language to communicate their perceptions, contribute to socially constructed understanding. This process of reflection and schematization form more sophisticated gestalts that can guide a teacher's tendencies and actions in a way that allows for more possible reactions to a given stimulus in the classroom (Korthagen & Lagerwerf, 1996).

To reach level three, teachers engage in reflection and try to make sense of their experiences, knowledge, motivation, actions, and connections, and as a result, begin to form a theory or a kind of logic that underlies the schema (Korthagen & Lagerwerf, 1996). This sense-making process makes up the third level in Korthagen's (2010) model of situated learning. However, gestalts remain the drivers of actions and reactions, so even when a teacher has moved through the process of schematization to theory-building,

they will not begin to enact different practices as unconscious reactions that are consistent with their theory, until they have had adequate opportunities for practice, experience, and reflection (Korthagen, 2010). When adequate opportunities are experienced, a teacher's schema and espoused theories can begin to shape action at the gestalt level. When this occurs, level reduction has taken place. In other words, what once required conscious thought, careful planning, and reflection is reduced to a simpler level of cognition that shapes enactment at a less conscious level (Korthagen, 2010). As level reduction occurs, and instructional practices that are supported by theories of teaching and learning are enacted, novice teachers move from the periphery toward full participation within the community of practice. While situated learning focuses on the internal processing of the experiences of the individual, complexity theory focuses predominantly on external factors that together influence the learning that emerges.

Complexity Theory

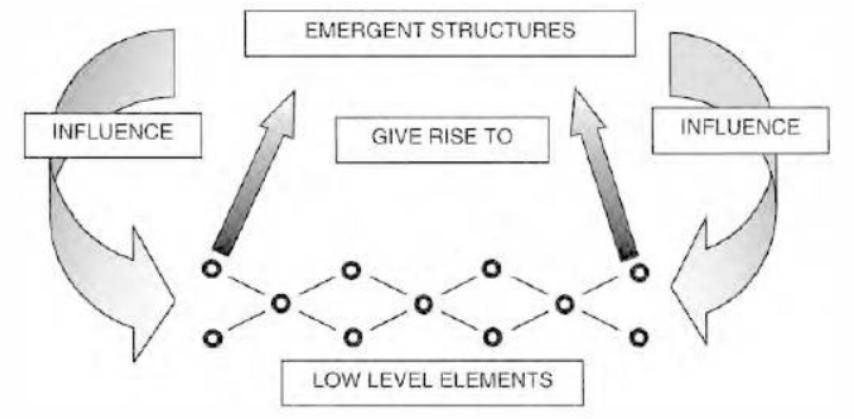
While situated learning theory reflects the interaction between cognitive processes and social construction of knowledge, complexity theory provides insight into how the interactions between parts of a whole can shape outcomes of teacher preparation programs. Complexity theory is based on emergence, which is the idea that when an environment is sufficiently complex, outcomes or behaviors can be unexpected and unpredictable when each component of the environment is considered in isolation (Mason, 2008). However, when the whole is examined, patterns emerge.

Complexity theory has primarily been used to describe phenomena in the natural sciences, such as physics, chemistry, and biology. However, within the last 20 years, complexity theory has begun to be used in the field of economics and even more recently,

in education (Mason, 2008). Figure 3 below illustrates this concept. Rather than a simple cause-and-effect relationship between the low-level elements of teacher preparation and the outcome of teaching, a variety of influences and interactions between elements create a somewhat unpredictable, emergent result.

Figure 3

Emergence Results in Complexity Theory



Note. From *School Leadership and Complexity Theory*, by K. Morrison, 2002, p. 10, Routledge. Copyright by Routledge. Reprinted with permission.

Complexity exists within a teacher preparation program due to characteristics of schools, educational inequities, and regulatory environments in addition to individual candidate characteristics such as beliefs, funds of knowledge, lived experiences, and identities. Participants make sense of complex experiences in different ways, resulting in simplex systems, or simplified representations of the vast influences on action (Van Geert & Steenbeck, 2014). Asking participants to reflect on how they perceive the organization of influences is supported as a technique for understanding conditions within a complex system. Pattern emergence across participants' simplex systems has the potential to lend insight into program outcomes and the interdependence of various elements of the teacher

preparation program in ways that only examining individual teacher outcomes or individual program components cannot (Ell et al., 2017).

In addition to gaining insight into program outcomes through the examination of interdependent program components, complexity theory provides a lens through which the process of engagement in the teacher preparation program may be examined. When the complex nature of teaching is viewed through Korthagen and Lagerwerf's (1996) three level model of knowledge acquisition outlined in situated learning theory, it follows that not all teachers will have reached the theory building and level reduction needed to support full enactment of what they learn in the teacher preparation program. In this case, the process of engagement during the teacher preparation program may yield insight into the learning that is occurring regardless of whether the outcome of that learning is evident immediately after the teacher completes the preparation phase of their learning (Clarke et al., 2005). Complexity theory offers another benefit in its search for patterns by providing a unique window into the collective learning of a group of teachers in a "community of practice" in a way that complements the learning of the individual in situated learning theory (Clarke et al., 2005).

While research yields some insight into components of teacher preparation programs, complexity theory holds that it is in the simultaneous emergence of learning through the interactions of the components that together produce knowledge-building systems or networks. This theoretical framework is built on the proposition that learning is non-linear, and the components of the teacher preparation program likely have unequal, but harmonious impacts on the teacher outcomes (Davis & Sumara, 2010). Situated learning theory and complexity theory provide important focus to both the internal

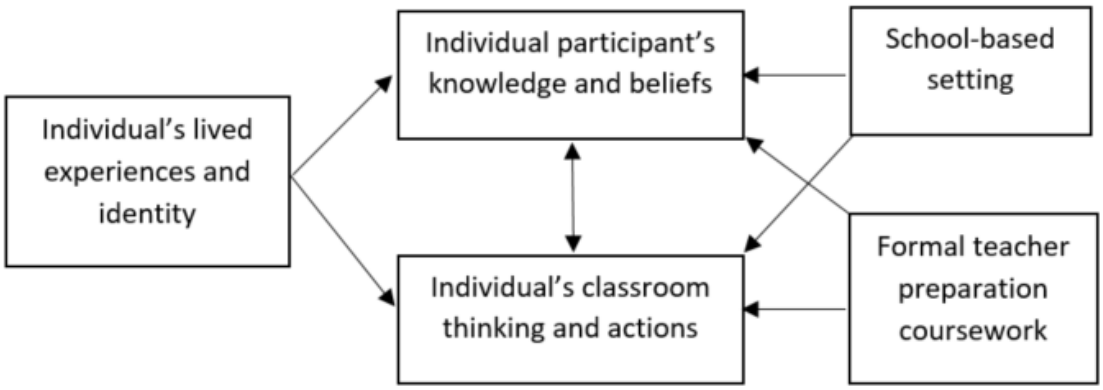
processes of teacher learning and the external factors that influence teacher learning. The review of literature turns next to some of the more salient components of teacher preparation programs that produce a knowledge-building network.

Teacher Preparation

A wide variety of teacher preparation program structures and philosophies have developed in the last several decades to prepare teachers to meet the needs of culturally and linguistically diverse students. The increased emphasis on accountability and teacher quality, changing needs in the economic and technological landscape, a growing diversity in learners, and evidence of increased inequity in schools are factors that shape research perspectives on teacher education (Cochran-Smith & Villegas, 2015). One such research perspective, introduced in Borko et al. (1992) suggests a conceptual framework for exploring how a teacher candidate's beliefs, knowledge, thinking, and actions are developed from a range of internal factors (e.g. identity and existing beliefs) and external factors (e.g. teacher preparation coursework, field experiences, and participation in a research project). Figure 4 shows the conceptual framework adapted from Borko et al. (1992) to study how a beginning teacher's thinking, actions, knowledge, and beliefs develop during the teacher preparation experience as a result of this range of influences.

Figure 4

Influences on Teaching



Note. Adapted from "Learning to Teach Hard Mathematics: Do Novice Teachers and their Instructors give up too easily?" by H. Borko, M. Eisenhart, C. Brown, R. G. Underhill, D. Jones, and P. C. Agard, 1992, *Journal for Research in Mathematics Education, 23*(3), p. 200 (https://doi.org/10.2307/749118). Copyright 1992 by the National Council of Teacher of Mathematics.

In this section of the literature review, this conceptual framework will be used to organize the relevant literature. First, literature on lived experiences in the schooling process and teacher identity will be reviewed, followed by an exploration of formal teacher preparation coursework. Finally, a summary on the literature on school-based settings and field experience will be shared.

Lived Experiences and Teacher Identity

Every teacher entering the profession brings a unique history of experiences with learning in a formal school setting along with a variety of "teaching" experiences from informal settings. For decades this "apprenticeship of observation" has been referred to in

the literature as an explanation for why teacher preparation often fails to result in the desired outcome of teachers who are able to meet the needs of diverse learners using innovative practices (Borg, 2004; Mewborn & Tyminski, 2006). However, the ways in which the lived experiences of novice teachers impact their practice do not always contradict more innovative practices supported by teacher preparation programs. Rather, the empirical evidence points primarily to affective elements of lived experience as influences for practices that teachers incorporate as they enter the profession (Mewborn & Tyminski, 2006; Smagorinsky & Barnes, 2014).

Both positive and negative affective experiences have been cited by novice teachers as rationale for the use of specific practices in their classrooms, with the positive experiences leading to imitation and the negative experiences influencing the adoption of practices that are different from what the teacher experienced as a student (Mewborn & Tyminski, 2006). Similarly, the structure of a teacher preparation program may encourage reflection on prior schooling experiences in ways that support novice teachers in developing new conceptions of effective teaching practices (Smagorinsky & Barnes, 2014). Their findings showed that preservice teachers' conceptions of effective pedagogy aligned with innovative and constructivist methods that were espoused by the teacher preparation program.

While this newer research shows promise for establishing the effectiveness of teacher preparation programs in influencing preservice teachers' conceptions of effective pedagogy, the data in Smagorinsky and Barnes (2014) were collected before preservice teachers had the opportunity to put into practice their learning through student teaching. The researchers highlight that the preservice teachers had not yet engaged in field

experiences. They acknowledge that enactment of the instructional practices in the unpredictable environment of a school could change their view on practices, once field experience is gained. When the apprenticeship of observation model is examined through the lens of situated learning theory, the possibility remains that a teacher who experienced transmission-ist teaching as a student may enact the same style of teaching in moments when she must rely on her unconscious gestalts, rather than the new conceptions of teaching that have not been reduced to the level of a new gestalt yet.

Identity, Dispositions, and Beliefs. In addition to lived experiences, preservice teachers bring all elements of their identities with them to the profession. Identity refers to an individual's conception of who they are and how they fit with others and the world around them. Hoffman-Kipp (2008) defines teacher identity as "the intersection of personal, pedagogical, and political participation and reflection within a larger sociopolitical context" (p. 153), and Trent (2016) argues that teacher identity is dynamic and formed, in part, through the process of learning to teach and engaging in discourse.

Upon entering the profession, mathematics teachers in many settings do not hold a strong body of mathematics knowledge, which necessitates building of identity as both a learner and teacher of mathematics in the teacher preparation program (Adler & Davis, 2006). Mathematical identities can be built through a combination of focused unpacking of mathematical concepts in addition to the promotion of productive dispositions toward mathematics (Adler & Davis, 2006).

A continuum from learner-centered to student-centered pedagogical leanings showcases a more nuanced understanding of the perspectives teachers hold as they enter the teaching profession (Erchick et al., 2014). As teachers gain experience in the

classroom, their perspectives on preferred pedagogical approaches tend to shift along the continuum toward student-centered. In addition, teachers' dispositions toward teaching mathematics from a procedural, conceptual, or integrated approach changed over time from mostly procedural approaches initially toward more integrated styles of instruction (Erchick et al., 2014).

Other studies also provide insight into the types of beliefs or perspectives that form a teacher's identity throughout their career. Dunleavy (2015) examined dispositions toward equitable practices through the delegation of mathematical authority in the classroom from the teacher to the students. Teachers' dispositions, formed through identity and experience, have the potential to shape instructional decisions in a way that supports equitable instruction (Hand, 2012), and when dispositions tend away from equity, a single transformative learning experience has the potential to shift the teacher's disposition toward innovative and equitable practices (Lloyd, 2018).

Knowing that teachers' dispositions are crucial to how they teach, it is imperative to examine the desirable elements of teacher identity and disposition that are crucial for novice mathematics teachers to possess. In addition to a deep understanding of the mathematics they are teaching, the AMTE includes in their standards that new teachers should hold the belief that all students can become proficient in mathematics. Further, they should be ready to provide appropriate instruction for all learners in their classrooms by building on the social, cultural, and linguistic resources that students bring with them to the classroom (AMTE, 2017). Finally, new teachers should be prepared to advocate for their students and encourage in them a disposition toward learning mathematics.

To adopt these dispositions, if not already held, new teachers need to reflect on their own experiences as learners of mathematics, as these experiences will have shaped their inclinations toward certain instructional actions (Hand, 2012). When teachers take time to reflect on their experiences as learners and teachers of mathematics, they are better positioned to learn about new teaching strategies (Koestler, 2010). Experience and reflection are thus important elements for learning about and supporting productive dispositions in teachers. In the following section of the literature review, research on formal teacher preparation coursework will be summarized, to emphasize the types of experiences and opportunities for reflection that may help teachers build a positive teacher identity.

Formal Teacher Preparation Coursework

In recent years, researchers have argued that teacher preparation coursework should be situated in practice, rather than focused on knowledge and beliefs or theoretical learning (Ball & Forzani, 2009; Ball et al., 2009; Grossman et al., 2009; McDonald et al., 2013). Descriptions of teaching as “unnatural” and “intricate” (Ball & Forzani, 2009) or “complex work that looks deceptively simple” (Grossman et al., 2009, p. 273) are used to differentiate the practice of formal teaching from the informal learning opportunities that are a frequent part of adult life. To better prepare prospective teachers for this complexity, some researchers argue that practice-based coursework should be used as a means of promoting enactment of core instructional practices (Ball & Forzani, 2009; Grossman et al., 2009; McDonald et al., 2013) because it is the experiences of enactment that push what is initially very challenging for new teachers to become more routine, clearing the way for attention to student learning.

While there is considerable agreement that practice-based coursework is necessary for supporting the transfer of theoretical knowledge into the classroom, researchers have focused on different aspects of this shift. First, the division of core pedagogical coursework and methods coursework is problematic, creating a fractured experience of knowledge-based and practice-based learning as distinct facets of preparation. As a remedy, a dramatic reconstruction of the teacher preparation program to be centered on a single set of core instructional practices that are integrated into every course and clinical experience is recommended (Grossman et al., 2009). Additionally, coursework should include a core set of instructional practices, but support and collaboration among teacher educators is also needed to ensure continuous improvement as well as consistency throughout the program (Ball et al., 2009). Finally, a systematic study of teacher educator pedagogy is offered as a necessary component to improving current preparation programs (McDonald et al., 2013).

One such example of practice-based teacher preparation and the study of teacher educator pedagogy can be found at Arizona State University, in partnership with Teach for America (TFA). In this model, teacher preparation occurs concurrently with induction and practice, paving the way for collaborative work between clinical instructors, TFA staff, and school-based personnel to provide support as teachers are learning. Clinical instructors use data to adjust coursework and instruction in response to emergent teacher needs, and the impact of the adjustments is considered for future course adjustments. The culmination of the teacher preparation experience is an action research project that requires teachers to identify and solve problems in their own classrooms. Proponents of

this model argue that teachers show more active engagement in instructional improvement by the end of the program (Heineke et al., 2010).

In addition to supporters of practice-based teacher preparation from a curricular design standpoint, several researchers have investigated whether practice-based programs support stronger student achievement for teachers when they enter service. For example, practice-based teacher preparation programs resulted in higher student achievement scores for first year teachers in New York City when compared to programs without a practice emphasis (Boyd et al., 2009). This trend was noted for both math and reading teachers, and the difference in student achievement scores between the most effective teacher preparation program and the average teacher preparation programs was significant. In a separate longitudinal study, findings showed that teachers' "learning by doing" in the early years of teaching, led to the steepest gains in student achievement when compared with experience later in a teacher's career (Harris & Sass, 2011). For elementary mathematics, teachers who were prepared through "on the job" training with Teach for America were shown to improve student achievement for students at all performance levels when compared to teachers prepared through other pathways (Penner, 2016).

School-based Settings

A critique of literature from 2000-2012 conducted by Cochran-Smith et al. (2015) points to a trend of struggle for novice teachers in navigating school settings during field experiences and the induction years of teaching in which accountability pressure, scripted lessons, and strict pacing guidelines are promoted. In these contexts, novice teachers experience a tension between a desire to enact instructional practices promoted by the

teacher preparation program and more traditional methods promoted by the school-based culture. Though situated learning theory and gestalt formation could imply that more experienced teachers serving as mentors in field experiences are better positioned to enact innovative practices, providing a model for preservice teachers, this is not always the case. Some experienced teachers form gestalts based on what keeps a classroom flowing smoothly, rather than what produces deep learning (Lunenberg & Korthagen, 2009). So, while experience is a prerequisite for gestalt formation, more experience alone is insufficient for progressing to innovative teaching, leaving many cooperating or mentor teachers making unconscious choices in the classroom that are inconsistent with learning theories that suggest how diverse student populations learn.

Additionally, while scholars have pointed to field experiences as opportunities to prepare novice teachers for diverse student populations, culturally responsive practices, and equity-oriented mindsets, they also acknowledge that the potential for more firmly entrenching deficit beliefs and traditional teaching practices also exists when field experiences are not carefully structured (Cochran-Smith, 1991; Gay & Howard, 2000; Villegas & Lucas, 2002; Williamson & Hodder, 2015). Further complicating understanding of the impact of field experiences is the tendency for research to explore a change in preservice teachers' beliefs and dispositions in isolation without considering if or how those changes impact teaching practices (Anderson & Stillman, 2013).

Field experiences have the potential to be impactful opportunities for preservice teachers to enact the learning from their teacher preparation program. Specifically, pedagogies promoted by the teacher preparation program and in the school setting have been found to influence teachers' enactment of instructional practices (Borko et al., 2000;

Boston & Smith, 2009; Darling-Hammond, 2006). The argument that "knowledge is inseparable from the contexts and activities in which it develops," (Borko et al., 2000, p. 195) provides a framework for understanding how the teacher's experiences in the teacher preparation program impact their instructional decisions in the classroom. A number of studies point to compatibility between the values, beliefs, and instructional practices between contextual settings as a key factor for the enactment of core instructional practices (Borko et al., 2000; Boston & Smith, 2009; Darling-Hammond, 2006), while other studies provide insight into how enactment occurs even in some cases when contextual settings promote conflicting instructional practices.

In a longitudinal study on clinical teaching, alignment between teacher preparation program field supervisors and cooperating teachers in the school setting improved over time with strategic and ongoing efforts to norm on teacher observations and to develop shared meaning around instruction (Darling-Hammond, 2006). Additionally, professional development with cooperating teachers can result in stronger enactment of target practices by cooperating teachers, providing a model for preservice teachers (Boston & Smith, 2009). Both of these studies demonstrate effective means of increasing alignment between teacher preparation programs and school settings (Darling-Hammond, 2006; Boston & Smith, 2009).

While alignment between the teacher preparation program and school setting seems intuitive and is supported by research, some studies have shown in some circumstances, novice teachers are able to enact instructional practices learned in teacher preparation even in school settings where those practices are not evident. For instance, Lloyd (2018) explored how preservice teachers internalized and enacted beliefs and

instructional practices learned in their math methods coursework using a continuum from traditional to innovative beliefs and practices. For preservice teachers who entered the program with either traditional beliefs about teaching (e.g. transmission-ist) or mixed beliefs (e.g. inconsistent evidence of innovative or reform beliefs), a single positive, transformative experience in the field was enough to push the teacher along the continuum toward innovative beliefs and enactment. Preservice teachers who did not encounter this type of transformative experience in the field remained fixed in their traditional or mixed beliefs throughout the program. Recommendations from the study included strong connections and norming around desirable practices between teacher preparation faculty and field supervisors to promote exposure within the field experience to innovative practices (Lloyd, 2018).

Other opportunities within a teacher preparation program that mitigate the challenges that result from misalignment between teacher preparation program and school setting include diversity in field experiences and frequent reflection to facilitate meaning-making (Williamson & Hodder, 2015). For example, clinical instructional rounds within a teacher residency program have been found to prepare teachers for diverse, urban settings. The experiences in the clinical instructional rounds can help teacher candidates more deeply understand the contexts and systems in which they work. They also promote learning of diverse teaching practices and appreciation for the strengths of diverse learners. While these findings provide insight into the potential for clinical instructional experiences, in some cases, candidates became more deeply entrenched in deficit view of their own students (Williamson & Hodder, 2015), which is consistent with a trend in research noted by Anderson and Stillman (2013).

A final example of successful enactment of innovative instructional practices by preservice teachers, despite more transmissive school-based practices, rests on the power of the mentoring relationship between preservice teachers and mentor teachers. In some cases, this relationship can be characterized as an apprenticeship with the mentor teacher providing a model of instruction for the preservice teacher to emulate. In other cases, the mentor teacher serves not as a model, but as a reflective coach, providing opportunities and support for enactment of practices different from those utilized by the mentor. In one study, a preservice teacher worked with two different mentors, one espousing the apprenticeship model and the other serving as a reflective coach (Smith & Avetisian, 2011). Findings of the study showed that the reflective coach, who happened to employ more traditional practices in his own instruction, was more impactful in the preservice teacher's enactment of innovative practices. In contrast, the mentor who provided more direct feedback, serving as the expert, had a negative impact on the preservice teacher's practices, though she used more innovative practices in her own instruction. This suggests that the use of constructivist coaching practices have the potential to support preservice teachers in their attempts to enact what they learn in the teacher preparation program, while more authoritative support can be counterproductive (Smith & Avetisian, 2011).

The literature reviewed here speaks to the nuances of what is known from existing research. Additional research is needed on effective means for disrupting the tension between formal teacher education and school-based cultures and practices with the goal of supporting novice teachers in enacting practices that have the potential to result in stronger outcomes for diverse learners (Anderson & Stillman, 2013; Cochran-Smith et

al., 2015). Based on existing research, attention to reflection opportunities, improved field experiences, and teacher preparation grounded in the practice of teaching promote enactment of core instructional practices. In the following section of the literature review, the core instructional practices of focus will be detailed.

Effective Mathematics Teaching Practices

As outlined above, scholars believe teacher preparation should be practice-based with opportunities for enacting core instructional practices both within the teacher preparation program and in school settings. Instructional practices can be described as actions that become habit or routine for thoughtful use in instruction (Lampert & Graziani, 2009). Core practices should be generalizable, useful, and teachable (Ball et al., 2009). Out of a set of eight criteria designed to evaluate instructional practices, four of the criteria are specifically related to teacher preparation, while the other four relate to specific needs for mathematics instruction. For example, for an instructional practice to be considered a core instructional practice, it must support improvement in learning for students on centrally important concepts in mathematics. The practice must be frequently used and applicable to multiple instructional approaches. In the teacher preparation context, core instructional practices must be teachable and accessible both in understanding and practice for novice teachers.

Added to the eight criteria (Ball et al., 2009) core instructional practices should promote learning about students and teaching and should not oversimplify or reduce the integrity of teaching (Grossman et al., 2009). Similarly, instructional practices should not reduce the cognitive lift for students (McDonald et al., 2013). Rather, core instructional practices should reflect the belief that instruction should be “built on the brilliance of

children," (McDonald et al., 2013, p. 380) and should seek to remedy or push back against systemic issues in schools that marginalize students.

In mathematics education, NCTM recommends eight research-based effective mathematics teaching practices EMTP that meet the criteria for core instructional practices and that are promoted in order to increase equity and provide access for all learners (NCTM, 2014). The eight practices include:

1. Establish mathematics goals to focus learning.
2. Implement tasks that promote reasoning and problem solving.
3. Use and connect mathematical representations.
4. Facilitate meaningful mathematical discourse.
5. Pose purposeful questions.
6. Build procedural fluency from conceptual understanding
7. Support productive struggle in learning mathematics.
8. Elicit and use evidence of student thinking. (NCTM, 2014, p. 10)

In support of theses eight practices, the AMTE include in the standards for mathematics teacher education programs that new teachers should be able to plan for and execute effective mathematics lessons by including the use of the EMTP (AMTE, 2017). The proposed study will use these eight practices as the foundation for investigating teachers' perceptions of their practice including how the various components of the complex system of teacher preparation influence their adoption of practices. In the remainder of the section of the literature review, each of the eight practices will be briefly deconstructed with a focus on how novice teachers learn to enact them.

Establish Mathematics Goals to Focus Learning

Teacher preparation programs should not be focused on expert level teaching skills, but rather on the foundational skills from which the work of teaching can be revisited and redefined over time (Hiebert et al., 2007). The first of their proposed skills is establishing the learning goal with precision clearly defining the specific learning the teacher hopes students will achieve in the lesson. From a clearly defined learning goal, teachers can identify the evidence that would yield insight into student learning within the lesson. Stein (2017) builds onto the establishment of learning goals with the argument that instructional decisions within the lesson should be made from the focused learning goal and should guide the work that students produce during the lesson.

Implementing Tasks that Promote Reasoning and Problem Solving

The practice of promoting reasoning and problem solving through rich tasks is supported by the research finding that "student learning is greatest in classrooms where tasks consistently encourage high-level student thinking and reasoning and least in classrooms where tasks are routinely procedural in nature" (NCTM, 2014, p. 17). For novice teachers, this practice involves first being able to identify and select tasks that are appropriately structured, and then learning to facilitate such tasks in the classroom without reducing the cognitive lift of the task (Boston & Smith, 2009).

The launch of a sufficiently challenging task provides an opportunity to increase mathematical reasoning, motivation, and access, or to decrease the cognitive demand of the task, depending on how the lesson is framed (González & Eli, 2017). Rather than attempting to establish a formulaic approach to launching a complex mathematical task, scholars argue that based on current research, teachers should balance scaffolding with

ambiguity to create the necessary environment for productive struggle to occur (González & Eli, 2017; Livy et al., 2018) and the experience to find this balance comes with reflecting on one's own practice over time (González & Eli, 2017).

During the execution of the lesson, teachers can build on the accessibility they planned beforehand by using differentiation in the form of enabling or extending prompts (Livy et al., 2018). Enabling prompts increase access and extending prompts have the added benefit of pushing beyond the scope of the original task for students who are ready (Livy et al., 2018). For preservice and novice teachers, leveraging this type of planning for differentiation can decrease the improvisational responses they must make in the lesson, leading to a higher likelihood for maintaining the cognitive level of the task (Borko & Livingston, 1989). Other strategies suggested for supporting preservice teachers in building proficiency with task facilitation include offering multiple opportunities to teach the same lesson, when possible, and offering feedback and reflection opportunities.

Use and Connect Mathematical Representations

When multiple mathematical representations are a regular part of instruction and the process of problem-solving, more students can access the mathematics (Murata & Stewart, 2017). Visual representations aid learners in gaining access to the mathematical concepts and in expressing their own strategies for solving problems and making sense of the mathematics (Driscoll et al., 2016). Visual representations support mathematical discourse in the classroom by providing a mapping of student thinking that can be shown and discussed (NCTM, 2014). Multiple representations, including visual models, tables, diagrams, contextual situations, and graphs connect understanding within different

portions of the brain creating brain growth and increased student engagement (Boaler, 2016). As students build new connections in their brain, they are better able to use representations flexibly and efficiently in problem-solving (NCTM, 2014).

Facilitate Meaningful, Mathematical Discourse

The practice of facilitating truly meaningful discourse can present a challenge to teachers due to the large number of factors that influence classroom discussions, ranging from task selection, promoting peer-to-peer talk, asking purposeful questions, and establishing and maintaining a classroom culture marked by academic safety (Boston et al., 2017; Krall, 2018; NCTM, 2014). While the challenges are numerous the payoffs of creating instruction, rich in discourse, include increased student achievement, more accessibility to mathematical concepts, and more equitable student outcomes (Boaler & Staples, 2008; Schoen et al., 1999).

Perhaps the most common framework for structuring a mathematical discussion comes from Smith and Stein's (2011) five practices. The first practice, a planning practice, involves *anticipating* how students will respond to a rich task that serves to advance understanding toward the goal in the lesson. Once the lesson launches, the teacher *monitors* student work to observe students thinking and reasoning. While the teacher monitors, he may use purposeful question to assess or advance student thinking. Following the monitoring phase, the teacher *selects* and *sequences* the student work to be presented to the class. Specific teacher moves that can be used to promote discourse include allowing ample wait time, inviting student participation, asking a student to revoice student thinking, probing thinking, and using the space within a lesson for student-to-student sharing of mathematical reasoning (Herbel-Eisenmann et al., 2013).

Pose Purposeful Questions

The questioning of a classroom has the potential to push students to think and make sense of the tasks or to reduce the cognitive work to mere recall of facts or procedures (Boston et al., 2017). A variety of frameworks have been developed by scholars to study how question types are used to serve different purposes within a lesson (Boaler & Broadie, 2004; Wimer et al., 2001; NCTM, 2014). The framework proposed by NCTM (2014) includes four main purposes for questions, including gathering information, probing thinking, making the mathematics visible, and encouraging reflection and justification. Using a framework, like this one, can support teachers in planning for and analyzing lessons that are built around sense-making and mathematical reasoning (Boston et al., 2017).

Additionally, patterns of questioning can become important considerations using questions purposefully. For example, overusing questions that gather information or focus on recall of information reduces the opportunity for a teacher to learn about how his students are thinking about the mathematics (Boston et al., 2017). The result is decreased learning opportunities for both students and teacher. Another problematic pattern of questioning, “Initiate-Response-Evaluate” or I-R-E (Mehan, 1979) stems not from the question type, but from the way in which the exchange between teacher and student takes place. In the I-R-E pattern of questioning the teacher poses a question, asks for a student response, and then the teacher immediately evaluates the response for accuracy (Mehan, 1979). The resulting impact on the class can include shutting down student thinking and justification, reduced motivation to formulate explanations of thinking, and positioning of the teacher as the mathematical authority in the classroom

(Boston et al., 2017). In contrast, a pattern of questioning that includes more open-ended opportunities with ample wait time to share thinking and reasoning, positions the students as capable, gives opportunities for the teacher to gather valuable data on what her students know and can do, and encourages students to be active learners (Boston et al., 2017; NCTM, 2014).

Build Procedural Fluency from Conceptual Understanding

Students who learn procedures through understanding are more likely to retain their ability to apply the procedures appropriately, derive procedures when they forget them, and select efficient methods based on contextual situations considered (Martin, 2009). Hiebert and Grouws (2007) in their synthesis of research findings found that students who learn procedures through direct instruction develop procedural fluency, but not conceptual understanding. In contrast, students who are instructed through methods that support conceptual understanding before procedures are introduced, develop both understanding and fluency.

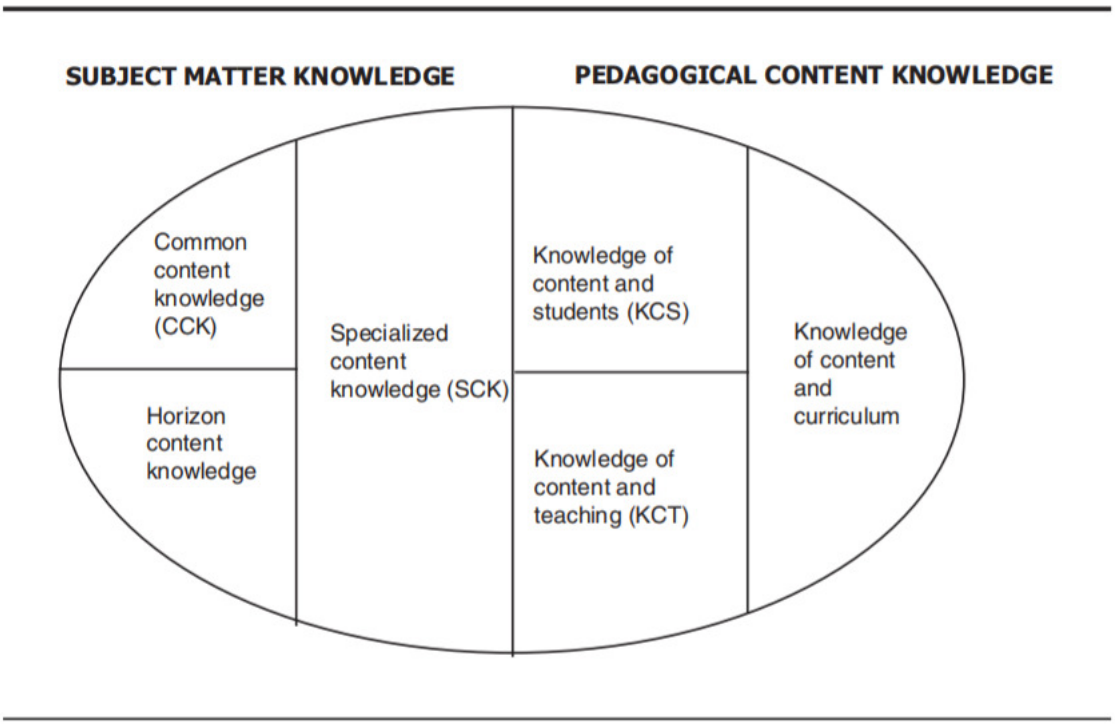
From a lens of equity and access, teaching from the basis of conceptual understanding increases opportunities for students who may have previously struggled to experience the mathematics differently and develop understanding. In contrast, teaching procedures that rely on previously learned procedures leads to marginalization of students who do not have the appropriate foundation of prior knowledge to build from (Boston et al., 2017).

To enact this EMTP, teachers must possess several types of knowledge, some of which are not typically present for preservice teachers upon entry into a teacher

preparation program. Figure 6 shows a framework, built around six different components, that together make up mathematical knowledge for teaching (Ball et al., 2008).

Figure 5

Knowledge Framework for Teaching



Note. From "Content Knowledge for Teaching: What Makes it Special?" by D. L. Ball, M. Hoover, and G. Phelps, 2008, *Journal of Teacher Education, 59*(5), p. 403 (https://doi.org/10.1177/0022487108324554). Copyright 2008 by Sage Publications.

Common content knowledge (CCK) refers to content knowledge that is very similar to how mathematics is used by those outside the field of teaching. Specialized content knowledge (SCK), refers to the knowledge that supports teachers' execution of specific teaching tasks, such as representing ideas or explaining procedures and solutions. Both CCK and SCK are knowledge related to the mathematics, but not specific to students or teaching (Hill et al., 2008). Knowledge of content and students (KCS),

knowledge of content and teaching (KCT), and knowledge of curriculum are all components of pedagogical knowledge for teaching, identified by Shulman (1986).

Using this framework for mathematical knowledge for teaching, teacher educators should first determine what conceptions about mathematics preservice teachers hold when they enter the course, and build based on those conceptions towards more robust understanding in each of the categories of knowledge (Thanheiser et al., 2010). The same goal can be accomplished by setting a norm in the classroom that only mathematical ideas that are brought up within the community can be used to explore and explain mathematical concepts. Thanheiser et al. (2010) focus their own coursework on opportunities for preservice teachers to construct their own understanding, engage in discourse, and assess their own knowledge to determine next steps. This combination of classroom norms and structures supports the development of conceptual understanding in teachers and provides a model of pedagogical strategies as well (Thanheiser et al., 2010). To support building procedural fluency through conceptual understanding, teachers will need to support productive struggle.

Support Productive Struggle in Learning Mathematics

Instruction involving productive struggle, promotes equity and understanding when a teacher, "consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships" (NCTM, 2014, p. 10). Hiebert and Grouws (2007) provide an example of opportunities for productive struggle as tasks that are challenging enough that students need to make new connections, but not so challenging that they are out of reach. Additionally, productive struggle manifests in classroom discourse when

students must justify their responses or evaluate and make sense of the mathematical reasoning of their peers (Franke et al., 2015). In contrast, in the direct instruction or transmission-ist model of teaching, productive struggle is notably absent as students are encouraged to mimic procedures that are modeled by the teacher (Boaler, 2016).

Appropriate teacher supports are prerequisite for students' engagement in productive struggle. When teachers are responsive to the understanding that manifests as students begin to work and affirm of students' ability to proceed successfully, challenging tasks result in productive struggle. Warshauer (2015) has identified four key instructional strategies for providing this type of support to students including using questions that encourage purposeful connections, allocating adequate instructional time for students to engage in problem-solving and sense-making, providing encouragement and praise for effort, and acknowledging that the task is intended to produce struggle (Warshauer, 2015).

When supports are in place and challenging tasks continue to be inaccessible, strategic lesson planning and task launch can provide the entry point that students need in order to struggle productively. Barlow et al. (2018) identified three types of scaffolds that teachers can prepare prior to instruction to increase accessibility to challenging tasks. The first of these scaffolds involves activating the prior knowledge needed to solve the problem (Barlow et al., 2018). The second and third scaffolds proposed both draw attention to the key features of the task. The second scaffold does so by removing the question students will tackle and drafting purposeful questions in order to allow students to understand the contextual situation first (Barlow et al., 2018). The final scaffold available in the planning phase involves creating a simpler problem that has similar key

features, so students can transfer their approach to the more challenging task (Barlow et al., 2018). All three of these scaffolds build on the knowledge students already possess, and thus support equity starting at the beginning of the lesson.

Finally, fostering productive struggle involves attention to the social and emotional needs of students in addition to their academic needs (Townsend et al., 2018). Explicit naming of productive struggle and encouragement to persevere (Warshauer, 2015; Livy et al., 2018) help students to see themselves as capable. Additionally, attention to when frustration replaces productivity can point teachers to appropriate scaffolds that support social and emotional needs (Townsend et al., 2018). Reflection on how students feel about the mathematics supports teachers' understanding of student learning in a way that may advance their development of effective instructional actions and timely reactions to their students' learning needs.

Elicit and Use Evidence of Student Thinking

The final EMTP focuses on teachers' noticing and interpretations of student thinking as well as how teachers can use student thinking in lesson planning, execution, and post-lesson reflection (Boston et al., 2017; Sleep & Boerst, 2012). In the planning phase of the lesson, teachers anticipate how students will approach the mathematical task(s) in the lesson. Teachers' anticipation practices include generating multiple correct approaches to problem-solving in addition to identifying common misconceptions or errors that students may generate (NCTM, 2014). During the lesson, teachers look for evidence of student thinking with intentionality, using a variety of instructional strategies including: checks for understanding, turn and talks, quick writes, observation, and mathematical discussions (NCTM, 2014). Finally, teachers must be able to use the

evidence gathered to interpret student reasoning and decide how to respond in order to move the students forward in their understanding. As with many of the other EMTP, responding to student thinking is largely improvisational, though planning potential responses using what is anticipated is helpful. Regardless of the choice of instructional response, the action should move students deeper into understanding, rather than focusing solely on arriving at a correct answer (NCTM, 2014).

Learning to Enact the EMTP

The EMTP are powerful practices for promoting student learning, which makes them important for preservice teachers to enact. Though the vision for mathematics teacher education is clear, enacting the EMTP can be very challenging for new teachers because of the vast number of in-the-moment decisions that must be made to elicit and react to student responses (Evans & Dawson, 2017). Additionally, if teachers experienced transmission-ist mathematics teaching as students, they may fall back onto direct instruction methods if not given adequate time and practice to overcome the apprenticeship of observation phenomenon (Borg, 2004).

For novice teachers, learning goals can be particularly important for success with student-centered instructional strategies. In more open-ended, student-centered lessons, student responses often produce unexpected pathways. With a clear and explicit learning goal for guidance, novice teachers are more equipped to select and sequence student ideas that if pursued will keep the class on track for reaching the goal (Smith & Stein, 2011).

In terms of multiple representations, new teachers must understand that allowing students a choice in which representation they use is a powerful way to open access to the mathematics in promotion of equity (NCTM, 2014). This understanding also combats a

tendency that some novice teachers may have to simply model several representations one after another or provide multiple practice problems in which students generate multiple representations from a directed list of instructions (Boston et al., 2017). Finally, novice teachers may need practice with keeping the focus of the problem-solving on the mathematical understanding, rather than the procedures involved to create representations (Boston et al., 2017).

Using questioning purposefully keeps the focus on the mathematical understanding in the classroom. Franke et al. (2015), in an exploration of how teachers can support engagement with the mathematical ideas of their peers, found that the initial questioning used to prompt such engagement was often less effective than follow-up questioning. This creates challenging in-the-moment decision-making about what questions to ask. New teachers have less experience from which they can draw, which only increases this challenge (Franke et al., 2015). Similarly, since effective questioning and instruction builds on the knowledge and strategies that students generate, new teachers may have more trouble analyzing atypical solution strategies to generate appropriate questions to advance student thinking. Novice teachers may use pre-generated student work as a starting point for instruction and mathematical discussions. Pre-generated student work allows the novice teacher an opportunity to plan initial questioning and follow-up questioning with less cognitive load in-the-moment (Evans & Dawson, 2017).

Reducing cognitive load in-the-moment is important as follow-up instructional actions based on the specific student, classroom, and mathematical context are more powerful for increasing students' engagement in productive struggle when compared with

initial instructional moves to invite participation (Franke et al., 2015). Instructional actions, both planned and in-the-moment, are informed by a teachers' perceptions and assumptions of their students, and Yanisko (2016) underscores the need to provide preservice teachers with opportunities to experiment with, and reflect on, their own choices of instructional actions in order to build their body of experience in a way that combats harmful assumptions about students. Teacher preparation should include opportunities for teachers to practice selecting appropriately challenging tasks, planning and practicing a task launch with appropriate scaffolding (Barlow et al., 2018). Finally, teachers should have opportunities to reflect on their facilitation of lessons to build a body of experience that leads to effective in-the-moment decisions (Yanisko, 2016). As core instructional practices, the EMTP provide a solid foundation for teacher preparation for mathematics teachers that support student learning, access, and equity in mathematics.

Summary

Teachers learn through legitimate peripheral experiences in which they gain knowledge and skills through practice. As a new teacher's instructional practices become more habitual, she moves toward full participation in the community of teachers (Korthagen, 2010; Korthagen & Lagerwerf, 1996; Lunenberg & Korthagen, 2009). For the habits and routines a teacher develops to reflect research-based core instructional practices, teacher preparation should include both concrete experiences and opportunities for reflection (Lunenberg & Korthagen, 2009). The school-based setting strongly influences the experiences a new teacher has, and thus may impact the practices she consciously and unconsciously chooses to enact. Additionally, teacher preparation programs are highly complex learning networks in which learning emerges in unexpected

ways. It is in the study of patterns within that the network, in addition to individual teacher outcomes, that new insights may emerge (Davis & Sumara, 2010; Ell et al., 2017; Mason, 2008).

As scholars and teacher educators work toward continuous improvement in the field of mathematics education, attention should focus on the extent to which new teachers are prepared for enactment of core instructional practices that support the learning needs of diverse student populations (Ball & Forzani, 2009; Ball et al., 2009; Grossman et al., 2009; McDonald et al., 2013). In the field of mathematics education, the EMTP serve as important practices for effective and equitable instruction. This study explored teachers' perceptions of their practice to understand individual teacher outcomes. Patterns that emerged within the cohort are used to gain insight into the complex system that makes up the teacher preparation program. In the following chapter, the methods of the study including context, participants, instruments, data collection and analysis procedures, and limitations will be outlined.

Chapter III

Methodology

Introduction

The study used Q-methodology to assess early career teachers' perceptions during their preservice and first years of teaching. Q-methodology combines qualitative and quantitative methods as a means to explore and summarize the subjective views of participants (Coogan & Herrington, 2011, Ramlo & Newman, 2011), which in this study was teachers' perceptions of their own enactment of the EMTP. This chapter will include the following sections: (1) an overview of Q-methodology, (2) research questions, (3) participants and setting, (4) procedures, (5) data collection and instruments, and (6) data analysis.

Overview of Q-Methodology

Q-methodology is a mixed methods approach to studying subjective perspectives (Ramlo & Newman, 2011). By studying subjectivity, Q-methodologists seek to understand how participants develop their own meaning based on a set of items or statements. Participants' points of view are systematically explored and analyzed in order to gain insight into the internal perspective of participants, rather than attempting to measure objective reality (McKeown & Thomas, 2013).

Q-methodology begins with the development of a Q-set that consists of a set of statements or descriptors that are representative of an issue of interest. Using the Q-set, participants complete a Q-sort which involves a forced ranking system, resulting in a participant communicating the meaning that they attribute to the statements and to the issue of interest at large (Coogan & Herrington, 2011). The data from the Q-sorts are

analyzed using statistical methods, most often the factor analysis method (Damio, 2018). The researcher then interprets the data based on their understanding of the topic being investigated through the Q-sort and from qualitative data gathered through interviews, focus groups, or written reflections (McKeown & Thomas, 2013).

Research Questions

The research questions for the study include:

1. Which of the EMTP do secondary mathematics teacher candidates rank most characteristic of their teaching?
2. Which of the EMTP do secondary mathematics teacher candidates rank least characteristic of their teaching?
3. How do teacher candidates' perceptions of their use of the EMTP change between the first and second years of their teacher preparation?
4. How do teacher candidates describe influences on their prioritization of the EMTP within their instructional practice?

Methodological Match

The Q-sort data collection tool is appropriate to answer the research questions in this study, as it allows for insight into individual perceptions while still including a means for whole group analysis (Damio, 2018). Q-methodology is suitable for large and small sample sizes alike, which makes it suitable for this study given the small number of participants. Q-methodology supports in-depth exploration of an individual's perceptions (McKeown & Thomas, 2013) which facilitates how the specific context of learning within the teacher preparation program impacts participants in different ways. The Q-sort and qualitative data support identifying the simplex systems that participants generate to

rationalize their own instructional practices and experiences within the teacher preparation program.

Methods

This study used a Q-sort consisting of 37 teacher actions associated with the eight EMTP followed by a questionnaire prompting participants to share their rationale for their sort. Following the independently completed questionnaire, participants discussed their perceptions on their own practice in a semi-structured group interview conducted using zoom video-conferencing. Using a group interview reflects the stance of situated learning theorists that argue group discussion spurs new observations and insight for teachers who are developing their schema around instructional practices (Korthagen & Lagerwerf, 1996). During a break in the group interview, participants had the opportunity to compare the Q-sort they completed with an earlier Q-sort from their preservice year. After individual reflection, the group interview continued in order to elicit participants' reflections on how their Q-sort changed. In the following sections, the participants and setting will be shared in order to provide more context around the teacher preparation program and the participants in the study.

Participants and Setting

The teacher preparation program from which participants were recruited is a two-year Master of Arts in Teaching program housed in a stand-alone graduate school of education in a large urban area in the south-central region of the United States. In addition to the master's degree, students have the option to pursue teacher certification, which is earned at program completion. Though the program has a small number of

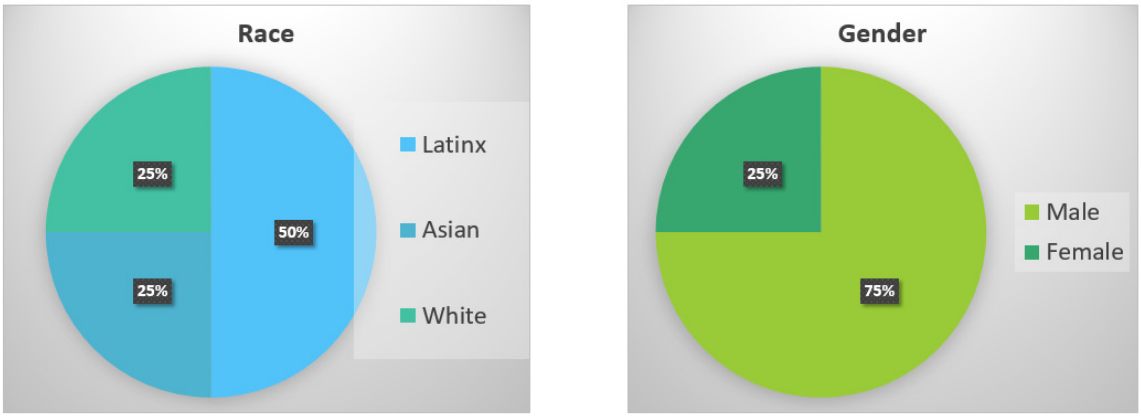
students who majored in education for their undergraduate degree, none of the participants in the study were education majors.

Students spend the first year of the program as teachers-in-residence, working in the classroom of an experienced teacher. In this study, the graduate students are identified as “preservice teachers” during the residency year. During the residency year, students attend half day deliberate practice sessions each week to practice instructional moves they learn in their graduate coursework. In the second year of the program, students are employed as teachers-of-record, sometimes remaining on the same campus from the residency year. During both years, students engage in graduate-level coursework in both core pedagogy and secondary mathematics methods.

While the exact number of students in the secondary mathematics cohort varies from year-to-year, the cohort is typically around 12-15 teachers. Four participants were recruited from the second year in the teacher preparation program, which is their first year as teachers-of-record. Figure 6 shows the demographic breakdown of participants.

Figure 6

Demographic Breakdown of Participant Pool



Participants were chosen from this secondary mathematics cohort as a convenience sample. This cohort completed the Q-sort in the previous school year, which made it possible for them to compare their perceptions of their own practice to their responses from a year prior. Further, these teachers were engaged in their graduate studies in the teacher preparation program of interest.

Comparison of Participants and Setting for Replication

The participants and their settings in the Wilburne et al. (2018) study differ from the participants and setting in this study in a number of notable ways. First, in Wilburne et al. (2018), 38 participants with teaching experience ranging from one to 30 years engaged in the Q-sort process, with a mean of 9.3 years and a median of 7.5 years. Fifteen of the 38 teachers in the original study taught in rural schools, 15 in suburban schools, and just six teachers taught in urban schools. Twenty-eight participants were female (74%), and 10 participants were male (26%). The participants in this study were significantly less experienced as a group than the participants in the original study, and all participants were teaching in urban schools.

Procedures

Participants were recruited in February 2020. Teachers were informed about the research project via e-mail (see Appendix A). They were offered a description of the time commitments and the format of the study to consider if they would find participation to be beneficial to them. They were informed that participation (or lack thereof) will have no bearing on their status or performance as a graduate student at GRADUATE SCHOOL. They had an opportunity to ask questions about the study and were given the

opportunity to consider their participation over a 2-week period. Consent forms (see Appendix B) were collected electronically over the 2-week period.

Upon enrollment, each participant was assigned a unique identification number that was used for all data collected. Assigned identification numbers and all data collected will be kept on a password protected hard drive. Archived Q-sort data were extracted from the Spring 2019 Math-302 files and participant names were replaced with their identification number.

Data collection occurred in two phases. During the first phase, participants were asked to reflect on their use of the EMTP and rank them in a Q-sort according to what is most/least characteristic of their teaching. Immediately upon completing the Q-sort, they completed a questionnaire reporting demographic data and responding to questions about their rationale for how they sorted the EMTP on the Q-grid. This phase of data collection follows the procedures in the original Wilburne et al. (2018) study. Q-sort data were then analyzed using descriptive statistics.

In the second phase of data collection, participants engaged in a semi-structured focus group. The group interview probed participants' perceptions of their use of the EMTP and elicited reflection on what elements of the teacher preparation program, their school-based setting, and their personal background most strongly influenced their practice. After the group reflected on the Q-sort from the first phase of data collection, they were given their archived Q-sort from Spring 2019. After providing time for participants to compare the two Q-sorts, the discussion proceeded with open-ended questions to probe any changes noted between the two Q-sorts. The group interview was recorded and transcribed. The transcribed data was coded and analyzed.

Finally, after data were collected and analyzed, narratives were written to summarize the perceptions of participants' practice, including influences and change over time. A participant check was conducted by asking participants for confirmation that the narrative accurately captures their perceptions. The questionnaire, group interview, and participant check was used for triangulation. In the following sections, each phase of data collection and the associated instruments will be described in detail.

Data Collection and Instruments

Q-sort

Before the first phase of data collection, I mailed a packet of materials to each participant. The packet included a large Q-grid on 11 x 17 paper, a bag containing the 37 Q-sort cards, a smaller size Q-grid, and the Q-sort they completed in April 2019. Participants were instructed to not open the packet of materials until the research session.

During the first phase of data collection, participants joined a zoom video conference and after opening and becoming oriented to the materials, they were asked to complete a Q-sort to rank their instructional practices. The Q-sort included 37 statements, each corresponding to one of the eight EMTP. Before beginning the Q-sort process, participants were informed that each of the 37 statements represent effective practices, and each was assigned a random number to facilitate data collection and analysis. The 37 statements originate from NCTM's Principles to Actions: Ensuring Mathematical Success for All (2014), and the same list of 37 statements was used in the Q-sort in Wilburne et al. (2018) (See Appendix C).

To start the Q-sort, participants were instructed to read each statement and sort them into three piles. One pile was to contain the statements that the participant felt are

very characteristic of their teaching. Participants were instructed to place this pile to the right of neutral on the large Q-grid (see Figure 1). Another pile was to contain the statements that the participant felt are not characteristic of their teaching. Participants were instructed to place this pile to the left of neutral on the Q-grid. The final pile was for statements about which the participant felt neutral or uncertain. Participants were instructed to place this pile between the other two piles to facilitate comparing statements (McKeown & Thomas, 2013). After this initial sorting, participants selected statements for the extreme columns of the Q-sort and continued sorting statements from the extremes toward the center. Beginning with the extremes is likely to result in greater confidence in statement placement, providing a grounding for comparison (McKeown & Thomas, 2013). Once all statements were placed, participants reviewed their rankings and made adjustments, if needed. Finally, participants recorded the number of each statement on their smaller Q-grid to preserve the final ranking.

Questionnaire

Immediately following the Q-sort, participants completed an electronic questionnaire reporting their grade, teaching assignment, gender, race, ethnicity, and school. The questionnaire also included questions similar to those asked in Wilburne (2018), including:

- Which of these actions were easiest to place on the Q-grid? Why?
- Which of these actions were hardest to place on the Q-grid? Why?
- Please share your rationale for the teaching actions in the 4 and 5 columns.

- Please share your rationale for the teaching actions you placed in the -4 and -5 columns.

Though the questionnaire was completed independently, questions were shared with the whole group prior to completion to ensure participants understood the questions. The full questionnaire can be found in Appendix D.

Group Interview

Once participants reflected independently by responding to the questionnaire, a group interview was conducted to probe participants beyond the responses they provided on the questionnaire. All four participants joined the group interview. The semi-structured group interview format was chosen in order to encourage reflection through discussion to bring to light how participants were building their simplex systems and developing their schema to make sense of instructional practices and the highly complex process of teacher preparation (Korthagen & Lagerwerf, 1996).

At the beginning of the group interview, participants were informed that the interview was going to be recorded for the purpose of transcription. After the recording was transcribed using participant's identification codes, the video was deleted from the secure server. Participants were reminded that the group interview was voluntary, and they reserve the right to withdraw consent at any time.

Additionally, norms were shared with participants before beginning the interview. For a full list of norms and group interview questions, see the group interview guide in Appendix E. The group interview guide was used throughout the semi-structured interview as a starting point for promoting discussion. The first set of questions probed participant thinking around their perceptions of the instructional actions that were

included in the Q-sort. Questions asked them to share about influences on their practice, how they learned the practices, their priorities in enacting certain practices while not using others, and perception of how their school leadership viewed the practices.

Following the initial discussion, participants transitioned to comparing the Q-sort they just completed to the Q-sort they completed last school year as preservice teachers. They received a list of guiding questions for independent reflection and note-taking as they compared (See Appendix F). After allowing silent reflection time, participants returned to the discussion to share how their Q-sort changed over time, and what factors they identified as influential in the change. Once the participants were interviewed to the point where no new data were surfacing, they were thanked for their participation and reminded of the norm to keep the discussion confidential. Their independent reflection papers on the comparison between the two Q-sorts were collected electronically through a google form. In the sections that follow, data analysis methods and limitations of the study will be shared.

Data Analysis

While data gathered in a Q-methodology study are typically analyzed using factor analysis and factor interpretation, this study replicated the analysis methods used in Wilburne et al. (2018). The Q-sort analysis described in this section was used with the two separate sets of Q-sort data. The first set of Q-sort data were collected in April 2019 during participants' preservice year. The second set of Q-sort data were collected in March 2020 during participants' internship year during which they served as teachers-of-record.

To analyze the Q-sort data, I assigned each placement on the Q-grid an integer value ranging from -5 to 5, with the extremes representing instructional actions that are least and most characteristic of the participant's teaching, respectively. The placements in each column are all assigned the same value, see Figure 8. I calculated the mean and standard deviation of placements for each of the 37 instructional actions from all participants' Q-sorts (Wilburne et al., 2018).

Figure 7

A Q-Grid with Values Assigned to Each Placement

				-1	0	1				
			-2	-1	0	1	2			
		-3	-2	-1	0	1	2	3		
-5	-4	-3	-2	-1	0	1	2	3	4	5
-5	-4	-3	-2	-1	0	1	2	3	4	5
-5	-4	-3	-2	-1	0	1	2	3	4	5

Teaching Actions **Least** Characteristic of My Teaching — Teaching Actions **Most** Characteristic of My Teaching

I then used the means to rank each of the instructional actions, with the greatest mean assigned a rank of 37, and the least mean assigned a rank of 1. When there were two or more instructional actions with the same mean, they were assigned the same rank and subsequent ranks were omitted until reaching an instructional action with a different mean. After ranking each of the 37 instructional actions, I calculated a mean and standard deviation for each of the eight EMTP using the assigned rank values for each of the

instructional items that fall under the umbrella of an EMTP. For example, the first EMTP, establish mathematics goals to focus learning, includes the instructional actions that were randomly assigned #1, #2, #14, and #17 on the Q-sort cards. Each of those four instructional actions had a rank value assigned between one and 37. I calculated the mean and standard deviations of those four instructional actions' rank values (Wilburne et al., 2018). These statistics allowed comparisons among the eight EMTP based on the Q-sort patterns of the group of participants, addressing the first two research questions for this study. Comparison of these summary statistics across the two years provided insight into how teachers' perception of their use of the EMTP has changed between the first and second years of the program, addressing the third research question.

To address the fourth research question, data were analyzed using the constant comparative method (Glaser, 1965). The constant comparative method is appropriate for generating plausible characteristics related to a phenomenon in support of theory development (Glaser, 1965). For this study, the constant comparative method supported theory development regarding how participants described the influences on their implementation of the EMTP.

Data analysis was conducted by first entering and coding in QDA Miner Lite v2.0. Coding was conducted using an initial codebook that was developed from the conceptual framework presented in Figure 4 along with findings from Wilburne et al. (2018). Use of the subcode structure allowed for both broader conclusions and nuanced understanding of the data in relationship to the conceptual framework (Saldaña, 2013). See initial codebook in Appendix G.

In the initial round of coding, each incident was compared within the data to other incidents within the same category to notice trends and properties of each category (Saldaña, 2013). While coding the data, emergent trends were noted that informed theory development related to participants' descriptions of influences on their prioritization of the EMTP. Memos were written when differing ideas or clear themes emerged within a category. While conducting initial coding, trends that were not represented in the codebook were noted in order to add new codes. When any new codes were added, a memo was written which served as a reference when other incidents of the code were noticed in the data (Glaser, 1965).

In subsequent rounds of coding, once comparison of incidents to other incidents in a category reached saturation, I began to compare incidents to the properties of the category in order to develop a holistic understanding of each category. Next, I determined what to include in the final list of categories to describe participants' descriptions of the influences on their use of the EMTP based on theoretical saturation of categories. I summarized findings, returning to the data for validation (Glaser, 1965). Finally, I conducted member checks with participants for further validation that my description of their shared perceptions is represented accurately. Triangulation of data and member checks were the two main sources of data validation that I used, though I also exercised reflexivity throughout the analysis and descriptions of findings by making note of when my prior experiences with the participants entered my thoughts (Creswell & Poth, 2018). When I noticed myself thinking about experiences with the participants, the schools, or other individuals they mentioned in the interview outside of the data sources from the study, I paused to check any bias I might hold. This allowed me to refocus and ensure

that bias was not entering my interpretation of the data. While the data analysis methods supported addressing the research questions, significant limitations in the study exist, which are outlined in the next section.

Summary

In this chapter, an overview of Q-methodology and a description of the methodological match between the research questions and the methods were provided. The data collection instrument and procedures used for conducting the Q-sort, questionnaire, and semi-structured group interview were also shared. Finally, the data analysis procedures were shared which included using summary statistics of the quantitative data and the constant comparative method (Glaser, 1965) for the qualitative data. In the next chapter, findings from the study are presented.

Chapter IV

Findings

The purpose of this study was to explore the priorities and perceptions of teacher candidates with respect to implementation of the EMTP using replicated methods from Wilburne et al. (2018). This study expanded on the Wilburne et al. (2018) study to address whether this data collection process is useful for capturing meaningful change in perceptions of teacher practice over time. Participants shared their perceptions through a Q-sort process that was conducted during their first year in a teacher preparation program and then repeated eleven months later during their second year in the teacher preparation program. They also reflected on their perceptions of their instructional practices on a questionnaire and through participation in a group interview.

This chapter presents results and findings from the study in order to address the research questions. First, descriptive statistics from the two Q-sorts will be shared and displayed to address the first two research questions and to partially address the third research question. These three research questions include:

1. Which of the EMTP do secondary mathematics teacher candidates rank most characteristic of their teaching?
2. Which of the EMTP do secondary mathematics teacher candidates rank least characteristic of their teaching?
3. How do teacher candidates' perceptions of their use of the EMTP change between the first and second years of their teacher preparation?

Quantitative data from the Q-sorts were entered into a Microsoft Excel workbook, which was used to calculate the descriptive statistics presented in this chapter.

To add insight into quantitative results for the third research question, and to address the fourth research question, qualitative findings will be shared. The fourth research question was:

4. How do teacher candidates describe influences on their prioritization of the EMTP within their instructional practice?

Qualitative data from the questionnaire, transcript of the group interview, and individual reflections on changes in the Q-sort between the two years were analyzed using the constant comparative method. This chapter contains the following sections: (1) quantitative findings, (2) qualitative findings, (3) and a summary.

Quantitative Results

In this section, summary statistics for the eight EMTP from the 2019 and 2020 Q-sorts are presented. The mean and standard deviation were calculated from the rank values of each instructional action associated with an EMTP. These statistics summarize the EMTP that teacher candidates perceive to be most or least characteristic of their teaching, addressing the first two research questions. Change in mean and standard deviation over the course of the study are also presented to address the third research question. As the summary statistics for EMTP are analyzed, the summary statistics for individual instructional actions, including change in mean placement on the Q-grid from 2019 to 2020 are also be presented.

Summary Statistics for the Eight EMTP

Table 1, on the following page, displays the mean and standard deviation calculations that summarize participants' perceptions of their practice, and which EMTP they consider most and least characteristic of their teaching.

Table 1

Mean and Standard Deviation of Instructional Action Rank by EMTP, by Year

EMTP (NCTM, 2014)	2019		2020			
	Mean	SD	Mean	SD	Δ in Mean	Δ in SD
VII. Support Productive Struggle in Learning Mathematics	30.25	6.30	32.75	3.49	2.50	-2.81
V. Pose Purposeful Questions	27.50	2.50	30.25	3.90	2.75	1.40
VIII. Elicit and Use Evidence of Student Thinking	22.00	7.82	22.20	12.24	0.20	4.41
III. Use and Connect Mathematical Representations	11.17	10.14	20.33	8.83	9.17	-1.31
VI. Build Procedural Fluency from Conceptual Understanding	26.80	7.25	20.00	8.88	-6.80	1.63
II. Implement Tasks that Promote Reasoning and Problem Solving	16.80	3.31	16.60	2.58	-0.20	-0.73
I. Establish Mathematics Goals to Focus Learning	12.75	11.78	7.75	6.83	-5.00	-4.94
IV. Facilitate Meaningful Mathematical Discourse	12.75	9.26	7.00	3.24	-5.75	-6.02

Note. Mean and standard deviation for each of the eight EMTP were calculated using the assigned rank values for each of the instructional items that fall under the umbrella of an EMTP. Rank values were assigned based on the mean value of the participants' placement of each instructional action on the Q-grid.

EMTP ranked "most characteristic" of participant teaching. In both 2019 and 2020, the mean calculations (from instructional action rank displayed in table 1) resulted in the highest values for practice VII, *support productive struggle in learning mathematics*, and practice V, *pose purposeful questions*. This indicates that as a group, the four participants perceived that these two practices were most characteristic of their teaching. The larger means for 2020 show that on average, participants perceived that these two practices were more characteristic of their teaching in the second year of the program than in the first. All of the instructional actions aligned to these two practices were in the top half of rank values, with most ranks in the top fourth.

Though all rank values were high, the mean Q-grid placement for each of the instructional actions aligned with the two practices tells a more nuanced story. Table 2 displays the summary statistics for instructional actions in 2019 and 2020 for practice V and practice VII. In 2020, for practice VII, *support productive struggle in learning mathematics*, the means reflect placements on the Q-grid that are further to the right when compared with the means of practice V, *pose purposeful questions*, with standard deviations that are slightly lower than the standard deviations for practice V for three of the four instructional actions.

Table 2

Summary Statistics for Instructional Actions for Practice VII. Support Productive Struggle in Learning Mathematics and Practice V. Pose Purposeful Questions

	2019			2020		
Instructional Action (NCTM, 2014)	Mean	SD	Rank	Mean	SD	Rank
VII. Support Productive Struggle in Learning Mathematics						
8. Giving students time to struggle with tasks, and asking questions that scaffold students' thinking without stepping in to do the work for them.	0.5	1.50	21	2.75	1.48	37
12. Praising students for their efforts in making sense of mathematical ideas and perseverance in reasoning through problems.	4	1.22	37	2.5	1.12	35
19. Anticipating what students might struggle with during a lesson and being prepared to support them productively through the struggle.	2	1.22	35	2	1.22	31
9. Helping students realize the confusion and errors are a natural part of learning, by facilitating discussions on mistakes, misconceptions, and struggles.	1	2.92	28	1.25	2.28	28
V. Pose Purposeful Questions						
18. Asking intentional questions that make the mathematics more visible and accessible for student examination and discussion.	1.25	1.30	30	2.75	1.92	37
31. Making certain to ask questions that go beyond gathering information to probing thinking and requiring explanation and justification.	0.75	2.49	30	1.25	2.49	28
6. Advancing student understanding by questions that build on, but do not take over or funnel, student thinking.	1.25	0.83	25	0.75	0.83	28
13. Allowing sufficient wait time so that more students can formulate and offer responses.	0.75	2.49	25	0.75	2.49	28

EMTP ranked "least characteristic" of participant teaching. In 2020, the practices that were ranked least characteristic of participants' teaching were practice I, *establish mathematics goals to focus learning*, and practice IV, *facilitate meaningful mathematical discourse*. Both of these practices had low means (from instructional action rank displayed in table 1) in 2019 as well, though practice III, *use and connect mathematical representations,* had a lower mean than practice I or IV in 2019.

In addition to the low mean (from instructional action rank), practice I had a relatively large standard deviation in 2020 and an even higher standard deviation in 2019. Practice IV had a large standard deviation in 2019, but a smaller standard deviation in 2020. The larger standard deviations reflect more spread in rank of the individual instructional actions.

The spread of rank is evident when narrowing the focus to the instructional action level. Table 3 displays the summary statistics for instructional actions in 2019 and 2020 for practice I and practice III. For practice I, ranks of instructional actions range from one to 19 in 2020 and from 1 to 32 in 2019. For practice IV, the range was two to 11 in 2020, and three to 28 in 2019. The wide range in rank along with the extreme low and relatively high ranks for individual instructional actions indicates that teacher candidates perceive that some instructional actions within these two EMTP are least characteristic of their teaching, while others they would categorize as neutral or even characteristic of their teaching. Based on the mean placement of the instructional actions on the Q-grid, only two of the eight actions in question had a positive mean in 2019, and none of the eight actions had a positive mean in 2020.

Table 3

Summary Statistics for Instructional Actions for Practice III. Facilitate Meaningful Mathematical Discourse and Practice I. Establish Mathematics Goals to Focus Learning

Instructional Action (NCTM, 2014)	2019			2020		
	Mean	SD	Rank	Mean	SD	Rank
III. Facilitate Meaningful Mathematical Discourse						
3. Selecting and sequencing student approaches and solution strategies for whole-class analysis and discussion.	-1.5	1.80	10	-1.25	2.05	11
33. Engaging students in purposeful sharing of mathematical ideas, reasoning, and approaches, using varied representations.	1	3.08	28	-2	2.00	8
5. Facilitating discourse among students by positioning them as authors of ideas, who explain and defend their approaches.	-2.5	1.66	3	-2.75	1.92	7
25. Ensuring progress toward mathematical goals by making explicit connections to student approaches and reasoning.	-1.5	2.06	10	-3.25	0.83	2
I. Establish Mathematics Goals to Focus Learning						
1. Using the mathematics goals to guide lesson planning and reflection and to make in-the-moment decisions during instruction.	1.5	1.66	32	0	2.35	19
14. Discussing and referring to the mathematical purpose and goal of a lesson during instruction to ensure that students understand how the current work contributes to their learning.	-1.75	1.48	6	-2.5	2.06	7
2. Establishing clear goals that articulate the mathematics that students are learning as a result of instruction in a lesson, over a series of lessons, or throughout a unit.	-1.25	3.27	12	-2.75	1.09	4
21. Identifying how the goals fit within the mathematics learning progression.	-3.5	2.60	1	-4	1.00	1

Change in Perception of Use of the EMTP from 2019 to 2020. The third research question in this study was: how do teacher candidates' perceptions of their use of the EMTP change between the first and second years of their teacher preparation? Table 1 shows both the mean and standard deviation of the ranks assigned to all the instructional actions that are aligned to a particular EMTP and the change in mean and SD from 2019 to 2020. From the change in mean, the greatest change in perception from 2019-2020 occurred with practice III, *use and connect multiple representations*. In 2019, the mean was 11.17. In 2020, the mean grew by 9.17 for a mean instructional rank of 20.33. From 2019 to 2020, the standard deviation had negative growth of 1.31. Two other practices, V and VII, showed positive growth in mean of 2.75 and 2.5, respectively. These two practices had the largest mean in both 2019 and 2020, and thus described practices that were perceived to be most characteristic of participants' teaching.

While the data show that participants perceived that practice III was more characteristic of their practice in 2020, data also show that participants perceived their use of practice VI to be less characteristic of their teaching in 2020. Practice VI, build procedural fluency from conceptual understanding had a decline in mean from 26.8 to 10 for a negative change of 6.8. Two other practices, I and IV also showed negative change in mean of -5 and -5.75, respectively. These two practices dropped in mean instructional rank to the lowest values for 2020, and thus described practices that were perceived to be least characteristic of participants' teaching.

Finally, practice VIII, *elicit and use evidence of student thinking*, and practice II, *implement tasks that promote reasoning and problem solving*, remained very stable in

mean instructional rank from 2019 to 2020. Practice VII had a mean of 22 in 2019 and 22.2 in 2020. Practice II had a mean of 16.8 in 2019 and 16.6 in 2020.

From the quantitative analysis, change in perspective was captured using the Q-sort process. A table that includes all 27 instructional actions, their means, standard deviation, and rank for 2019 and 2020, can be found in Appendix H. I now turn to the qualitative findings from the study in order to provide a more detailed understanding of the quantitative results and in order to address the fourth research question.

Qualitative Findings

To analyze the data from the open-ended questionnaire responses, the group interview transcript, and responses to the independent reflection questions, I used the constant comparative method (Glaser, 1965). I began with the code and subcode structure outlined in Appendix G, but ultimately, I added several subcodes that emerged in the data. The initial codebook was organized by broad categories of possible influences on teacher practice. The initial categories were lived experience, school-based setting, formal teacher preparation coursework, knowledge, and beliefs. The emergent subcodes fell within the structure of the conceptual framework. However, there were a few adjustments to the categories that are notable.

First, there were very limited comments that could be coded in the knowledge category. Teacher candidates did not reference educational theories, and any references to content knowledge were referenced in the context growing as a result of experience teaching. As a result, the knowledge category was eliminated from the final coding structure, and notable references to content knowledge growth were captured within a new subcode, experience level. Experience level was categorized as lived experience.

Another change made to the codebook was with the beliefs category. While analyzing the data, I noticed that the language used in incidents that were initially coded as beliefs had two qualities that led me to broaden the category. Specifically, incidents that were coded in this category were usually very general, but tended toward descriptions of teaching and learning, rather than beliefs about students. As a result, I decided to broaden this category to beliefs about teaching and learning. I eliminated the subcodes after failing to find meaningful nuance within this category.

The remainder of this section will utilize the final category structure in the codebook to share findings related to how teacher candidates describe influences on their use of the EMTP. In each category, I share candidates' descriptions of positive influences, negative influences, and influences that changed teacher candidates' perceptions of their practice. Direct quotes are provided, though filler words such as, "um" and "like" have been removed to improve readability. Descriptions of influences will be presented in the following order: formal teacher preparation coursework, beliefs/perspectives on teaching and learning, lived experience, and school-based setting.

Formal Teacher Preparation Coursework

Throughout the group interview and questionnaire responses, teacher candidates referenced their graduate coursework as a general influence on their practice. However, only two of the four teacher candidates elaborated on specific instructional actions that are aligned to the EMTP from their teacher preparation coursework. Both instances referenced their mathematics coursework from the first year of the teacher preparation program, and both referred to one of the two practices that were ranked "most characteristic" based on the Q-sort summary statistics.

The first description of coursework influence was shared in reference to how one candidate saw supporting productive struggle, practice VII, as a cornerstone of her instructional practice. When asked about practices she indicated were most characteristic of her teaching, she said:

> I can say that on my positive side, I put a lot of this stuff about making mistakes and struggle because I really like from our class last year where we just talked about academic struggle and how if kids aren't at the right level of struggling, then they're not going to understand and they're not going to conceptually get there. But I've really just kind of pushed myself to not let my kids give up or ask, "what do I do next?" I want them to be able to recognize it, but I also want them to know that they're welcome to make mistakes because that's how we learn…I'm consistently telling my kids, "We love it. It's great. You tried. That's the part that matters." So it was really easy for me to put that stuff on the right side because I know that that's how I run my classroom.

She went on to share later in the interview that her placement of actions related to welcoming mistakes was placed near the right of the Q-sort in both years.

Another candidate described how one module within one of the mathematics methods courses supported his enactment of instructional actions within practice V, *pose purposeful questions*. He describes his adoption of planning for questioning by anticipating incorrect responses and planning for contingencies. He also shares how his

daily enactment of this practice supports enactment of practice III, *using and connecting multiple representations*. He shared:

> For me on the right hand side was a lot of what we learned from back in methods two. I think it was with the seven question sequence of the probe, the gather, the visibility, justification and then connect, articulate and one more. But a lot of that is just so much of my daily practice now that that's why it does come a lot easier. It's just anticipating what can go wrong, not necessarily will go wrong, but what can go wrong and having a plan for that. And that's what makes making in-the-moment decisions so much easier now. So instead of like panic, "Oh, I didn't plan for this," now it's like, "Oh wait, I did plan for this. Now let's go about this a different way." And then that lends itself into just making the math visible and the different representations of the math.

The candidate who shared this response did not comment on any changes within his practice from 2019 to 2020 related to the practice of *posing purposeful questions*.

All other references to teacher preparation coursework by any candidates were general, and were accompanied by comments about other influences that inhibit enactment of the EMTP. As a result, these findings are shared in a later section that corresponds with the inhibiting influence. While candidates did not frequently reference specific content from their teacher preparation coursework as supportive of enactment, they did often reflect on what I categorized as their beliefs or perspectives on teaching and learning. In the section that follows, I present teacher candidates' beliefs and perspectives as they shared them in the group interview or questionnaire responses.

Beliefs about Teaching and Learning

Teacher candidates expressed beliefs about teaching that centered on practice VII, productive struggle paired with the teacher as a supportive, caring figure. They also shared their perspectives about ways data can be used to inform instruction with a focus on student understanding, not student test performance. Finally, teacher candidates shared a belief in their own capacity and need for growth as educators.

Several statements are representative of teacher candidates' beliefs regarding productive struggle.

> Praising students for their efforts in making sense of mathematical ideas and perseverance in reasoning through problems. This was easiest because I know that I am consistently congratulating my students for mastering the lesson that day. I leave little notes on exit tickets and remind kids that they shouldn't second guess themselves because they clearly understand. I call all my students superstars and just make sure they feel supported in my class.
>
> I have noticed that a lot of my students like to give up when things are difficult or ask for a hint that will take away the struggle. They're afraid to get something wrong and feel bad about it, but I want them to think the opposite. I love wrong answers because they aren't the only ones who have them, and I also want them to know that their mistakes help them avoid them in the future.

Use of data for instructional adjustments was referenced with candidates sharing a desire to use data judiciously in their practice without losing sight of the students as individuals. Candidates also expressed resistance to using data solely for the purpose of test preparation. One candidate shared that his school was tracking so many different

sources of formative assessment data that he felt he did not have time to use most of it to improve understanding. He said, “Personally it's not my practice to collect data for the sake of having it and not to use it to benefit your students in your teaching practices.” One response shared by a candidate included:

> I don't see kids as numbers. Like out of 40. It just doesn't work that way. So, I very much do focus on what I can see physically happening in front of me in that moment. So yes, we will spend three days on constant of proportionality when it comes to fractions, if that's what my kids need. And yes, period four is a day behind, but they needed extra practice and they needed a manipulative. And so being a day behind is fine. It's just, that has been a really big thing, not worrying so much about where am I on the pacing calendar. But where are my kids?

Another response described the tension between goals related to testing and the goal of helping students develop understanding.

> I don't really focus a lot on the end goals. I like to focus on the present and see where my kids are. Typically, the end goal is passing the test. I want to focus on the understanding of that day and not what the [standardized test] is going to ask.

Notably, no negative beliefs about students were expressed, and when teachers expressed failed attempts to enact the EMTP, they did so with ownership of responsibility and acknowledgement of their own areas for growth. This belief in their own ability to grow with support and experience was most evident when they spoke about facilitating

discussions in their classroom. For example, one candidate shared struggles with mathematical discussion in the classroom. He said,

> When I start trying to get them to like defend their own reasoning and use different logic for defending or justifying a math problem or an answer, you know, there's only a handful of students in each class that are really comfortable either sharing or really justifying those answers. So if I try to create a discourse back and forth, it's often either really circular or ends up feeling like I'm wasting a lot of time. I'm just trying to force kids to participate when they're either not ready to or, maybe I'm just not presenting it in a way that they're fully understanding yet, but, I don't know. I'm still working on, on that.

A different candidate shared, "I need more experience (and perhaps real-time coaching) with leading in-class discussions."

While most statements that communicated a belief or perspective on teaching and learning communicated consistency in belief, there were two statements that were specific to a shift in perspective that the candidate experienced during the teacher preparation program. The first shift in perspective that was noted occurred during the first year in the program for one candidate as she grappled with practice VI, *build procedural fluency from conceptual understanding*. In reference to why she placed certain instructional actions on the least characteristic end of the Q-grid, she shared:

> I placed the teaching actions in -4 and -5 because I am still struggling with getting past the idea that kids need to learn the procedures. I know that I need to work on connecting the lesson that day to their mathematical goals in general. I also know that I need to find more ways to invest kids, regardless of their background.

The second description of a shift in perspective was shared related to the structure of the mathematics lesson and how productive struggle can be supportive of learning and student confidence. This shift is described as being driven by a change in the school-based setting, which will be explored more in-depth later in this chapter. The candidate stated:

> For me, I think I previously held this belief and it just might've been that teaching at a very structured type of a school network is just this belief that the lesson needs to be do now, connect, INM [introduction to new material], independent practice, and assess. So that for a bit was ingrained in like, okay, this is how math should be. But, now just having the flexibility to really guide the lesson on my own. And so really getting more towards like activity based and inquiry based, that's kind of challenged the belief that I had. Like everything should be structured and now maybe you don't need 20 problems, but maybe you just need three or four really good problems and that students can struggle with and try their hand at and you can still do that and build up the confidence in students to do the risk.

Lived Experience

In some ways, every influence on a teacher candidate's practice could be categorized as a lived experience. However, three themes within the teacher candidate's descriptions emerged that I categorized as lived experience. First, candidates described their growing level of experience in the classroom as an influence on their use of the practices they identified as most characteristic of their teaching. Second, candidates described their workload as a negative influence on their use of the EMTP that they

ranked least characteristic of their teaching. While both experience and workload could be impacted by the unique circumstances within a school-based setting or teacher preparation program, candidates' rationale for how experience and workload influence their practice were not specific to the setting. The sections that follow detail candidates' descriptions of how their growing level of experience and the workload associated with teaching and going to graduate school influence their use of the EMTP.

Classroom Experience. Teacher candidates described their experience in the classroom as both a positive influence that supported their use of the EMTP and as a negative influence that resulted in reluctance to incorporate other EMTP. Experience as a positive influence emerged when candidates were asked to reflect on what influenced change in their use of the EMTP between their first year and second year in the teacher preparation program. Candidates' responses indicated that as they accumulated experience in the classroom, they began to understand and use some of the instructional actions more. One example shared was:

> One that I said I do typically use is the making the math visible and the multiple representations. That was just influenced because last year I was in Geometry and then this year I'm in Algebra II. And so the courses follow each other. And so in my very limited knowledge of teaching, I thought these were two very different subjects and one's more visual and one is much more arithmetic based. But now that I've moved on with the progression, it actually turns out that a lot of algebra makes sense because of its geometry.

This reflection aligns with the practice III, *use and connect multiple representations*, which was the EMTP that had the largest growth in mean from 2019-2020.

Another candidate shared improvements in lesson planning and task selection as a result of more classroom experience. He said:

> Just having even this little bit more experience from like last semester, coming up into now, almost even just this whole first year, just the efficiency. Like how much time I spent lesson planning at the beginning of the year. Or like choosing lesson materials really to like what I can actually focus on now in my lesson planning and future planning.

Though candidates shared other general reflections on how more experience in the classroom improved their practice, there were more specific instances of experience as a negative influence for use of the EMTP. The negative influences emerged either as initial unsuccessful attempts that limited further attempts at using an EMTP or as a self-identified area of growth. Many of the negative statements related to classroom experience referenced in practice IV, *facilitate meaningful mathematical discourse*. Practice IV was the practice with the lowest mean in 2020, indicating that on average, participants perceive this EMTP to be least characteristic of their practice. The change in mean rank for practice IV from 2019 to 2020 was -5.75, which indicates that candidates perceived that practice IV became less characteristic of their teaching in the second year of the teacher preparation program. Sample statements that indicated initial unsuccessful attempts included:

> When I start trying to get them to like defend their own reasoning and use different, uh, like logic for defending or justifying a math problem or an answer, um, you know, there's only a handful of students in each class that are really comfortable either sharing or really justifying those answers. So if I try to create a

> discourse back and forth, um, it's often either really circular or ends up just being like, I feel like I'm wasting a lot of time. I'm just trying to force kids to participate when they're either not ready to or maybe I'm just not presenting it in a way that they're fully understanding yet, but, um, I don't know. I'm still working on, on that.
>
> There's only a handful of kids in each class that really participate in the discussion. So sometimes it's hard to get them to talk about like why they would choose a different method and then argue that with a different student. So that's why I don't do that as often.

Statements that indicate a self-identified area of growth included, "I need more experience (and perhaps real-time coaching) with leading in-class discussions," and "Engagement through discussion is still something that I am working on. I believe it is more of a matter of not enough practice or flow to this in the routine as opposed to not having the confidence to do it."

Workload. The general workload associated with teaching and going to graduate school emerged as an influence that teacher candidates named as inhibiting their use of the EMTP. In their responses, this theme often emerged as a tradeoff or weighing of priorities for the teacher candidates and was sometimes mentioned in relationship to the limited experience that candidates had in the classroom. For example, one participant voiced the following in response to what influences may be keeping them from integrating the EMTP:

> Just the fact that it's like first year of actually running a classroom and doing the lessons and also having the [graduate school name] stuff and like all of that. So I

> want to set up how I want to teach, but also I don't really have the time or don't really know how to integrate goals and the progression.

Another participant described:

> All of the high school fellows were all multi prep, so we all teach at least two classes. So it's a bit of a challenge to do the work of two teachers as one person and be a full time grad student. And on top of that, we're all also the only teacher for that subject. And so for example, I'm the only AP stats teacher and the lead algebra two teacher. So I'm doing the work here of two teachers and it feels like this give and take of like if I am going to do a really good thing for stats, it means that maybe my algebra two kids that day might be a little gypped on some kind of inquiry or activity or vice versa. If I'm going to do something really planned out for algebra two that might mean I have to take a step back on my AP stats kiddos and do something a little bit more guided.

Finally, a third participant described workload in much stronger terms as a factor that has prevented implementation of the EMTP altogether.

> For me, time has been a big issue. I'm really struggling with the workload. Um, just planning lessons for both classes, doing all the grading, creating exemplars. That takes up all my time. I don't really have time to think about like implementing stuff I've learned at [graduate school name], unfortunately. Um, so yeah, so I haven't really had time, um, to think about how to implement discussions, how to, you know, basically do all the different strategies and things we've learned at [graduate school name].

When asked about changes in his practice from the first year in the program to the second year in the program, he indicated that his workload increased in the second year of the program. He shared:

> I think that I've had a lot less time this year to prepare for lessons and think deeply about my teaching practices; as a result, I haven't been able to do many things, like identifying what counts as evidence of student progress and engaging students in sharing of ideas, approaches, etc.

The responses shared in this section were general statements about how workload negatively impacted teacher candidate's perceived use of the EMTP. However, when asked about factors that most influenced change in practice from the first year to the second year, only one of the four participants definitively voiced workload as the strongest influence in his de-prioritization of the EMTP. In the section that follows, responses related to the school-based setting are shared, some of which add additional insight into the workload the teacher candidates experienced.

School-based Setting

Participants described a variety of influences related to the schools in which they worked during their time in the teacher preparation program. None of the influences were universally described as supportive of EMTP enactment. At times, the influence of a mentor teacher, the curriculum, or school supports were described as supportive of enactment. Influences that were always described as inhibiting enactment of the EMTP included external pressures of standardized testing and time constraints. Teacher candidates' descriptions are shared in the sections that follow beginning with standardized testing and time constraints.

Standardized Testing and Time Constraints. In their interview and questionnaire responses, teacher candidates referenced standardized testing and time constraints as influences that inhibited their use of the EMTP. The pressure they felt was frequently described as coming from their school administration and instructional coaches, which is why I have categorized these influences within the larger school-based setting category. In reference to standardized testing, candidates shared that the pressure to prepare students for the test inhibited their enactment of practice I, *establish mathematics goals to focus learning*.

Mathematics goals that focus learning were identified both as something candidates deprioritized because of time constraints, but also as a conflict between testing goals that were communicated by the school and mathematics goals for learning. This tension between two very different sets of goals was described by one candidate in the following comments:

> I don't really focus a lot on the end goals. I like to focus on the present and see where my kids are. Typically, the end goal is passing the test. I want to focus on the understanding of that day and not what the STATE STANDARIZED TEST is going to ask.
>
> I need to see less focus on the administration side on the goals because I know that's what is pushed on kids from day one. I also want to see a better way to integrate goals without it being related to the tests and data.

Another candidate shared his thoughts on the pressure of standardized testing, time pressure, and instructional coach/administrator priorities. He said:

> There's just not enough time in the year to like talk about all the goals and stuff, in my opinion. At least I think in my case, you know, you have coaches and other people that are comparing the data from different formative assessments and end of modules and things back and forth. They were looking at, “Oh, here's your most missed question,” and “What is your reteach opportunity going to be and what are you going to do with this”. So you spend a lot of time planning these reteaches that sometimes are very beneficial, but a lot of it's not. A lot of times, I feel like maybe the time could have been more well-spent, like doing something like talking about our goal setting or just how the lessons fit into the grand scheme of things.
>
> There’s just not enough time with all the testing and all this to fit these kinds of lessons in. I feel like I'm teaching a middle school curriculum on a high school schedule where we have a lot more days of testing, so a lot less days that I have to actually teach lessons. There’s lot of pressure to stay on this pacing calendar. Now “you're three days behind,” or “you're five days behind”. And it's like, “Yeah. We just tested five [standardized tests] last week, and middle school didn't have that.” Or they didn't have midterms or whatever it was. And so sometimes I feel like I just don't have enough time to get to these things even though I wish we could.

Finally, one candidate did not reference specific EMTPs, but he did describe how his prioritization in planning was impacted by time constraints and standardized testing pressure. For this candidate, the influence of these factors led to a trade-off or choice between his classes. He shared:

> It feels like this give and take, If I am going to do a really good thing for stats, it means that maybe my Algebra II kids that day might be a little gypped on some kind of inquiry or activity. If I'm going to do something really planned out for Algebra II that might mean I have to take a step back on my AP Stats kiddos and do something a little bit more guided. And so it's just this constant dynamic of like, “Okay, am I enough for both or do I have to pick which one?” Also we have this big “AP for All” push. And so predominantly the focus goes to my AP Stats kids. However, I only teach two sections of that. Whereas I teach four sections of Algebra II. So my four sections of Algebra II feel a little left out when there's this big push of like, “Oh, AP Stats is doing this”. And, “Oh, we have campus visitors that are going to go see AP Stats.” And so on top of that, the message is shared through admin. So sometimes it just gets a little wonky to focus on that investment for my students.

The same candidate also reflected on his experience teaching different courses in the first and second years of the program. He spent his first year in the program in a geometry classroom, which does not have a standardized test requirement. His description of messaging from campus administers is in conflict with practice VIII, *elicit and use evidence of student thinking*. He shared:

> Going from a non-tested subject to now an AP subject and another [tested] subject, there are times where I'm given like, “Oh, this is a priority.” Or like, “Oh, I know you were planning on doing this, but you actually need to give this assessment,” or, “Hey, your kids need to take this IA [interim assessment] that is actually not aligned to any of the content you've taught, but we need the data.”

> And there's nothing we can do to change that. It's just the metrics that they've selected and that we have to opt into. But, uh, personally it's not my practice to collect data for the sake of having it and not to use it to benefit your students and your teaching practices.

In summary, the pressure of standardized testing and the time constraints that resulted from testing and test preparation practices were described as negative influences on participants' use of the EMTP. School testing goals and administrator directives around data and reteaching practices were cited as reasons for deprioritizing practice I and VIII. In the next section, participants' thoughts on their curriculum are shared.

Curriculum. Similar to how standardized testing was always described as a negative influence, curriculum was described negatively as an influence with one notable exception from a participant who cited an external curricular resource as the strongest influence on his use of the EMTP. Though the resources he references are external to his school curriculum, I've categorized this comment as a school-based incident because he has been permitted to make this choice by his school administrators. While his description does not reference any of the specific EMTP, the inquiry model of teaching he describes shares characteristics of several EMTP. This candidate described:

> A recent influence has been this resource I found online. It's called statsmedic.com. And basically it's an experienced AP stats teacher who posted all of her lessons. So, basically she provides a lesson for each day of AP stats throughout the year. All of the lessons are activity-based, instead of it being more like guided notes and then independent practice, it's more of where students engage in an activity and they kind of explore the concept themselves and then we

> formalize it after the lesson. That's been the most recent influence on my teaching in AP stats.

Shifting focus to the curriculum that was provided to candidates by the school, descriptions become more negative. This is illustrated in the following statement which was shared as rationale for characterizing the statement, ensuring progress toward mathematical goals by making explicit connections to student approaches and reasoning, as least characteristic of his teaching. The action he referenced is aligned with practice IV, *facilitate meaningful mathematical discourse*. The participant shared:

> I will say that is me, but then I will also say it's also per consequence of [school district name]. We have our own separate curriculum and the [standards} from the traditional [school district name] network. And so a lot of that has resulted in the restructure of the way material is presented. And so even though there's this very large push towards conceptual math and that is what we're working towards, often it feels like the unit plans are very much like skill, skill, skill, discussion, skill, skill, skill, and the progression doesn't make a lot of sense per se. And so I usually end up just reorganizing the structure still in a way that meets the curriculum standards, but in a way that presents content so that there's more of a natural flow and connection to it as opposed to, well, here's the, graphical analysis side… So for me it is a consequence of what materials were given to me. And so just like zoning out is a little bit difficult because right now I'm zoning in and reorganizing what I think is best for my students.

A different candidate spoke about the same action within practice IV. She described an informal evaluation process that she used with the curriculum when encountering content that could potentially support her use of the practice. She said:

> I don't do that a whole lot of talking about the goals and how it connects to where students, um, how students are doing things. Unless like Participant 4 was saying, it somehow is fumbled up into the curriculum. So there are times where like curriculum is discussing one thing and then all of a sudden throws in something that really isn't going to be discussed until the next year. So then at that point, that's where I'm like, "okay, well the way you did this would not help in your progression of school," or "the way you did this is going to be really helpful when you do move to this next like [standard] or goal or whatever." Um, but I don't really do that a whole lot, and I still don't really talk about like the learning progression. I recognize "well, if you don't understand fractions, then you won't be able to understand like this, this and this." So I do recognize those things, but I don't really use them to push how I plan a lesson.

Of these two candidates, one described intentional reordering, while the other described an evaluate, and either use or discard, approach to the curriculum. Though the two approaches were different, both candidates shared the belief that rearranging the curriculum was done in the best interest of the students they teach. In the next section, the focus shifts to how mentor teachers, referred to as resident advisors in the teacher preparation program served as influence on the participants' instructional practices.

Resident Advisor. During the first year of the teacher preparation program, participants observed in an experienced teacher's classroom. Throughout the year, they

gradually took on more teaching responsibilities with full day teaching occurring towards the end of the school year. The experienced teachers are called “resident advisors” in the teacher preparation program, and in this study, participants referenced their resident advisor as an influence on their enactment of the EMTP.

For example, one teacher candidate referenced her resident advisor as an influence on her enactment of practice VII, *supporting productive struggle*. The influence was described as supportive of her enactment of the practice, though the she perceived the resident advisor’s practices as contrary to the EMTP. She said:

> So for me, I know last year, the classroom that I was in with my mentor, we had very different approaches to how we ran things. And so for him, it wasn't so much about joy and like struggle, it was about getting to the data end of things. I just realized that that isn't what I want to do. Like I want kids to be comfortable. I want them to know that they're allowed to make mistakes. I want things to not just be a worksheet that they can master. I want them to, you know, have some fun. Like, they are currently staring at superhero drawings that were related to surface area and volume, which isn't something we would have done last year. So I know that for me it's like bringing in comfort into the classroom because I don't want kids to come in and be scared of their teacher, but that's why they're obedient. I want it to be like, they're welcome to make mistakes and they're welcome to struggle and still know that at the end of the day it's going to be okay. So that's a big thing for me.

This statement reflects the candidate’s current perception of her practice while teaching on her own. During the first year in the program, while still teaching in the

resident advisor's classroom, she shared similar thoughts when asked about the experiences that influenced her use of practices that she characterized as most representative of her teaching.

> One of my biggest reasons is knowing that the way my RA teaches is not my style. I like to make sure kids feel inspired and walk away from class, not only having learned the standard for that day, but also knowing that I pushed them deeper and brought joy into the class.

All three other teacher candidates also referenced their resident advisor as an influence on their practice, though their descriptions were more general. In response to the question about influences on practices that candidates characterized as most characteristic, two candidates said, "learning from my RA," "teaching/observing in my RA's classroom". The remaining teacher candidate shared in the second year, "I get to plan the course as opposed to working alongside someone who may not have the same background/views as I did."

In summary, two candidates described their resident advisor's influence as a model that contrasted with their perceived enactment of the EMTP, while the other two candidates indicated that their resident advisor was a model they aligned with their perceived enactment of the EMTP. The resident advisor is intended to serve as a support during the first year of the teacher preparation program. In the following section, I will share other school-based support structures that candidates referenced as influences on their practice.

School-based Supports. In their descriptions of influences on their teaching, candidates referenced several school-based supports, including lesson planning

requirements, instructional coaches, and external professional development opportunities that were paid for by the school.

First, one candidate shared that some of the actions he sorted as most characteristic of his teaching were actions that were built into planning process that were required at his school. The ones he placed as least characteristic were not required at his school. In reference to the actions on the far right and far left of his Q-grid, he said, "That one is pretty much embedded into our lesson plan, our planning protocol at School Name 1. And then the other side is like what is highly suggested that we might not always get to."

In addition to lesson planning requirements, candidates mentioned instructional coaching as an influence on practice. In reference to practice VIII, *elicit and use evidence of student thinking*, one candidate shared how his instructional coaches helped him become more aware of evidence of student thinking and progress in his classroom. He shared:

> I think that that just came through the coaching that I was receiving at [School Name] and stuff. Them coming in and being like, "these six people had no idea what you were talking about" or whatever it may have been.

Though this candidate shared growth as a result of instructional coaching, he also described pressure from the instructional coach to deviate from some of the practices in favor of test preparation practices. In response to a question on what experiences he thinks he needs to make the teaching actions that he placed in the least characteristic columns of the Q-grid, he said:

> I often have to switch up planned lessons to incorporate essential or nonessential reteaches that are required for coaches or other administrators and do not feel I have enough time to progress through the unit and talk about all of the things that I would in an ideal world or ideal classroom.

Finally, two participants cited external professional development that was approved and paid for by their school as influences on their use of the EMTP. One participant shared:

> I think for me the biggest influence in how I teach stats has been that stats medic website that I mentioned. And I went to a workshop also led by that teacher. So I think that has had the biggest influence on how I teach stats.

Another participant described a professional development opportunity provided by the National Math and Science Initiative (NMSI) as supportive of his enactment of inquiry-driven learning. He said:

> We were able go to a NMSI training. It wasn't so much content focused as opposed to very much inquiry based and a lot of inquiry learning. And so having that training was just super beneficial because at least for my stats kiddos I tried to do inquiry maybe once or twice a week because stats is really one of those maths that is best learned through the application. And so having that training really provided the tools that I needed this year to one, make sure the content is being delivered properly, but also making the math memorable, making it fun.

Both of these descriptions do not specifically reference the EMTP. However, inquiry-driven instruction includes elements of the EMTP. To conclude this section on school-based settings, I will share findings on three teacher candidates' perceptions of

how a change in school-based setting between the first and second year of the teacher preparation program influenced their instructional practice.

Change in School-based Setting. Three of the four participants in the study changed schools between the first and the second years in the teacher preparation program. All three candidates indicated that the change in school was a strong influence on shifts in their enactment of the EMTP. During the group interview, one candidate shared her thoughts on the influence of experiences in two different school cultures. She said:

> The school that I was at last year was very much like "class needs to look like this and if it doesn't, then it's not like to our standards." At my new school I definitely have a lot more freedom as to what I get to do in my classroom. I still get the questions about where are you on the pacing calendar and that kind of stuff. But I don't feel like if I'm not directly on the pacing calendar that I'm not doing my job right. That's been a huge difference for me because I am behind on my pacing calendar, but my kids, are learning and are understanding and I'd rather they learn and understand and make the mistakes and struggle.

When asked to think about the strongest influence on changes in their practice between the first and second year of the program, this same candidate shared:

> For me the biggest change has been different school. I can say that I was genuinely unhappy where I was. I didn't love the approach to education. I didn't love the push on the way things had to be. I feel like I have a lot more freedom here…It's just, that has been a really big thing, is not worried so much about where am I on the pacing calendar, but where are my kids?

Though the other two participants who changed schools did not work at the same school as the candidate who shared the above thoughts, one had similar descriptions of how the structured environment of their previous school inhibited their enactment of the EMTP. These two participants worked at the same school for the first year and then moved to the same school the second year. The first of these two shared strong sentiments around the change, while the second participant agreed, but did not add any further details. The specific comments from the first of these two candidates included:

> Participant 1 and I, we actually both came from the same school and they couldn't separate us. It has been a very beneficial transition. I would say. The previous location we were at was very much structure and you know, if you were ever observed and you weren't meeting the structure, then you weren't, it felt as though you weren't doing a good job. Whereas at our new location, it's very much celebrated that each day looks a little different. While there, structure is important, it's more important that students feel engaged and empowered by the learning. And so I will say just having that atmosphere for teachers, it makes me want to make sure that my lessons are interactive and fun, and I want to make sure that my students are enjoying it as opposed to I need to make sure I've got these five or six different components that meet the T and meet the CFS (criteria for success). It’s just feeling like you have that space to do as you wish, as long as it does abide by the curriculum. That for me has just put me in a better mental space and consequently has been better for my students.

Based on the statements from all three candidates, the school-based setting in the first year of the program required a set structure that did not support candidates in

instructional decision-making that may result in a slower pace of learning or instruction that deviates from the delivery methods that were approved by the school. For these candidates, changing schools provided the opportunity to reprioritize the EMTP within their instructional practice.

In conclusion, this study found that teacher candidates described positive and negative influences on their use of the EMTP that could be categorized as formal teacher preparation coursework, beliefs/perspectives on teaching and learning, lived experiences, and school-based settings with several instances of overlap between the categories. Teacher candidates described changes in their practice as resulting from growing experience, professional development, and changes in school-based setting.

Integration of Quantitative Results and Qualitative Findings

Chapter 4 presented results and findings from the data analysis of the Q-sorts, questionnaires, and transcripts from the group interview of four teacher candidates. The Q-sort data were collected and analyzed to explore which EMTP candidates ranked as most and least characteristic of their teaching. The qualitative data were collected and analyzed to explore how teacher candidates described influences on their use of the EMTP, and to determining how teacher candidates' perceptions changed between the first and second year of the teacher preparation program.

Quantitative results indicated that candidates ranked practice V, *pose purposeful questions*, and practice VII, *support productive struggle in learning mathematics,* as most characteristic of their teaching. Candidates ranked practice I, establish mathematics goals to focus learning and practice IV, *facilitate meaningful mathematical discourse,* as least representative of their teaching. Candidates perceptions of their use of practice III, *use*

and connect multiple representations, grew the most of all the eight practices between 2019 and 2020. Candidates perceived use of practice VI, *build procedural fluency from conceptual understanding*, declined the most between the two years.

The qualitative analysis resulted in findings that suggest teacher candidates are influenced by their formal teacher preparation coursework, their beliefs and perspectives on teaching and learning, their lived experiences, and the school-based settings in which they work. Candidates' descriptions of their formal teacher preparation coursework as an influence on their practice were vague with two exceptions, both from the first year math methods class. One candidate categorized "making mistakes" and "productive struggle" as hallmarks of her practice, and another candidate shared that planning for questioning and adjusting instruction based on student responses have become a part of his daily practice.

Findings that were categorized as beliefs about teaching and learning included three key ideas. First, teacher candidates believed they support productive struggle by acting as a caring, supportive figure for their students. Second, candidates expressed a belief that data should inform instruction for the purpose of improving understanding, as opposed to being used solely for the purpose of improving test performance. Finally, candidates shared a belief in their own continued need for growth in order to gain proficiency with the EMTP.

Candidates lived experiences were referenced as influences on their practice in three different ways. First, as candidates gained classroom experience, they began to better understand and use practice II, *implement tasks that promote reasoning and problem-solving*, and practice III, *use and connect multiple representations*. However, for

practice IV, *facilitate meaningful mathematical discourse,* candidates voiced that a lack of success on attempts to use the practice reduced their willingness to continue working on mathematical discussions in their classes without further coaching or support.

Candidates cited their workload as another negative influence related to their lived experiences. All four candidates mentioned workload as one reason for failing to enact the EMTP. One candidate shared that workload prevented him from trying any of the practices he learned in the teacher preparation program.

The final set of findings demonstrated how the candidates' school-based setting influenced their practice. Negative influences including the pressure of standardized testing, curricular inconsistencies, and instructional coaching that at times conflicted with desired practices. At other times administrators and instructional coaches were described as a positive influence, empowering teacher candidates in their practice. Resident advisors were also described as positive influences, though two candidates shared that they were able to enact effective practices because of the contrast they saw in the practices their resident advisor used. Finally, the three candidates who changed schools between the first and second year in the teacher preparation program felt that the difference between the culture and leadership in between the two schools had a strong influence on their growth in the second year.

Chapter five will include a discussion of results and findings specific to several EMTP and to the influences teacher candidates described with connections to existing literature. Then, a comparison of the findings from this study to Wilburne et al. (2018) will be provided. Finally, chapter five will include implications for the teacher preparation program, limitations, and opportunities for future research.

Chapter V

Discussion

The purpose of this study was to examine the perceptions of teacher candidates with respect to their implementation and prioritization of the EMTP using replicated methods from Wilburne et al. (2018). This study also served to determine whether the Q-sort data collection tool paired with individual reflection and a group interview could be useful for identifying change in perceptions of teacher practice over time. Four secondary mathematics teacher candidates shared their perceptions by completing a Q-sort at two points in time, eleven months apart, during their teacher preparation experience. The Q-sort consisted of 37 instructional actions that align with the eight EMTP. All four participants also reflected on their perceptions of their instructional practices in a group interview and on a questionnaire.

This study addressed the following research questions:

1. Which of the EMTP do secondary mathematics teacher candidates rank most characteristic of their teaching?
2. Which of the EMTP do secondary mathematics teacher candidates rank least characteristic of their teaching?
3. How do teacher candidates' perceptions of their use of the EMTP change between the first and second years of their teacher preparation?
4. How do teacher candidates describe influences on their prioritization of the EMTP within their instructional practice?

This chapter includes interpretation of study findings with connections to the existing body of literature. The interpretation of findings is presented as it relates to the

EMTP and the influences on teacher candidate practice. Then a comparison of findings from this study and the study conducted in 2018 by Wilburne and colleagues is shared. The chapter concludes with study limitations, implications for the teacher preparation program, and opportunities for future research.

In this study, candidates ranked practice V, *pose purposeful questions*, and practice VII, *support productive struggle in learning mathematics*, as most characteristic of their teaching. Candidates ranked practice I, *establish mathematics goals to focus learning* and practice IV, *facilitate meaningful mathematical discourse*, as least representative of their teaching. Candidates perceptions of their use of practice III, *use and connect multiple representations*, grew the most of all the eight practices between 2019 and 2020. Candidates perceived use of practice VI, *build procedural fluency from conceptual understanding*, declined the most between the two years.

Candidates described a variety of influences on their practice. Practices taught in formal teacher preparation coursework were described as influential for their daily practice. Candidates beliefs about teaching and learning influenced their use of instructional actions that support productive struggle through encouragement and care for the student. Candidates also shared a belief that assessment data is useful for promoting student understanding and should not be used for test preparation purposes to the exclusion of promoting understanding. Finally, candidates expressed a belief in their own need and desire for continued growth as educators.

With respect to lived experiences, teacher candidates shared that their growing body of experience within a classroom influenced their use of the EMTP. This influence tended to be positive when candidates experienced success, and negative when a practice

was unsuccessfully implemented. Candidates also shared that the workload associated with teaching along with pursuing a graduate degree often prevented them from having enough time to try new instructional practices.

Finally, findings suggest how the candidates' school-based setting influenced their practice. The pressure of standardized testing and time constraints within the academic calendar negatively influenced teacher candidates' enactment of the EMTP. Candidates also shared that they felt the need to rearrange their school-provided curriculum, which shifted their focus off some of the EMTP. School administrators and instructional coaches were seen as both effective supports for teacher growth in some areas but also as negative influences when directives issued were in contrast to what teacher candidates thought would promote understanding for their students. Finally, the resident advisors that supported teacher candidates during their first year in the program were described as positive influences on candidate use of some EMTP. However, two candidates shared that they sought not to emulate the resident advisor, but rather acted in direct contrast when the resident advisor's practices did not align with teacher candidates' beliefs. In the sections that follow, the study's findings will be interpreted with connections to the existing body of literature.

Interpretation of the Findings

The findings in this study provide insight into how teacher candidates prioritize the EMTP within their practice. Findings related to influences on teacher candidate practice provide insight into how the complex system of teacher preparation is functioning to support their growth as educators. While each individual teacher candidate's journey to becoming a teacher is different, the alignment between the

findings in this study and the relevant literature reinforces how teacher candidates learn to teach. The interpretation of key findings will be presented beginning with those specific to the EMTP and following with interpretation of influences on teacher candidate practice.

Interpretation of EMTP Findings

Three EMTP were frequently referenced by teacher candidates when they described influences on their practice. Each of the three will be discussed in this section. First, practice VII, *support productive struggle in learning mathematics*, was ranked most characteristic of teacher candidates' teaching. This study found that teacher candidates saw themselves as supportive teachers, encouraging students to persist through struggle and welcoming mistakes as a part of the learning process. This finding suggests that teacher candidates may gravitate toward instructional strategies that support the social and emotional needs of students as a means of supporting productive struggle (Livy et al., 2018; Townsend et al., 2018; Warshauer, 2015). However, they may not be equipped to scaffold tasks or encourage purposeful connections which have been shown to increase the likelihood that the struggle is leading towards the desired learning outcome (Warshauer, 2015).

While *supporting productive struggle* was perceived as characteristic of candidates' teaching, practice I, *establish mathematics goals to focus learning*, was one of the two practices that were ranked least characteristic of candidates' teaching. In this study, teacher candidates shared tension between school goals that drive toward testing and goals to promote student understanding. Further, teacher candidates' limited classroom experiences seemed to hinder their ability to see how the mathematics within a

daily lesson fit into a larger learning progression. Candidates felt their workload, time constraints associated with school pacing calendars, and schedule disruptions due to testing and required re-teaching influenced their de-prioritization of *establishing mathematics goals to focus learning.* This is concerning, as learning goals have been shown to help novice teachers make instructional decisions within a lesson that are based on what students are understanding in the lesson (Stein, 2017). When students respond in unexpected ways, novice teachers are more likely to flounder in their selection of which ideas to take up for discussion if a clear learning goal is not driving the lesson (Smith & Stein, 2011). Without a learning goal to focus, *facilitating meaningful mathematical discourse*, practice IV, becomes even more challenging to enact.

Practice IV was ranked least characteristic of teacher candidates' teaching, and findings in the study suggest that teacher candidates were uncomfortable with attempts at discussion, as a result of previous unsuccessful attempts, or as a result of a lack of confidence in their existing skill set with discussion. Successful discussions require a culmination of many instructional skills, such as purposeful questioning, attending to students' thinking, supporting peer-to-peer talk, building a climate of academic safety, and making many in-the-moment decisions (Boston et al., 2017; Krall, 2018; NCTM, 2014). Findings in this study suggest teacher candidates may need to spend more time on these skills in a more isolated way before effectively integrating discussion in their classroom.

Both *establishing mathematics goals to focus learning* and *facilitating meaningful mathematical discourse* were de-prioritized by teacher candidates. While discourse can be exceptionally challenging to enact, the entry point for establishing mathematics goals

is much more accessible for new teachers. The interpretation of findings that are shared in the next section describe the influences on teacher practice that may be resulting in teacher candidates' prioritization of other practices over the more accessible practice of establishing and using learning goals.

Interpretation of Influences on Teacher Perception of Instructional Practices

In this study, teacher candidates described a variety of influences on their practice. Some influences supported enactment of the EMTP, while others inhibited enactment. Candidates' descriptions fell into four broad categories: a) formal teacher preparation coursework, b) beliefs about teaching and learning, 3) lived experiences, and 4) school-based setting.

Formal Teacher Preparation Coursework. Findings in the category of formal teacher preparation coursework suggest that the practices referenced by candidates from their coursework became a part of their daily practice. Their descriptions of the content taught in their teacher preparation coursework along with how they use what they learned in their classes imply that concrete experiences and repeated practice have supported gestalt formation with regards to the specific practices referenced (Korthagen, 2010). This is further reinforced in the findings as candidates described how their lesson planning process has evolved from a taxing exercise that may still result in being caught off-guard with unanticipated student responses to a more efficient process that supports the teacher in making in-the-moment adjustments based on current student understanding.

While findings suggest that gestalt formation was limited to specific instructional actions within two EMTP, the evidence that candidates carried knowledge of the rest of

the EMTP is promising. Since the participants in this study were not even 75% finished with their first year as teacher of record, their productive disposition and knowledge of the other practices may yet result in gestalt formation as they gain more experience in the classroom.

Beliefs about Teaching and Learning. The AMTE standards include a focus on the need for new teachers to believe that all students are capable of becoming proficient in mathematics (2017). The findings in this study provide some evidence that the participants do hold this belief. For example, teacher candidates shared a belief in the teacher as an encouraging, supportive figure who promotes valuing mistakes and productive struggle as important means for learning mathematics. Findings further suggest that teacher candidates saw the support they provided to students as important for fostering a productive disposition towards mathematics in their students (Adler & Davis, 2016; AMTE, 2017).

The findings in this study also suggest that teacher candidates grappled with advocacy for their students, which is also included in the standards for teacher preparation of mathematics teachers (AMTE, 2017). Candidates voiced a desire to use formative assessment data to promote student understanding but experienced pressure to use data to improve test performance. While understanding and test performance are not mutually exclusive, candidates' descriptions included using too much time gathering data at the expense of instructional time. Further reteach plans were prescriptive from administration with a focus on test performance. These findings suggest candidates were not fully equipped to advocate for what they felt was best for their students, and align with findings in existing literature (Clarke et al., 2005).

Though candidates may not have been fully empowered as advocates, they did espouse a belief that as teachers, they were capable of and in need of continued professional growth. This belief manifested when they spoke about failed attempts at enactment of practices and trying to meet the needs of students who had experienced failure in previous mathematics classes. It is encouraging that, for this group of educators, all assumed personal responsibility for the success of their students, and shared their thoughts on instructional skills they were still trying to build. One clear area of growth identified by the teacher candidates included facilitating mathematical discussions in their classrooms. In the next section, the discussion turns to teacher candidates' lived experiences in the classroom and their workload as teachers and graduate students, both of which negatively impacted candidates' ability to grow in their facilitation of discussion.

Lived Experiences. Growing classroom experience was found to support teacher candidates' enactment of practice II, *implement tasks that promote reasoning and problem solving,* and practice III, *use and connect mathematical representations.* Further, quantitative results showed practice III as the practice with the greatest positive change from 2019 to 2020. Candidates described their increased use of this practice as a result of stronger knowledge of the learning progression associated with the course(s) they taught.

Instances in which candidates described classroom experience as negatively impacting their enactment of the EMTP included one of two sentiments. Candidates either felt their previous attempts at enactment were unsuccessful, or they felt they lacked the confidence to adequately integrate the practice in their teaching. However, candidates were able to knowledgeably speak about the practices, which suggests that their

knowledge and skill acquisition in these areas is incomplete, not absent. This is supported in the literature by existing findings that learning may not be evident upon completion of a teacher preparation program (Clarke et al., 2005). Rather, teachers may need more experiences and intentional attempts to achieve theory building and level reduction to the point that leads to successful and fluid enactment of the practices (Korthagen & Lagerwerf, 1996). Other existing research that shows steeper gains in student achievement in the early years of a teacher's career, when compared to later years, is also encouraging support for the idea that teacher candidates have the base level of knowledge, and simply need more experience in the classroom to experience success (Harris & Sass, 2011).

In addition to classroom experience as either a positive or negative influence on enactment, teacher candidates' shared that their workload as teachers and graduate students inhibited their attempts to integrate more complex practices. When taken in context with findings related to classroom experience described above, this finding too becomes a cause for cautious optimism. As teacher candidates complete their graduate coursework and gain experience that leads to more efficient lesson planning, stronger attempts at integration of the practices may become possible. However, the strongest chance for decreased workload to support enactment of the EMTP over time occurs when the school-based setting in which the teacher works encourages aligned instructional practices and perspectives on teaching and learning (Borko et al., 2000; Boston & Smith, 2009; Darling-Hammond, 2006). The next section includes a discussion of findings related to the schools where teacher candidates worked.

School-Based Setting. Findings from previous studies suggest that when the teacher preparation program and school-setting hold similar values and encourage similar instructional practices, enactment of core instructional practices by new teachers is more likely to occur (Borko et al., 2000; Boston & Smith, 2009; Darling-Hammond, 2006). This study found some tension between the teacher preparation program coursework and the school-based instructional supports, though there were areas of alignment as well.

First, consistent with previous findings, the teacher candidates in this study reported feeling pressure to focus on test performance and alignment with the district provided pacing calendar (Cochran-Smith et al., 2015). This pressure was described as instructional time lost to reteaches that did not always align with the teacher perception of what students needed, excessive time spent in benchmark testing, and an emphasis on school wide goals for achievement on standardized tests to the exclusion of mathematics goals for understanding. Some of this negative pressure was mitigated if administration was supportive of the teacher candidate deviating from the pacing calendar to meet student needs. However, most candidates accepted this pressure as the reality of their school-setting and did not express empowerment to advocate for different practices regarding using data to support students understanding. Similarly, they did not express a perception that the school-based practices could be used for improving student understanding, while simultaneously maintaining the same drive toward test performance.

Similarly, when candidates spoke about their curriculum, they saw inconsistent support for their enactment of the EMTP, specifically with regards to making mathematical connections to the larger goals of mathematics learning. Candidates

expressed a need to rearrange or rewrite lessons to make them make sense for their students. One candidate shared a disconnect between a district focus on conceptual understanding and a largely procedural curriculum, while another candidate shared that he chose an external, inquiry-based curriculum instead of using the district provided curriculum. It is encouraging that teacher candidates felt supported in their schools to make adjustments to support student learning. However, it is unclear whether their adjustments supported student understanding or enactment of the EMTP.

The curriculum is one tool that teacher candidates can use to support their own knowledge development as they learn to teach. Another support that is specific to the teacher preparation program is that of the resident advisor. Resident advisors are experienced teachers that host the teacher candidate for the entire first year of the teacher preparation program. Findings in this study related to the resident advisors are the only findings that allude to the apprenticeship of observation literature (Borg, 2004; Mewborn & Tyminski, 2006). Teacher candidates did not share any descriptions of influences from their experiences as mathematics students, but they did share how observing their resident advisor during the first year in the program influenced the practices they prioritized. Two candidates shared descriptions that indicated that they sought to imitate their resident advisors' enactment of practices. The other two candidates sought to prioritize practices they did not see their resident advisor using, and they indicated they did so in reaction to affective elements they noticed in the classroom. For example, one candidate described students' fear of her resident advisor as something she wanted to avoid, which led to prioritization of support and encouragement for students. This

contrast between enactment and observation based on affective factors aligns with the findings of Mewborn and Tyminski (2006).

Finally, this study's findings related to general school supports associated with lesson planning templates and protocols, instructional coaching, and support for external professional developments are supported by the findings from existing literature. The literature suggests that when school-based settings are compatible with the practices that are promoted by the teacher preparation program, teacher candidates are more likely to enact the promoted practices (Borko et al., 2000; Boston & Smith, 2009; Darling-Hammond, 2006). In this study, when these supports aligned with the focus of the teacher preparation program and the values and beliefs of the candidate, they were described as a positive influence on the teacher candidate's enactment of the EMTP. When misalignment marked the support, candidates shared descriptions that tended toward acceptance of the school-based influence and de-prioritization of the EMTP. In the next section, the findings from this study are compared to that of the Wilburne et al. (2018) study, from which it is based.

Comparison of Findings with Wilburne et al. (2018)

Q-methodology seeks to measure subjective perspectives of participants. For this reason, findings are not typically generalizable outside of the participants in a particular study. Nevertheless, the comparison of results and findings between this study and Wilburne et al. (2018) provides useful context and raises a number of questions.

The replication of Wilburne et al. (2018) occurred in the quantitative portion of this study. Specifically, the Q-sort data collection and quantitative data analysis were replicated to gain insight into teacher candidates' perceptions of their use of the EMTP.

Though these methods were replicated, there were notable differences in the participants and settings between the two studies. The 38 participants in Wilburne et al. (2018) averaged significantly more years of experience in the classroom (9.3 years) when compared to this study, and the majority of participants in Wilburne et al. (2018) taught in rural or suburban schools. The four participants in this study all taught in urban schools, and all had less than a full school year of experience in the classroom as a teacher of record.

Table 4, shown on the next page, displays the EMTP in order from those ranked "most characteristic" to "least characteristic" of participant teaching from this study and from Wilburne et al. (2018). The two highest ranked EMTP in Wilburne et al. (2018) were also the two highest ranked in this study. One of the two lowest were the same for both studies as well.

Table 4

Comparison of EMTP Ranking from "Most Characteristic" to "Least Characteristic"

This Study EMTP (NCTM, 2014)	Mean	Wilburne et al. (2018)	Mean
VII. Support Productive Struggle in Learning Mathematics	32.75	**VII. Support Productive Struggle in Learning Mathematics**	32.25
V. Pose Purposeful Questions	30.25	**V. Pose Purposeful Questions**	27
VIII. Elicit and Use Evidence of Student Thinking	22.20	II. Implement Tasks that Promote Reasoning and Problem Solving	21.5
III. Use and Connect Mathematical Representations	20.33	VI. Build Procedural Fluency from Conceptual Understanding	20.8
VI. Build Procedural Fluency from Conceptual Understanding	20.00	IV. Facilitate Meaningful Mathematical Discourse	20
II. Implement Tasks that Promote Reasoning and Problem Solving	16.60	III. Use and Connect Mathematical Representations	17
I. Establish Mathematics Goals to Focus Learning	7.75	**I. Establish Mathematics Goals to Focus Learning**	15
IV. Facilitate Meaningful Mathematical Discourse	7.00	VIII. Elicit and Use Evidence of Student Thinking	14.4

Note. Mean values from this study are from 2020. Mean values in both studies were calculated from the rank values of the instructional actions that are aligned with the EMTP.

Similarities in qualitative findings between the two studies are also evident in both positive influences for use of the EMTP and negative influences for de-prioritization

of the EMTP. For example, participants in both studies referenced practices that were a part of their daily practice as actions they placed in the “most characteristic” portion of the Q-grid (Wilburne et al., 2018). This reinforces that when gestalt formation related to an EMTP is complete, teachers can continue to implement the practice with less effort than they needed to expend initially.

Classroom experience was also a trend in both studies. In Wilburne et al. (2018) participants more clearly stated that their past success with the practices supported continue implementation. In this study, classroom experience was a bit more mixed as an influence. Similar to Wilburne et al. (2018), candidates voiced classroom experience as supporting their use of some EMTP. However, there was also a clear trend related to past failures and a hesitancy to try again. When the teacher candidates in this study struggled to implement discussions in their classroom, they became more hesitant to do so. Commonalities in negative influences in participant use of the EMTP from the two studies included time constraints and pressure of standardized testing. In both studies teachers de-prioritized some practices in order to focus more on school requirements related to test preparation. In Wilburne et al. (2018) participants described in more detail a process of selecting practices that they felt were not time consuming, and discarding practices that they did not have time for. This nuance was not present in findings from this study. Rather, participants in this study simply stated that they didn’t have time to implement some practices.

The final similarity in findings related to negative influences was not an exact match. In this study, teachers cited their workload as teachers with multiple courses to plan and as graduate students as being a limiting factor for trying new practices or

planning intensive practices. In Wilburne et al. (2018), participants shared sentiments of teacher burnout and losing a desire to put forth the effort they once did. In reading the statements of the participants in this study compared to that of Wilburne et al., it seems that what teacher candidates are describing as workload could develop into burnout as the teachers gain more years of experience in the classroom.

In addition to some similarities in findings, notable differences emerged between the two studies. First, teachers in the earlier study referenced task selection as a key part of their planning process that supported integration of the EMTP (Wilburne et al., 2018). In this study, teacher candidates did not reference task selection, but did speak about the limitations of their district provided curriculum.

The second major difference is evident in findings related to how participants perceived their students as learners of mathematics. In this study, none of the candidates shared any negative beliefs about the ability of their students to learn mathematics. In Wilburne et al. (2018), participants questioned the mathematical competence of their students to the point that they did not choose to ask higher level questions or pose challenging tasks.

Finally, classroom management concerns were not mentioned by candidates in this study, while in Wilburne et al. (2018), classroom management was found to limit participants' integration of some EMTP in their classrooms. For example, discussions were limited due to off task behavior. While these differences are notable and interesting, further research would be needed to determine whether these negative influences were more limited for the teacher candidates in the study or whether they simply chose to share about other influences on their practice instead. One possible explanation that should be

explored is that the teacher preparation program from the study has a heavy classroom management focus in the first year of the program. Rehearsals of classroom management techniques occur weekly during a three-hour deliberate practice class.

Implications for the Teacher Preparation Program

Teacher preparation programs are highly complex systems due to the interplay between schools, coursework, educational policy, and teacher candidates' beliefs and identities. Complexity theory provides a means of understanding how this interplay of influences leads to emergent outcomes for teacher candidates providing a view of the collective learning of the group (Clarke et al., 2005). In this study, the emergent outcomes suggest some components of the teacher preparation program that are functioning as intended, as well as some areas where adjustments could lead to stronger results.

First, findings suggest that the opportunities for reflection on resident advisor's practices is supporting teacher candidates in sifting through what they observe. Teacher candidates were able to successfully identify practices that aligned with their beliefs and the practices that the teacher preparation program encourages. Continued opportunities for reflection would be expected to support candidates in their decision-making about which practices they should imitate and which they should discard or replace with more effective practices.

Second, the absence of negative mindsets around student ability to learn mathematics, paired with the teacher candidates' espoused belief in their own capacity for growth as educators, suggests that the teacher mindsets that are reinforced throughout the teacher preparation program coursework are also held by the teacher candidates. This

alignment could be a result of screening practices for applicants to the program as well. Both continued screening for appropriate teacher mindsets and reinforcement through programming should continue to ensure teacher candidates complete the program with a belief in the capacity for student learning and teacher growth.

While findings in this study support continued action in the above-mentioned areas, findings also support change to improve teacher preparation program outcomes. First, the teacher preparation program may benefit from adjusting how teacher candidates are prepared to set and use goals to drive instruction. Findings suggest that decomposing the practice, *establishing mathematics goals to focus learning,* would be beneficial for ensuring teacher candidates have a solid foundation from which they can build their practice. In the existing program, teacher candidates receive support with writing daily objectives, and aligning instruction to those objectives, but the findings suggest teacher candidates are ill-prepared to make connections outside of the daily lesson. Similarly, candidates voiced that goals at their school were often directed toward test performance. In addition to a focus on decomposition of this practice, the teacher preparation program could provide opportunities for teacher candidates to reflect on their use of mathematics goals, as opposed to testing goals, to focus the learning in their classroom.

Another related area for focus in the teacher preparation program is with teacher advocacy. Findings in this study suggest teacher candidates accepted test preparation practices on their campuses that they did not believe were in the best interest of their students' learning. Supporting teacher candidates to become stronger advocates for their students may better equip them to navigate accountability policy, which has been shown to shift instructional decisions away from equity (Garner et al., 2017).

Finally, findings in the study point to necessary adjustments to the mathematics methods coursework. In the first year of the program, teacher candidates spend a semester learning about purposeful questioning and facilitating mathematical discussions. The course includes asynchronous online work consisting of reading, watching videos of mathematical discussions, and planning for discussions for their instruction. In addition to the asynchronous online work, the class includes three face-to-face sessions. The first session is focused on planning for discussions with case study analysis, discussion about video footage of a mathematical discussion, and planning time for their instruction with peer feedback. The second session focuses on implementing mathematical discussion. Teacher candidates rehearsed the mathematical discussions they planned in the online and previous class session, and they receive feedback from their peers and the instructor. Rehearsals within teacher preparation have been shown to support teacher candidates' development of complex and adaptive teaching (Lampert et al., 2013). The final face to face class includes a discussion of advanced facilitation techniques.

This sequence of instruction could include several adjustments based on the findings from this study. First, the three face to face classes on this complex topic are taught in the last three months of the school year. This coincides with standardized test preparation and administration on school campuses. As findings from this study suggest, teacher candidates feel pressured during this time to implement test preparation practices that are recommended by their school administrators. Candidates have struggled to find time to integrate mathematical discussions during these months when school administrators are recommending direct instruction reteaches. I believe this decreases candidate motivation in the rehearsal space that is allocated, especially when they have

limited opportunities to implement in their classroom. Shifting this instruction to the first semester of the second year of the program would allow teacher candidates to focus on building classroom culture to support discussion. This would provide more opportunities to implement discussions in their own classrooms when compared to current course sequence.

A second adjustment that may support enactment of mathematical discourse is in the structure of the teacher preparation program itself. Courses in the teacher preparation program are split between core pedagogy which includes classroom management, lesson planning, and assessment practices that can be applied in any content area, and methods courses that provide a more specific focus on the content. Core pedagogy classes meet twice monthly, whereas the methods course only meets once per month in a face to face environment. Integrating coursework and teaching all pedagogy through the lens of content-specific practices could dramatically increase opportunities for rehearsals with the instructional actions needed for successful facilitation of mathematical discussions.

If core and methods coursework were integrated, instructors with expertise in the content area could more effectively support teacher candidates in routine practices that are prerequisite to effective mathematical discussions. For example, previous research findings have shown that novice teachers struggle to facilitate meaningful discussions because the practice involves a confluence of factors, such as task selection, promoting and supporting peer-to-peer talk, asking purposeful questions, and fostering academic safety in the classroom (Boston et al., 2017; Krall, 2018; NCTM, 2014). Candidates' perceptions of unsuccessful attempts with discussion suggest that they may benefit from breaking down mathematical discussions to promote mastery of each routine component

before pushing for full discussions in their classrooms. This might mean spending more time on establishing academic safety in the classroom, or it could mean more time executing very brief peer-to-peer responses with opportunities to reflect on their practice. After building the component skills, teacher candidates could begin attempting an orchestrated math discussion. This is consistent with findings from Lampert et al. (2013) which suggest that rehearsals can effectively support teachers in their development of complex teaching practices, while simultaneously supporting them in building proficiency with routine elements of teaching.

Limitations and Opportunities for Future Research

In this section, limitations of the study will be shared with corresponding opportunities for future research. First, this study only included four participants from one teacher preparation program. The four candidates were all employed in the same school district, which is a partner of the teacher preparation program. Through the partnership, some alignment of values between the teacher preparation program and the school-based setting exist, though the alignment varies from school to school within the district.

Additionally, I was the instructor of the mathematics methods class during the first year in the teacher preparation program for a cohort of teachers that included these four teacher candidates. While I made every effort to put the candidates at ease and encourage them to talk freely about their experiences, I cannot be certain that their thoughts were shared objectively and openly.

Future research could involve increasing the number and diversity of participants to give a richer picture of how the teacher preparation program is functioning. The

teacher preparation program in the study prepares teachers in a number of states across the country. Sampling students from different geographical regions who teach in different settings could yield valuable insight into whether some of the struggles the teacher candidates encountered with enacting the EMTP are present across a larger sample. Greater diversity could yield different results with respect to the influences on teacher candidate practices and would also address this study's limitation that resulted from a former instructor conducting the interview and data collection.

Findings in this study may also be limited due to the timing of the data collection which resulted in candidates completing the Q-sort, answering the questionnaire, and then participating in the group interview immediately following. By the end of the group interview, it seemed that candidates were fatigued, which may have impacted their responses. Collecting data all in one sitting also prevented the formulation of interview questions in reaction to Q-sort trends, as that data had not yet been analyzed. It is possible that breaking up the parts of data collection could have yielded richer responses from participants.

Along with increasing the number and diversity of participants, a future study could be conducted by segmenting the data collection to allow for more probing questions in response to Q-sort trends. Conducting the Q-sort and independent reflection during one session and the group interview in a different session would likely reduce participant fatigue and allow for more targeted questioning based on the trends in the Q-sort data.

The Q-sort process itself is also limited. Given that participants are asked to place one instructional action on each space on the Q-grid, the participants are forced into

choosing actions that lie at the extremes. One participant shared that he did not feel like he used many of them, and he “ran out of room on the negative end”. This raises a question about the Q-sort as an appropriate tool for collecting data on teacher candidate perception of practice. To determine whether the Q-set in this study is an appropriate fit for investigating teacher candidates’ perceptions of their practice, a future study could develop the Q-set through participant interviews, rather than from the aspirational set of actions outlined by NCTM (2014).

Finally, the comparison between the findings in this study and those in Wilburne et al. (2018) suggest there is research to be conducted in looking at how teachers of all experience levels perceive the difficulty of the EMTP. Though the number of participants in this study is very small, I was surprised when the two practices that were ranked as “most characteristic” in both studies were the same. With one of the two “least characteristic” practices also the same, and with some similarities in trends in the qualitative findings, it is reasonable to ask whether the Q-sort is capturing meaningful perceptions of practice or whether it is capturing differences in the difficulty level for the EMTP. Future research would involve conducting another Q study with an adjustment to the axis. Instead of asking teachers to sort according to what is most or least characteristic, they could be asked to sort according to what practices are most and least difficult to use in the classroom. If findings show that some EMTP are simply much more difficult to enact, professional learning could be adjusted to further decompose those practices and attempt to build proficiency in teachers in a different way.

Conclusion

The findings in this study indicate that as a group, the four participants believed that of the eight EMTP, practice VII, *supporting productive struggle*, and practice V, *pose purposeful questions*, were most characteristic of their teaching. They identified practice I, *establish mathematics goals to focus learning*, and practice IV, *facilitate meaningful mathematical discourse* as least characteristic of their teaching. The group's ranking of practice III, *use and connect mathematical representations,* increased the most between 2019 and 2020, while practice V, *build procedural fluency from conceptual understanding*, decreased the most during that time.

Teacher candidates identified influences on their use of the EMTP that fell into four broad categories: 1) formal teacher preparation coursework, 2) beliefs about teaching and learning, 3) lived experiences, and 4) school-based setting. Within each of these categories. Positive and negative influences emerged in each of the categories, illuminating how the complex system of the teacher preparation process effectively encourages use of the some of the EMTP and failing to effectively promote enactment of others.

Formal teacher preparation coursework was found to impart knowledge of the EMTP to the teacher candidates, while their beliefs led them to aspire to be supportive and encouraging teachers who support productive struggle. Teacher candidates believed in their own potential for growth, and they believed that their use of assessment data should drive toward student understanding. Teacher candidates felt that as they gained more classroom experience, they become better equipped to enact some EMTP, while the workload associated with teaching and going to graduate school inhibited their ability to

use some of the more challenging EMTP, like *facilitating meaningful mathematical discussions.* Finally, teacher candidates pointed to their schools as places that either fostered their growth and ability to enact effective practices or as cultures in which test preparation was paramount. When candidates moved from a school with a very structured culture to a school with a more empowering culture, they perceived growth in their instructional practices. Teacher candidates learned from mentor teachers, from professional development, and from instructional coaches.

The findings from the study suggest opportunities for reflection on practice are resulting in desired outcomes. Teacher candidates are able to evaluate practices that they observe or are asked to enact at their school, and weigh the actions against what they feel is in the best interest of their students. However, the teacher preparation program could increase support of teacher candidates in advocating for equitable practices in the face of accountability policy. Finally, the teacher preparation program can learn from the teacher candidates' reluctance to attempt mathematical discussions. Adjusting instruction to further break down the practices associated with discussions could lead to stronger future outcomes.

Learning to teach is exceptionally challenging and complex. Teacher candidates are simultaneously trying to make sense of concrete experiences in the classroom and theory-based knowledge presented in coursework all while trying to establish their identity as a teacher. On top of this mostly internal knowledge and skill building process, external influences like school policy, instructional coaching, and school culture bombard the teacher candidate. What emerges from the complexity forms the foundation of instructional practices that make it into daily use by the new teacher. Understanding the

emergent outcomes from teacher preparation programs is a critical first step in trying to better prepare teachers to face the challenges that await them in their classrooms.

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Appendix A

Recruitment E-mail

Hello, math teachers,

You are being invited to participate in a research study about mathematics teachers' perceptions of their instructional practices. Only teachers who are students at GRADUATE SCHOOL, who teach secondary math, are invited to participate in this study.

The study entails:

1. Attend a research session to complete a ranking activity of your instructional practices (no more than 30 minutes).
2. Complete a questionnaire asking for your rationale on your ranking of instructional practices (no more than 30 minutes).
3. Participate in a focus group interview, directly following the ranking activity and questionnaire (no more than 60 minutes).
4. Possibly answer questions in a follow-up interview, if selected for the individual interview portion of the study (no more than 30 minutes).
5. Read the researcher's write-up of your responses to check for accuracy and provide clarification (no more than 45 minutes).

The overall time commitment will not exceed 3 hours and 15 minutes, and the study will be conducted in Spring 2020. While there are no direct benefits to your participation, you may enjoy: 1) the opportunity to reflect on your own practice, 2) the opportunity to discuss your instructional practices and how they may have changed over the course of

your study at GRADUATE SCHOOL, and 3) being a part of research that will help teacher educators understand how new teachers learn instructional practices.

While study risks are minimal, you will be talking about your own instructional practice with your peers. This can be stressful. Norms will be established with the group to minimize this stress and ensure supportive group dynamics. I believe strongly that the benefits of participating in the study outweigh the risks.

Participation in the study is OPTIONAL. Your participation (or lack thereof) will have no bearing on your status or performance as a graduate student at GRADUATE SCHOOL GSE. Your participation (or lack thereof) will be kept confidential and will not be shared with any instructors assigning grades at the time of the study. You can sign up for the study today, or let me know by _____ if you need more time to think about it. I'm also happy to answer any questions via e-mail or phone.

Thank you for your careful consideration of this opportunity to help me learn and grow!

Katherine Legreid

Appendix B

Consent Form and IRB Approval

UNIVERSITY of HOUSTON
A CARNEGIE-DESIGNATED TIER ONE PUBLIC RESEARCH UNIVERSITY

Consent to Take Part in a Human Research Study

Title of research study: *Perceptions on Enactment of the Effective Mathematics Teaching Practices by Teacher Candidates: A Replication Study*

Investigator: Katherine Legreid-This study is a dissertation being conducted under the supervision of Dr. Justin Burris.

Key Information:

The following focused information is being presented to assist you in understanding the key elements of this study, as well as the basic reasons why you may or may not wish to consider taking part. This section is only a summary; more detailed information, including how to contact the research team for additional information or questions, follows within the remainder of this document under the "Detailed Information" heading.

What should I know about a research study?

Someone will explain this research study to you.
Taking part in the research is voluntary; whether or not you take part is up to you.
You can choose not to take part.
You can agree to take part and later change your mind.
Your decision will not be held against you.
You can ask all the questions you want before you decide, and can ask questions at any time during the study.

We invite you to take part in a research study about teacher candidates' perceptions of their use of effective mathematics teaching practices because you meet the following criteria: you are a first year secondary mathematics teacher of record completing the second year of a teacher preparation program.

In general, your participation in the research involves completion of a Q-sort based on your instructional practices, completion of a questionnaire, and participation in a focus group discussion. You will also have the opportunity to review the data collected to verify accuracy.

The primary risk to you in taking part is minor mental stress resulting from participation in a focus group discussion, which you can compare to the possible benefit of enjoying reflecting and discussing your instructional experiences with your peers. You will not receive compensation for participation.

Detailed Information:

The following is more detailed information about this study, in addition to the information listed above.

Why is this research being done?

Learning to teach is a highly complex process. This research will yield insight into how new teachers are learning and practicing effective mathematics teaching practices and what factors influence teacher candidates' use of these practices in the classroom.

How long will the research last?

We expect that you will be in this research study for a single visit totaling no more than 2 hours and 30 minutes plus an opportunity to verify accuracy of collected data remotely. It is expected that data verification would take no more than 45 minutes.

How many people will be studied?

We expect to enroll about 5-10 people in this research study.

What happens if I say yes, I want to be in this research?

You will receive an invitation with the date and time for the Q-sort, questionnaire, and focus group discussion. This research will be done at GRADUATE SCHOOL campus at a date and time that work for all participants. The principal investigator, Katherine Legreid will be facilitating throughout all data collection processes. Participants will interact with the principal investigator and the other participants in the study. No sensitive matter will be discussed. Participants will complete:

- A Q-sort activity that will take no more than 30 minutes,
- A questionnaire asking for rationale on the Q-sort that will take no more than 30 minutes.
- A focus group interview that will take no more than 90 minutes.
- A member check (data verification) that will take no more than 45 minutes.

Total time for each participant in the study will be no more than 3 hours 15 minutes.

This research study includes the following component(s) where we plan to video record you as the research subject. The video recording will be transcribed for data analysis:

- ☐ I agree to be video recorded during the research study.
  - ☐ I agree that the video recording can be used in publication/presentations.
  - ☐ I do not agree that the video recording can be used in publication/presentations.
- ☐ I do not agree to be video recorded during the research study.

If you do not agree to be video recorded, you may not participate in the study.

What happens if I do not want to be in this research?

You can choose not to take part in the research and it will not be held against you. Choosing not to take part will involve no penalty or loss of benefit to which you are otherwise entitled.

If you are a student, a decision to take part or not, or to withdraw from the research will have no effect on your grades or standing with the GRADUATE SCHOOL.

Your alternative to taking part in this research study is not to take part.

What happens if I say yes, but I change my mind later?

You can leave the research at any time and it will not be held against you.

If you decide to leave the research, contact the investigator so that the investigator can destroy any data that have been collected.

If you stop being in the research, already collected data that still includes your name or other personal information will be removed from the study record.

Is there any way being in this study could be bad for me?

We do not expect any risks related to the research activities. If you choose to take part and undergo a negative event you feel is related to the study, please contact ***Katherine Legreid.***

Will I receive anything for being in this study?

No

Will being in this study help me in any way?

We cannot promise any benefits to you or others from your taking part in this research. However, possible benefits include enjoyment from reflecting on your instructional growth with your peers.

What happens to the information collected for the research?

Efforts will be made to keep your personal information private, including research study records, to people who have a need to review this information. Each subject's name will be paired with a code number, which will appear on all written study materials. The list pairing the subject's name to the code number will be kept separate from these materials. We cannot promise complete secrecy. Organizations that may inspect and copy your information include the Institutional Review Board (IRB) and other representatives of this organization, as well as collaborating institutions and federal agencies that oversee our research.

Your information that is collected as part of this research will not be used or distributed for future research studies, even if all of your identifiers are removed.

We may share and/or publish the results of this research. However, unless otherwise detailed in this document, we will keep your name and other identifying information confidential.

Who can I talk to?

If you have questions, concerns, or complaints, or think the research has hurt you, you should talk to the research team at kelandry@uh.edu or 713.208.7637. To speak to the faculty sponsor for this study, please contact Justin Burris at jburris2@uh.edu or 713.743.9472.

Signature Block for Capable Adult

Your signature documents your consent to take part in this research.

Signature of subject	Date
Printed name of subject	
Signature of person obtaining consent	Date
Printed name of person obtaining consent	

Date: Friday, January 10, 2020 10:00:25 AM

Print Close

View: UH812 SF: Basic Information

Basic Information

1. * **Title of study:**

   PERCEPTIONS ON ENACTMENT OF THE EFFECTIVE MATHEMATICS TEACHING PRACTICES BY TEACHER CANDIDATES: A REPLICATION STUDY

2. * **Short title:**

   PERCEPTIONS ON ENACTMENT OF THE EMTP BY TEACHER CANDIDATES

3. * **Brief description:**

   1.1 This study will provide insight into priorities, skills, and perceptions of first year teachers with respect to implementation of the effective mathematics teaching practices (EMTP). This study will build on the work of Wilburne, Polly, Franz, and Wagstaff (2018) who incorporated Q-methodology to unearth teacher perceptions of their own practice with regards to the EMTP.

   In addition to examining influences on teacher practice during the first year of teaching, participants will reflect on how their practice has changed between their first and second years in the teacher preparation program. This portion of the study expands on Wilburne et al. (2018) to address whether the data collection process used can capture meaningful change over time. Should this prove to be possible, the methods used in this study could be used to investigate changing practice over time in other settings.

   The first three research questions parallel those of Wilburne, Polly, Franz, and Wagstaff (2018). The fourth research question deviates from Wilburne et al. (2018) to explore

whether and how teacher perceptionsâ€™ of their practice change from the first year of the teacher preparation program to the second year.

1. Which of the effective mathematics teaching practices do teacher candidates rank most characteristic of their teaching and why?
2. Which of the effective mathematics teaching practices do teacher candidates rank least characteristic of their teaching and why?
3. How do teacher candidates rationalize their priorities regarding implementation of the EMTP?
4. How do teacher candidatesâ€™ perceptions of their use of the EMTP change between the first and second years of their teacher preparation?

4. * Principal investigator:

Katherine Legreid

5. * If subjects will take part in research procedures on the University of Houston campus, specify applicable building(s). If not, please select â€œNot Applicableâ€□:

Not Applicable

6. * Does the investigator have a financial interest related to this research?

○ Yes ● **No**

7. * Which IRB should oversee this study?

IRB

8. * Will an external IRB act as the IRB of record for this study?

○ Yes ● **No**

9. * What kind of study is this?

Single-site study

10. Attach the protocol:

	Document	Category	Date Modified	Document History
View	Legreid Protocol Modified with Track Changes 1.10.2020.docx(2)	IRB Protocol	1/10/2020	History

- Use one of these templates:
  - HRP-503 - Template - Protocol
  - HRP-508 - Template - Site Supplement to Sponsor Protocol

View: UH81 SF: Funding Sources (not integrated with Grants)

Funding Sources

1. * Identify each organization supplying funding for the study:

Funding Source	Sponsor's Funding ID	Grants Office ID	Attachments
College of Edu			

View: UH812 SF: Study Team Members

Study Team Members

1. **Identify each additional person involved in the design, conduct, or reporting of the research**

   All student-led protocols must designate a faculty sponsor:

Name	Roles	Financial Interest	Involved in Consent	E-mail	Phone
Justin Burris	Faculty Sponsor	no	no	jburris2@uh.edu	

2. **External team member information:**
   External team member information (Click here to download the External Team Member template**):**

Name	Description
There are no items to display	

View: UH81 SF: Study Scope

Study Scope

1. * **Are there other research sites where the investigator will conduct or oversee the research?**

   ○ Yes ● **No**

2. * **Does the study do any of the following:**

   - Specify the evaluation of an approved drug or biologic?

- Use an unapproved drug or biologic?
- Use a food or dietary supplement to diagnose, cure, treat, or mitigate a disease or condition?

○ Yes ● **No**

3. * Does the study do any of the following:

- Evaluate the safety or effectiveness of a device?
- Use a humanitarian use device (HUD)?

○ Yes ● **No**

4. * Does the research require access to/use of Protected Health Information from a HIPAA-covered entity? ○ Yes ● **No**

View: UH81 SF: Local Site Documents

Local Site Documents

1. Consent forms and HIPAA Authorization: (if applicable)

	Document	Category	Date Modified	Document History
View	Legreid Consent Form with Track Changes 1.10.2020.docx(0.01)	Consent Form	1/10/2020	History

Refer to the following templates and instructional documents:

- HRP-502a - Template Consent Document - NON CLINICAL
- HRP-502b - Parental Permission Document - NON CLINICAL
- HRP-502c - Template Consent Document - CLINICAL
- HRP-502d - Parental Permission Document - CLINICAL
- HRP-502e - Template Cover Letter (Waiver of Documented Consent)
- HRP-507 - Template - Consent Document - Short Form
- Template - Child Assent
- Template - HIPAA Authorization
- HRP-090 - SOP - Informed Consent Process for Research
- HRP-091 - SOP - Written Documentation of Consent

2. Recruitment materials: (add all material to be seen or heard by subjects, including ads)

	Document	Category	Date Modified	Document History
View	Legreid Recruitment E-mail.docx(1)	Recruitment Materials	10/31/2019	History

3. Other attachments:

Document	Category	Date Modified	Document History

	Document	Category	Date Modified	Document History
View	K_Legreid_Consent_2019.pdf(1)	Letters of Cooperation / Permission	10/31/2019	History
View	Q-Sort Questionnaire.docx(1)	Study tools (ex: surveys, interview/focus group questions, data collection forms, etc.)	10/31/2019	History
View	Q sort statements on grid.docx(1)	Study tools (ex: surveys, interview/focus group questions, data collection forms, etc.)	10/31/2019	History
View	Q sort blank grid.docx(1)	Study tools (ex: surveys, interview/focus group questions, data collection forms, etc.)	10/31/2019	History
View	Focus Group Guide10.22.19.docx(1)	Study tools (ex: surveys, interview/focus group questions, data collection forms, etc.)	10/31/2019	History

Suggested attachments:

- Completed checklist for meeting funding agency requirements, if applicable (ex: DoD, DOE)
- Letters of cooperation from collaborating institutions and/or letters of permission from recruitment sites
- Additional IRB approvals
- School approvals (if research takes place within a school district)
- Study tools (ex: surveys and interview questions)
- Safety information
- Certificates of confidentiality
- Translation assurance document
- Other study related documents not previously attached

Finalized Documents

Draft	Category	Final	Last Finalized	Document History
Q sort statements on grid.docx	Study tools (ex: surveys, interview/focus group questions, data collection forms, etc.)	Q sort statements on grid.pdf	1/10/2020 3:46:26 PM	History
Legreid Consent Form with Track Changes 1.10.2020.docx	Consent Form	Legreid Consent Form with Track Changes 1.10.2020.pdf	1/10/2020 3:46:24 PM	History
K_Legreid_Consent_2019.pdf	Letters of Cooperation / Permission	K_Legreid_Consent_2019.pdf	1/10/2020 3:46:25 PM	History
Legreid Recruitment E-mail.docx	Recruitment Materials	Legreid Recruitment E-mail.pdf	1/10/2020 3:46:28 PM	History
Q sort blank grid.docx	Study tools (ex: surveys, interview/focus group questions, data collection forms, etc.)	Q sort blank grid.pdf	1/10/2020 3:46:27 PM	History
Focus Group Guide10.22.19.docx	Study tools (ex: surveys, interview/focus group questions, data collection forms, etc.)	Focus Group Guide10.22.19.pdf	1/10/2020 3:46:27 PM	History

Draft	Category	Final	Last Finalized	Document History
Legreid Protocol Modified with Track Changes 1.10.2020.docx	IRB Protocol	Legreid Protocol Modified with Track Changes 1.10.2020.pdf	1/10/2020 3:46:25 PM	History
Correspondence_for_STUDY00001968.docx	Correspondence	Correspondence_for_STUDY00001968.pdf	11/20/2019 9:42:38 PM	History
Q-Sort Questionnaire.docx	Study tools (ex: surveys, interview/focus group questions, data collection forms, etc.)	Q-Sort Questionnaire.pdf	1/10/2020 3:46:26 PM	History

Appendix C

Q-Sample

Q-Sample: Effective Mathematics Teaching Practices and Instructional Actions

EMTP	Instructional Action	Random Number Assignment
Establish Mathematics Goals to Focus Learning	Using the mathematics goals to guide lesson planning and reflection and to make in-the-moment decisions during instruction.	1
Establish Mathematics Goals to Focus Learning	Establishing clear goals that articulate the mathematics that students are learning as a result of instruction in a lesson, over a series of lessons, or throughout a unit.	2
Establish Mathematics Goals to Focus Learning	Discussing and referring to the mathematical purpose and goal of a lesson during instruction to ensure that students understand how the current work contributes to their learning.	14
Establish Mathematics Goals to Focus Learning	Identifying how the goals fit within the mathematics learning progression.	21
Implement Tasks that Promote Reasoning and Problem Solving	Motivating students' learning of mathematics through opportunities for exploring and solving problems that build on and extend their current mathematical understanding.	20
Implement Tasks that Promote Reasoning and Problem Solving	Selecting tasks that provide multiple entry points through the use of varied tools and representations.	26
Implement Tasks that Promote Reasoning and Problem Solving	Posing tasks on a regular basis that require a high level of cognitive demand.	34

Implement Tasks that Promote Reasoning and Problem Solving	Supporting students in exploring tasks without taking over student thinking	11
Implement Tasks that Promote Reasoning and Problem Solving	Encouraging students to use varied approaches and strategies to make sense of and solve tasks.	4
Use and Connect Mathematical Representations	Selecting tasks that allow students to decide which representations to use in making sense of the problems.	23
Use and Connect Mathematical Representations	Allocating substantial instructional time for students to use, discuss, and make connections among representations.	32
Use and Connect Mathematical Representations	Introducing forms of representations that can be useful to students.	16
Use and Connect Mathematical Representations	Asking students to make math drawings or use other visual supports to explain and justify their reasoning.	7
Use and Connect Mathematical Representations	Focusing students' attention on the structure or essential features of mathematical ideas that appear, regardless of the representation.	35
Use and Connect Mathematical Representations	Designing ways to elicit and assess students' abilities to use representations meaningfully to solve problems.	10
Facilitate Meaningful Mathematical Discourse	Engaging students in purposeful sharing of mathematical ideas, reasoning, and approaches, using varied representations.	33
Facilitate Meaningful Mathematical Discourse	Selecting and sequencing student approaches and solution strategies for whole-class analysis and discussion.	3
Facilitate Meaningful Mathematical Discourse	Facilitating discourse among students by positioning them as authors of ideas, who explain and defend their approaches	5

Facilitate Meaningful Mathematical Discourse	Ensuring progress toward mathematical goals by making explicit connections to student approaches and reasoning.	25
Pose Purposeful Questions	Advancing student understanding by questions that build on, but do not take over or funnel, student thinking.	6
Pose Purposeful Questions	Making certain to ask questions that go beyond gathering information to probing thinking and requiring explanation and justification.	31
Pose Purposeful Questions	Asking intentional questions that make the mathematics more visible and accessible for student examination and discussion.	18
Pose Purposeful Questions	Allowing sufficient wait time so that more students can formulate and offer responses	13
Build Procedural Fluency from Conceptual Understanding	Providing students with opportunities to use their own reasoning strategies and methods for solving problems.	36
Build Procedural Fluency from Conceptual Understanding	Asking students to discuss and explain why the procedures that they are using work to solve particular problems.	28
Build Procedural Fluency from Conceptual Understanding	Connecting student-generated strategies and methods to more efficient procedures as appropriate.	37
Build Procedural Fluency from Conceptual Understanding	Using visuals models to support students' understanding of general methods.	27
Build Procedural Fluency from Conceptual Understanding	Providing students with opportunities for distributed practice of procedures.	15
Support Productive Struggle in Learning Mathematics	Anticipating what students might struggle with during a lesson and being prepared to support them productively through the struggle.	19

Support Productive Struggle in Learning Mathematics	Giving students time to struggle with tasks, and asking questions that scaffold students' thinking without stepping in to do the work for them.	8
Support Productive Struggle in Learning Mathematics	Helping students realize the confusion and errors are a natural part of learning, by facilitating discussions on mistakes, misconceptions, and struggles.	9
Support Productive Struggle in Learning Mathematics	Praising students for their efforts in making sense of mathematical ideas and perseverance in reasoning through problems.	12
Elicit and Use Evidence of Student Thinking	Identifying what counts as evidence of student progress toward mathematics learning goals.	17
Elicit and Use Evidence of Student Thinking	Eliciting and gathering evidence of student understanding at strategic points during instruction.	22
Elicit and Use Evidence of Student Thinking	Interpreting student thinking to assess mathematical understanding, reasoning, and methods.	24
Elicit and Use Evidence of Student Thinking	Making in-the-moment decisions on how to respond to students with questions and prompts that probe, scaffold, and extend.	29
Elicit and Use Evidence of Student Thinking	Reflecting on evidence of student learning to inform the planning of next instructional steps.	30

Note. Language of the EMTP and instructional actions from *Principals to Actions: Ensuring Mathematical Success for All,* 2014. Copyright 2014 by the National Council of Teacher of Mathematics.

Appendix D

Q-Sort Questionnaire

Basic Demographic Info

1. Please enter your first and last name.
2. Please select your gender.
    a. Female
    b. Male
    c. Non-binary
3. Please select the statement that describes your ethnicity.
    a. Hispanic or Latino or Spanish Origin
    b. Not Hispanic or Latino or Spanish Origin
4. Please select your race from the list below.
    a. American Indian or Alaska Native
    b. Asian
    c. Black or African American
    d. Native Hawaiian or Other Pacific Islander
    e. White
    f. Multiracial
5. Please select the grade level/course that you teach.
    a. 5th
    b. 6th
    c. 7th
    d. 8th grade math

e. 8th grade Algebra I

f. 9th grade Algebra I

g. Geometry

h. Algebra II

i. PreCalculus

j. AP Calculus

k. AP Statistics

l. Other: _____

Teaching Actions

1. Which of the teaching actions were easiest to place on the Q-grid? Why?
2. Which of the teaching actions were hardest to place on the Q-grid? Why?
3. Please share your rationale for selecting the teaching actions you placed in the 4 and 5 columns.
4. Please share your rationale for selecting the teaching actions you placed in the -4 and -5 columns.

Appendix E

Group Interview Guide

Facilitator's welcome, introduction and instructions to participants

Welcome

Thank you for agreeing to participate in today's focus group. I am very interested in your thoughts and perspectives.

Introduction: This focus group discussion is designed to gather your perspectives on your instructional practice, what influences your instructional practice, and how your practice has changed over time. The focus group discussion will take no more than 90 minutes. I will be videotaping to help me recall everything you share today. Is it ok if I begin taping now?

Anonymity:

Though I am videotaping, the discussion that we have today will be anonymous. After the discussion group, the memory card will be uploaded to a secure, password-protected server. After the video has been transcribed, using your participant IDs as a substitute for your real names, the video will be deleted. Please try to answer questions and share your thoughts without reservation or concern that your identity may be exposed. Please do not share comments from the discussion outside of this focus group. If at any time you do not want to share, you do not have to share. However, please try to participate as fully as possible.

Norms

- There are no right or wrong answers. You do not need to agree with the views of other participants, but please be respectful.

- I will be video-taping, so I can transcribe and anonymize the data after the focus group ends. Please do not speak when someone else is speaking.
- Please address the group when you are speaking. My role will be to guide the discussion.
- Does anyone have any questions? (answers).

Warm up

- First, I'd like everyone to share their name, residency assignment from last year and teaching assignment this year.

Introductory question

I am going to give you a couple of minutes to review the instructional practices that you placed on the far right and far left of your Q-sort. Would anyone like to share general thoughts about completing the Q-sort process?

Part I: Guiding questions

- Would anyone like to share your thoughts on the practices you chose to place on the far right?
- What influences have shaped your use of the practices you placed on the far right?
    - What past experiences/beliefs/coursework have influenced your use of these practices?
- Why do you feel you prioritize these practices over others?
- Where did you learn these practices?
- Look now at the instructional practices you placed on the far left of the Q-sort. Would anyone like to share your thoughts on the practices you chose to place on the far left?
- What influences can you identify that led you to place these practices on the far left?
    - What past experiences/beliefs/coursework have influenced your use of these practices?
- Why do you feel you do not prioritize these practices over others?
- How does your use of the instructional practices in the Q-sort impact student learning?
- How does your use of the instructional practices in the Q-sort impact student behavior?
- What do you know about how your campus leadership or instructional coach thinks about these practices? Please reference specific practices when you share.
- What experiences or support do you think you need to more effectively enact the practices from the Q-sort?

Transition to Part II: Q-sort Comparison

We will take a brief break now, so I can pass out the Q-sort that you completed in April 2019. I'll give you some time to compare your Q-sort from last year to the Q-sort from this year. You may use the reflection questions on the handout to explore whether and how your sorting has changed.

Part I: Guiding questions

- Would anyone be willing to share some ways in which your sort has changed?
- What influences on your practice have changed between last year and this year?

Concluding question

- Of all the things we've discussed today, how would you summarize what factors influence your use of these practices?

Conclusion

- Thank you for your participation in the focus group today.
- Your thoughts and perceptions will be a valuable part of this study and will give me insight into how you are learning and growing as a math teacher.
- I hope you have enjoyed reflecting on your practice today.
- If you have any concerns or complaints about the process, please contact me via e-mail.
- As a reminder, any comments that will be shared in the study will be anonymous, and the transcript of this focus group will be analyzed using your participant ID numbers.
- Please turn in your Q-Sort Comparison Guiding Questions sheet before you leave.

Appendix F

Q-Sort Comparison Guiding Questions

First, compare the two columns on the far right of this year's Q-sort to the two columns on the far right of last year's Q-sort.

1. What practices are in the far right columns for both years?

2. What practices did you sort into the two far right columns this year that were not placed there last year?

3. What factors do you think have influenced your increased prioritization of those practices?

Now, compare the two columns on the far left of this year's Q-sort to the two columns on the far right of last year's Q-sort.

4. What practices are in the far left columns for both years?

5. What practices did you sort into the two far left columns this year that were not placed there last year?

6. What factors do you think have influenced your decreased prioritization of those practices?

7. Please record anything else you notice and would like to comment on as you reflect.

Appendix G

Qualitative Data Initial & Final Codebooks

Initial Codebook

LIVED EXPERIENCES (LI)
- POSITIVE EXPERIENCES AS A P-12 STUDENT (LI-POS)
- NEGATIVE EXPERIENCES AS A P-12 STUDENT (LI-NEG)
- PRIOR TEACHING EXPERIENCES (LI-TEACHING)
- PRIOR UNIVERSITY EXPERIENCES (LI-UNIV)
- APPRENTICESHIP OF OBSERVATION (LI-OBS)

SCHOOL-BASED SETTING (SBS)
- SCHOOL CULTURE (SBS-CUL)
- RESIDENT ADVISOR (SBS-RA)
- MENTOR (SBS-MENTOR)
- ADMINISTRATION (SBS-ADMIN)
- PROFESSIONAL DEVELOPMENT (SBS-PD)

FORMAL TEACHER PREPARATION COURSEWORK (TPREP)
- CORE PEDAGOGY COURSEWORK (TPREP-CORE)
- MATHEMATICS METHODS COURSEWORK (TPREP-MATH)
- DELIBERATE PRACTICE (TPREP-DP)

KNOWLEDGE (KNOW)
- STRONG CONTENT KNOWLEDGE (KNOW-S)
- WEAK CONTENT KNOWLEDGE (KNOW-W)
- EDUCATIONAL THEORY (KNOW-THEORY)

BELIEFS (B)
- BELIEFS ABOUT STUDENTS (B-S)
- BELIEFS ABOUT TEACHING (B-T)
- BELIEFS ABOUT MATHEMATICS (B-M)

Final Codebook

LIVED EXPERIENCES (LI)
- WORKLOAD (WL)
- CLASSROOM EXPERIENCE (EXP)

SCHOOL-BASED SETTING (SBS)
- SCHOOL-BASED SUPPORTS (SBS)
- RESIDENT ADVISOR (RA)
- CURRICULUM (CUR)
- STANDARDIZED TESTING & TIME CONSTRAINTS (TEST)

FORMAL TEACHER PREPARATION COURSEWORK (TPREP)
- CORE PEDAGOGY COURSEWORK (CORE)
- MATHEMATICS METHODS COURSEWORK (METHODS)

BELIEFS ABOUT TEACHING AND LEARNING (B)

Appendix H

Quantitative Data

Table 5

Summary Statistics for the 37 Instructional Actions with their Alignment to the EMTP

		2020			2019		
EMTP	Instructional Action	Mean	SD	Rank	Mean	SD	Rank
VII	8	2.75	1.48	37	0.5	1.50	21
V	18	2.75	1.92	37	1.25	1.30	30
VII	12	2.5	1.12	35	1.22	20	37
VIII	29	2.5	2.87	35	2.25	1.92	36
VIII	30	2.5	2.06	35	-0.5	1.66	15
III	35	2.25	1.92	32	-1.75	2.95	6
VII	19	2	1.22	31	2	1.22	35
VI	27	1.75	1.09	30	0.75	2.17	25
III	16	1.5	2.29	29	1.75	3.42	33
VII	9	1.25	2.28	28	1	2.92	28
V	31	1.25	2.49	28	0.75	2.49	25
V	6	0.75	0.83	28	1.25	0.83	30
III	7	0.75	1.09	23	-1.75	2.38	6
V	13	0.75	2.49	28	0.75	2.49	25
VI	15	0.75	2.28	28	2	0.71	35
VIII	22	0.75	2.38	23	-0.25	2.28	16
II	20	0.5	0.87	20	-0.75	1.09	14
III	32	0.5	1.80	19	-1.5	1.80	10
VI	36	0.5	1.80	23	1	2.12	28
II	34	0.25	2.17	19	-1.25	1.92	12
I	1	0	2.35	19	1.5	1.66	32
II	4	0	1.87	16	0.25	2.17	19
II	26	0	2.00	15	0	1.87	18
VIII	24	-0.25	1.92	15	0.75	1.92	25
III	10	-0.75	1.92	12	-2.75	0.83	2
II	11	-0.75	1.30	13	0.5	1.66	21
IV	3	-1.25	2.05	11	-1.5	1.80	10
VI	28	-1.5	1.12	10	1.5	2.06	32

VI	37	-1.75	2.38	9	-0.75	3.42	14
IV	33	-2	2.00	8	1	3.08	28
III	23	-2.25	2.38	7	-1.5	2.60	10
I	14	-2.5	2.06	7	-1.75	1.48	6
I	2	-2.75	1.09	4	-1.25	3.27	12
IV	5	-2.75	1.92	7	-2.5	1.66	3
VIII	17	-2.75	2.28	3	0	1.22	18
IV	25	-3.25	0.83	2	-1.5	2.06	10
I	21	-4	1.00	1	-3.5	2.60	1

Appendix I

Group Interview Transcript

Researcher (00:03):

Okay. So Participant 4, do I have your permission to record?

Participant 4 (00:05):

Yes.

Researcher (00:09):

Participant 3, do I have your permission to record?

Participant 3 (00:12):

Yes.

New Speaker (00:14):

Participant 2, do I have your permission to record?

Participant 2 (00:16):

Yes.

Researcher (00:17):

And Participant 1. Do I have your permission to record?

Participant 1 (00:22):

Yes, you do.

Researcher (00:26):

Thank you. Okay. So thank you for agreeing to participate in today's, um, group interview. I'm very interested in your thoughts and perspectives. This group discussion is designed to gather your perspectives on your instructional practice, what influences your instructional practice and how your practice has changed over time. The group discussion will take no more than, probably will take about an hour from here. Um, I'll be videotaping to help me recall everything you share today. Mmm. Though I'm videotaping the discussion that we have today will be anonymous when I present it. After we discuss, Mmm. The video will be uploaded to a secure server and then the video is going to be transcribed and once the video is transcribed, um, I'll remove your names from the video and use a pseudonym so no one will know what you're saying or that it's you. Um, and then the video will be deleted.

Researcher (01:23):

Please try to answer questions and share your thoughts without reservation or concern that your identity may be exposed. Please do not share comments from the discussion today outside of this group. Um, and if anytime you do not want to share, you don't have to share, Oh, just share it to your point of comfort. Um, but please try to participate as fully as possible, um, because that's how we're gonna get the best information. So some norms for our discussion. There are no right or wrong answers and you don't need to agree with each other's views. Um, and you certainly don't need to say anything. I'm not looking for anything in particular. I'm looking for your thoughts and your perspectives. Um, whatever it is that you want to share is totally fine. Um, no matter what. Mmm, you mentioned the videotaping, please address like the group as we discuss rather than just talking to me. I'll pose a question and then we can have a chance to hop on and off of mute to be able to share perspectives. Um, and I'll be the one to guide the discussion. Do you have any questions before we begin?

Researcher (02:32):

Awesome. Thanks. Um, so first I would love for us just to do a quick whip around. Um, I'm sure you all probably know your teaching assignments for the year, but just in case I know you've been in an online content class, which might be a little bit different, I'd love for you just to hop off of mute and share what and where you're teaching. Um, and then we'll begin with the real questions.

Speaker 2 (02:54):

[inaudible]

Participant 4 (02:57):

Participant 4 SCHOOL DISTRICT NAME School Name 1, high school algebra two and AP statistics.

Participant 3 (03:00):

I'm Participant 3 . I'm teaching AP statistics and college prep math at SCHOOL DISTRICT NAME generation's collegiate high school. So 11th and 12th grade.

New Speaker (03:19):

Um, I'm Participant 2 . I'm teaching seventh grade math at SCHOOL DISTRICT NAME School Name 2. Um, so pre algebra

Participant 1 (03:28):

and I'm Participant 1 and I teach algebra one or algebraic reasoning and college ready math at School Name 1 high school.

Researcher (03:41):

Are those classes, um, are those for credit classes?

Participant 1 (03:50):

They're for credit. They're not the like algebraic reasoning supplements. The algebra one class. Um, and they, I mean they do get grades and uh, it is for like a math for math credits. The college ready math is for seniors that need to pass the TSI. Um, I mean Participant 3 teaches it also, but I don't know. I'm not sure exactly. We don't have much of a curriculum to go by. More of a list of sequence. Like I don't know, kind of a list of topics that are all algebra one, algebra two and geometry and some pre-calculus stuff too. But, um, I don't know. The algebra algebraic reasoning pretty much follows the same same pattern as algebra one.

Researcher (04:40):

Okay, great. So it's kind of like an intervention or support block it sounds like. Okay, great. Thank you so much for sharing that. Um, so we've taken time to review our Q sort. Um, I'd love to just hear any general thoughts about completing the process?

Participant 1 (05:06):

Well since I'm unmuted I guess I'll say, uh, that um, I mean I was definitely hard cause I definitely wanted to say that I like do all these at some point or another. Even that, I definitely don't spend as much time talking about some as others. But, um, like the middle section, I thought it was particularly hard to choose. Like which ones I wanted to put, like just barely positive versus barely negative. And I don't know, I feel like it could switch easily, but I don't know, I feel like it could change from year to year depending on just how the classroom is.

Participant 3 (05:56):

Um, so I guess I kinda ran out of room on like the negative and I don't do a lot of these things, so I felt like I had to place some stuff in stuff that's most characteristic of my teaching just cause I ran out of room on the lower end. Um, there's some of these I didn't completely understand. I

didn't know that I was thinking about them in the right way. I was trying to find an example. Um, see, yeah, I can't really find an example at the moment, but there are a few, couple different, I wasn't sure I completely understood.

Participant 4 (06:38):

Um, for me I think it was easier to do like what I know for sure I'm doing. And so the ends were a lot easier. The tail is basically, and that one is pretty much embedded into like our lesson plan, our, uh, planning protocol at School Name 1. And then the other side is like what is highly suggested that we might not always get to. So for example, I think one was the um, uh, discussing and referring to the mathematical purpose and goal of a lesson during instruction to ensure students understand how the current work contributes to their learning. Uh, I'm really good at zoning in in algebra two, but I'm not the best at zoning out and how algebra two connects to the greater scheme of math.

Participant 2 (07:28):

Yeah. I'm, I was actually kind of the same where like a lot of the goal stuff is towards the negative. Um, because I don't really focus a whole lot on like the end goal of the year, which is like to be ready for algebra. I focus more on like, well, what is making sense in that moment and not so much like the goal of the lesson or the mathematical progress or purpose. Um, and so like the goal stuff was really easy to put towards the negative, but then at the same time it was like, should this be on the negative side? So it's just like really, I'm like second guessing myself as I was doing it. Um, but then just decided to trust my gut.

Researcher (08:12):

So it sounds like, um, as a tool for reflecting on your process, you probably had some realizations through it about maybe things you are emphasizing more or less. And it also sounds like some of

that's coming from, um, like supports that are in place, like the lesson planning template for example. Um, so let's, let's zone in now to the, um, the ones that you placed on the far right. So the ones that you said were most characteristic of your teaching, um, what past experiences, beliefs or coursework have influenced your use of these practices?

Participant 2 (08:56):

Um, so I can say that like on my positive side, I put a lot of this stuff about, um, making mistakes and struggle. Um, cause I really, like from our class last year where we just talked about academic struggle and how if kids aren't at the right level of struggling, then they're not going to understand and they're not going to conceptually get there. But I've really just kind of pushed myself to not let my kids give up or like ask like what do I do next? Like I want them to be able to recognize it. Um, but I also want them to know that they're welcome to make this mistakes because that's how we learn. Um, and I am consistently, whether it's wrong or right. And I know that I'm consistently like telling my kids like, we love it. It's great. Like you tried. That's the part that matters. Um, and so it was really easy for me to put that stuff on the right side because I know that that's how I run my classroom. Okay.

Participant 4 (09:54):

For me on the right hand side or the tail was a lot of what we learned from back in methods three Oh two. I think it was with the seven question sequence of the uh, the probe, the gather, the visibility justification and then the um, connect, articulate and one more. But a lot of that is just so much of my daily practice now that that's why it does come a lot easier is just anticipating like what can go wrong, not necessarily will go wrong, but what can go wrong and having a plan for that. And that's what makes um, making in the moment decisions so much easier now. So instead of like panic, Oh, I didn't plan for this. Now it's like, Oh wait, I did plan for this, now let's go

about this a different way. And then that lends itself into just making it visible and the different representations of the math.

Participant 1 (10:48):

Yeah, I'd say it sounded really similar with that. Like, um, I mean the ones that I had on the right hand side were a lot of value, I like gathering evidence from student understanding and yeah, making like in the moment decisions. Um, but yeah, when I was reflecting on it in that survey, I was saying the same thing that Participant 4 was just saying. Like, um, even though there are a lot of in the moment decisions like having that all planned out ahead of the time, like even if you're switching your lesson plans last minute teaching different things than you thought you might've been like the day before. Um, because you had to switch something up. Like having that all planned out makes that a lot easier to do. Um, so yeah, that's why I have those. I mean, I thought the right side was definitely the easiest because those are just things that happen. Yeah. On a daily basis I feel like, you know, pushing as I've said, like asking intentional, intentional questions that make the mathematics more visible, uh, was, that's like pretty much, you know, the entirety of my class is like asking really intentional questions to push their thinking.

Participant 3 (11:54):

So one of the things that I put on column four, column five was wait time. And I know that was one of the first things we learned in just the general core GRADUATE SCHOOL class. So I think that's something that had I not learned that that probably wouldn't have been in the four or five column.

Researcher (12:17):

Thank you all for sharing. So I heard a lot of, um, things that you learned at GRADUATE SCHOOL, which is nice, but are there other influences you can think of that, um, might have

shaped those practices that do show up in your instruction more frequently than the others? And the answer could be no, but I want to ask the question again. So you might think about beliefs, you might think about, um, other teachers. You might think about school culture. You might think about instructional coaches, um, what else has influenced things that you're regularly doing? Okay.

Participant 2 (12:53):

Mmm. So for me, I know last year, the um, classroom that I was in with my mentor, um, we had very different approaches to how we, um, ran things. And so for him, it wasn't so much about joy and like struggle, it was about getting to the data end of things. Um, and I just realized that that isn't what I want to do. Like I want kids to be comfortable. I want them to know that they're allowed to make mistakes. I want things to not just be like a worksheet that they can master. I want them to, you know, have some fun, like their currently staring at superhero drawings that were related to surface area and volume. Um, which isn't something we would have done last year. So I know that for me it's like bringing in comfort into the classroom cause I want, I don't want kids to come in and scared, um, of their teacher, but that's why they're obedient. Like, I, I want it to be like, they're welcome to make mistakes and they're welcome to struggle, um, and still know that at the end of the day it's going to be okay. Um, so that's a big thing for me.

Participant 4 (14:07):

Um, for me. And, uh, Participant 4 and I, we actually were in the same boat last summer with AP statistics. We were able to, um, get an NMSI training. And so there was a lot, um, it wasn't so much content focus as opposed to very much inquiry based and a lot of inquiry learning. And so having that training was just super beneficial because at least for my stats kiddos was I tried to do inquiry maybe once or twice a week because stats is really one of those maths that is best learned through the application. And so I'm just having that training really provided the tools that I

needed this year to one, make sure the content is being delivered properly, but also making the math memorable, making it fun.

Participant 1 (14:59):

I mean, I'll say it just also through um, I guess that's just personal experience in the classroom stuff also. Um, reading this one is like gathering evidence, at strategic points. So just like, I guess CFUs and checking for understanding that we learned in a bunch of different ways also at GRADUATE SCHOOL, but, um, realize like how crucial those are. Just like in any lesson, like lessons that I'll be going through, assuming that they're following along and seeing what I'm doing. And then I get, you know, 30 minutes in and realize that like nobody's on the same page. Um, and so like now I'm like, you know, every five minutes or so, I'm making sure that, uh, everybody has all the same things either. Like, you know, we're all at the same point whether I'm walking in another room or using whiteboards or whatever it may be. Um, but I think that that just came with like also through the coaching that I was receiving at School Name 1 and stuff. Also. Um, them coming in and being like, these six people had no idea what you were talking about or whatever it may have been, but I don't know.

Participant 3 (16:17):

So I guess for me, a recent influence has been this resource I found online. It's called a stats medic.com. And basically it's this, um, experienced AP stats teacher who posted a lot of, or well all of her lessons. Um, so basically provides a lesson for each day of AP stats throughout the year. And, um, all the lessons are activity-based and instead of it being more like uh, like guided notes and then independent practice, it's more of where students engage in activity and they kind of explore the concept themselves and then we like formalize it after the lesson. Um, so that's kind of influenced, I don't know if it directly applies to any of these teaching actions, but that's been the most recent influence on my teaching in AP stats.

Researcher (17:09):

Things like that would be definitely influencing some of the planning practices I would think. And like your selection of tasks perhaps. Um, I think it would easily be considered an influencer. Um, so thank you for sharing. Um, there again, um, I heard some different beliefs about like what math, um, maybe should be or could be. Are there any other, um, are there any other beliefs that you, um, hold currently or have held in the past that, um, you feel like influenced your practice as a teacher?

Participant 1 (17:54):

Well, I didn't really put this in my right column, but when Participant 2 was saying that, I mean, I would like to think I could. The one about making mistakes and like normalizing making mistakes. and I do talk about that, but I just don't, don't talk about it every day I guess. But I think that is so important and its definitely not something I thought about when I was in school, but, um, but I wish that I did have like that influence when I was in high school for sure. Because I think that a lot of the time kids do caught, get caught up in like, unless they're doing it right then they're they like there's no use of doing it at all. Um, and like Participant 2 was saying it, I mean the struggle is really the important thing and can't remember who said the quote is like that failing or like something to do with like if you're failing, you're learning. Um, but if I say that to them, they'd be like, Oh, I can fail and not do anything but like failing, like trying and failing is learning. Um, and so I think that, uh, yeah, it really is so important to include that I can get that ingrained into your classroom culture.

Participant 4 (19:13):

For me, I think I previously held this belief and it just might've been that teaching at a very structured type of a school network is just this belief that like the lesson needs to be do now, connect, INM, independent practice, and assess. So that for a bit was ingrained in like, okay, this

is how math should be. But, um, now just having the flexibility to really guide the lesson on my own. And so really getting more towards like activity based and inquiry based, um, that's kind of challenged the belief that I had. Like everything should be structured and now maybe you don't need 20 problems, but maybe you just need three or four really good problems and that students can struggle with and try their hand at and you can still do that and um, build up the confidence in students to do the risk.

Researcher (20:16):

I've got one more question about those practices on the far right. This might actually, um, this might actually go with just all of the practices in general. Mmm. The three of you changed schools from last year to this year. Um, and one of you, Participant 3, you stayed at the same school. I'm curious if, um, if there are any thoughts about particularly the shift from one school to another and how that may or may not have impacted your practice.

Participant 2 (20:48):

Um, it definitely did for me. Um, the school that I was at last year was very much like class needs to look like this and if it doesn't, then it's not like to our standards. Um at my new school I definitely have a lot more freedom like as to what I get to do in my classroom. As long as it's like I still get the questions about where are you on the pacing calendar and that kind of stuff. But I don't feel like if I'm not directly on the pacing calendar that I'm not doing my job right. Um, and that's been a huge difference for me. Um, cause I am behind on my pacing calendar, but my kids, are learning and are understanding and I'd rather they learn and understand and make the mistakes and struggle. Um, the thing that they [inaudible] need to struggle on before moving on to the next thing. Um, so that school shift has been huge for me. Um, and then also just having my own classroom, um, being able to do things the way that like I've envisioned myself as an educator has been. Um, very just like empowering for me too.

Participant 4 (21:59):

Um, Participant 1 and I, we actually both came from the same school and they couldn't separate us. So, um, it has been a very beneficial transition. I would say. Um, just the previous location we were at was very much structure and you know, if you were ever observed and you weren't meeting the structure, then you weren't, it felt as though you weren't doing a good job. Whereas at our new location, it's very much celebrated that, um, each day looks a little different. While the structure is important, it's more important that students feel engaged and empowered by the learning. And so I will say just having that atmosphere for teachers, um, it makes me want to make sure that my lessons are interactive and fun and I want to make sure that my students are enjoying it as opposed to I need to make sure I've got these five or six different components that meet the T and meet the CFS. Um, it's just feeling like you have that space to do as you wish, as long as it does abide by the curriculum. Um, that for me has just put me in a better mental space and consequently has been better for my students.

Participant 1 (23:13):

Uh, yeah. I mean I couldn't agree more with what Participant 4 was just saying. Um, yeah. And especially, yeah, not teaching with somebody else and everything. Also, it makes a big difference. But, um, being, and especially in the course that I'm teaching, that's not actually the algebra one that has a Eureka curriculum to follow. Um, I mean, I still look at that and look at what they're supposed to be doing in algebra one. Um, and, um, me and the algebra one teacher at School Name 1, collaborate, every single day really, um, we [inaudible] or, uh, communicate really well. And luckily are good friends also, so that helps. But, um, yeah, so we always look at what each other are doing and I have a lot of freedom to kind of give them whatever I think they need to really like stamp whatever the learning goal is for that day, in either his class or if we're a little bit behind in the pacing calendar, I can take a couple of his lessons or things like that. Um, but that being said, like Participant 4 was saying, you know, every day can look a little different. There's

still definitely things they expect to see, um, in terms of like lesson planning and, you know, board configurations and things like that. But, um, but yeah, I think that, there's a lot, um, more like celebration among just like student engagement and learning, um, in different ways than just one set way. So I think that's good.

Researcher (24:49):

Thank you. So we're going to shift focus now to the left side of the Q-sort. So these are the practices that you feel are least characteristic of your teaching. Mmm. We, you all shared a little bit about like how the Q sort was in general. I want you to kind of zone in on those practices on the far left. And first I would love if we would just do a whip around and share just some, like maybe some of those practices that stood out to you and share a little bit about why you placed them on the far left.

Participant 3 (25:25):

So there's one about discourse facilitating student discourse. Um, actually I don't end up having much class discussion in my class unfortunately. So that one was kind of easy to place in the negative four negative five column. And then there are also some about goals about, um, articulating the goals and by explaining like how the goals fit within what the entire curriculum or the entire year. I don't think I do a great job of that. So yeah, particularly though the, the discussion pieces is kind of missing in my class and that one was easy to place in the lower columns.

Participant 4 (26:14):

Um, for me it was a lot of like the zoning out. And so again, like ensuring progress towards goals by making explicit connections. Um, I will say that is me, but then I will also say it's also per consequence of the way. Um, so Texas we do SCHOOL DISTRICT NAME Texas, we have our

own separate curriculum and the TEKS from the traditional SCHOOL DISTRICT NAME network. And so a lot of that has resulted in the restructure of the way material is presented. And so even though there's this very large push towards conceptual math and that is what we're working towards, um, often it feels like the unit plans are very much like skill, skill, skill, discussion, skill, skill, skill, and the progression doesn't make a lot of sense per se. And so I usually end up just reorganizing the structure still in a way that meets the curriculum standards, but in a way that presents content so that there's more of a natural flow and connection to it as opposed to, well, here's the, graphical analysis side. But then, Oh, here we're actually looking at the geometry of it and vice versa. So for me it is a consequence of what materials were given to me. And so just like zoom zoning out is a little bit difficult because right now I'm zoning in and reorganizing what I think is best for my students.

Researcher (27:39):

Um, let me just check my own understanding. So you're talking about the whole like SCHOOL DISTRICT NAME national or whatever. Mmm. Is mostly based in common core. School District Name is using the state standards and potentially college and career readiness standards or just the state standards.

Participant 4 (27:55):

Both.

Researcher (27:57):

Okay, great. Thank you.

Participant 1 (28:06):

Mmm. Yeah, just like Participant 2 and Participant 3 kind of talked about just now, but Participant 2 was saying earlier when she's talking about, um just doing this in general most of

my goal setting, like the goal setting ones and stuff like that I have on the left also, I'm just like fitting in to the greater progression. of everything. Um, and I do feel like even though I don't have it all the way on the left, I kind of do agree with, uh, Participant 3. I mean, I think I do have just math discussions on an almost daily basis at least. Um, but when I start trying to get them to like defend their own reasoning and use different, uh, like logic for defending or justifying a math problem or an answer, um, you know, there's only a handful of students in each class that are really comfortable either sharing or really justifying those answers. And then when, so if I try to create a discourse back and forth, um, it's often either really circular or ends up just being like, I feel like I'm wasting a lot of time. I just trying to force kids to participate when they're either not ready to or, um, maybe I'm just not presenting it in a way that they're fully understanding yet, but, um, I don't know. I'm still working on, on that. So those things were more like to the left, maybe not all the way left, but I like, I feel like I often, it's like, {Participant 1 mutes himself unintentionally, and is inaudible} I wonder how long I was talking and muted right then

Participant 2 (29:54):

just for a second.

Participant 2 (29:58):

Um, okay. So for me, uh, it is like on the far, far left in five, I have ensuring progress toward mathematical goals by making explicit, explicit connections to student approaches and reasoning. Um, and I don't do that a whole lot like talking about the goals and how it connects to like where students, um, how students are doing things. Um, unless like Participant 4 was saying, it somehow is fumbled up into the curriculum. So there are times where like curriculum is like discussing one thing and then all of a sudden throws in something that really isn't going to be discussed until the next year. Um, and so then that point, that's where I'm like, okay, well the way you did this would not help, um, in your progression of school or like, or the way you did this is

going to be really helpful when you do move to this next like TEK or goal or whatever. Um, but I don't really do that a whole lot and I still don't really talk about like the learning progression. Mmm. I like, I recognize like, well, if you don't understand fractions and you won't be able to understand like this, this and this. Um, so I do recognize those things. Um, but I don't really like use them too push how I plan a lesson. Yeah.

Participant 1 (31:20):

It actually reminded me of a couple of things I did want to say. Back to what she was just saying though about like, yeah, if they don't understand fractions, then maybe they can't move on to the next thing. But it's like I can't spend a month and a half teaching fractions. Like I have to move on to the next thing. Um, for the sake of the other 80% of the kids that already understand fractions [inaudible] or whatever the topic might be. But she also reminded me, um just like, there's just not enough time in the year to like talk about all the goals and stuff in my opinion, either like, especially when, at least I think in my case, you know, you have coaches and other people that are, you know, comparing the data from different formative assessments and end of modules and things back and forth. And you're, um, instead then they were like looking at, Oh, here's your most missed question and what is your like, reteach opportunity going to be and what are you going to do with this? So you spend a lot of time planning these like reteaches and things that sometimes are very beneficial, but a lot of it's not, a lot of times, sometimes I feel like maybe the time could have been more well-spent, like doing something like talking about our goal setting or something like that, or not goal setting, but just how the lessons fit into the grand scheme of things. Um, there's just not enough time with all the testing and all this to fit these kinds of lessons in. And so I think if I had more days or if even sometimes I feel, uh, like, woe is me, whatever about, but like I feel like I'm teaching a middle school curriculum on a high school schedule where we have a lot more days of testing, so a lot less days that I have to actually teach lessons. So then there's a lot of pressure to be like, you need to stay on this pacing calendar. Now

you're three days behind or you're five days behind. And it's like, yeah, we just tested five STATE STANDARIZED TESTs last week and middle school didn't have that. or they didn't have midterms or whatever it was. And so sometimes I feel like I just don't have enough time to get to these things even if, um, even though I wish we could. So that's also a factor that builds in that I wanted to mention.

Researcher (33:33):

Yeah, my two year olds right here, just grabbing my arm, but I am listening. Um, I heard a lot about time. I heard curriculum, um, I heard school pressure, um, that impacts you, um, ability to integrate those practices. Are there any other things you can think of that might be keeping you from using some of those practices on the far left?

Participant 2 (34:05):

Um, I mean also just the fact that it's like first year of actually running a classroom and doing the lessons and also having the GRADUATE SCHOOL stuff and like all of that. Um, so it's like I want to set up how I want to teach, but also I don't really have the time or don't really know how to integrate goals and the progression without taking up like 15, 20 minutes of class, um, that we don't have. Um, so, so just figuring out how that pacing is working out and like getting into like my persona of who I am as a teacher, um, has like made a big difference in like why I haven't really looked at the goals and like the stuff that is on the far left. Um, just cause experience.

Participant 4 (34:57):

Yeah. To piggyback off of that and I think actually all of the high school, I don't know. Okay. I thought you were telling me to stop. Um, to piggyback off of that, um, all of the high school fellows were all multi prep, so we all teach at least two classes. So it's a bit of a challenge to do the work of two teachers as one person and be a full time grad student. And on top of that, we're

all also the only teacher for that subject. And so for example, I'm the only AP stats teacher and the uh, the lead algebra two teacher. So I'm doing the work here of two teachers and it feels like this give and take of like if I am going to do a really good thing for stats, it means that maybe my algebra two kids that day might be a little gypped on some kind of inquiry or activity or vice versa. If I'm going to do something really planned out for algebra two that might mean I have to take a step back on my AP stats kiddos and do something a little bit more guided. And so it's just this constant dynamic of like, okay, am I, am I enough for both or do I have to pick which one? And then also for the, we have this big AP for all push. And so predominantly the focus goes to my AP stats kids. However, I only teach two sections of that. Whereas I teach four sections of algebra two so my four sections of algebra two feel a little left out when there's this big push of like, Oh, AP stats is doing this. And, Oh, we have campus visitors that are going to go see AP stats. And so it's uh on top of like that message is shared through admin. So sometimes it just gets a little wonky to focus on that investment for my students.

Participant 1 (36:37):

Yeah. I couldn't agree more with what Participant 4 was just saying. Also, uh, just about deciding like, yeah, which class do you have time? I mean not even deciding. It's like, I feel like honestly the priority for me is my algebra one kiddos because they're all trying to pass the STATE STANDARIZED TEST and my priority just make sure they like my job really is to make sure they all pass this STATE STANDARIZED TEST exam cause they should have already in eighth grade and already a year behind. And so, um, so I'm already struggling to either take a bunch of kids that already are behind in math to do that, but then I get observed a lot during my senior classes. Um, so then I feel like I need to really make these ones really solid. Also. Um, even I get a little bit of a mixed message about how serious of a class that even really is.

Participant 1 (37:25):

Anyway. So yeah, there is this like really tricky balance of like, what do I do and when um on top of everything else. Um, but yeah, I think also contributing to like Participant 2 couldn't be more spot on either, just like not having the experience, it's like one of the ones that I actually had all the way on the left was selecting tasks that allow students to decide which representations to use, um, and making sense of problems. And even though I feel like I do provide lots of opportunities where they could do problems in lots of different ways. Like when I go into the [inaudible] a lesson of the day, usually I'm like looking at a particular method to target and be like, this is what we're really trying to focus on to make sure y'all are, um, capable of doing it this way. And then I, I always do try to link it back to other things, but I don't think that they, unless it's a test, um, like a big test, like the a STATE STANDARIZED TEST benchmark where they have to choose, um, they're not really choosing the method per se.

Participant 1 (38:28):

Um, unless I'm doing like a review, cause I know how, uh, like what I just said out loud made it, I just heard it and I was like, that doesn't sound like they're very ready for the tests either. Um, I feel like I do provide them with more opportunities, but I just don't, like I was saying, there's only a handful of kids in each class that really participate in the discussion. So sometimes it's hard to get them to talk about like why they would choose a different method and then argue that with a different student. Um, so that's why I don't do that as often.

Participant 3 (39:04):

Um, I think I may have forgotten the original question, but, but for me, like time is, has been a big issue. I'm really struggling with the workload. Um, just planning lessons for both classes, doing all the grading, creating exemplars. Like that takes up all my time. I don't really have time to think, even think about like implementing stuff I've learned at GRADUATE SCHOOL, unfortunately. Um, so yeah, so I haven't really had time, um, to think about how to implement

discussions, how to, you know, basically do all the different strategies and things we've learned at at GRADUATE SCHOOL.

Speaker 7 (39:43):

[inaudible]

Researcher (39:47):

you guys have really big jobs, so don't, uh, don't feel bad. You, you will gain experience over time. Mmm. Couple more questions and then we'll move into comparing last year's Q-sort to this year's Q-sort. So I'm curious about if anything has changed. Um, but before we do that, I am curious about, um, whether you have seen your use of some of these practices influence either student learning in a particular way or student behavior in a particular way. So you can comment on either of those or both of those. Um, and I think you would be thinking about practices you use rather than practices you don't use, cause we may not know how that is impacting learning or behavior.

Participant 4 (40:44):

Um, just to make sure I'm on the right path here, we're talking about, um, what we've learned through GRADUATE SCHOOL that has influenced the practices that we use.

Researcher (40:54):

So you would be thinking about the practices themselves. So if you look at some of those that you know for sure you use in your classroom, how do you think those are impacting student learning and or behavior?

Speaker 7 (41:08):

[inaudible]?

Participant 4 (41:28):

So one that I said I do typically use is the making the math visible and the multiple representations, and um, that was just influenced because last year I was in geometry and then this year I'm in algebra two. And so the courses follow each other. And so in my very limited knowledge of teaching, I thought these were two very different subjects and one's more visual and one is much more, um, arithmetic based. But now that I've moved on with the progression, it actually turns out that a lot of algebra makes sense because of its geometry. And so having that, um, sequencing there and being able to tell my students like, no, actually I do know that you learned this last year. So that's been fun. And, um, it, uh, because we can do not just literal equations and actually drawing and making diagrams and pictures that, uh, increases the engagement and also just increases the interest and just, um, getting my students to see how math is not this just solving equations, but rather we use math to quantify or to express very abstract ideas. And so, um, on days where the inquiry is really fun and I teach them how to disprove or prove conspiracy theories using math, they love those days. But on days when I have to talk about like the fundamental theorem of algebra and, end behavior and where it's a little bit more, um, archaic in a sense, it, those are the days where I noticed behavior might be in, I'll lose focus really fast. Uh, my, my students don't feel it's as engaging and so that's when behavior tends to spike up. At tad.

Participant 2 (43:10):

um, for me, I think one of the things that has really like made a difference in my classroom and like affects behavior and things like that is, um, encouraging students to use varied approaches and strategies. Mmm. Because I know that a lot of times with math, it can be very much like, here's how to do this and this is the one way, and if you don't do it, it's wrong. Mmm. And so I like to show different, like whether it's just like a different form of the formula. Cause right now we're in like surface area and volume and it's very just formulaic. Um, but like I, if a kid says like,

well, here's how I found this, and if I see that it's transferable, then I introduce it and say like, do what works for you. Um, because I know that at the end of the day I can push my way down their throats, but if they don't like it or if they don't understand it, they're not gonna do well.

Participant 2 (44:09):

Um, so if drawing a picture is what works for them, then I pushed that. Um, since we're doing surface area right now, I'm like, you need to draw a picture. That's how it's going to make sense to you. So I'm always pushing them to use visuals, um, and then just be doing what works for them. As long as I can see their thinking. Um, and when I, on days where, like Participant 4 was saying, where it's like, if he's like lecturing, so like on days where I'm, uh, where there's like one formula, like circles is kind of just like, here's the formula and solve, those are the days where they get kind of crazy. Um, cause they just, they don't like it. Um, but on days where it's like, here are all the different ways. If you find a different one, that's cool. They're, they're more invested in the work. Hm.

Participant 1 (00:02):

[inaudible]

Researcher (00:09):

any other thoughts on how it impacts learning or behavior, your use of these specific practices?

Participant 1 (00:18):

Um, yeah, I think that the spy or whether they, like I was saying earlier, they don't get, I don't necessarily give them the opportunity to choose all these different ways to represent their own learning. I do, try to present it with a lot of different visual models, uh, of different ways to support their understanding. Mmm.

Participant 1 (00:35):

And yeah, I think that providing them with, um, all the different representations to connect their learning through different subjects and how equations, charts, tables and graphs and Mmm.

Participant 1 (00:53):

You know, are all really the same thing. Um, it was really important for them to understand and see. I think showing them as many different representations cause you never like some of them are going to understand it one way and some of them are going to understand it a different way before they really understand the full picture. Um, and so I think when it all comes together, uh, or like when they all come together in a classroom and, and can

Speaker 3 (01:16):

figure that out, it's really cool.

Researcher (01:24):

Okay. Hey, are you guys ready to look at your Q sort from last year? I'm going to send you yours, Participant 3. Um, and then what we can do is I'll give you some time just to compare. When you compare, I want you to focus on the extremes. So focus on the far right and the far left. Um, cause like I think Participant 1 it was you that mentioned earlier on any given day or any given year, like a lot of the middle probably would switch places. So I want you to, um, take a look at that. I'm going to send you a link. This is a very brief, this is another Google form just so I can capture your independent reflections. And then just to give you an idea of where we are in tonight. Um, there's only two questions that we're really going to discuss when we come back together.

Researcher (02:14):

So, um, let me, let's see here. So you're going to, um, in the Google form, you're going to look at practices that showed up in the far right column for both years. You're going to also look at any

practices, um, that you put in the two far right columns this year that you didn't place there last year, and then you'll do the same thing for the far left. Um, and then you're going to look at what you think has influenced the ones that have shifted to the extremes that weren't there last year. Um, and so that's really that the Google form is gonna have you look at the far right first and the far left. But the questions are, are the same. So once see the first set of questions, you can kind of be thinking about the second set. Um, so let's take, um, you guys want to take about a 10 minute break to do your thing and fill out the form and then come back. That sound good. Okay. So feel free to, um, turn off your camera if that is helpful. We'll come back at 7:55.

Researcher (00:26):

I've got three of them in. Participant 4, how much time do you need? Your good. So my first question, um, I would love to just hear some thoughts about, um, how your Q sort changed from last year to this year so I can see your responses, but your peers can't, so you might just, um, share some things that you noticed when you were comparing last year to this year.

Participant 1 (01:06):

So at the left side of my, Q sort it was really similar to what it was last year. Um, like all four of the ones that I had chose this time were either like in the two already already in those four or like in the column right next to it, pretty much. Um, but the ones that I chose on the right side, none of them were what I chose last year. And they were all kind of, all those ones were kind of like in the middle for me. Um, and they all shifted to the right this time. And I think that was just because, um, you know, more experienced with all the lesson planning. And because of that, being able to make those like in the moment decisions and asking all the like, intentional questions and probing questions and things like that.

Participant 2 (02:07):

For me. Um, so there was one on each side that was the same. Um, but on my left side, uh, well actually on my right side, what I had last year has ended up kind of on the left side, which was interesting to see. Um, but some of this I can see is like last year it was because of, Mmm. Just experience and others were like, because of where I was like at my school and how it was just so data-driven, um, that a lot of that data stuff was further to the right because I had to do it. Um, and this year it's like, it's still like a big thing. Data is still important, but it's not like if you don't do it, you're doing everything wrong. Um, but like the biggest one was the establishing clear goals is still just very much on the left. So that was, and then making mistakes and like welcoming them still very much on the right. Hmm.

Researcher (03:12):

So the one that you, you mentioned some that stayed and you mentioned one that made a huge shift. What was the one that made the huge shift?

Participant 2 (03:21):

Um, so last year I had, um, number one, which these are all over the place, so I don't even remember what what it is, but it was like in column four and this year I've put it in column negative two. Um, and then like 33 it's in the middle 12. It's, I can't even [inaudible] Oh 12 is on the one that stayed the same. Yeah. And then 29 is also a negative two. So like they went from being 29 was five for me and now it's negative too. Um, so it's just interesting seeing like those, those changes.

Researcher (04:07):

Would it be okay, Participant 2? I know that I'm like, you've got papers probably everywhere. Um, could I just follow up with you for an email and get your thinking about why those two in

particular might've shifted a whole bunch. Great. Thank you. Other thoughts about changes between last year and this year?

Participant 4 (04:28):

Um, for me, my number seven actually shifted from the far left to I think a positive one or two onto my current one. And uh, that one just says that asking students to make math drawings or use other visuals, which I don't know why that was on my left side if I taught geometry, whoops. But, um, again, just talking about moving up like up in content with my students. Um, it's just more of a practice now to, uh, Polish up that geometric thinking because I do think we do a lot of emphasis on the algebraic thinking and the model the equation, model the function. But we don't really do a great job at pushing the geometric thinking, which is can we draw a visual? Is there a diagram? Can we do this with shapes or display? And so, especially to now teaching AP stats, um, having that visual I've seen is just super beneficial to students because even though there are multiple approaches, the visual might be what helps bridge that content gap for students and makes it, um, just the connectedness of the content.

Participant 3 (05:37):

I guess for me there, there were a lot of similarities in what I picked this this year and last year there were some big shifts like, uh, with number 16 for example, last year I put that in column five this year I put it in, in column negative two and 16 was introducing forms of representations that can be useful to students. Um, I'm actually not sure why I placed that in five last year. Um, maybe it's cause I really didn't understand it, but, uh, yeah, generally this year and last year were, were pretty similar in there. Like I said, just a few big shifts. 16 was one of them.

Researcher (06:22):

It's really interesting. I wonder too, it might've been what you were teaching during the week that we, you did the Q sort or something that made you think differently. That's, that's, that is very interesting. Mmm. So my last question, if you were to summarize how influences on your practice have changed. There've been a lot of, a lot of this has already come out, but I'd love to hear just one summary. Uh, um, what has influenced change in your practice the most from last year to this year?

Participant 2 (07:01):

For me, um, the biggest change has been different school. Um, I can say that I was like genuinely unhappy where I was, I didn't love the approach to education. I didn't love the like push on the way things had to be. Um, and I feel like I have a lot more freedom here. Um, and I definitely, I'm not as like, but to me I don't see kids as numbers. Um, like out of 40. I it just doesn't work that way. Um, and so I, I very much do focus on like what I can see physically happening in front of me in that moment. So yes, we will spend, um, three days on constant of proportionality when it comes to fractions, if that's what my kids need. Um, and yes, period four is a day behind, but they needed extra practice and they needed a manipulative. And so being a day behind is fine. Mmm. It's just, that has been a really big thing, is not worried so much about where am I on the pacing calendar. But where are my kids?

Participant 4 (08:24):

um, for me it's been the shift in content because last year geometry, uh, well actually geometry in Texas is just not a STATE STANDARIZED TEST tested subject. And so if you're not something where the results are heavier, there's a heavy buy-in to those results, then you kind of get swept under the rug. And so going from a non tested subject to now an AP subject and another STATE STANDARIZED TEST subject, um, there are times where I'm given like, Oh, this is a priority. Or like, Oh, we, uh, I know you were planning on doing this, but you actually need to give this

assessment or, um, Hey, your kids need to take this IA [interim assessment] that is actually not aligned to any of the content you've taught, but we need the data. And so that has, um, there's nothing we can do to change that. It's just the metrics that they've selected and that we have to opt into. But, uh, personally it's not my practice to collect data for the sake of having it and not to use it to benefit your students in your teaching practices.

Participant 1 (09:34):

Yeah, I think, um, I'd say the biggest change for me from last year to this year, um, and my teaching practice is, comes from, yeah, I mean the change in content and change in school definitely is a lot. But, um, just having, just even this little bit more experience from like last semester, coming up into now, almost even just this whole first year, um, just the efficiency, like how much time I spent lesson planning at the beginning of the year. Um, or like choosing lesson materials really to like what I can actually focus on now in my lesson planning and future planning and stuff like that has changed a lot. Um, just I could just gotten a lot more efficient and gotten a lot more, um, effective and I think more fun lessons too. So, uh, yeah, just the experience and um, trying to like, not to stress about every single little last sale, like our school leader always says, when you make everything important, then nothing is important. Um, and so yeah, I try to focus on a few things. Um, and generally I'll try to focus on some of my weaknesses to improve those once, once I have a handle on those, I guess I can choose a few other ones. But I don't know they kind of circle background, not always.

Participant 3 (11:05):

I think for me the biggest influence in how I teach stats has been that stats medic website, um, that I mentioned. And I went to a workshop also, um, led by that teacher. So I think that has had the biggest influence on how I teach stats.

Speaker 3 (11:21):

Okay.

Participant 4 (11:25):

Awesome. Thank you guys. I'm going to go ahead and stop recording.

Appendix J

Questionnaire Responses

Timestamp	4/13/2019 13:26:32	3/5/2020 18:53:21
Name	Participant 1	Participant 1
School	School A	School B
Grade Level/Course	9th Grade Algebra I	9th Grade Algebra I
Which of the teaching actions were easiest to place on the Q-grid? Why?	16, 12, 9, 11 - These are things that we do every day.	None because I like to think I do all of these at least a little bit. The ones that were easier to place were I guess the things that I do every day.
Which of the teaching actions were hardest to place on the Q-grid? Why?	Many of the goal setting ones were hard for me to place, like; 2 , 21, because even though we do set goals throughout the year, we do not talk about it much in terms of actual goal setting.	The middle section was hardest to place because depending on how I'm feeling that day I feel like it could flip flop entirely.
Please share your rationale for the placement of the teaching actions in the 4 and 5 columns.	(27, 28, 16, 37) Many of these go hand in hand. 3 of the 4 are all related to students explaining their thinking in the classroom, and using that thinking to come to new conclusions. The fourth action talks about introducing these representations that students may use.	I think that I make lots of in the moment decisions based on what I am seeing in each class period. These decisions are based on what evidence I am gathering from the students work. Depending on what I am seeing, I will ask specific questions to push student thinking or help make the math more visual.
What experiences this year influenced your use of the teaching actions that you placed in the 4 and 5 columns?	Interacting with students and learning from my RA.	I feel like even when planning months in advance, plans can easily change from day to day. However, having things planned out definitely helps with these in the moment or daily shifts and decisions.
Please share your rationale for the placement of the teaching actions in the -4 and -5 columns.	We do not talk to much about goal planning and setting with our students as much as we should.	I do not spend as much time as I should talking to the students about learning goals and how all of the different units are related and where we are on the entire spectrum.
What experiences do you think you need for the teaching actions you placed in the -4 and -5 column to become more characteristic of your teaching?	Even though we may set goals for our students. We need to talk about these goals and let them be part of the goal setting process.	I often have to switch up planned lessons to incorporate essential or nonessential reteaches that are required for coaches or other administrators and do not feel I have enough time to progress through the unit and talk about all of the things that I would in an ideal world or ideal classroom.

Timestamp	4/13/2019 13:30:01	3/5/2020 19:08:53
Name	Participant 2	Participant 2
School	School C	School D
Grade Level/Course	6th	7th
Which of the teaching actions were easiest to place on the Q-grid? Why?	Praising students for their efforts in making sense of mathematical ideas and perseverance in reasoning through problems. This was easiest because I know that I am consistently congratulating my students for mastering the lesson that day. I leave little notes on exit tickets and remind kids that they shouldn't second guess themselves because they clearly understand. I call all my students superstars and just make sure they feel supported in my class.	Assuring kids that mistakes lead to better students and using their thinking and work to differentiate lessons.
Which of the teaching actions were hardest to place on the Q-grid? Why?	Posing tasks on a regular basis that require a high level of cognitive demand. I like the believe that I am consistently giving kids work that I know will make them think further than just meeting the goal for that day, but I also know that there are days where I just follow the curriculum to have something for them to do. It's a consistent battle trying to make class interesting, making kids think, and having all the time to actually do it.	Using goals during the lesson and also anything about visuals or questioning.
Please share your rationale for the placement of the teaching actions in the 4 and 5 columns.	I know that I work hard to make kids feel welcomed and know what the end goal is for that lesson so I know that when I need to change something because it isn't working out. I also know that I try my best to make sure kids are involved in a purposeful class and not just copying everything I write, word for word.	I know that I like to see struggle in my classroom and I like to push them to really think before they give up. I like to use my students work to guide where I go next and I want my students to know that they are welcome to make mistakes because it's how we learn.
What experiences this year influenced your use of the teaching actions that you placed in the 4 and 5 columns?	One of my biggest reasons is knowing that the way my RA teaches is not my style. I like to make sure kids feel inspired and walk away from class, not only having learned the standard for that day, but also knowing that I pushed them deeper and brought joy into the class.	I have noticed that a lot of my students like to give up when things are difficult or ask for a hint that will take away the struggle. They're afraid to get something wrong and feel bad about it, but I want them to think the opposite. I love wrong answers because they aren't the only ones who have them and I also want them to know that their mistakes help them avoid them in the future.

Please share your rationale for the placement of the teaching actions in the -4 and -5 columns.	I placed the teaching actions in did in -4 and -5 because I am still struggling with getting past the idea that kids need to learn the procedures. I know that I need to work on connecting the lesson that day to their mathematical goals in general. I also know that I need to find more ways to invest kids, regardless of their background.	I don't really focus a lot on the end goals. I like to focus on the present and see where my kids are. Typically, the end goal is passing the test. I want to focus on the understanding of that day and not what the STATE STANDARIZED TEST is going to ask.
What experiences do you think you need for the teaching actions you placed in the -4 and -5 column to become more characteristic of your teaching?	I need to find a way to connect what I already know to the deeper meanings and finding ways to show kids math can be fun and purposeful, without worrying too much about the data. It involves more research and more work in digging deeper.	I need to see less focus on the administration side on the "goals" because I know that's what is pushed on kids from day 1. I also want to see a better way to integrate goals without it being related to the tests and data.

Timestamp	4/13/2019 13:28:50	3/5/2020 18:32:40
Name	Participant 3	Participant 3
School	School E	School E
Grade Level/Course	Algebra II, AP Statistics	AP Statistics
Which of the teaching actions were easiest to place on the Q-grid? Why?	13 (allowing sufficient wait time), because I normally wait several seconds after asking the class a question before taking student responses	I think #5 ("Facilitating discourse among students...") was the easiest to place, because we rarely have discussions in my classes.
Which of the teaching actions were hardest to place on the Q-grid? Why?	3 (selecting a sequencing student approaches), because I've never had a discussion of this type in my classroom.	I think that #21 ("Identifying how the goals fit...") was the hardest to place, because I'm not sure I completely understood this teaching action.
Please share your rationale for the placement of the teaching actions in the 4 and 5 columns.	I tried to place actions that I take most often in the 4 and 5 columns (praising students for their efforts, establishing clear goals, introducing forms useful to students).	I placed the actions I use most frequently in the 4 and 5 columns. I usually allow sufficient wait time after asking students a question, many of the tasks in AP Statistics require a high level of cognitive demand, etc.
What experiences this year influenced your use of the teaching actions that you placed in the 4 and 5 columns?	Teaching/observing in my RA's classroom	I think my experiences interacting with students in AP Stats influenced these decisions; for example, I often have to make in-the-moment decisions on how to respond to student questions effectively in AP Stats.
Please share your rationale for the placement of the teaching actions in the -4 and -5 columns.	These actions had to do with leading mathematical discussions in the classroom (I haven't done this much yet).	I place the actions that I perform very infrequently in the -4 and -5 columns. For example, we rarely have class discussions in my classes, so I placed #5 ("Facilitating discourse among students...") in the -4 column.
What experiences do you think you need for the teaching actions you placed in the -4 and -5 column to become more characteristic of your teaching?	I think I need to have more of the discussions of the type we've been learning about in my classroom.	I need more experience (and perhaps real-time coaching) with leading in-class discussions.

Timestamp	4/13/2019 13:25:31	3/5/2020 18:28:35
Name	Participant 4	Participant 4
School	School A	School B
Grade Level/Course	Geometry	Algebra II, AP Statistics
Which of the teaching actions were easiest to place on the Q-grid? Why?	12. Praising students for their efforts. As a person, I operate on positivity and I believe this can change students' attitudes towards math. Especially when they take a risk, it's a great opportunity to praise them as mathematicians.	Actions that included praise, in the moment decisions for students, misconceptions and scaffolding came easiest to me because these are immediate, short-run decisions with long-run impacts. These are not necessarily improvised, however they can be adjusted accordingly per class and consequently per student.
Which of the teaching actions were hardest to place on the Q-grid? Why?	Sufficient wait time. This is a skill that I am working on everyday, however I just feel like there is never enough time to address all the needs of my students and utilize the GRADUATE SCHOOL practices I am given. I have gotten better at doing so, however there is always room for improvement.	Actions that required overview steps or the "zoom out." Thinking of actions that play into the larger role of our students math journey and whole group discussion that is intentional as opposed to just making sure it is happening.
Please share your rationale for the placement of the teaching actions in the 4 and 5 columns.	These were practices that without a doubt I know that I am consistently executing regardless of the lesson. These are actions I have self-identified as core strengths of my teaching persona.	Misconceptions, in the moment decisions, and focusing on multiple representations come into play for every single lesson whether it is a guided practice or inquiry. For me, these come much more natural and my students enjoy that not every day in class looks the exact same as the day before.
What experiences this year influenced your use of the teaching actions that you placed in the 4 and 5 columns?	These were practices that I was utilizing back in my graduate level teaching at my previous institution. These were characteristics that I already had been actively working on before my time at GRADUATE SCHOOL.	I get to plan the course as opposed to working alongside someone who may not have the same background/views as I did. Similarly, getting to apply the course work from GRADUATE SCHOOL to practice as opposed to just "in theory" now that I am responsible for students.
Please share your rationale for the placement of the teaching actions in the -4 and -5 columns.	These are actions that I am aware of, however I have not been intentional about utilizing. I would like to include them into my classroom culture for my second year of my fellowship, however, at this point, as I am operating on my RA's established culture, it may be too late to implement these practices without straining my students.	Engagement through discussion is still something that I am working on. I believe it is more of a matter of not enough practice or flow to this in the routine as opposed to not having the confidence to do it. Similarly, sometimes I let methods linger and try to avoid "short cut" or efficient mathematics if the methods presented by peers make sense to my students.

What experiences do you think you need for the teaching actions you placed in the -4 and -5 column to become more characteristic of your teaching?	I need to make a growth plan with myself and my RA to see what I did this year that would indicate I used these practices and what I can start next year with ensuring that these practices are an established part of the routine. I also want to hold myself accountable by placing these action steps into my lesson plans or reviewing my lessons and looking for explicit examples of when I am utilizing a strength and when I am being intentional about addressing an area for growth.	Engagement techniques that are efficient with time and do hold students accountable outside of participation only if I am within close proximity.

Timestamp	3/5/2020 19:49:02	3/5/2020 19:50:35	3/5/2020 19:54:15	3/5/2020 19:57:28
What is your name?	Participant 1	Participant 2	Participant 3	Participant 4
What practices are in the far right columns for both years? (You can type the number of the practice.)	None	Praising students for their efforts in making sense of mathematical ideas and perseverance in reasoning through problems.	13	19
What practices did you sort into the two far right columns this year that were not placed there last year? (You can type the number of the practice.)	1, 18, 22, 30	30, 9, 8	18, 29, 34	14
What factors do you think have influenced your increased prioritization of those practices?	More planning and even more in the moment changes and intentional questions.	I have noticed that struggle is important because that's when students make the mistakes that can really teach them where they went wrong and what we can do to grow from there. I also use student data and experiences to plan for the next day/minutes.	I think that since I'm lead-teaching this year, I've had to make more in-the-moment decisions; that's why I placed #29 in the far right columns. I also think that many of the tasks in AP Statistics require a high level of cognitive demand; that's why I placed #34 in the far right columns.	Thinking about the misconceptions has always been a part of my practice so this is a priority for me regardless. For the left end, #14 is the same because I am not great at looking at the larger picture in students' mathematical journey.
What practices are in the far left columns for both years? (You can type the number of the practice.)	21 and 25	21	5, 23	14
5. What practices did you sort into the two far left columns this year that were not placed there last year?	5 and 23	2, 14, 25	17, 33	17, 33, 37
6. What factors do you think have influenced your decreased prioritization of those practices?	Time more than anything, but also school culture.	I think the biggest factor is the change in school. My last school really pushed data and making the mathematical goals evident. I don't feel that pressure anymore.	I'm not sure exactly. I think that I've had a lot less time this year to prepare for lessons and think deeply about my teaching practices; as a result, I haven't been able to do many things, like	Changing content and new school location.

			identifying what counts as evidence of student progress and engaging students in sharing of ideas, approaches, etc.	
Please record anything else you notice and would like to comment on as you reflect.				