# NARROWING THE GAP: THE MEDIATED FIELD EXPERIENCE AS A PEDAGOGY TO IDENTIFY AND BUILD COHERENCE BETWEEN MATHEMATICS METHODS COURSEWORK AND FIELD EXPERIENCE

by

Sister Cecilia Anne Wanner, O.P.

A Dissertation Submitted in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Philosophy in Mathematics and Science Education

Middle Tennessee State University
August 2021

Dissertation Committee:

Dr. Alyson E. Lischka, Chair

Dr. Sarah K. Bleiler-Baxter

Dr. Angela G. Hooser

Dr. D. Christopher Stephens

Dr. Jeremy Winters

ACKNOWLEDGEMENTS

I am grateful to Mother Anna Grace Neenan, O.P. and Mother Ann Marie Karlovic, O.P., for extending to me the opportunity to study at Middle Tennessee State University. I would like to express my deep gratitude toward all of my sisters in our Congregation of the Dominican Sisters of St. Cecilia for their ongoing support and love. I would like to especially thank Sister Catherine Marie Hopkins, O.P., and the sisters at St. Rose of Lima Convent, Murfreesboro, who so conscientiously and graciously embraced me within community during my doctoral studies.

I would also like to express my gratitude to Dr. Alyson Lischka who has been generous with her time and expertise, offering invaluable advice, continuous encouragement, and unwavering guidance. I extend my sincere thanks to Dr. Sarah Bleiler-Baxter for her treasured friendship and support, which has been highly influential in my formation as an academic scholar. I would like to also thank the faculty and staff of Middle Tennessee State University, particularly those in the Math and Science Education program, the College of Basic and Applied Sciences, and the College of Education, whose collaboration, guidance, and friendship have meant so much to me during the course of my studies.

Thank you to Sister Mary Elizabeth Sallese, O.P. for graciously allowing me access to needed school resources for this study. It is with immense gratitude that I acknowledge my colleagues at Aquinas College, with whom I share the joy of providing for the formation of educators who are sent forth to teach, preach, and witness to Truth and Charity for the salvation of souls and the transformation of culture.

May God Almighty bless this work and use it for His greater honor and glory.

ABSTRACT

Preservice teachers (PSTs) in teacher education programs frequently experience a disconnect between coursework and fieldwork, often referred to as the theory-practice gap. This study considered the mediated field experience (MFE) as a pedagogy that may help to bridge this divide in mathematics education by encouraging the creation of a hybrid space in which PSTs, cooperating teachers, and teacher educators collaborate to strategically build coherence between knowledge gained from coursework and knowledge acquired from authentic field experiences. PSTs' reflections, both in the context of a chronological progression over the course of multiple cycles of MFEs as well as corresponding to the various elements of the MFE, were explored to provide a deeper understanding of the effect of MFEs on PSTs.

This study addressed the following research questions:

1. How, if at all, does the focus of PSTs' reflections evolve over the course of their participation in multiple cycles of MFEs?
2. How, if at all, does the content of PSTs' reflections differ amongst each individual element of the MFE?
3. As PSTs participate in multiple cycles of MFEs, how do characteristics of coherence between theoretical concepts and authentic classroom experiences reveal instances of PST entry into hybrid space?

This qualitative case study analyzed the written and oral reflections of two PSTs who participated in six cycles of MFEs over the course of nine weeks while enrolled in a mathematics methods course. These reflections were considered both as they relate to the MFEs as a whole and as they relate to each individual element of the MFE. The construct of two Mathematics Teaching Practices (NCTM, 2014) provided a structure for analysis. The study employed an analytical framework building upon Wood and Turner's (2015) application of Lampert's (2001) three-pronged model of teaching practice, in the context of a mathematics methods course in a teacher education program.

The findings of this study revealed that PST reflections evolved over the course of the PSTs' participation in multiple cycles of MFEs, shifting from a focus on the teacher and the content of their college coursework toward an intensified focus on the students and the mathematical content. Findings also showed that the content of PSTs' reflections differed amongst the various elements of the MFE. Finally, the findings of this study identified and described instances of PST entry into hybrid space in terms of characteristics of coherence between PST engagement in both the theoretical principles learned through coursework and the authentic classroom setting, as identified through PST reflections.

The results of this study indicate that the PSTs did, in fact, enter into hybrid space at various points, simultaneously engaging in both the theoretical principles learned through coursework and the realities of the actual classroom setting. The hybrid space, which is hypothesized as the "place" wherein coherence resides, consequently had the potential to diminish the theory-practice gap.

## TABLE OF CONTENTS

## List of Tables

## List of Figures

# CHAPTER I: INTRODUCTION

In *Standards for Preparing Teachers of Mathematics*, the Association of Mathematics Teacher Educators (AMTE; 2017) charged those involved in the preparation of mathematics teachers to "be committed to improving their effectiveness in preparing future teachers of mathematics" (p. 2). This is a fitting charge, as the preparation of future teachers of mathematics, particularly at the K-8 level, is currently often inadequate (National Research Council, 2010). This inadequacy is due, at least in part, to a certain disconnect that has been recognized as frequently existing between coursework and field experiences (Grossman, Hammerness, & McDonald, 2009).

The present study addresses this problem by examining how one particular pedagogy, that of the mediated field experience (MFE), impacts the coherence that elementary preservice teachers (PSTs) perceive between coursework and field experience in a mathematics methods course.

In this chapter, I provide an introduction to the need for and purpose of this study. I begin by acknowledging some problematic aspects of the current state of teacher education. I then state the need to address some of these problems, highlighting particular gaps that are present in the current body of research. I provide rationale for the importance of this study within a theoretical perspective situated within integrity, and I identify some specific contributions that this study offers the field of teacher education. Finally, in order to provide clarity and consistency throughout this study, I define the terminology that is central to this research.

**A Problem in Teacher Education**

The field of education in general, and mathematics education in particular, lacks sufficient research on the preparation of quality teachers. Thirty years ago, Grant and Secada (1990) called for an increase in teacher education research, stating that the field was in need of "more information about the scope of effective educational practice and the combinations of practice that result in optimal outcomes" (p. 413). Although scholars continue to make valuable contributions to the field of teacher education, we still "lack empirical evidence of what works in preparing teachers for an outcome-based education system. We don't know what, where, how, or when teacher education is most effective" (Levine, 2006, p. 18). Yet, the expectations we have of teachers continue to rise. This is particularly true for teachers of mathematics, as standards for student achievement in mathematics are continually advanced (e.g., AMTE, 2017; National Council of Teachers of Mathematics [NCTM], 2000, 2014; National Governors Association Center for Best Practices & Council of Chief State School Officers [NGA/CCSSO], 2010; National Research Council, 2002).

According to the National Research Council (2010), "many, perhaps most, K-8 mathematics teachers are not adequately prepared, either because they have not received enough mathematics and pedagogical preparation or because they have not received the right sort of preparation" (pp. 122-123). This may be due, in part, to the gap between learning about theory in coursework and the actual implementation of practice in field experiences.

Darling-Hammond (2006a), recognizing the disconnect between coursework and clinical experiences, called for a renewed focus on fostering coherence in teacher education. She recognized this process as including the incorporation of "newly emerging pedagogies . . . that link theory and practice in ways that theorize practice and make formal learning practical" (p. 307). Although attempts continue to be made to narrow the theory-practice gap, much work remains in this area.

## Statement of Purpose and Research Questions

In the National Council for Accreditation of Teacher Education's (NCATE) 2010 Report, the Blue Ribbon Panel on Clinical Preparation and Partnerships for Improved Student Learning called for teacher education in the U.S. to be "turned upside down," moving toward "programs that are fully grounded in clinical practice and interwoven with academic content and professional courses" (p. ii). The National Research Council (2010) included clinical preparation (i.e., field experience) as one of three aspects of teacher education that is likely to produce positive outcomes for K-12 students. However, field experiences in teacher preparation programs are often not used to their full potential, lacking both clear objectives and purposeful connection to university coursework (Darling-Hammond, 2010; Guyton & McIntyre, 1990).

The American Association of Colleges for Teacher Education's (2018) report noted that since the publication of the Blue Ribbon Panel report (NCATE, 2010), many teacher preparation programs have haphazardly attempted reform, seeking to increase PSTs' immersion in clinical experiences. Although research has shown the importance of coherence between the coursework and field experience of PSTs (Francis, Olson, Weinberg, & Stearns-Pfeiffer, 2018; Grossman, Hammerness, McDonald, & Ronfeldt, 2008), oftentimes PSTs do not receive opportunities to make needed connections between the theory learned in class and the experience gained in the field (Feiman-Nemser, 2001).

Instead, PSTs often experience coursework and field placements as "inconsistent and uncoordinated," resulting in a culminating effect that resembles "a series of disjointed silos" (Weston & Henderson, 2015, p. 324).

This gap between theory and practice has been recognized as problematic since the early twentieth century (Vick, 2006). In order to address this divide between theory and practice, definitions for these terms must first be made clear. For the purposes of this study, *theory* is defined as the broad systematic conception of principles related to concepts and skills that PSTs learn in the coursework of their teacher preparation program. *Practice* refers to the instruction, activities, and pedagogy that occur under the guidance of a teacher in an authentic K-12 classroom setting. Using the terms in this sense allows for this theory-practice gap to be interconnected with Zeichner's (2010) recognition of the lack of coherency between coursework and fieldwork. Traditional teacher preparation programs may provide sufficient coursework, but these courses and the clinical field experience attached to them may provide incohesive experiences for PSTs (Grossman, Hammerness, & McDonald, 2009; McDonald, Kazemi, & Kavanagh, 2013).

Recognizing the need for PSTs to experience authentic classrooms in the K-12 setting, the American Association of Colleges for Teacher Education's (2018) report called for teacher education programs to reconsider and emphasize the role of field experience in their preparation of PSTs. With this increased emphasis on the centrality of clinical experiences, the question of how to integrate these placements with what is being taught in coursework becomes even more central. Although research has attempted to address the lack of coherency between coursework and field experiences (e.g., Canrinus, Bergem, Klette, & Hammerness, 2017; Canrinus, Klette, & Hammerness, 2019; Grossman et al., 2008; Weston, 2019; Weston & Henderson, 2015), much work remains to be done.

This need to address the problems posed by the theory-practice gap extends to the field of mathematics education. Mathematics education policy documents, including *The Mathematical Education of Teachers [MET] II* (Conference Board of the Mathematical Sciences, 2012) and the *Standards for Preparing Teachers of Mathematics* (AMTE, 2017), have highlighted the need for PSTs to experience quality field placements that are embedded within coursework, bridging the gap between what is learned in university courses and what is experienced in the field. Clift and Brady (2005), in their review of research on methods courses, found that in the area of mathematics, a level of coherence between the methods course and field experiences is more likely to result in PSTs' enactment of desirable teaching practices due to the supportive environment created by this coherence. However, Clift and Brady acknowledged that research in how this coherence is actually achieved was lacking.

Mathematics methods courses often provide the context through which PSTs can learn about instructional strategies and overarching principles that are necessary to effectively teach mathematics in the K-12 classroom setting (Grossman, Hammerness, & McDonald, 2009). In an attempt to counteract the gap between theory and practice, policy documents such as the *Standards for Preparing Teachers of Mathematics* (AMTE, 2017) have specified that in mathematics methods courses, PSTs should not only discuss and engage in high-level tasks and activities, but also learn how to implement these instructional routines in a K-12 classroom setting. PSTs develop the ability to enact solid mathematics teaching practices by their participation in coursework that "complements and aligns with field experiences" (AACTE, 2018, p. 14).

Campbell (2012), in her study involving pedagogy used in a secondary mathematics methods course, concluded that increased attention to the activities and structure of field experience could help to address the gap between theory and practice. However, little is known about what elements make field experiences effective (National Research Council, 2010); there is a need to "expand the knowledge base to identify what works and support continuous improvement" (NCATE, 2010, p. iv).

Weston and Henderson (2015) contended that the missing paradigm in teacher education is the presence of coherent experiences, which they define as "experiences that build upon each other toward a consistent end and are intentional, continuous, unified, and clear" (p. 322). Specifically, Weston and Henderson pointed to a lack of coherence between PSTs' coursework and field placements.

Although the importance of coherence in teacher education is increasingly emphasized (Canrinus et al., 2019; Weston, 2019), researchers have not yet given much attention to how coherence between coursework and field experiences can be achieved. Grossman and colleagues (2008) noted,

> In particular, although discussions of reform in teacher preparation often center on coherence as a means to bridge the gap between fieldwork and clinical work, research on coherence has not yet examined the particular characteristics of field placements and coursework that support coherence. (p. 275)

This challenge is present internationally; Canrinus et al. (2017), after conducting a study of survey data from student teachers in five different countries, concluded that there is a need for coursework and field experiences to be more closely integrated.

Some researchers have turned to the theory of hybrid space to better understand the structures that connect the worlds of theory and practice (Flessner, 2014; Wood & Turner, 2015). Hybrid space, also referred to as third space, provides a fluid framework that illustrates the integration of two contexts, which may at times seem opposed to one another, into a new unified space (Flessner, 2008; Soja, 1996). In the current study, I explore this hybrid space and its role in the building of coherence in the setting of a mathematics methods course.

One pedagogy that may help to bridge the theory-practice gap is the mediated field experience (MFE). This pedagogy, often situated within third space (Horn & Campbell, 2015), seeks to mediate the experiences of PSTs within their methods course and their field experience through the creation of a *shared text* by which PSTs, K-12 cooperating teachers, and mathematics teacher educators partner together in an authentic K-12 classroom setting (Horn & Campbell, 2015). Primary elements of the MFE include planning, observation and/or microteaching, and a debrief session (Campbell, 2012). Although the research base on MFEs is growing, studies have not yet explored the individual elements of the MFE and how these might contribute to aspects of the preparation of PSTs (Swartz, Billings, et al., 2018).

Using the pedagogy of an MFE, scholars seek to reconceptualize the theory-practice gap by creating a hybrid space in which PSTs, cooperating teachers, and teacher educators collaborate to strategically integrate knowledge gained from coursework with knowledge acquired from field experiences (Horn & Campbell, 2015). Wood and Turner (2015) studied the contributions of the cooperating teacher to PSTs' learning experience in a model of hybrid space, and Williams (2014) considered the opportunities and challenges to the teacher educator when working in a hybrid space with PSTs and cooperating teachers. Williams put forth a call for further research on how similar hybrid space experiences affect others involved, such as the PST.

When considering the hybrid space that may be formed by the integration of the coursework and field experiences of a PST, it is helpful to have a specific construct that bridges both of these settings. This construct may be in the form of particular principles or strategies that are studied in a teacher education program. The National Council of Teachers of Mathematics' (2014) publication *Principles to Actions: Ensuring Mathematical Success for All* introduced eight Mathematics Teaching Practices that provide a research-based framework of student-centered core teaching practices. These eight practices, aimed at strengthening the teaching and learning of mathematics in the classroom, have been endorsed as an example of a foundational set of teaching practices that have been proven effective (AMTE, 2017). Although teacher preparation coursework may introduce these Mathematics Teaching Practices to PSTs, exposure to and discussion of the Mathematics Teaching Practices do not necessarily translate to effective implementation of these practices in an actual classroom setting. A disconnect may exist between coursework and the field, prohibiting the formation of a hybrid space and detracting from coherence with regards to the theoretical aspect of the Mathematics Teaching Practices and their related practical application.

This study aimed to identify and describe structures and activities that support a deeper synthesis of theory and practice by more coherently connecting PSTs' perceptions of Mathematics Teaching Practices as discussed in coursework to their encounters with Mathematics Teaching Practices experienced in the field. PSTs' reflections, both in the context of a chronological progression over the course of multiple cycles of MFEs as well as corresponding to the various elements of the MFE, were explored to provide a deeper understanding of the nature of these considerations of the PST. PSTs' perceptions of this coherence were themselves analyzed to determine the efficacy of the MFE as a pedagogy that is supportive of connecting theory and practice in methods courses that are included in traditional university-based teacher education programs. Finally, the hybrid space entered into by PSTs was examined as a potential space wherein coherence between coursework and fieldwork is found and the theory-practice gap is reconceptualized and narrowed.

This study addressed the following research questions:

1. How, if at all, does the focus of PSTs' reflections evolve over the course of their participation in multiple cycles of MFEs?
2. How, if at all, does the content of PSTs' reflections differ amongst each individual element of the MFE?
3. As PSTs participate in multiple cycles of MFEs, how do characteristics of coherence between theoretical concepts and authentic classroom experiences reveal instances of PST entry into hybrid space?

# Theoretical Perspective

The challenge involved in establishing coherency between coursework and fieldwork in the preparation of PSTs is well recognized in the field of mathematics teacher education (Østergaard, 2013). Addressing this challenge, I have used the concept of *integrity* to situate the overarching rationale for the importance of this study. In the following section, I first clarify the definition of integrity that I choose to use. I then discuss elements of the conceptualization of the human person that manifest why a study of this nature, namely a study that examines coherence of theory and practice, is important. Finally, I relate this more broadly to its implication on learning how to teach, building a basis for the centrality of a foundational integrity in a teacher education program that seeks to achieve a high level of coherence between the theory imparted to PSTs in coursework and the practical applications experienced in the field.

## The Definition of Integrity

The term *integrity* has been characterized in a variety of ways. Rendtorff (2015) defined integrity as referring to "the wholeness, totality, and unity of the human person" (p. 1), and went on to clarify that "[i]ntegrity has mostly been understood as coherence or completeness" (p. 7). Dudzinski (2004), likewise acknowledging distinct yet interrelated dimensions of integrity, listed the first sense of integrity as "the quality or state of being complete" (p. 300). Dudzinski gave the analogy of a bridge to assist in the understanding of this sense of integrity, explaining how a bridge has integrity when its intention, design, and function are unified, with each component of the bridge contributing substantially and essentially to the coherent concept of a bridge. It is this sense of integrity, as a state of unity, wholeness, and coherence, to which I refer in the use of this term.

## Integrity of the Human Person

As Maritain (1962) noted, “Every theory of education is based on a conception of life and, consequently, is associated necessarily with a system of philosophy” (p. 39). The subject of education is the human person, and thus in order to determine the proper end of education, we must first consider the nature of the human person (Maritain, 1943).

The human person possesses a basic psychosomatic unity (Maritain, 1962), consisting of the integration of both a corporeal and a spiritual dimension (Rendtorff, 2015), the body and the soul. As such, the human person is not merely a body (materialism) nor only a soul (idealism), nor even a body with the addition of a soul (dualism) (Cuypers, 2004). Rather, the human person is composed of a material body and a spiritual soul that are perfectly integrated in one composite human being (Elias, 1999), thus possessing an intrinsic integrity.

Due to the sense of integrity that is inherent in the very being of every human person, each person naturally strives toward a wholeness, an ordering of all of the facets of his or her life, in which all elements cohere (Cottingham, 2010; Pianalto, 2012). This natural desire for unity extends to the learning and application of various principles and theories; what one learns about in a generalized abstract sense must be unified with what one experiences in a particular concrete setting.

## Integrity in Teacher Preparation

A teacher education program that values the importance of integrity makes it a priority to assist PSTs in the integration of the many components of effective teaching. Maritain (1943) wrote that “education and teaching should never lose sight of the organic unity of the task to be performed, and of the essential need and aspiration of the mind to be freed in unity" (p. 47). In this way, a program that itself possesses integrity can likewise contribute to the personal integrity of the individual person. As such, teacher preparation programs have a responsibility to promote coherence between the various aspects of teaching, in order to contribute to the integrity of each individual future teacher, who will then be tasked with guiding his or her own students toward greater personal integrity.

The importance of having an integrated, coherent unity is reflected in the design of current policy and standards. For example, the Council for the Accreditation of Educator Preparation (CAEP, 2018) *K-6 Elementary Teacher Preparation Standards* boast of substantial differences from past standards in that the recent standards are "conceived and expressed in more *integrated* and *holistic terms* [emphasis added] designed to better reflect the complex and organic practice of K-6 teaching and learning" (p. 141), and that "there is a high degree of intentional integration across standards" (p. 143). CAEP's reference to the degree of integration is consistent with the general concept of integrity, as the unity and wholeness of integrity is not an all-or-nothing concept, but rather can be possessed in varying degrees (Pianalto, 2012).

Cottingham (2010) suggested that one means by which one can better understand the importance of integrity is by studying the opposite of integrity, namely fragmentation or compartmentalization. Grossman, Hammerness, and McDonald (2009) pointed out that an emphasis on theoretical aspects of teaching can lead to too little attention to the more practical work of teaching. Similarly, although studies have shown that PSTs sometimes privilege practice over theory (Allen, 2009), an overemphasis on practice to the exclusion of any theoretical foundations has shown to be detrimental to teacher formation

(Østergaard, 2013). Rather than deconstructing teacher preparation into the demarcated elements of theory and practice, a conception of an integrated *wholeness* must mark teacher education, "a wholeness which reconciles the theoretical with the practical" (Carr, Haldane, McLaughlin, & Pring, 1995, p. 170). Research confirms the importance of this integration of practical application with theory (e.g., Allen & Wright, 2014; Ball & Cohen, 1999; Grossman, Hammerness, & McDonald, 2009; Johnson & Barnes, 2018; Korthagen & Kessels, 1999; McDonald et al., 2014).

Recognizing the value of promoting the integrity of PSTs as individual human persons, this study sought to deepen our understanding of how the MFE can be used as a means to promote integrity in teacher education programs, and particularly in the context of a mathematics methods course. This quality of integrity is characterized by the prerequisite of unity and coherence (Dudzinski, 2004) that counteracts the fragmentation (Cottingham, 2010) that is both the cause and the result of the theory-practice gap that is so prevalently experienced in teacher education (Darling-Hammond, 2008).

## Significance of the Study

This study contributed to the field of teacher education in a number of ways. First and foremost, the study added to research on how the pedagogical structure of the MFE serves to address the theory-practice gap that is currently dominant in traditional teacher preparation programs. This responded to the call from NCATE (2010) and from the National Research Council (2010) by identifying structural elements of a pedagogy that contribute to the effectiveness of field experiences. It also addressed AMTE's (2017) goal of providing PSTs with quality field experiences that are more solidly embedded within coursework. In this way, this study added to the research on traditional university-based teacher education by identifying and describing a means that potentially supports a deeper synthesis of theory, as learned in the classroom, and practice, as experienced in the field.

More specifically, this study added to the research associated with PSTs' perceptions of the integration of theory and practice. Scholars have pointed out a general lack of empirical research that is associated with the perceptions PSTs have of their journey through teacher preparation (Cochran-Smith, 2005). The present study increased what is known about PSTs' perceptions regarding the coherence sensed between a mathematics methods course and corresponding field experience.

Another major contribution provided by this study is the identification of "particular characteristics of field placements and coursework that support coherence," a need expressed by Grossman and colleagues (2008, p. 275). As noted above, previous research has time and again noted the lack of coherency between coursework and fieldwork in teacher education programs (e.g., Feiman-Nemser, 2001; McDonald, Kazemi, & Kavanagh, 2013; Weston & Henderson, 2015), yet little research has been conducted on how this coherence can be increased. This study provided insights on how concrete structural elements of one pedagogy, the MFE, contribute to the achievement of coherence between perceptions of Mathematics Teaching Practices as learned in coursework and as observed and enacted in the field.

This study added to the understanding of hybrid space in two ways. First, I examined a potential connection between hybrid space and coherence; namely, in what ways hybrid space may provide the context within which coherence resides. Also, this study added to the research on how PST reflections and perceptions can indicate the formation of a hybrid space in the context of a methods course with a field experience component.

This study also contributed to the existent research on MFEs, helping to begin filling a gap of empirical research that explores the essential features of the MFE (Swartz, Billings, et al., 2018). By focusing on the contributions of each individual element of the MFE in the context of a methods course for PSTs, this study added to the literature an important extension of what is already known about the affordances and constraints of the pedagogy of the MFE.

Finally, this study is significant not only in the field of teacher education in general, but also specifically to the field of mathematics teacher education. The National Research Council (2010) noted that many elementary mathematics teachers lack proper preparation. In response, the National Council of Teachers of Mathematics (2014) offered eight Mathematics Teaching Practices as a set of research-based practices that contribute to the effective teaching of mathematics. A few research studies have addressed contexts in which Mathematics Teaching Practices can be used in PST preparation (e.g., Lee, Lim, & Kim, 2016), but none have considered the coherence perceived by PSTs as they first learn about the Mathematics Teaching Practices in coursework, then experience these practices enacted in the field. This study made an important contribution to the literature on the use of Mathematics Teaching Practices in PST education.

## Definition of Terms

Certain terms are used repeatedly throughout the following chapters. The field of teacher education has offered recommendations for research design, including a call for clarity and consistency in terminology (Zeichner, 2005). For the sake of clarity, these key terms are defined as follows:

**Classroom lesson**

In this study, *classroom lesson* refers to a lesson taught in the K-12 classroom (not a lesson taught to PSTs in the university course).

**Clinical experience**

In this study, *clinical experience* is used synonymously with *field experience*.

**Coherence**

In this study, *coherence* refers to the alignment and connectedness of experiences that PSTs undergo during their teacher preparation program.

**Cooperating teacher**

In this study the *cooperating teacher* is defined as a K-12 teacher who hosts PSTs and the mathematics teacher educator in his or her classroom, models quality teaching practices, and participates in the ensuing debriefing sessions.

**Debriefing**

In this study, *debriefing* is a process in which the PSTs, the cooperating teacher, and the mathematics teacher educator have a purposeful discussion of a preceding shared classroom experience.

**Field experience**

In this study, a *field experience* is a placement in a K-12 classroom that allows PSTs to experience authentic classroom contexts. Ideally, this experience is closely integrated with the coursework required by the teacher preparation program.

**Fieldwork**

In this study, *fieldwork* is used synonymously with *field experience*.

**Integrity**

In this study, *integrity* is defined as a state of completeness, wholeness, and unity within the human person, absent from any sense of division.

**Mathematics teacher educator**

In this study, the *mathematics teacher educator* is defined as a university faculty member who instructs, guides, and helps prepare the PSTs to become teachers of mathematics. In this study, the mathematics teacher educator designs and teaches the mathematics methods coursework, coordinates the mediated field experience, and facilitates the debriefing sessions.

**Mediated field experience (MFE)**

In this study, a *mediated field experience* is a field experience in which the teacher educator, the cooperating teacher, and the PSTs are all present, creating a *shared text*. Essential components of a mediated field experience include preparation through a prebriefing session, a classroom lesson in the K-12 classroom, and a structured debriefing session.

**Methods course**

In this study, a *methods course* is a college course taught by a teacher educator that focuses on the pedagogical aspects of teaching.

**Practice**

In this study, *practice* refers to the instruction, activities, and pedagogy that occur under the guidance of a teacher in an authentic classroom setting.

**Prebrief**

In this study, the *prebrief* refers to the initial introduction to what will be taught in a K-12 classroom lesson that is part of a mediated field experience. Ideally, the cooperating teacher and the teacher educator are both present with the PSTs for this prebriefing session.

**Preservice teacher (PST)**

In this study, the *preservice teacher* is a student who is enrolled in a university-based teacher preparation program that culminates in a recommendation for initial-level state teaching licensure and certification.

**Student**

Unless otherwise specified, in this study, the *student* refers to the K-12 student in the classroom.

**Teacher Education**

In this study, *teacher education* is used synonymously with *teacher preparation*, both referring to the coursework and clinical experiences involved in the preparation of PSTs for initial licensure by traditional university teacher education programs.

**Theory**

In this study, *theory* refers to the broad systematic conception of principles related to concepts and skills that PSTs learn in the coursework of their teacher preparation program.

## Conclusion

This chapter has provided an overview of the study described in this dissertation, drawing upon the need for further research in the area of mathematics teacher education in order to explore the potential of new pedagogies, such as the MFE, to facilitate a hybrid space that increases PSTs' perception of coherence between mathematics methods coursework and field experiences. This study is situated in the theoretical perspective of the concept of integrity, which provides the rationale for the importance of this study. In preparation for the more in-depth discussions that follow, I have clarified definitions of terminology that are important in this study.

In the following chapter, I review the literature that is relevant to this study. In addition, I present the conceptual and analytical frameworks that guide this research. In subsequent chapters, I provide details regarding the methodology for this study, analysis of data, and associated findings as well as any related implications.

# CHAPTER II: LITERATURE REVIEW AND FRAMEWORK

The field of teacher education, and more specifically mathematics teacher education, is in need of further research to provide evidence regarding effective pedagogies to be used in preservice teacher (PST) education (Levine, 2006). Many elementary mathematics teachers have had inadequate preparation in their teacher education program (National Research Council, 2010), stemming in part from a lack of coherency between coursework and field experiences (Weston & Henderson, 2015) that results in a lack of integrity in teacher preparation and a disconnect between theory and practice (Grossman, Hammerness, & McDonald, 2009).

To address this need, this study considered the mediated field experience (MFE), and in particular its specific elements, as a pedagogy that has the potential to increase coherence in the education of future teachers of mathematics. In particular, this study considered the nature of PSTs' reflections during their participation in multiple cycles of MFEs, both overall and in each of the various elements of the MFE specifically. The study also analyzed the nature of PSTs' perceptions of coherence between Mathematics Teaching Practices (NCTM, 2014) as studied in coursework and as encountered during field experiences. Finally, I also studied the entry into hybrid space by the PSTs in relation to Mathematics Teaching Practices.

In this chapter, I review the research that is relevant to this study. This review provides a foundation upon which this study is based. I begin by providing an overview of the literature that addresses the divide between theory and practice in teacher preparation programs, especially as it relates to the dynamics between coursework and clinical experiences. I then define terms and concepts related to hybrid space, focusing upon their use in research of PST education. Next, I consider the MFE in terms of its history, its structure, and the research that has already been conducted in this area. Following this, I situate the study specifically in the realm of mathematics teacher preparation by discussing the role of the mathematics methods course and a few relevant instructional routines, namely number talks (Parrish, 2010) and Smith and Stein's (2011) Five Practices to Orchestrate Productive Mathematical Discussions. In addition, I give an overview of NCTM's (2014) eight Mathematics Teaching Practices, focusing particularly on the two practices of posing purposeful questions and facilitating meaningful mathematical discourse. Finally, I provide details regarding the conceptual framework used for this study. I used the concept of coherence as a lens through which to view the various elements of which the study consists; fittingly, in this chapter, I provide a foundation for this framework as can be found in the literature.

## The Theory-Practice Gap

In traditional teacher education programs, PSTs typically have opportunities to learn through both coursework and fieldwork. Unfortunately, the experience of PSTs in each of these areas can often be characterized by a certain disconnect (Grossman, Hammerness, & McDonald, 2009; McDonald et al., 2013), as the PST is left to attempt to independently navigate the gap between coursework and fieldwork (Britzman, 2003). Zeichner (2010) illustrated:

> For example, it is very common for cooperating teachers with whom students work during their field placements to know very little about the specifics of the methods and foundations courses that their student teachers have completed on campus, and the people teaching the campus courses often know very little about

> the specific practices used in the P-12 classrooms where their students are placed. (p. 90)

As the PST, possessing inherent integrity, is naturally moved toward wholeness and connectedness, this fragmented approach to learning how to teach can be very problematic in the preparation of the future teacher.

This gap has been termed in many different ways, including the two worlds pitfall (Feiman-Nemser & Buchmann, 1985), the Achilles heel of teacher education (Darling-Hammond, 2009), the university-school divide (Anagnostopoulos, Smith, & Basmadjian, 2007), an abyss between theory and practice (Levine, 2006), a polarization of theory and practice (Baumfield, 2016), an imbalance between theory and practice (Levine, 2006), and the theory/practice binary (Honan, 2007). Although the phrases and names given to this phenomenon vary, the problem remains consistent: teacher preparation occurs in two different settings, that centered in coursework and that experienced in the field, and the PST is tasked with the integration of these two often dissimilar worlds (Britzman, 2003).

I generally refer to this challenge by its most oft-used phrase, the *theory-practice gap*. This expression notes the tension that is clearly evoked by the lack of consonance between theory and practice (Silver & Herbst, 2007). Theory, as noted by Mason and Waywood (1996), is “a value-laden term with a long and convoluted history” (p. 1055). As Putnam and Grant (1992) recognized, “neither theory nor practice provides both the necessary and sufficient conditions for dynamic teaching and learning . . . . Both theory and practice have beneficial features, strengths that the other can not possess” (p. 89). Shulman (2004) recognized John Dewey’s echoing of these sentiments, holding that theory and practice are inextricably linked, and that each “gains richness and clarity from the incursion of the other" (p. 167). Bhabha (1994) similarly held that the worlds of theory and practice enable one another.

This theory-practice gap extends its effects beyond the years of teacher preparation; novice teachers often experience difficulty when they attempt to make use of what they learned in coursework by applying it to their classroom, a dilemma referred to as the problem of enactment (Ghousseini, 2009; Hammerness, Darling-Hammond, & Bransford, 2005). Studies have shown that novice teachers are more successful when they have had the opportunity in their teacher preparation programs to consider how university coursework and field experiences relate to their predicted initial teaching experience (Darling-Hammond, 2000). For example, Boyd, Grossman, Lankford, Loeb, and Wyckoff (2009) studied the relationship between teacher effectiveness, as measured by student test score performance, and the type of training and instruction that these teachers received in their teacher preparation programs. They found that programs that directly link coursework to practice tend to provide the most benefit to novice teachers.

Traditional teacher education programs may have inadvertently promoted this divide between theory and practice in a few different ways (Britzman, 2003; Campbell, 2012). One of the proposed causes of the theory-practice gap is the historically dominant acquire-apply approach to pedagogy, which magnifies the disparity between these two areas by treating theory and practice as disjointed concepts (Horn & Campbell, 2015). The acquire-apply approach, sometimes referred to as the theory-to-practice model, expects PSTs to learn theory at the university followed by learning practice when later in the school setting (Korthagen & Kessels, 1999). This approach accompanies the mindset that once the PST acquires knowledge of theory of teaching through the university setting, the more practical knowledge about teaching will naturally come to the novice teacher while serving as teacher-of-record in a classroom setting (Zeichner, 2010). Other causes of this disconnect include a haphazard approach to clinical experiences, including sometimes much time in the field accompanied by little structure or guidance, or an approach to coursework that overemphasizes the abstraction and generalization of theory, to the detriment of practical application (Darling-Hammond, 2006a).

This theory-practice gap that pervades teacher education extends to the realm of mathematics. Østergaard (2013) wrote that "[e]stablishing coherence between theory and practice is one of the main challenges in mathematics teacher education" (p. 2). The problematic lack of coherence is exhibited in two different ways in mathematics education, according to Østergaard: (a) a gap between theory of pedagogies specific to mathematics and the actual teaching practice of mathematics, and (b) the divide between mathematical and pedagogical knowledge. The present study primarily addresses the first manifestation of the theory-practice gap in mathematics education.

In response to the call from scholars and policymakers alike to increase the coherence between theory and practice (Baumfield, 2016; Darling-Hammond et al., 2017; Moon, 2016; NCATE, 2010; Teacher Education Ministerial Advisory Group, 2014), many prospective solutions have been proposed as possible means to narrow the coursework-fieldwork gap. These include strategies such as representation, decompositions, approximations of practice (Grossman, Compton, et al., 2009), rehearsals of instructional activities (Lampert & Graziani, 2009), and microteaching (Kallenbach & Gall, 1969). Yet each of these strategies, although valuable in certain aspects, still lacks a very important component—namely, the PSTs' interaction with the complexities of an actual classroom (Darling-Hammond, 2006b; Horn & Campbell, 2015).

One possible solution with potential to strengthen the connection between theory and practice, suggested by numerous scholars, is a greater emphasis on practice-based teacher education (e.g., Ball & Cohen, 1999; Ball & Forzani, 2009; Grossman, Hammerness, & McDonald, 2009; Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2010). The phrase *practice-based* abounds in the current literature; unfortunately, the term has been widely used with few distinctions, leading to its rather amorphous current usage (Forzani, 2014; Lampert, 2010). My use of the term *practice* in the context of practice-based learning aligns closely with Jenset's (2017) delineation of the enactment approach to practice-based teacher education. This enactment approach portrays practice as interactive, addressing both the predictable and improvisational aspects of teaching, and relying on a strong foundation of content knowledge as applied to teaching. This last characteristic gives emphasis to the importance of Ball and Bass's (2002) practice-based theory of mathematical knowledge for teaching.

Practice-based teacher education programs give PSTs an opportunity to experience authentic classroom settings in their complexity. For example, Dani and colleagues (2019) proposed a model of cyclical collaborative mentoring, in which PSTs are given opportunities to reflect upon authentic classroom situations with a designated mentor. This model was found to be a beneficial approach to help narrow the theory-practice gap. Although providing advantages, this response, similar to the response of some programs to simply increase the amount of time in which PSTs are situated in actual classrooms, does not automatically solve the persisting gap between theory and practice (Campbell, 2012); intentional coordination between coursework and field experiences (Darling-Hammond & Hammerness, 2005) and collaboration between the cooperating teacher and the university teacher educator (Zeichner & Conklin, 2008) are other essential elements in strengthening the coherence of PSTs' experiences to result in PSTs who are more prepared for the complexities of teaching. Under the guidance of experts both in the university classroom and in the field, in the context of coursework and field experiences that are highly integrated, Virmani (2014) posited that "practice-based teacher education programs may provide an ideal environment for preservice teachers to deeply examine their practice and develop a richer knowledge of teaching" (pp. 3-4).

## Hybrid Space

As already noted, a gap between theory and practice is evident in many disciplines, presenting challenges to all involved. Grossman, Hammerness, and McDonald (2009) have challenged teacher educators to *re-imagine* teacher education, reconceptualizing the field so as to eliminate many of the historical divisions such as that of the theory-practice gap. Flessner (2014) suggested using the theory of third, or hybrid, space as a lens through which to re-envision course structure and pedagogy. Wood and Turner (2015) advocated the use of this same theory as university teacher educators and K-12 teacher practitioners work together in ways that enable the PST to gain insights into how these two worlds can interconnect.

The theory of hybrid space was introduced by Bhabha (1990) in the context of postcolonialism. Bhabha (1994) used the concept of hybrid space to consider how individuals navigate different cultural contexts in which they find themselves by defining a space that is not "one nor the other," but rather "exists somehow in between these political polarities" (p. 22). Built upon a sociocultural foundation consistent with the writings of Vygotsky, hybrid space presumes and requires "simultaneous existence in two different worlds" (Flessner, 2011, p. 122), thus creating a new space "in which new ways of educating future teachers can be imagined and implemented" (Flessner, 2008, p. 4).

The concept of *third space* is drawn from Bhabha's (1994) conception of hybrid space. Moje and colleagues (2004) described third space as a type of hybrid space in which various constructs are brought together. For the context of this study, I use the term *third space* synonymously with *hybrid space*.

Although the concept of third space can be used by some in a context that is highly political (e.g., Bhabha, 1990, 1994), I choose to use a conception of hybrid space that focuses not on the issue of marginalization, but rather a theory that is intended to be transformative in its bridging of elements that are themselves each important to teacher education, namely the concepts of theory as learned through coursework and practice as experienced in a K-12 classroom.

**Binary Relationships**

Flessner (2008) defined binaries as "those sets of terms typically situated in opposition from one another" (p. 22). The acknowledgement of binaries led to the construction and development of third space theory. Examples of binaries include large/small, private/public, open/closed, urban/rural, and self/other (Bhabha, 1994; Soja, 1996). In the context of this study, theory as learned in coursework and practice as experienced in the field are recognized as binaries. The creation of a hybrid space would "yoke together theory and practice by making the practical theoretical and the theoretical practical" (Klein, Taylor, Onore, Strom, and Abrams, 2013, p. 39). Third space theory rejects an either/or mentality, choosing instead to consider how both/and might be accommodated by a space that is “other” (Soja, 1996). In third space, one does not completely reject the binaries; rather, these binaries are selectively restructured in order to establish the hybrid space (Soja, 1996). Although it is important to acknowledge that not all binaries are fluid, certain binary terms can come together in a manner that builds integrity and a certain connectedness that might not otherwise be possible.

**Integration of Spaces**

In order for a hybrid space to exist, two or more component spaces must be integrated; in a sense, they must *overlap*. At times, literature regarding third space gives the opposing binary terms the names of *first space* and *second space* (Flessner, 2008). However, scholars maintain that the designation of which term is first space and which is second is arbitrary; what is important is understanding how these spaces contribute to the creation of a third space (Moje et al., 2004). Because of this arbitrariness, I simply refer to the spaces contributing to the hybrid space as *component spaces*.

For purposes of his self-study as both an elementary teacher and a teacher educator, Flessner (2008) considered the elementary classroom and the university setting as component spaces. In this way, he “purposely separate[d] the two spaces in an attempt to unite them, build upon them, react to them, and rethink them within the third space” (p. 29). Moje et al. (2004) recognized the home and community setting as component spaces. Flessner (2011) used the public-school classroom and a university-based methods course as component spaces. For the purpose of this study, I have designated the university-based methods course and an elementary school classroom as the two component spaces (see Figure 1). Unlike Flessner (2008, 2011, 2014), who used third space to better understand the role of the instructor-researcher in various settings, I use hybrid space to consider perceptions of a PST in the context of a mathematics methods course that includes field experiences in an elementary school classroom.

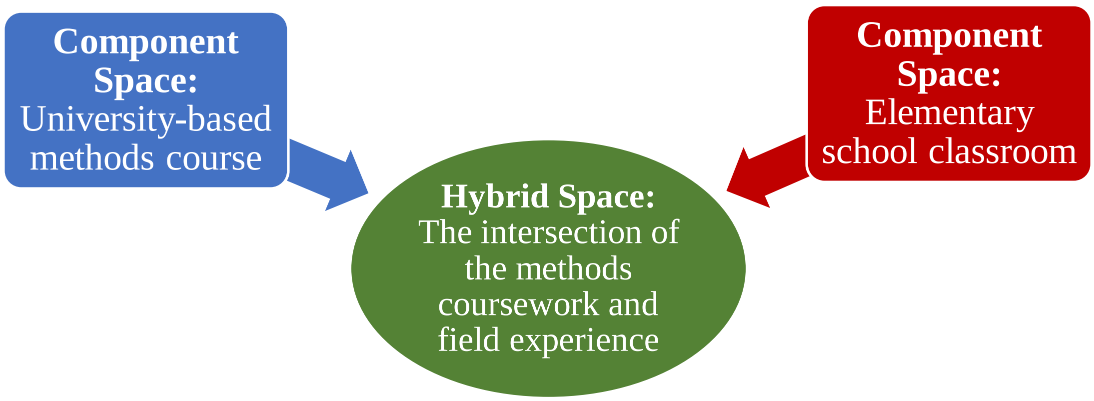


*Figure 1.* The relationship between the component spaces and the hybrid space for this study (adapted from Flessner, 2011).

**Application to Education**

The concept of third space did not originate in the field of educational research. However, the idea of entry into hybrid space has been increasingly included in educational research agendas. One example of this is the inclusion of acknowledgement of third space as “the context for university and school interactions” (p. 25) in the report of the American Association of Colleges for Teacher Education’s (2018) Clinical Practice Commission.

Gutiérrez, Rymes, and Larson (1995) applied the concept of hybrid space to the classroom, studying how the dynamic interrelation between teacher and student scripts can be transcended by means of an unscripted third space. In their model, the teacher script was conceptualized as an official component space and the student counterscript was considered an unofficial component space. The interaction between these two scripts resulted in an unscripted hybrid space. Their study presented third space as “a framework for redefining what counts as effective classroom practice” (p. 467).  Gutiérrez, Baquedano-López, and Turner (1997) continued to consider the relation between teacher and student scripts, developing the notion of a “radical middle” (p. 372) that must accompany the notion of third space. This concept of a radical middle is not merely a compromised middle-ground between binaries, but rather a “new theoretical and pedagogical stance” (p. 372) that the authors developed in the context of literacy education. Also situating their study in literacy learning, Moje and colleagues (2004) used third space theory to conceptualize the integration of knowledge and discourse of students of Latin American descent, building on the contributions made from the component spaces of home/community and school.

Continuing the entry of hybrid space theory into the classroom setting, in their study of the use of mediational tools to promote the emergence of third spaces, Gutiérrez, Baquedano-López, and Tejeda (1999) observed that “learning contexts are imminently hybrid, that is, polycontextual, multivoiced, and multiscripted” (p. 287). These often-diverse contexts in an educational setting, conceptualized as component spaces, have the potential to be transformed into rich opportunities for learning; the theory of third space can give language to better describe this transformation.

Zeichner (2010) applied the concept of hybrid space to the context of teacher education, focusing upon “the creation of hybrid spaces in preservice teacher education programs that bring together school and university-based teacher educators and practitioner and academic knowledge in new ways to enhance the learning of prospective teachers" (p. 92). This includes a variety of applications, including having hybrid educators who teach both in the university setting and in the K-12 setting, inviting K-12 teachers into the university classrooms, and teaching campus methods courses in an elementary or secondary school setting. Yet, simply combining two different spaces, such as conducting a university methods course in a K-12 setting, is not enough to constitute a hybrid space; the two component spaces must not only be present, but integrated (Cuenca, Schmeichel, Butler, Dinkelman, & Nichols, 2011; Horn & Campbell, 2015).

Conceptualization of hybrid spaces has been used in studies in the field of mathematics education. For example, Wood and Turner (2015) situated their exploratory research in third space theory, studying how elementary teachers contributed to a field experience of PSTs during their mathematics methods course. Horn and Campbell (2015) used the pedagogy of the MFE to form a hybrid space in which secondary mathematics PSTs were able to integrate coursework and field experience.

The notion of hybrid space provides concepts and language that can describe and illustrate how different pedagogies can contribute to narrowing the gap between theory and practice for PSTs. This theory of third space has allowed me to explore the potential of the MFE, in particular, for meeting this challenge. In the study described in this dissertation, I have analyzed PSTs' perceptions of Mathematics Teaching Practices as the PSTs were immersed in two component spaces: that of a university mathematics methods classroom and that of an elementary mathematics classroom. Using third space theory, I have identified when PSTs' comments and reflections indicate that they have entered into a hybrid space that is generated from an intersection of these component spaces, describing the level of coherence perceived by the PSTs while in each component space and in the resulting hybrid space.

## Mediated Field Experiences

The National Mathematics Advisory Panel (2008) acknowledged a need for strengthening the mathematics preparation of elementary teachers in order to improve teacher effectiveness, consequently recommending that research be conducted on different approaches of mathematics preparation of PSTs. One approach that has been put forth to address this need, intensified by the challenges posed by the theory-practice gap, is the *mediated field experience* (MFE).

The MFE is a pedagogical model for a school-based field experience for PSTs that is directly connected to a university course as a component of a teacher education program. The goal of the MFE is to produce a hybrid space between coursework and field experience that subsequently leads to greater coherence between theory and practice for PSTs. As Horn and Campbell (2015) commented regarding their choice to implement MFEs, "[i]nstead of trying to eliminate the gap between coursework and field placements, we sought to reconceptualize it" (p. 157).

### History

In an attempt by scholars to bridge the gap between a secondary mathematics methods course and its associated field experiences, what is now known as the *mediated field experience* found its origins. The MFE was developed as a collaborative partnership between a teacher education program and a high school as a way to assist PSTs in building connections between what they were learning in their coursework and what they were experiencing in the field (Campbell, 2012). The model that had previously been used in this particular course had followed an acquire-apply pedagogy (Korthagen & Kessels, 1999), in which PSTs were expected first to acquire theoretical knowledge from coursework, then practically apply it in a classroom setting (Horn & Campbell, 2015).

Two years prior to the development of the MFE, the instructor of the mathematics methods course developed a partnership with local high school mathematics teachers, providing them with professional development opportunities focused especially on issues of equity. After building camaraderie with the teachers, the mathematics methods instructor invited them to participate in the preparation of PSTs in the secondary mathematics methods course as she “re-designed the course in an effort to create greater coherence across the various contexts in which candidates learn to teach” (Campbell, 2012, p. 55). Campbell related that this field experience was termed a “mediated field experience” since “the intended goal was to mediate the candidates’ experiences within the methods course and the field by partnering with teachers who were generating local knowledge by critically examining their teaching practice” (p. 56). In recent years, the MFE has gained the interest of researchers, resulting in forums such as a working group dedicated to the study of MFEs and their impact at annual meetings of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA; Swartz, Billings, et al., 2018).

**Structure**

Although allowing for much flexibility, the basic structure of the MFE consists of three primary sequenced activities: preparation in the context of the university course, observation and/or presentation of a lesson in a K-12 classroom setting, and a debriefing that immediately follows the lesson (Campbell, 2012; Horn & Campbell, 2015). The first component typically takes place on the university campus, and the latter two occur in a school setting (elementary, middle, or high school) (Horn & Campbell, 2015). Figure 2 illustrates the three primary structural components of the MFE. In addition to these foundational elements, oftentimes PSTs are asked to independently complete a written reflection at the conclusion of the MFE (Horn & Campbell, 2015; Swartz, Lynch, & Lynch, 2018).

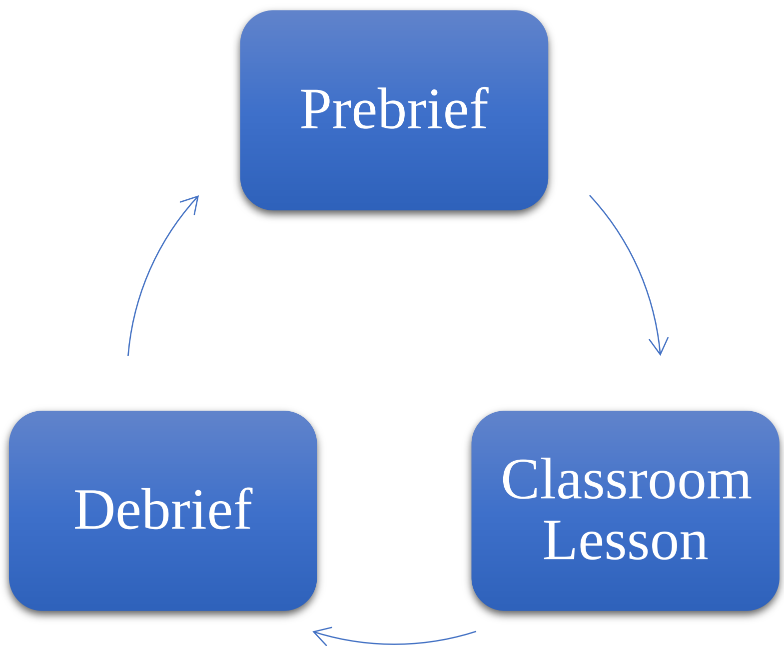


*Figure 2.* Cycle of activities that provides the structure of the MFE.

**Prebrief.** Although the initial time spent planning and preparing for the classroom lesson to be taught during the field experience is considered the first essential structural element of the MFE, many of the studies involving MFEs provide only limited descriptive details regarding this time (e.g., Campbell & Dunleavy, 2016; Horn & Campbell, 2015; Laman, Davis, & Henderson, 2018). Consequently, this first element of the MFE does not have a consistent referent title. Clarke and colleagues (2013), in their research on demonstration lessons, use the term *prebrief* for this initial introduction to what will be taught in the K-12 classroom; I have adopted this same terminology for the MFE.

The prebrief is often focused around some weekly theme or essential question to be addressed in the university course (Campbell, 2012). Cooper (1996) recommended that strong collaboration occur between the university teacher educator and the cooperating teacher in the planning stages of field experiences. To facilitate this collaboration, the instructor communicates this weekly theme, as well as any other important information related to what is being taught in the university course, to the cooperating teacher in advance. If the classroom lesson is to be planned and taught by the cooperating teacher and observed by the PSTs, the cooperating teacher provides lesson plans and any corresponding handouts that are to be used in the lesson. If the classroom lesson, or some part of it, is to be co-planned and/or taught by the PSTs, time is spent on designing and analyzing the mathematics tasks that are to be used, planning and discussing the lesson as a whole, and microteaching with fellow PSTs (Campbell, 2012). Regardless of who teaches the lesson, the PSTs work through the mathematics tasks and consider potential student responses to the task (Horn & Campbell, 2015). This allows the PSTs to focus on student learning during the lesson, instead of needing to themselves make sense of the mathematics as it is being taught (Campbell, 2012).

**Classroom lesson.** Methods courses provide PSTs with the opportunity to develop the pedagogy necessary for effective teaching in a specific subject area. In the case of mathematics methods courses, PSTs learn how to teach mathematics (Ball, 1989). A literature review conducted by Cochran-Smith and Zeichner (2005) revealed that methods courses and field experiences are often interconnected facets of the preparation of PSTs. In an MFE, time in the field is intentionally structured and directly related to the content being studied in the methods course (Horn & Campbell, 2015). Also, unlike many traditional field experiences in which the teacher educator is not present for the PSTs' clinical experience (Campbell & Dunleavy, 2016), when involved in an MFE, the teacher educator, cooperating teacher, and PSTs all experience the same lesson. This shared experience provides the teacher educator with first-hand knowledge of the practices and strategies that are actually implemented in the classroom.

Classroom lessons may include a wide array of structured activities, such as guided observation, interactions with students in a small group setting, the teaching of a lesson, co-teaching, conducting student interviews, etc. Although the structure of these activities can vary tremendously, they all have a common goal of allowing PSTs to authentically experience teaching students in a way that is not possible in the setting of the university classroom (Swartz, Billings, et al., 2018). Participation in these instructional activities is also unique in that it contributes to a common vision shared by the PSTs, the cooperating teacher, and the teacher educator (Campbell & Dunleavy, 2016), who are all present for the classroom lesson.

Everyone involved in the MFE who is not teaching participates by observing the classroom lesson. The PSTs' focus for the lesson, whether they are teaching or observing, mirrors the weekly course focus, which was introduced prior to or as part of the prebrief. In this way, the MFE generates a "shared text" (Horn & Campbell, 2015, p. 160) between coursework and field experiences as well as among the teacher educator, the cooperating teacher, and the PSTs, that can be drawn upon for future reflection. This integration of the component spaces of the methods course and the elementary classroom invites entry into hybrid space to occur.

**Debrief.** Immediately following the lesson (Dufrene & Young, 2014), the teacher educator, cooperating teacher, and PSTs meet to debrief the experience (Campbell, 2012). This time of debriefing has been referred to as the "heart of the MFE" (Horn & Campbell, 2015, p. 162), and more generally, the "heart and soul" (Rall, Manser, & Howard, 2000, p. 517) and "cornerstone" (Dreifuerst, 2010, p. 8) of any simulation learning experience, such as an MFE. Debriefing, in a general sense, has been found to be the most important component for both acquiring knowledge (Dufrene & Young, 2014) and developing judgment (Kelly, Hager, & Gallagher, 2014) in simulation-based learning. Providing structured opportunities for PSTs to reflect on field experiences are a critical component in effective teacher preparation (Darling-Hammond & Hammerness, 2005; Jenset, Hammerness, & Klette, 2019).

Lederman (1992) defined debriefing as a process during which a facilitator guides individuals who have shared a common experience through a purposeful discussion of that shared experience. Lederman went on to provide two assumptions on which the debriefing process is based: "First that the experience of participation has affected the participants in some meaningful way. Second, that a processing (usually in the form of a discussion) of that experience is necessary to provide insight into that experience and its impact" (p. 146). Applied to the shared experience of participating in a classroom lesson, either as teaching or observing, the debriefing process can assist PSTs to become more deeply aware of the insights that can be gained from the authentic classroom experience.

In the context of an MFE, the teacher educator, who established and shared learning goals for the MFE beforehand (cf. Decker et al., 2013), acts as a moderator in facilitating the debrief session. As moderator, the teacher educator must seek to form an environment of trust and respect (Fanning & Gaba, 2007). The debrief focuses particularly on the weekly theme of the methods course, considering both what was experienced in the current lesson and the implications for future lessons (Clarke et al., 2013).

The session begins with whomever taught during the lesson providing an overview of their goals for the lesson, their analysis of what they think students learned with accompanying evidence, and any lingering misconceptions they think students may still have. Allowing the one who taught the lesson to speak first gives him or her an opportunity to share personal perspectives regarding the lesson and what students learned (Campbell, 2012) and to speak about any difficulties experienced during the lesson before these are pointed out by others (Lewis, 2002). Following this, others share observations and comments, as well as pose questions. Each of the PSTs is required to make at least one contribution during the debrief (Horn & Campbell, 2015).

Research has shown that in general, the communication between PSTs and cooperating teachers during clinical experiences often lack in depth, as conversations remain superficial without delving into the complexities of teaching in an authentic classroom setting (Borko & Mayfield, 1995; Clarke, Triggs, & Nielsen, 2014). One of the opportunities that the debriefing component of the MFE can provide is a space in which PSTs can interact with the cooperating teacher and talk openly about practice (Turunen & Touvila, 2012). The PSTs “no longer behave as students, but as practitioners, and develop their conceptual understanding through social interaction and collaboration in the culture of the domain" (Brown, Collins, & Duguid, 1989, p. 40). Through open and honest conversation, PSTs can gain a better understanding of why teachers make certain decisions in the classroom and how these decisions affect student outcomes (Campbell, 2012).

**Reflection.** Although not considered one of the structural components of the MFE, a time for reflection, which can take a variety of forms, is often embedded into the MFE. Horn and Campbell (2015) required PSTs to submit a short online reflection later in the same day during which the MFE was conducted, the purpose of which was "to bring coherence to the novices' learning by having them synthesize across these experiences to articulate their current understanding of a critical teaching concept or practice" (p. 163). Swartz, Lynch, et al. (2018) expected PSTs to maintain written journals that included entries after each individual MFE. These journal entries, which were guided by structured prompts, were followed up with a more formal summative reflection after the final MFE of the course. Campbell (2012) noted that PSTs were encouraged to draw on course texts and readings, as well as knowledge they had gained through other coursework in the teacher education program, in their post-MFE reflections. Some MFEs, such as those studied by Campbell and Dunleavy (2016), did not include an explicitly independent reflection piece, instead considering the debrief itself as inclusive of this reflection.

In addition to encouraging PSTs to make connections between what they have learned in coursework and what they have experienced in the field, written reflections can provide the teacher educator with insights into PSTs' perceptions and understanding of the MFE (Campbell, 2012). These reflections can also give PSTs an opportunity to share questions and comments that they may not have felt comfortable voicing during the debrief. Horn and Campbell (2015) noted that these written reflections composed by the PSTs can be invaluable from both a practitioner perspective, acting as a formative assessment, and from a research perspective, providing data on PSTs' perceptions and understandings. The MFEs described in this study include a post-debrief reflection written by the PSTs after each cycle of the MFE, as well as shorter informal reflections by the PST after the prebrief and the classroom lesson.

**A framework for conceptualizing the MFE.** McDonald et al. (2013) developed a learning cycle that has been used as a framework for a variety of pedagogies in teacher education. This framework has often been used to help conceptualize the MFE (Campbell & Dunleavy, 2016; McDonald et al., 2014; Swartz, Billings, et al., 2018; Swartz, Lynch, et al., 2018; Virmani, Taylor, & Rumsey, 2018), addressing the need for a common language for analysis between the MFE and other related pedagogies (Grosser-Clarkson, 2016).

McDonald et al.'s (2013) learning cycle of enactment and investigation conceptualizes pedagogies for teacher education. The cycle, originally designed for the learning of a set of core practices, consists of four quadrants: 1) Introducing and learning about the activity, 2) preparing for and rehearsing the activity, 3) enacting the activity with students, and 4) analyzing enactment and moving forward. This framework provides PSTs with the opportunity to enact a set of practices in a progressively authentic setting, first in the context of a methods course situated at the university, then in a methods course that takes place in a K-12 classroom, and finally in a fully authentic environment during student teaching or a teaching practicum. McDonald and colleagues (2013) comment on this framework:

> This cycle intends to offer guided assistance to candidates to learn particular practices by introducing them to the practices as they come to life in meaningful units of instruction, preparing them to actually enact those practices, requiring them to enact the practices with real students in real classrooms, and then returning to their enactment through analysis. (p. 382)

The MFEs in the current study can be viewed through the lens of McDonald et al.'s (2013) framework. The prebrief addressed the first two quadrants, introducing PSTs to the weekly theme and the activities that were planned to take place in the classroom, as well as giving PSTs the opportunity to plan and prepare for those activities. The classroom lesson was the context in which the activity was enacted, either by the cooperating teacher, the teacher educator, or the PSTs themselves; this aligned with the third quadrant of the framework. Finally, the debrief (and optionally an additional reflection component) provided a forum in which the PSTs, along with the cooperating teacher and the teacher educator, could analyze the enactment of the activities in an authentic classroom setting, which satisfied the elements of the fourth quadrant. Connecting the elements of the debrief with McDonald et al.'s (2013) learning cycle of enactment and investigation serves to link the pedagogy of the MFE to other pedagogies used in PST education, which has the potential to "further professionalize the field by offering teacher educators opportunities to collectively engage with one another to generate and aggregate knowledge" (McDonald et al., 2013, p. 384).

**Research on Mediated Field Experiences**

Although clinical experience is a typical component of teacher preparation, Jacobson (2017) observed that time spent in the field has often been overlooked in research that examines how PSTs develop an understanding of the teaching of mathematics. The advent of the MFE brought new opportunities for research in this particular expression of field experience. Several instances of MFEs implemented in mathematics-related teacher education coursework have been the subject of research conducted since the formal conception of the MFE.

A series of seven MFEs taking place in the context of a secondary mathematics methods course has been studied from a number of angles (Campbell, 2012; Horn & Campbell, 2015). Horn was the mathematics teacher educator for these MFEs, and Campbell participated as a graduate assistant. These MFEs took place within a high school where a partnership with high school mathematics teachers had been previously established. The PSTs' classroom experience involved only observations, without direct interactions between the PSTs and students. Each PST chose, as the focus of his or her observations, one particular student (identified by the cooperating teacher as struggling in mathematics in some manner) who was unlike the PST in some significant way. These MFEs particularly emphasized equitable mathematics teaching practices (Campbell, 2012), with a goal of "broadening the [PSTs'] pedagogical reasoning by developing their sensitivity to the diversity of student experience, particularly experiences significantly departing from their own" (Horn & Campbell, 2015, p. 161). Horn and Campbell (2015) considered the MFEs in the context of sociocultural learning theory and the situative perspective on learning (Greeno, 1998), whereas Campbell (2012) used cultural-historical activity theory as a lens for her study of MFEs.

Virmani and colleagues (2018) provided three exemplars of MFEs that were implemented as part of a mathematics methods course, each of which employed at least one activity from McDonald et al.'s (2013) learning cycle of enactment and investigation. Although one of the component spaces in which all three exemplars are conducted is similar—a mathematics methods course (two elementary and one secondary)—the second component space varied. The first exemplar illustrated how an after-school mathematics club can provide the setting for the classroom lesson of an MFE. The second exemplar took place in a fourth-grade classroom, allowing PSTs to co-plan lessons and observe the cooperating teacher's implementation of the lessons, followed by a debrief. The final exemplar involved PSTs engaging in teaching in a secondary mathematics classroom, accompanied by a prebrief and a debrief. By comparing and contrasting these three variations of MFEs, Virmani et al. were able to compile a list of commonalities that can guide future implementations of MFEs. These common traits of MFEs included having a teacher educator present for all classroom lessons; focusing upon a specific topic, theme, or practice; allowing for pauses during instruction during the classroom lesson, in order to provide in-the-moment support for PSTs; teacher educators, cooperating teachers, and PSTs having a shared plan for student learning; and debriefs that allow teacher educators, cooperating teachers, and PSTs to together reflect upon the classroom lesson.

Although studies regarding MFEs appear most prevalently in mathematics education literature, researchers have also presented findings from MFEs conducted in other subject areas as well. After their research (noted above) involving MFEs used in a secondary mathematics methods course, Campbell and Dunleavy (2016) expanded a second cycle of MFEs to include five methods courses, all in the context of secondary education. In addition to a mathematics methods course, MFEs were also implemented in methods courses for world languages, social studies, science, and language arts. Campbell and Dunleavy (2016) looked at MFEs through the lens of cultural-historical activity theory, considering how the structure of the MFE related to the role of PSTs in an activity system. They surmised that PST learning was magnified in the MFE activity system due to the alignment of the structure and focus of coursework and field experience. In addition, they also found that MFEs situated in the context of social studies supported PSTs' development of noticing (Sherin, Jacobs, & Philipp, 2011) skills, and that MFEs conducted in language arts strengthened PSTs' skills in building positive relationships with students. Finally, Campbell and Dunleavy (2016) concluded that although the teacher educators involved had different learning goals related to field experiences, all drew largely upon the knowledge and experience of the cooperating teacher to help narrow the theory-practice gap.

Literacy and language arts methods courses have provided the context for MFEs as well. Laman, Davis, and Henderson (2018) studied the learning of four PSTs who participated in MFEs in an urban school setting as part of an elementary language arts methods course. A goal of the course was for PSTs to recognize assumptions and biases they may possess regarding the children and families of the school. Findings from the study showed that the MFEs provided a context in which PSTs began to shift their deficit perceptions of the students, their families, and their communities toward views that were less biased, and in which PSTs grew in their pedagogical understanding of how to implement writing workshops. McDonald and her colleagues (2014), in their study of MFEs that were implemented in a secondary English language arts methods course and an elementary literacy methods course, found that a shift from discussing and modelling how to teach to engaging PSTs in authentic teaching in a collaboration among teacher educators, cooperating teachers, and PSTs, began to narrow the gap between theory and practice. The researchers concluded that this experience yielded PSTs who were better prepared to become effective teachers.

Although they did not use the term *mediated field experience*, Swartz, Lynch, et al. (2018) studied the impact of MFEs in the context of mathematics education and special education in an elementary school. Swartz and her colleagues connected their research strongly to McDonald et al.'s (2013) pedagogical cycle of learning. The MFEs were integrated into three different courses: a mathematics content course, a mathematics methods course, and a special education behavioral strategies course. All were implemented in a continual sequential cycle ranging between four and eight MFEs. The researchers found that these cycles of MFEs assisted PSTs in learning from mistakes made in order to modify future instructional plans. PSTs reported that the feedback received during the course of the MFEs was particularly beneficial.

Findings from previous research on MFEs have indicated that this pedagogy has potential to narrow the gap between teacher education coursework and field experience. Swartz, Lynch, et al. (2018) attributed this potential shift toward greater connection between coursework and field experiences to the opportunities that the MFE provides for structured collaboration among PSTs, cooperating teachers, and mathematics teacher educators. Drawing upon the benefits derived from the integration of what PSTs learn in coursework and what they experience in the field, this resulting hybrid space has already been shown to exhibit positive results both in the field of mathematics education as well as in other areas. These include a broadening of PST pedagogical reasoning skills (Horn & Campbell, 2015), a strengthening of PST noticing skills (Campbell & Dunleavy, 2016), a shifting away from deficit perceptions (Laman et al., 2018), better preparation for future leadership (McDonald et al., 2014), and the strengthening of PSTs' relationship-building skills in student-teacher interactions (Campbell & Dunleavy, 2016). The present study seeks insights about the effects of not only the MFE as a whole, but also the individual elements of the MFE, on the perceptions of PSTs regarding the teaching of mathematics, specifically in the setting of a mathematics methods course.

## Mathematics Methods Courses

A mathematics methods course is neither a content course nor a general pedagogy course, "but instead lie[s] at the intersection and focus on the pedagogy associated with teaching mathematics" (AMTE, 2017, p. 33). Ball (1989) called methods courses "the mainstay of traditional teacher education programs" (p. 6), Cochran-Smith and Zeichner (2005) termed them as "complex and unique sites" (p. 15) in the formation of future teachers, and Yow, Waller, and Edwards (2019) referred to methods coursework as the "hallmark" (p. 396) of effective teacher education programs, especially in the area of mathematics. Ball (1989) described the challenge inherent in a methods course:

> A methods course faces a tension not faced by other courses: a tension that reflects the fundamental nature of teaching. Teaching is about weaving together knowledge about subject matter with knowledge about children and how they

> learn, about the teacher's role, and about classroom life and its role in student learning. An educational psychology course can focus on theories of learning. A mathematics course can be about algebra, or geometry, or combinatorics. But a methods course can be about the weaving that produces teaching. As such, a math methods course is about mathematics. It is also about children as learners of mathematics, about how mathematics can be learned—and taught, about how classrooms can be environments for learning math. (p. 6)

AMTE's (2017) *Standards for Preparing Teachers of Mathematics*, seeking to address this complex challenge involving the integration of both the teaching of mathematics and the teaching of children, claimed that effective mathematics teacher preparation programs must include practice-based mathematics methods courses.

Teacher education programs typically rely upon a mathematics methods course to provide PSTs with the opportunity to focus on the development of instructional strategies and overarching principles and pedagogies for teaching mathematics in the classroom (Grossman, Hammerness, & McDonald, 2009). Even though the emphasis in methods courses tends to be more on practical tools than conceptual strategies (Ball, 1989), Lampert (2005) commented how this may translate into learning more *about* instructional strategies and pedagogy than actually learning how to *enact* such practices:

> But learning about a method or learning to justify a method is not the same thing as learning to do the method with a class of students, just as learning about piano playing and musical theory is not learning to play the piano. The latter requires getting one's hands on the instrument and feeling it "act back" on one's performance. Because teaching is situated in instructional interaction, learning

> how to teach requires getting into relationships with learners to enable their study of content. It is here that one learns how to teach as students "act back" and responses must be tailored to their actions. (p. 36)

Unfortunately, what PSTs learn in a methods course may not be perceived as directly relevant to the realities of an actual classroom setting (Grossman, Compton, et al., 2009).

Clift and Brady (2005), in their meta-analysis of almost two dozen studies of mathematics methods courses, found that most PSTs reported a positive perception of their mathematics methods course. However, these studies did not provide conclusive evidence as to whether the PSTs effectively connected the principles and practices learned in their methods coursework to actual classroom practice in the field. Zeichner (2010) posited that the time that PSTs spend in the K-12 classroom during a methods course often does not include the opportunity for PSTs to integrate the theory learned in the course with practices they enact in the field.

PSTs many times do not perceive a direct connection between the theory learned in a methods course and field-based experiences (Darling-Hammond, 2006b), causing them to "prioritize what they learn in the field, as this learning is directly transferable to what they need to do in the new teaching context" (Murata & Pothen, 2011, p. 104). Because of this disconnect, the National Council for Accreditation of Teacher Education (2010) recommended a "clinically based preparation for prospective teachers, which fully integrates content, pedagogy, and professional coursework around a core of clinical experiences" (p. 8). Cooper (1996), in her case studies of PSTs enrolled in elementary mathematics methods courses, concluded that deliberate and purposeful connections between mathematics methods courses and authentic field experiences add relevance to

PSTs' experiences and give teacher educators an opportunity to help build PST mathematical understanding in ways not possible without the added benefits from integrated field experiences.

One important tool that teacher education programs, and particularly methods courses, must provide elementary PSTs is a working knowledge of content-focused instructional pedagogies and instructional routines specific to mathematics (Forzani, 2014). Gainsburg (2012), in her study of the impact of university teacher education programs on novice teachers' implementation of reform-based teaching strategies, found that new teachers were most likely to implement a particular practice when they had tried it themselves at an earlier time, such as in a methods course. Grossman and McDonald (2008) advocated for pedagogies of enactment to be included within PST education programs, in order to allow PSTs to become more comfortable with implementing a variety of teaching strategies. A methods course can provide PSTs with this opportunity to practice various strategies in a guided setting. This study made use of two particular instructional routines that are introduced and developed in the context of this methods course, namely number talks and the orchestration of whole-class mathematical discussions.

## Number Talks

A number talk is a short lesson or activity that tasks students with reasoning about numbers and their relationships (Parrish, 2010). Number talks are designed to elicit from students an array of different strategies that could be employed in solving a purposefully crafted problem involving mental mathematics (Brown, 2019), with the end goal of enhancing students' number sense (Okamoto, 2015). The idea of developing number sense in school mathematics has been emphasized as fundamentally important by a variety of reports and curriculum documents (e.g., NCTM, 1989, 2000; NGA/CCSSO, 2010; National Mathematics Advisory Panel, 2008; National Research Council, 2002). The National Research Council report *Everybody Counts* (1989) stated that the development of number sense is “[t]he major objective of elementary school mathematics” (p. 46). The conception of number talks was in response to a call to expand mathematics education beyond rote memorization and an exclusively procedural understanding of mathematics (NCTM, 2000; National Research Council, 2002).

A number talk typically requires between five and fifteen minutes of classroom time to elicit conversations among students around intentionally selected mental mathematics computation problems (Parrish, 2011). Number talks provide an opportunity for students to learn to reason mentally about numbers, focusing on conceptual understanding and sense-making (Humphreys & Parker, 2015). After solving a given mathematics problem mentally, students are asked to communicate and justify their solution strategy to other members of the class (Flick & Kuchey, 2015). Parrish (2011) claimed that the result of these number talks was the development in students of more efficient, accurate, and flexible computation strategies.

Number talks have been included in various research studies. For example, Johnson and Partlo (2014) found that fourth-grade students’ regular participation in number talks yielded growth in both their abilities regarding mental mathematics and their articulation of problem-solving strategies. Okamoto (2015) found similar results in his study, in which a six-week number talk intervention with sixth-grade students resulted in a significant increase of students’ test scores on items related to number sense.

Looking to expand the use of this strategy, Biro and Dick (2019) described how number talks can become more accessible to students in early elementary grades by making use of anchor charts.

Researchers have also considered the value of number talks in the education of PSTs. In their quantitative study, Lustgarten and Matney (2019) found that after experiencing number talks from a learner perspective, most PSTs indicated that they would consider using this instructional strategy in their own classrooms. Expanding upon the foundation of number talks, researchers have sometimes combined this tool with other instructional strategies. Baldinger, Selling, and Virmani (2016), using the structure of McDonald et al.'s (2013) cycle of enactment and investigation, presented an instructional activity for PSTs that was designed to help facilitate classroom talk; the PSTs received instruction on number talks as part of the preparation for this activity. The study described in this dissertation has made a similar connection, asking PSTs to make use of both number talks and strategies for orchestrating whole-class discussions.

**Orchestrating Whole-Class Mathematics Discussions**

Teachers often use whole-class discussions to encourage student-centered learning by building upon ideas and responses of peers in a way that builds the mathematical understanding of the entire class (Ball, 1993; Lampert, 2001). Whole-class discussions can be focused on a mathematical concept or procedure, a definition, or a problem-solving task (Boerst, Sleep, Ball, & Bass, 2011). Having students share thoughts and solutions with the class encourages them to take an active role in both learning and in communicating ideas with clarity. The role of the teacher in this forum is to encourage students to contribute their mathematical ideas to the discussion and to build upon the ideas of one another (Sherin, 2002). However, teachers often struggle with providing the guidance necessary to assist in building authentic student understanding in an efficient manner (Ball, 1993, 2001).

Although various strategies for leading a whole-class discussion have been delineated in past research (e.g., Inagaki, Hatano, & Morita, 1998; Jones & Tanner, 2002; Myhill, 2006; O'Connor, Michaels, Chapin, & Harbaugh, 2017; Stephan, 2014), PSTs may still experience difficulties when attempting to lead a class discussion. This is partly due to the lack of expertise and experience of the PST, as he or she may not yet have developed the pedagogical content knowledge that is required in order to successfully guide students through a large-group mathematical discussion (Stein, Engle, Smith, & Hughes, 2008). When uncertain about how best to facilitate a whole-class discussion, PSTs may resort to a method resembling a "show-and-tell," during which students take turns sharing the procedure that they used in order to procure the correct answer (Ball, 2001).

Stein and colleagues (2008) offered a pedagogical model that identifies five concrete practices that teachers, as well as PSTs, can use to more effectively orchestrate productive mathematical discussions (see also Smith & Stein, 2011). These Five Practices include anticipating, monitoring, selecting, sequencing, and connecting (see Table 1) (Smith & Stein, 2011; Stein, Engle, Smith, & Hughes, 2015; Stein et al., 2008).

Table 1

*An Overview of Smith and Stein's (2011) Five Practices to Orchestrate Productive Mathematical Discussions*

| Practice | Description |
|---|---|
| 1) Anticipating | The teacher anticipates potential student responses to a particular mathematical task, including a variety of strategies and any predicted possible misconceptions |
| 2) Monitoring | The teacher monitors students' responses as they are working by circulating around the classroom |
| 3) Selecting | The teacher intentionally selects particular student responses to be shared in a whole-class setting |
| 4) Sequencing | The teacher purposefully sequences the selected responses in a predetermined order |
| 5) Connecting | The teacher helps the class to build connections between the various student responses through questioning and focusing techniques |

Implementation of these Five Practices has been shown to be a way to foster active learning in the mathematics classroom, placing the student at the center of the learning (Nabb, Hofacker, Ernie, & Ahrendt, 2018). These Five Practices are not new constructs; similar ideas can be found in earlier documents, such as NCTM's (1991) *Professional Standards for Teaching Mathematics.* Stein and colleagues (2008) provided a clear articulation of teacher practices in a sequential way that teachers may find more concise and simpler to implement on a daily basis. Nabb et al. (2018) provided examples of how these Five Practices can be implemented in a classroom, pointing out three components that are necessary for successful implementation of these practices, namely the use of high-level, cognitively demanding tasks, the integration of authentic student work, and a classroom culture that values learning from mistakes and productive struggle (NCTM, 2014).

Both number talks and strategies to promote productive whole-class mathematical discussion have been shown to yield successful results in the classroom setting. Johnson and Partlo (2014), in their two-month study of fourth graders, concluded that consistent student participation in number talks positively affected their ability to perform mental mathematics and articulate problem-solving strategies. Okamoto (2015) came to similar conclusions in his mixed methods study involving sixth-grade students. Nabb and colleagues (2018) shared two vignettes illustrating the positive classroom learning that occurred in a classroom in which Smith and Stein's (2011) Five Practices were implemented. As they learn to implement these instructional strategies, PSTs may benefit from an opportunity to further ground these strategies in research-based practices that are common to effective mathematics teaching.

## Mathematics Teaching Practices

In 2014, NCTM published *Principles to Actions: Ensuring Mathematical Success for All* to provide a supportive structure addressing the essential elements of a mathematics classroom that works toward empowering every student to be mathematically successful. The overall theme of *Principles to Actions* is that "effective teaching is the nonnegotiable core that ensures that all students learn mathematics at high levels and that such teaching requires a range of action" (p. 4). In this document, a framework consisting of eight Mathematics Teaching Practices was introduced (see Table 2), representing "a core set of high-leverage practices and essential teaching skills necessary to promote deep learning of mathematics" (p. 9). These practices, which "describe intentional and purposeful actions taken by teachers to support the engagement and learning of every student" (Huinker & Bill, 2017, p. 4), are often used to further the education of teachers, both pre-service and in-service (e.g., Huinker & Hedges, 2015).

Table 2

*An Adaptation of NCTM's (2014) Eight Mathematics Teaching Practices*

| Practice | Description |
|---|---|
| 1. Establish mathematics goals to focus learning | The teacher articulates clear and appropriate mathematical goals for students, then uses these goals to guide classroom instruction |
| 2. Implement tasks that promote reasoning and problem solving | The teacher implements rich learning tasks that encourage all students to develop their mathematical reasoning and problem-solving skills |
| 3. Use and connect mathematical representations | The teacher assists students in their ability to build and strengthen connections between various mathematical representations, leading to a deeper conceptual understanding of mathematics and a greater flexibility in application of problem solving strategies |

(continued)

Table 2 Continued

| Practice | Description |
|---|---|
| 4. Facilitate meaningful mathematical discourse | The teacher facilitates mathematical discourse among students, giving students the opportunity to build a shared understanding of the mathematics, analyze one another's approaches, and foster mathematical communication skills |
| 5. Pose purposeful questions | The teacher poses questions that are deliberate and purposeful, seeking to both assess student understanding and advance students' mathematical sense-making |
| 6. Build procedural fluency from conceptual understanding | The teacher acknowledges the importance of both conceptual understanding and procedural fluency, building in students a foundation of conceptual understanding upon which they can develop flexibility and fluency in the application of procedures to mathematical problems |
| 7. Support productive struggle in learning mathematics | The teacher provides students with the opportunity to engage in productive struggle as they build their individual and collective understanding of mathematics and grow in mathematical sense-making |
| 8. Elicit and use evidence of student thinking | The teacher consistently elicits student thinking to assess student mathematical understanding and to continually adjust instruction for the benefit of student learning |

Just as can be seen in Smith and Stein's (2011) Five Practices to Orchestrate Productive Mathematical Discussions, these particular practices are not new constructs; elements of each can be found in previous initiatives by NCTM (1991, 2000). However, when similar ideas were presented in earlier documents, they were in the form of standards, rather than practices; the articulation of these eight practices was a response to a call by scholars (e.g., Ball & Forzani, 2011; McDonald et al., 2013) for an explicit set of research-based teaching practices that are common to effective teaching of mathematics.

Consequent literature has emphasized the need for teachers of mathematics to consistently make use of these practices. Lee and colleagues (2016), in their study examining PSTs' use of Mathematics Teaching Practices when critiquing and modifying lesson plans, found that PSTs' interpretations of the eight practices were not clearly aligned with the actual intention of the Mathematics Teaching Practices, as depicted in NCTM's (2014) *Principles to Actions*. Huinker and Bill (2017), in their analysis of the eight Mathematics Teaching Practices, showed how these practices are aligned with an approach that supports equity in the mathematics classroom. Leinwand, Huinker, and Brahier (2014) posited that teachers' effective use of these practices, coupled with the support of principals, coaches, and other school leaders, is a means by which all students can achieve mathematical success.

In this study, I have highlighted two of these eight Mathematics Teaching Practices, posing purposeful questions and facilitating meaningful mathematical discourse (see Table 2). These are both identified by the mathematics education community as core practices in the effective teaching of mathematics. In her dissertation examining secondary mathematics PSTs' enactment of discourse-based mathematics teaching practices, Grosser-Clarkson (2016) recognized these two practices, along with eliciting and using evidence of student thinking, as being particularly focused on discourse in the mathematics classroom.

**Pose Purposeful Questions**

The strategy of asking students questions in mathematics class serves multiple purposes. First, it is an informal assessment of what students know and understand, allowing the teacher to make instructional decisions that are tailored to the needs particular to the students in the classroom (Steinberg, Empson, & Carpenter, 2004). However, teachers can also use purposeful questioning as a technique to "encourage students to explain and reflect on their thinking" (NCTM, 2014, p. 35), supporting students in their mathematical sense-making abilities as they attempt to make important mathematical connections. In this sense, the art of questioning becomes an instructional tool through which teachers can support students in their building of deep conceptual understanding of mathematical concepts (Huinker & Bill, 2017).

Boaler and Brodie (2004), in their longitudinal study following approximately 1000 students in three schools over four years, found that the different questions teachers ask have the potential to "shap[e] the nature and flow of classroom discussions and the cognitive opportunities offered to students" (p. 781). If they hope to further their students' understanding of mathematics, teachers must first use various questioning techniques in order to better assess how students are reasoning (Grosser-Clarkson, 2016). One common practice emphasized in research is the importance of including open-ended questions that require higher-level thinking of students (Lampert, 2001). Anthony and

Walshaw (2009), in their summary of characteristics of effective teaching of mathematics, posited that questions that allow for a variety of strategies and have multiple possible solutions allow teachers to gain valuable insights into their students' mathematical thinking skills.

Research has been conducted on the questioning techniques of PSTs. For example, Moyer and Milewicz (2002) examined the questioning strategies of 48 elementary PSTs enrolled in a mathematics methods course and found that authentic experience questioning students, even if it only involves questioning a single child, can aid PSTs in developing valuable questioning skills. Ralph (1999) found that PSTs engaged in an extended practicum experience with contextual supervision improved their oral questioning techniques over a period of sixteen weeks. Weiland, Hudson, and Amador (2014) conducted a case study to provide in-depth insights regarding the development of questioning techniques of two PSTs over the course of a semester. They found that weekly opportunities for PSTs to interact with students, then reflect upon the student thinking that they encountered, resulted in the improvement of various questioning techniques.

Purposeful questioning cannot stop with the simple posing of a question; effective teaching requires the teacher to both listen to (Empson & Jacobs, 2008) and hear (Wallach & Even, 2005) their students. Well-posed questions have the potential, when timed and presented appropriately, to elicit student thinking, allowing teachers the opportunity to advance the presence of meaningful mathematical discourse in the classroom.

**Facilitate Meaningful Mathematical Discourse**

The field of mathematics education recognizes the valuable contributions of student mathematical thinking to the teaching and learning of mathematics (Fennema et al., 1996). Opportunities to interact with one another, share mathematical strategies, communicate mathematical thoughts, and justify their reasoning help students to develop a deeper understanding of mathematical concepts (Walshaw & Anthony, 2008). The National Council of Teachers of Mathematics (2014) explained that “[e]ffective teaching of mathematics facilitates discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments” (p. 29).

Although the value of discourse in the mathematics classroom is recognized by many, the actual practice of encouraging meaningful mathematical conversations in the classroom can be difficult (Scherrer & Stein, 2013). As Sfard, Nesher, Streefland, Cobb, and Mason (1998) observed, “the question is not *whether* to teach through conversation, but rather *how*” (p. 50). In addition, discourse itself can differ from truly productive discourse, and the latter is what is particularly beneficial to the mathematics classroom.

Stockero, Leatham, Ochieng, Van Zoest, and Peterson (2019), in their study of teachers’ orientations toward the use of student mathematical thinking and reasoning in the context of a whole-class discussion, pointed out that although the mathematics education community as a whole advocates the use of student thinking in classroom lessons, actually putting this ideal into practice is difficult for teachers. The classroom teacher, as acknowledged by Cohen (2011), has the responsibility to “manage complicated interactions, keep track of many difficult ideas, help regulate students’ participation, and help students learn the conventions of the discourse and how to conduct themselves in it, all more or less at once" (p. 156). In addition, facilitation of classroom discourse requires the ability to react to in-the-moment student thinking (Van Zoest, Peterson, Leatham, & Stockero, 2016), which can be challenging for teachers.

Also acknowledging the difficulty of facilitating quality classroom dialogue, Leinhardt and Steele (2005) analyzed the complexity of discourse in a fifth-grade classroom in which the teacher used instructional dialogues to engage students in sharing understanding through intellectual conversation. Leinhardt and Steele concluded that facilitating meaningful classroom discourse is a challenging endeavor, and they recommended that teacher education programs help PSTs to recognize the flexibility that is needed to first listen closely to student thinking and reasoning, then respond appropriately, modifying the lesson as needed.

To attend to this need to support teachers, scholars have proposed various teaching strategies to address the inclusion of meaningful mathematical classroom discourse (e.g., Sherin, 2000, 2002; Stephan, 2014). One such strategy is the enactment of Smith and Stein's (2011) Five Practices to Orchestrate Productive Mathematical Discussions. These practices serve as one model termed by Nabb and colleagues (2018) as a "particularly illuminating" (p. 367) framework through which social interaction and active discourse can be productively enacted in the mathematics classroom.

NCTM's (2014) Mathematics Teaching Practices are a means by which teachers can encourage all students toward the achievement of mathematical success (Leinwand et al., 2014). In the context of teacher preparation programs, PSTs may experience the Mathematics Teaching Practices, including posing purposeful questions and facilitating meaningful mathematical discussion, in two distinct settings: in the context of a primarily theoretical approach, as the mathematics teacher educator presents these practices to the PSTs in the setting of the mathematics methods coursework, and in the context of a practice-based approach, as the PSTs experience these practices in authentic K-12 classroom settings. In order for a teacher education program to possess a true sense of integrity, these two settings must begin to merge into a coherent whole (Carr et al., 1995).

Thus far, I have set forth the theory-practice gap as a problem needing attention in the field of teacher education. I then provided the basis for the theory of hybrid space and how this can be useful in the analysis of educational contexts. Next, I gave an overview of the MFE, providing details regarding its history, the structure of each of its elements, and how past research has begun to build a scholarly foundation for further study of this particular pedagogy. I also described how mathematics methods courses can provide an appropriate setting for developing PSTs' knowledge of and ability to make use of various pedagogies in the teaching of mathematics. Finally, I have delineated how two specific Mathematics Teaching Practices (NCTM, 2014) focused on classroom discourse are beneficial to developing the effective teaching of mathematics. Building upon these foundational areas, I next set forth a conceptual framework that makes use of the concept of coherence to address how the MFE has the potential of addressing the existing theory-practice gap.

## Conceptual Framework: The Lens of Coherence

This study examined PSTs' perceptions of coherence between Mathematics Teaching Practices as discussed in a mathematics methods course and as enacted in an authentic elementary classroom. Recognizing the theory-practice gap that hinders integration of coursework and field experiences, including in the context of internalizing Mathematics Teaching Practices (see Figure 3), I have investigated the MFE, the elements of which may to various extents encourage entry into a hybrid space, as one specific response to this challenge (see Figure 4). The conceptual framework for this study is built upon these elements, as seen through the lens of the theoretical construct of coherence.

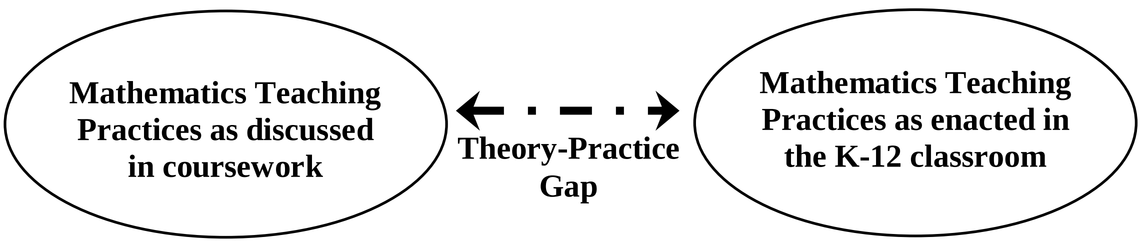


*Figure 3.* A traditional mathematics methods course. This figure displays the gap between how PSTs perceive Mathematics Teaching Practices in coursework and in field experiences.

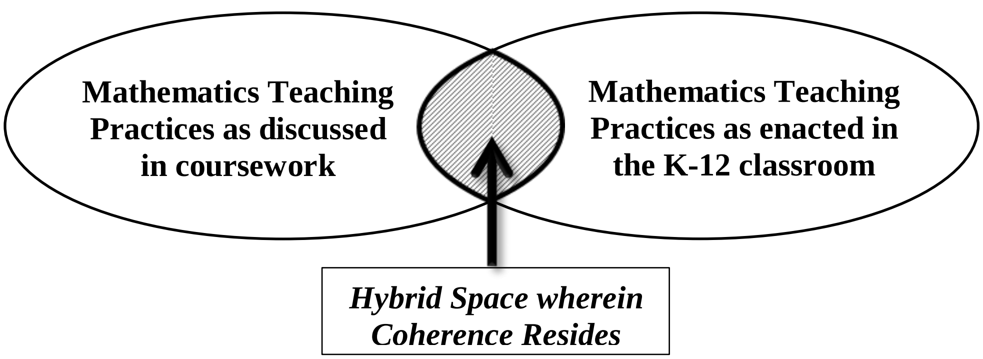


*Figure 4.* A mathematics methods course with MFEs. This figure illustrates a potential outcome that may result from the use of the MFE in a mathematics methods course to increase PSTs' perceptions of coherence between Mathematics Teaching Practices as discussed in coursework and as enacted in the classroom.

The goal of teacher preparation programs is straightforward, namely the preparation of highly qualified teachers (Schmidt et al., 2011). Traditional teacher education programs rely on a combination of theoretically-based coursework and practically-grounded field experiences to prepare PSTs to take on the multi-faceted role of a teacher (Lotter, Smoak, Blakeney, & Plotner, 2019). These areas, encompassing both the theoretical and practical aspects of teaching, need to have a purposeful underlying integrated structure that allows PSTs to build connections between theory and practice (Grossman et al., 2008). The concept of *coherence* encapsulates this quality of consistent connections that form a unified whole and can be used to frame the complex relationship between theory and practice (Weston & Henderson, 2015).

Østergaard (2013) posited that "[e]stablishing coherence between theory and practice is one of the main challenges in mathematics teacher education" (p. 2). Scholars claim that PSTs, in order to integrate elements of theory and practice, must experience a certain level of coherence in their teacher preparation program (Weston & Henderson, 2015). In this section, I examine this idea of coherence in teacher preparation programs by first setting forth definitions of coherence, both generally speaking and with reference to different categorizations of coherence. Following this, I consider why and how coherence is important in the more specific realm of connecting coursework with field experiences, as well as how one might evaluate coherence, focusing especially upon PSTs' perceptions of coherence.

**Defining Coherence in Teacher Education**

Although coherence is oft advocated in teacher education programs, the term itself is frequently left undefined (Grossman et al., 2008). However, a few scholars have attempted a working definition. Weston and Henderson (2015) defined *coherent experiences* as "experiences that build upon each other toward a consistent end and are intentional, continuous, unified, and clear" (p. 322), pointing toward the lack of coherent experiences as a significant problem in teacher education. Coherence is characterized by a certain level of connectivity (Buchmann & Floden, 1992) and "the alignment of ideas and learning opportunities" (Grossman et al., 2008, p. 274). This sense of connection and alignment are congruent with and point toward the wholeness exemplified by the concept of integrity, a wholeness that takes place within the dynamisms of the human person as he or she more fully embodies what it means to be a teacher (Guardini, 1954).

Coherence can take on a variety of shapes and forms. A consideration of the different types of coherence is important in determining both the specific kinds of coherence that are desirable (Hammerness, 2006) and how to increase certain types of coherence. A number of distinctions in types of coherence have been made in the literature (e.g., Canrinus et al., 2017; Hammerness, 2006; Muller, 2009; Smeby & Heggen, 2014); however, the terms used often have unclear boundaries, referring to concepts that may be indistinct and overlap with one another. Although other researchers may set forth different interpretations of the various categorizations of coherences, for the purposes of this study, I refer to coherence in two overarching contexts, structural coherence and conceptual coherence.

*Structural coherence* refers to the alignment and integration of program components, including coursework and field placements. Coherence in this sense is typically applied broadly to the interconnections between courses and major components of a teacher education program and is often referred to as *program coherence* (Smeby &

Heggen, 2014). This categorization of coherence is focused upon logistics and program design (Grossman et al., 2008), is guided by a set of principles that include a shared vision and common standards of practice (Richmond, Bartell, Andrews, & Neville, 2019), and often includes efforts to sequence courses and corresponding activities, experiences, and assignments in a purposeful manner, so that these build upon one another (Hammerness, 2006). In recent years, there has been a focus on improving structural program coherence in teacher education programs (Canrinus et al., 2019; Richmond et al., 2019; Samaras, Frank, Williams, Christopher, & Rodick, 2016).

The extent to which the philosophy and theoretical underpinnings of a program are meaningfully connected with actual classroom practice is often referred to as *conceptual coherence* (Canrinus et al., 2019). This idea of conceptual coherence can be applied specifically to the connections between the structure and content of a program (Feiman-Nemser, 1990) or more broadly to the general purposeful linking of theory and practice (Kessels, Koster, Lagerwerf, Wubbels, & Korthagen, 2001). Conceptual coherence focuses primarily on philosophies, ideas, and visions (Grossman et al., 2008).

Coherence is not an end in itself; rather, it is a process, a means by which a teacher preparation program and its various components can make adjustments in order to better support PSTs in their formation as effective educators (Honig & Hatch, 2004; Weston & Henderson, 2015). Samaras and colleagues (2016) emphasized that coherence does not imply that all involved in the teacher preparation program think alike, but rather that all focus on achieving the same central goal. Smeby and Heggen (2014) similarly made a distinction between coherence and consistency; consistency implies an absence of any kind of contradiction, whereas coherence allows for the conflicts and tensions that are unavoidable in the multi-faceted educational setting that gains its value from the varied experience of students and educators (Buchmann & Floden, 1992). As such, coherence is not something that a teacher education program can ever fully achieve, as if it were a box to be checked off, but rather programs must continually evaluate and adjust its components in order to progress toward ever-increasing coherence at multiple levels (Hammerness, 2006) and simultaneously increase the integrity of its offerings.

**Building and Evaluating Coherency Between Coursework and Field Experience**

Past research has indicated that when they are given field placements in an environment that is consistent with the teacher education program's philosophy of teaching and learning, PSTs learn more from the experience. LaBoskey and Richert (2002) employed a case study approach to investigate two student teachers' analyses of the components necessary for a positive and productive student teaching experience. They found that coherency between the principles learned in coursework from the teacher preparation program and their experiences in the student teaching classroom was an important element: "[T]he student teachers searched for evidence of all of the principles in their fieldwork settings, and it was those settings where a composite of the principles was present that most student teacher learning occurred" (p. 27). Koerner, Rust, and Baumgartner (2002), in their study of student teachers, their cooperating teachers, and their university-based supervisors, found that student teachers often see their cooperating teachers primarily as role models and their university supervisors primarily as mentors, leading to the conclusion that a successful student teaching experience includes a common understanding by both of the vision and purpose of the clinical experience. Research has also shown that PSTs who experience greater coherence between coursework and field experience are more likely to enact effective instruction when they are teaching (Clift & Brady, 2005).

An important aspect to consider is the degree to which PSTs perceive coherence and complementarity between what they are learning in their coursework and what they experience in the field (Canrinus et al., 2019). Canrinus and colleagues (2017), in their international quantitative study of student teachers, reported that "[j]ust as the overall goals and aims of curriculum and courses are clear and apparent to faculty, but 'hidden' for students, so too can the coherent nature of a teacher education program" (p. 314). Grossman and colleagues (2008) pointed out that "one important measure of coherence is the degree to which student teachers in these programs perceive that they have coherent opportunities to learn, particularly in terms of the relationship between fieldwork and coursework" (p. 275). Weston (2019), in his single case study of a PST in a methods course, included evaluation from the perspective of the PST as one of three required components of the conceptualization of coherence. Unfortunately, aside from these studies, research in the area of PSTs' perceptions of coherence between their coursework and fieldwork is extremely limited (Canrinus et al., 2019).

Various studies, largely quantitative in nature, have examined structural coherence in teacher education programs. The majority of these have considered the coherence of the program as a whole (e.g., Canrinus et al., 2019; Grossman et al., 2008; Hammerness, 2006; Samaras et al., 2016; Smeby & Heggen, 2014); few studies have considered the coherence between coursework and field experience in a single particular course (e.g., Weston, 2019).

Weston and Henderson (2015) presented a model to build coherency in teacher education. Important components of this model included providing PSTs with consistent opportunities for authentic classroom teaching practice, as well as providing PSTs with expert feedback immediately following their classroom field experience. This model is in line with the pedagogy of MFEs, especially when these experiences include opportunities for the PSTs to teach and observe in an authentic classroom.

Canrinus and colleagues presented examples of multi-institution quantitative studies. Canrinus et al. (2017) conducted Likert surveys from 486 student teachers studying in eight teacher education programs in five countries; they found that these student teachers perceived a reasonable level of coherence and connection between various elements of their teacher education programs overall, yet found coherence specifically between coursework and field experiences to be lacking. Further clarifying, Canrinus et al. (2019) published findings concerning PSTs from three teacher education programs (n=269) regarding coherence, including an evaluation of the PSTs' perceived coherence between their coursework and their field experiences. Overall, PSTs reported a reasonable level of coherence between these two areas. The PSTs reporting the highest level of coherence represented a program that included continuous field placements, in which the PSTs alternated between coursework and time in the field on a daily basis, unlike the other two programs that assigned field experiences during three or four blocks in the course of the school year. This research represents a few of the very limited number of studies that have examined coherence between coursework and field experiences from the perspective of the PST. The current study complements and adds to these quantitative multi-institutional findings by qualitatively studying one particular course in one program.

In addition, this study more specifically adds to the literature base on coherence by focusing on the extent to which PSTs perceive the coherence of a mathematics methods course, specifically as seen through connections between coursework and field experience facilitated by multiple cycles of MFEs focused on particular Mathematics Teaching Practices. By examining the entry of PSTs into hybrid space in the context of the MFEs, I consider how the different components of the MFE, as well as the MFE as a whole, affected PSTs' perceptions of the degree of coherence experienced between what they learned about Mathematics Teaching Practices in their methods coursework and the opportunities they had to both observe and implement these Mathematics Teaching Practices in the field.

## Conclusion

This chapter provided a review of literature that informs this study. I began by considering the research surrounding the existence of the theory-practice gap in teacher education. I then gave an overview of hybrid space theory. I introduced the MFE, including its history, its structure, and relevant research that has been published to date. I considered the role of the mathematics methods course and particular instructional strategies in PST education and gave background information on NCTM's (2014) Mathematics Teaching Practices. Finally, I situated the study in a conceptual framework built upon the concept of coherence. In the following chapter, I will explain in detail the methodology used in the implementation of this study.

# CHAPTER III: METHODOLOGY

Traditional teacher education programs often experience disconnect between coursework and fieldwork (Grossman, Hammerness, & McDonald, 2009); the separation between theory and practical application diminishes the integrity and wholeness that are desired within the teacher education program (Carr et al., 1995). Researchers have suggested the mediated field experience (MFE) as one pedagogy that could potentially provide a more coherent approach by reconceptualizing the gap between coursework and fieldwork (Horn & Campbell, 2015) and encouraging the development of a hybrid space for preservice teachers (PSTs) between what is learned in the university classroom and what is experienced in the field (Zeichner, 2010). In the field of mathematics education, one specific context in which this could take place is in the study and application of Mathematics Teaching Practices (NCTM, 2014) in a mathematics methods course.

The need for more detailed research on the MFE as a tool for building coherence between coursework and fieldwork for PSTs, particularly in their preparation to teach mathematics, has guided the present study. The purpose of this study was to consider the nature of PSTs' reflections during their participation in MFEs in general, as well as in the setting of each particular element of the MFE, and also to examine PSTs' perceptions of coherence between Mathematics Teaching Practices in methods coursework and in field experiences and any entry into hybrid space by the PSTs in relation to these practices. Consequently, the research questions for this study included:

1. How, if at all, does the focus of PSTs' reflections evolve over the course of their participation in multiple cycles of MFEs?

2. How, if at all, does the content of PSTs' reflections differ amongst each individual element of the MFE?
3. As PSTs participate in multiple cycles of MFEs, how do characteristics of coherence between theoretical concepts and authentic classroom experiences reveal instances of PST entry into hybrid space?

To address these research questions, I used a research methodology situated in the interpretivist paradigm (Paul, 2005). In my search for "meaningful understanding" (Patton, 2015, p. 113), I employed a qualitative approach consisting of two case studies. I analyzed the two cases using the lens of hybrid space theory, identifying when PSTs are thinking and acting in a particular component space, and when they enter into a hybrid space, heightening the integrity of their PST experience. This provided insights as to the nature of PSTs' entry into hybrid space, wherein coherence may reside.

This chapter provides details pertaining to the design of the study. The following sections include my rationale for choosing a case study approach; an outline of the context in which the study took place, including the setting, the selection of participants, and the context of the learning environment itself; and details regarding data collection. The chapter also includes my analytical framework, which is built upon Wood and Turner's (2015) adaptation of Lampert's (2001) three-pronged model of teaching practice. This illustrates the choices I made regarding an approach to analyze my data. Next, the chapter presents relevant details regarding the actual data analysis stage. Finally, I put forth considerations of trustworthiness, as well as some limitations and delimitations of this study. To increase transparency, I have been as thorough and detailed as possible in my explanations of research methods employed.

## A Case Study Approach

As the purpose of this study was to examine the nature of PSTs' reflections in various contexts, as well as PSTs' perceptions of an experience, I employed a methodology that allowed me to explore the experience of PSTs in the context of the various elements of the MFE. I thought it important to include multiple participants, as I was interested in using "a variety of lenses which allows for multiple facets of the phenomenon to be revealed and understood" (Baxter & Jack, 2008) in depth within a bounded system (Stake, 1995).

Merriam (1998) described the case study as a helpful tool to better understand the lived experience of individuals in a certain system. Yin (2003) added that this approach allows the researcher to explore individuals, relationships, interventions, and programs. Researchers have determined that case study methodology tends to give attention to the MFE experience in ways that allow one to better understand the MFE and its effects (Swartz, Billings, et al., 2018). Hence, I have employed a qualitative case study approach to this study, bounded within the PSTs' experience in the methods course and the corresponding elements of an MFE.

Case studies benefit from a clear recognition of the unit of analysis. Yin (2003) considers the unit of analysis to be that which clarifies the beginning and the end of a case study. The complex nature of teaching can provide a challenge for the identification of a specific unit of analysis. Yin advises that the definition of a unit of analysis be strongly connected to the research questions identified for the study. Consideration of both the research questions and the related ultimate purpose of this study—namely, an exploration of the nature of PSTs' reflections over the course of multiple cycles of MFEs undertaken in order to provide a deeper understanding of the MFE as a pedagogy—gave clarity to the definition of a case in this particular study. The unit of analysis in this study was the perceptions of individual PSTs, set in the context of each PST's experience in a cycle of MFEs, as manifested primarily through written and oral reflections and interviews.

This case study approach allowed me to describe in depth the PSTs' perceptions of their experience with the MFE as a whole, as well as with various elements of the MFE (Patton, 2015) This approach yielded rich descriptions of how the MFE, as experienced in each of its elements, can contribute to a narrowing of the theory-practice gap in the context of Mathematics Teachings Practices taught in a mathematics methods course.

## Context of the Study

This section addresses various components of the context of this study. I first describe the setting for the study, followed by an overview of the selection of participants for the study. I then outline the learning environment within which this study was situated, giving details regarding the implementation of the cycles of MFEs within the methods course.

### Setting

This study was conducted at Teacher Preparation College (a pseudonym; all names and places have been given pseudonyms throughout), a small private faith-based liberal arts college in an urban area of the southeastern United States. Although the college offers several degree programs, teacher education is the explicitly stated primary focus of the college; 90% of students enrolled in the college are seeking initial licensure in teaching. The college offers both undergraduate and graduate degrees in education. Just over 40% of the PSTs in the teacher education program come already having attained a baccalaureate degree in a non-education field and are therefore enrolled in the Master of Arts in Teaching (MAT) program. In addition, about one-third of those in the undergraduate program are transfer students who have had one or two years of college at another institution, often in a program other than education. The majority of the graduates of the program will teach in a faith-based K-12 school; consequently, teacher preparation focuses on expectations that encompass both the public and private school settings.

The course in which this study was conducted is a mathematics and science teaching methods course designed for elementary PSTs. According to the course catalog, this three-credit-hour course gives attention to strategies on planning, instruction, and assessment as these pertain to the teaching of mathematics and science in the elementary classroom. This course, which met for an hour and twenty minutes twice a week, is required for all students pursuing initial licensure in elementary education through the baccalaureate program. Although the course addressed the teaching of both mathematics and science, this study only focused upon the weeks dedicated to mathematics teaching methods, which occurred during roughly the first half of the sixteen-week course. This was the first time that an MFE had been initiated in any course at this institution. The textbook used for the course was Huinker and Bill's (2017) *Taking action: Implementing effective mathematics teaching practices in K-Grade 5.* The coursework that took place in the college classroom comprised one of the two component spaces that I investigated in this study.

The clinical aspect of the MFEs was conducted at a nearby PreK-8 private school, Learning Academy. This setting provided the second component space for this study. I chose this school because of its convenient location, the relatively diverse student population served, and the positive relationship that I had previously formed with the principal of the school. A partnership between Teacher Preparation College and Learning Academy had been in place for a number of years; the principal encouraged teacher candidates from Teacher Preparation College to gain clinical experience at the school and was open to increased collaboration. Johnson and Barnes (2018) noted the importance of establishing and maintaining partnerships in addressing the theory-practice gap, and Horn and Campbell (2015) recognized the value of this pre-established partnership in the planning and designing of MFEs; drawing upon these previously acknowledged benefits, the relationships that had previously been established with Learning Academy were built upon in the selection of the cooperating teacher, which is described below.

## Participants

PSTs served as the participants for this study. However, the cooperating teacher and the mathematics teacher educator were also key participants in the MFEs. Individuals fulfilling each of these three essential roles are described in this section.

**PSTs.** Two PSTs, Lucy and Maria, were enrolled in the mathematics and science methods course; both agreed to participate in this study. These participants were both females pursuing initial licensure in elementary education. This was a convenience sample of a complete target population (Patton, 2015), namely all of the PSTs enrolled in this particular methods course. As this course is required only for undergraduate students pursuing licensure in elementary education, the class size tends to be small, typically between two and six students. For both participants, this was the first methods course in which they had been enrolled.

Lucy was a Caucasian student in her early twenties, born and raised in the United States. She described her previous experiences in mathematics classes as “very collaborative” and “hands-on” (Lucy, Background Survey).

Maria was an Asian student in her early twenties, born in the Philippines and raised in Canada. When asked what she hoped to learn in the course, Maria replied: “I hope to learn how to teach math and science in a way that is developmentally appropriate, academically rigorous, and practical to students in grades K-5. I want to gain clarity and confidence as one studying to become a teacher” (Maria, Background Survey).

**Cooperating teacher.** Due to my role at Teacher Preparation College, I had previously observed a number of the teachers at Learning Academy. As part of each observation involving a lesson in mathematics, I used the Mathematics Classroom Observation Protocol for Practices (MCOP$^2$) (Gleason, Livers, & Zelkowski, 2015, 2017) (see Appendix A) as a tool to measure the student engagement and teacher facilitation during the lesson. The MCOP$^2$ is “a K-16 mathematics classroom instrument designed to measure the degree of alignment of the mathematics classroom with the various standards . . . that focus on conceptual understanding in the mathematics classroom” (Gleason et al., 2015, para. 1). These observations provided me with: (a) data-based evaluations of the degree to which the teaching and learning in the observed mathematics classrooms aligned with research-based practices, and (b) an informal sense of which teachers would be confident in their instruction of mathematics and open to the collaboration required to conduct MFEs.

Using information from these observations, particularly the scores from items #1, 4, 9, 11, and 16 of the MCOP$^2$ (see Appendix A), I selected a K-5 teacher and classroom that presented an environment that is supportive of the two Mathematics Teaching Practices (NCTM, 2014) that the methods course focused upon, namely posing purposeful questions and facilitating meaningful mathematical discourse. Items #1 and 4 of the MCOP$^2$ provide information about the engagement of the students in the class in exploring mathematical concepts and assessing mathematical strategies. Item #9 provides insights into the type of tasks that are used in the classroom, specifically whether multiple paths and/or multiple solutions are typically encountered in tasks. The final two items, #11 and 16, measure the teacher's actions, providing information about how the teacher encourages student thinking and uses student responses to help move the class forward mathematically.

After observing six third- and fourth-grade teachers at Learning Academy, I used the MCOP$^2$ scores from each observation to identify Ms. Ross, a fourth-grade teacher, as providing the best match for the MFEs. After a final consultation with the principal of Learning Academy, I invited Ms. Ross to participate in the MFEs as the cooperating teacher, and she agreed to do so.

Before becoming a teacher, Ms. Ross received a bachelor's degree in exercise science and worked as an x-ray technician. After having children, Ms. Ross earned her master's degree in education and started teaching. She spent her first few years teaching preschool, then began teaching fourth grade at Learning Academy, where she has remained for the past twenty years. Her two grown children are also elementary teachers in other area schools (one charter school and one public school), and Ms. Ross collaborates with them regularly about teaching practice.

**Mathematics teacher educator.** I served as the instructor for this course, thus fulfilling the role of the mathematics teacher educator. This was my second semester teaching part-time at this institution, and it was my first time to teach this course. My background includes undergraduate degrees in mathematics, education, and communication and master's degrees in science and mathematics education and Thomistic theology. I have an active professional teaching license both in elementary education (K-8) and in secondary mathematics education (7-12). I have experience teaching middle school, high school, and undergraduate mathematics. In the two years previous to this study, I gained experience gathering data and conducting qualitative research in the area of PST education. In the year before the present study, I conducted two cycles of MFEs in a mathematics content course for elementary PSTs; these MFEs were modified in such a way that video technology allowed the PSTs to participate without leaving their university classroom. As an instructor-researcher, I have a unique perspective that allowed me to analyze the data in a way that would not have been possible if I were an outsider to the study (Ball, 2000).

## Context of the Learning Environment

The goal of the MFE is to generate a hybrid space as a learning environment, in which the PSTs, the cooperating teacher, and the teacher educator can learn from one another (Horn & Campbell, 2015). A key component to the success of the MFE is communication between all involved. For this reason, the mathematics teacher educator (myself) and the cooperating teacher (Ms. Ross) collaborated before the course began, both via e-mail and in person, to discuss overall learning goals.

As outlined in Table 3, I situated this study within the first eight weeks of the methods course. During the first week, I introduced the course to the PSTs. This included using class time to introduce PSTs to NCTM's (2014) eight Mathematics Teaching Practices. I also introduced number talks (Parrish, 2010). This introduction included class discussion and video simulations of number talks. Finally, I introduced Smith and Stein's (2011) Five Practices to Orchestrate Productive Mathematical Discussions, providing an opportunity for PSTs to practice certain aspects of these practices.

Table 3

*Overview of Weekly Themes and Activities*

| Week | Weekly Theme | Overview |
|---|---|---|
| 1 | Introduction | Methods class met twice this week, both times at the Teacher Preparation College campus: introduced Mathematics Teaching Practices, number talks, orchestrating whole-class discussions |
| 2 | Posing Purposeful Questions | MFE #1: PSTs observed cooperating teacher conducting a whole-class number talk and teaching a lesson |

(continued)

Table 3 Continued

| Week | Weekly Theme | Overview |
|---|---|---|
| 3 | Posing Purposeful Questions | MFE #2: PSTs each conducted a number talk with a small group of students; observed cooperating teacher teaching a lesson |
| 4 | Use of Manipulatives | Learning Academy had special activities this week that prohibited an MFE from taking place. PSTs used both classes to focus upon the use of manipulatives in teaching elementary school mathematics. |
| 5 | Posing Purposeful Questions | MFE #3: PSTs each conducted a number talk with a small group of students; Lucy and Maria co-taught a lesson focusing on the Five Practices |
| 6 | Facilitating Meaningful Mathematical Discourse | MFE #4: Lucy conducted a whole-class number talk (Maria observed); Maria taught a lesson focusing on the Five Practices (Lucy observed) |
| 7 | Facilitating Meaningful Mathematical Discourse | MFE #5: Maria conducted a whole-class number talk (Lucy observed); Lucy taught a lesson focusing on the Five Practices (Maria observed) |
| 8 | Facilitating Meaningful Mathematical Discourse | MFE #6: PSTs observed cooperating teacher conducting a whole-class number talk and teaching a lesson |

During the first week, I also met with the cooperating teacher, Ms. Ross, to communicate with her regarding course expectations and goals. I shared with her the course syllabus and a draft of our weekly themes (see Table 3). Together, we discussed how this experience could be most beneficial both to the PSTs and to Ms. Ross and her class. Throughout the time of the study, Ms. Ross and I were in close communication regarding weekly themes and topics studied both in the college classroom and in the elementary classroom. I used Ms. Ross' scope and sequence to match the mathematical content for the PSTs to that which Ms. Ross had already been planning to teach in her class. In return, I asked that Ms. Ross be open to tasks conducive to allowing students to work in small groups or individually, followed by time for whole-group discussion.

Six cycles of MFEs took place between weeks 2-8, with one MFE being implemented during each week of class, excepting one week (week 4) during which Learning Academy was unable to host an MFE due to pre-planned school-wide activities. For each of the weeks during which an MFE occurred, the class met in the component space of the Teacher Preparation College campus classroom for the first class session, during which the prebrief occurred. Discussion focused primarily upon the hypothetical classroom, as discussed in coursework, for the majority of the first class session each week. The cooperating teacher joined the prebrief conversation via videoconferencing. The second class session each week met at Learning Academy, the other component space, for the classroom lesson and the debrief, which focused primarily upon the authentic classroom of the cooperating teacher. The intentional arrangement for the entire progression of MFEs to occur in the same fourth-grade classroom was intended to allow PSTs to build relationships with students in this particular class.

**Instructional constructs and routines.** The content of the course was focused upon two particular teaching practices and two instructional strategies. The practices, posing purposeful questions and facilitating meaningful mathematical discourse, are a subset of NCTM's (2014) Mathematics Teaching Practices. I deliberately chose two instructional routines, namely number talks (Parrish, 2010) and Smith and Stein's (2011) Five Practices for Orchestrating Productive Mathematical Discussions, to focus upon over the eight-week span. By using the same basic structure repeatedly, in similar but slightly different contexts, PSTs were presented with an opportunity to build skills and knowledge through the vehicle of these tasks (Ericsson, 2002; Lampert et al., 2010).

**Mathematics Teaching Practices.** I chose to focus upon two of the eight Mathematics Teaching Practices (NCTM, 2014) in this methods course. These included posing purposeful questions and facilitating meaningful mathematical discourse. These two practices formed the basis for weekly themes that were provided for PSTs, focusing discussion and activities both in their coursework and in the field. I used these weekly themes as the context for determining the level of coherence between coursework and field experience.

**Number talks.** PSTs were introduced to number talks during the first week of the course (see Table 3). This instructional activity served as a means for PSTs to gain confidence in this particular teaching strategy. In the first MFE, the cooperating teacher led a whole class number talk while the PSTs observed. Then, during the second and third MFEs, each PST led a number talk with a small group of students. For the next two MFEs, each PST had a turn presenting a number talk to the entire class, while the other

PST observed. Finally, the cooperating teacher presented a whole-class number talk during the last MFE, which the PSTs observed.

During the debriefs, the presenter(s) of the number talk(s), whether it be the cooperating teacher or one or both of the PSTs, had the opportunity to share reflections on the experience, receive feedback and comments from others, and ask any questions.

**Five Practices.** Smith and Stein's (2011) Five Practices for Orchestrating Productive Mathematical Discussions were introduced to the PSTs as part of coursework during the first week of class (see Table 3). The PSTs considered the usefulness of implementing this pedagogy. As the mathematics teacher educator, I led the PSTs in in-class simulations of anticipating student responses, selecting certain responses, and purposefully sequencing these responses. I also communicated these practices to the cooperating teacher, so that we would have a common language with which to discuss lessons and a common goal in practicing this pedagogy.

During the first MFE, the PSTs observed the cooperating teacher as she taught a lesson that made use of the Five Practices. In preparation for the second MFE, the PSTs were given the mathematical task for the classroom lesson ahead of time and were asked to anticipate possible student responses. During the prebrief (before the lesson was taught), the PSTs compared their anticipated responses with those of the cooperating teacher and the mathematics teacher educator. Then, as they observed the cooperating teacher teach a lesson during the second MFE, I asked the PSTs to pay particular attention to the components of the Five Practices that they noticed. I gave the PSTs a protocol to help them organize their observation of each lesson (see Appendix B); this observation protocol was also available for the use of the mathematics teacher educator and the cooperating teacher.

For the third MFE, which took place during Week 5, the two PSTs had the opportunity to co-teach a lesson with a focus on the Five Practices. During the fourth and fifth MFEs, each PST independently taught a lesson using the Five Practices. Finally, for the sixth and final MFE, the cooperating teacher taught a lesson, while the PSTs observed. For MFEs #3-6, everyone, including the mathematics teacher educator and the cooperating teacher, collaborated on planning each lesson, including the anticipation of potential student responses. The debrief sessions provided an opportunity to comment on the Five Practices, especially in relation to the weekly highlighted Mathematics Teaching Practice.

**Elements of the MFE.** With one exception, each of the six cycles of the MFE included all three elements—the prebrief, the classroom lesson, and the debrief—as well as multiple opportunities for the PSTs to reflect upon their experience. Due to personal illness, the cooperating teacher was unable to participate in the prebrief of the final cycle of the MFE. Although these three foundational elements of the MFE varied in some ways, such as whether the PST was an observer or the teacher, they also contained many characteristics common to each particular element.

***Prebrief.*** The prebrief for each MFE took place during the latter part of the first day of class each week (see Figure 5). During the first part of class, the mathematics teacher educator outlined the mathematical goals for the week, including the Mathematics Teaching Practice and instructional routine(s) that would be the focus of the week. Any relevant theoretical aspects of these were discussed at this time.

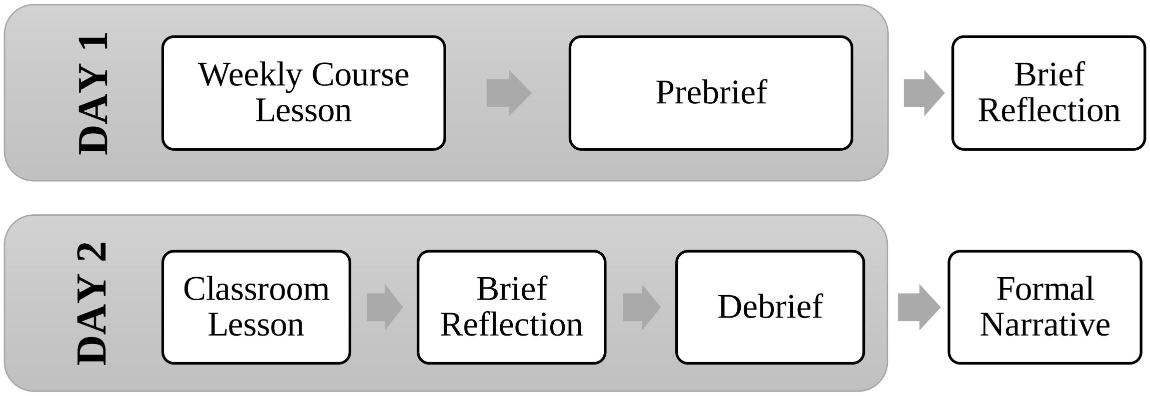


*Figure 5.* The general structure of a weekly MFE cycle. Day 1 takes place on the campus of Teacher Preparation College; day 2 takes place at Learning Academy.

The last portion of class consisted of the prebrief, for which the cooperating teacher joined the class session via videoconference. The mathematics teacher educator facilitated the prebrief. Whoever was teaching during the primary instructional routine being focused upon that week shared her goals for the lesson, the overall structure of the lesson, and expected misconceptions and difficulties. The PSTs, the cooperating teacher, and the mathematics teacher educator discussed the task(s) to be presented and compared anticipated student responses. The presence of the cooperating teacher at the prebrief was intended to assist in the beginning stages of integration of the two component spaces, as a member of the elementary school classroom—the cooperating teacher—was included in the environment of the university course.

As a required homework assignment, the PSTs were asked to write a short reflection regarding what they perceived to have learned in this class period, which was submitted via e-mail before the next class. The prompt, which is described in the data collection section below, focused particularly on PSTs' understanding of the Mathematics Teaching Practice being focused upon.

***Classroom lesson.*** On the second day of class each week during which an MFE was scheduled, the PSTs met at Learning Academy. The mathematics teacher educator, the cooperating teacher, and the PSTs were all present for the number talk and classroom lesson, which took place during the first forty-five minutes of the methods class (see Figure 5). This corresponded with the last forty-five minutes of the school day for the students at Learning Academy. The format of each of the classroom lessons in the MFE cycle was the same: First, the students participated in a number talk, which typically lasted 10-15 minutes. Following this, the students were presented with a lesson consisting of a mathematical task and follow-up discussion, guided by Smith and Stein's (2011) Five Practices to Orchestrate Productive Mathematical Discussions. Depending on the lesson, students were at times in small groups and at other times participated as a whole class (see Table 3).

As specified in Table 3, the cooperating teacher presented the number talk in the first MFE, the PSTs each conducted a small-group number talk twice, each PST had the opportunity to teach one number talk to the entire class, and the cooperating teacher taught the final number talk. The cooperating teacher taught the first two lessons; the PSTs first co-taught, then independently each taught, a lesson; and the cooperating teacher taught the final lesson. Whoever was not teaching at the time participated as an active observer. Observers used an observation protocol to help guide their observations of the lesson; the protocol focused on the implementation of the Five Practices (see Appendix B).

After the time in the classroom, PSTs were given approximately five to ten minutes to reflect upon the activities and what they thought they learned from the experience (Bruce & Ladky, 2010). Each PST was provided with a digital audio recorder to verbally reflect upon provided questions (see Appendix C), beginning with whichever question(s) the instructor indicated as most relevant to that day's particular experience. PSTs were also encouraged to use this time to write down any questions or comments they hoped to share during the debrief, which followed immediately after this brief time for reflection.

***Debrief.*** The mathematics teacher educator was the moderator for the debrief, which lasted approximately 30 minutes. The cooperating teacher and both PSTs were present for and participated in the entire debrief session.

The debrief consisted of two general cycles, the first focusing upon the lesson that was taught, and the second focusing on the number talk. The first segment of each debrief began with whomever taught the lesson being given the opportunity to share what she thought the students had learned, supported by any observed evidence of student learning. She also commented on what more she thought the students needed to learn from the day's activities. She explained how the Five Practices guided her decisions. This was followed by an opportunity for all observers both to share observations and comments from the lesson and to ask questions. Each of the PSTs was required to make at least one contribution to this discussion, either in the form of a comment or a question.

Following this, the debrief shifted to focus upon the number talk. If the number talk took place in a whole-class setting, as in the cases of the first, fourth, fifth, and sixth MFEs (see Table 3), whomever led the number talk shared comments and reflections on the experience. After this, all observers shared comments and questions. Again, each PST was required to contribute to the discussion at least one time. If a number talk took place in a small-group setting, as in the second and third MFEs (see Table 3), the two PSTs took turns sharing comments and reflections on their experiences. There was an opportunity for questions and comments after each individual PST shared her thoughts. This was followed by a general discussion regarding how number talks can best be used to facilitate the building of number sense in students.

At the conclusion of the debrief, which completed a cycle of the MFE, each PST was required to write a narrative reflecting upon the MFE (see Appendix D) that was intended to draw out the PSTs' perceptions of Mathematics Teaching Practices, as well as her perceptions of coherence between coursework and time spent in the field. This narrative addressed both the MFE as a whole and various elements of the MFE in particular. PSTs were asked to submit their typed reflection within 24 hours of the completion of the debrief.

## Data Collection

This study focused upon the nature of PSTs' reflections during the course of their participation in multiple cycles of MFEs, the identification of hybrid space formed by PSTs during the MFEs, and how PSTs perceived the building of coherence between Mathematics Teaching Practices as taught in coursework, then as experienced at Learning Academy. In order to better understand these perceptions of the PSTs regarding MFEs, hybrid space, and coherence, I collected data from a number of sources, including written and oral reflections, audio-recorded sessions of the MFEs, artifacts, and interviews of PSTs. I used my research questions to guide the decisions I made regarding data collection (Stake, 1995). A description of each of the data sources is included below, listed in rough chronological order of when I collected each type of data.

**Background Survey**

Near the beginning of the semester (see Figure 6), I collected background information from the participants by means of a short survey (see Appendix E). In addition to a few demographical queries, this survey included questions about the participants' experience as students of mathematics, thoughts regarding teaching, and what was hoped to be gained through this methods course.

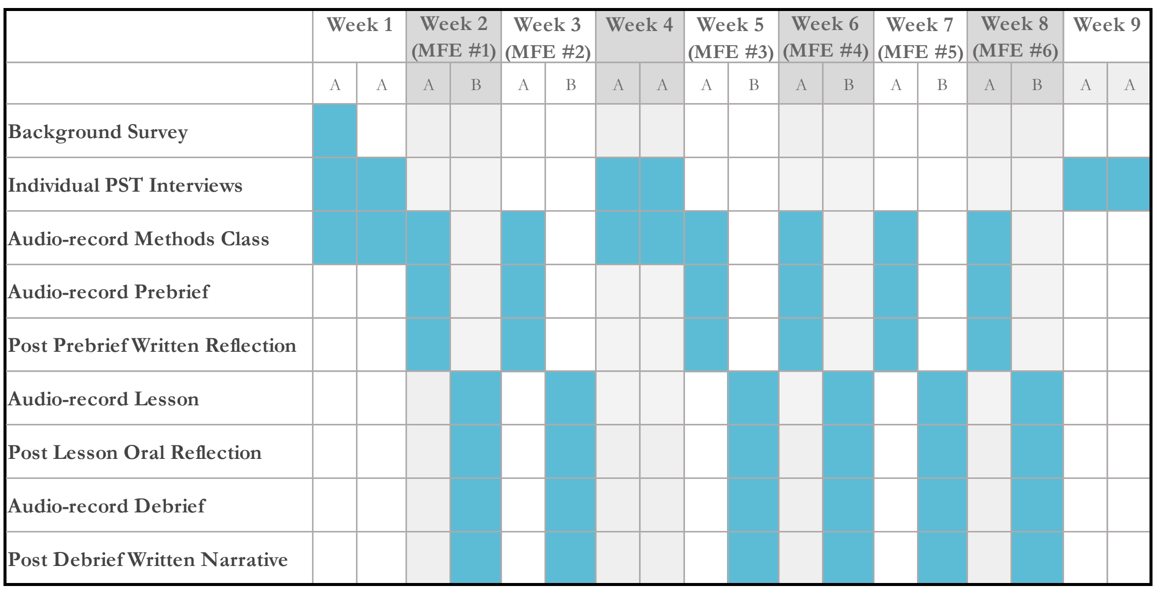


*Figure 6.* Timeline of data collection. Columns designated as "A" indicate data collected at Teacher Preparation College; columns designated as "B" indicate data collected at Learning Academy.

**Audio-Recording of Coursework and MFE**

I audio recorded each of the class sessions and elements of the MFE during the six-week cycle of MFEs that took place over the first eight weeks of the methods course (see Figure 6). This included both the weekly course lesson and the prebriefing that occurred at the Teacher Preparation College campus on the first day of each week of the MFEs, as well as the classroom lesson and debriefing session at Learning Academy on the second day of each week. These recordings provided a rich source of information as PSTs posed questions and made comments in the various settings surrounding the MFE. Audio recording provided me with an accurate record of the dialogue that occurred first in preparation for the MFE, then as the PSTs, cooperating teacher, and mathematics teacher educator planned, implemented, and reflected upon the classroom lesson of the MFE. These recordings gave me a means to review and capture any comments that may have been made by PSTs that were relevant to this study. The prebrief and debrief sessions were fully transcribed. In addition, other relevant sections of the weekly course lessons at Teacher Preparation College and classroom lessons at Learning Academy were transcribed as needed.

**Research Journal**

Throughout the study, I maintained a research journal (Borg, 2001). The purposes for this journal were threefold: (a) to maintain an accurate chronological account of details of the study, including data collection, (b) to record my reflections upon notable comments, experiences, or other happenings during the course lessons and the MFEs, and (c) to keep a written account of my reasoning behind the decisions that I made during the planning and implementation of the study.

**Post-Prebrief Written Reflection**

At the conclusion of each prebrief (see Figure 6, also Figure 5), PSTs were assigned to write a short reflection in response to the following prompt:

> What Mathematics Teaching Practice are we currently focusing upon? What does this practice currently mean to you? What do you think this practice will look like in an actual classroom setting? Are there any connections between this practice and what we discussed during the prebrief? If so, please explain.

PSTs were asked to type their reflections and submit them via e-mail to the mathematics teacher educator the night before the next class session.

**MFE Artifacts**

During selected MFEs (see Table 3), the PSTs observed the cooperating teacher teaching a portion or all of the classroom lesson. As they observed, PSTs were asked to take notes on their observations. An observation protocol was provided to PSTs for each of the lessons that they observed, to facilitate their reflection upon use of Smith and Stein’s (2011) Five Practices for Orchestrating Productive Mathematical Discussions (see Appendix B). I collected PST observation notes, including the completed observation protocols. I used these notes from observations of classroom lessons to examine any connections PSTs may have been making to coursework in general or Mathematics Teaching Practices in particular.

**Post-Lesson Reflection**

Immediately following the classroom lesson portion of each MFE, PSTs were given approximately five to ten minutes to prepare for the debrief (see Figure 5). During this time, I gave each PST a digital audio recorder and asked her to record her thoughts regarding the planning and execution of the lesson, using given prompts to guide her reflections (see Appendix C). I focused the reflections by choosing two or three of the prompts, based upon what I believed would yield the most useful data given the particular experience of that day, and asking the PSTs to begin with these particular questions. After replying to these questions, the PSTs could use the remainder of their time to respond to any of the other prompts. PSTs were also encouraged to write down any questions or comments to include during the debrief. I fully transcribed these PST audio recordings of post-lesson reflections. The primary purpose of this data was to help differentiate between how each different element of the MFE contributed to building coherence between coursework and field experience.

**PST Written Narratives**

PSTs were required to complete a formal written narrative at the conclusion of each cycle of an MFE (see Figure 5) as part of course requirements. I provided reflection questions to act as a prompt for this assignment (see Appendix D). This narrative was to be a reflection by the PST on her experience during the MFE and any perceived connections to coursework. It incorporated questions regarding the MFE as a whole, including its perceived effect upon the PST, as well as a question delineating the perceived benefits of the different elements of the MFE. PSTs were instructed to submit this typed narrative via e-mail to the mathematics teacher educator within 24 hours of completion of the debrief. A total of six written reflections was collected from each PST (see Figure 6).

**Interviews**

To better understand how the PSTs perceived the MFE experience, I conducted and audio-recorded three rounds of semi-structured interviews with each of the PSTs during the course of the study. The first interview took place after the first course meeting and before the first MFE began. The second interview took place during week four, between the second and third MFEs, and a final interview occurred in the week following the sixth and final MFE (see Figure 6). During the interviews, I asked PSTs about the connections they may or may not have been perceiving between their coursework and their time in the field.

For qualitative case study, Stake (1995) recommended that the researcher prepare a short list of issue-specific questions; then, recognizing that each individual interviewed has a unique perspective and unique experiences, supplement as needed with follow-up questions. Following this recommendation, I prepared a set of interview questions to guide the semi-structured interviews during the initial interviews (see Appendix F), another set of questions for the mid-point interviews (see Appendix G), and a third set of questions for the final semi-structured interviews (see Appendix H). I was open to including other probing and clarifying questions as the need arose during each interview session. After the conclusion of data collection, I fully transcribed each interview.

In order to make sense of the data that I collected, I developed an analytical framework that has been built upon past scholarship in the field of teacher education. I next describe this framework, which was used in the process of data analysis.

## Analytical Framework

My research focused on the nature of PSTs' reflections as they participated in a series of MFEs, the identification of hybrid space entered into by the PSTs in relation to Mathematics Teaching Practices learned and implemented during the MFEs, and PSTs' perceptions of coherence between Mathematics Teaching Practices as discussed in coursework and as experienced in the field, as the PSTs participate in MFEs. In order to better identify and describe reflections and perceptions, including those regarding coherence, an analytical model was needed that could help parse out the complex interactions encompassed by a number of different components, including the individuals involved in the elements of the MFE—namely, the PST, the mathematics teacher educator, and the cooperating teacher; the teaching of Mathematics Teaching Practices in the university setting of methods coursework; the teaching of Mathematics Teaching Practices in an authentic K-12 classroom; and the resulting potentiality of a hybrid space. Lampert's (2001) three-pronged model of teaching practice provided a valuable starting point in the endeavor to create a model that would address the multi-faceted dynamics involved in this research.

**Lampert's Three-Pronged Model of Teaching Practice**

Leinhardt and Steele (2005), in their study of instructional dialogue, acknowledged that "[t]eaching in any form is a complex task" (p. 160). They expounded upon this:

> One must bring to bear knowledge of the subject, of teaching in general, and of the particulars of teaching that subject and the topic of the moment. One must coordinate these knowledge bases dynamically, adding knowledge of students in general and one's own students in particular. (p. 160)

The complicated endeavor of teaching requires careful consideration of how these facets can be accurately and effectively analyzed.

Lampert (2001), attempting to develop an analytical representation that captures elements of the complexity found in teaching, produced a three-pronged model illustrating a number of relationships important in the work of teaching (see Figure 7).

This model includes arrows that signify a number of important relationships and actions that are central to the act of effective teaching practice.

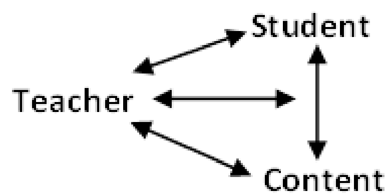


*Figure 7.* Lampert's (2001) three-pronged model of teaching practice. Reprinted with permission from Springer Nature: Springer Nature, *Journal of Mathematics Teacher Education*, Wood and Turner (2015).

An arrow between the teacher and the student represents the interaction that must take place between the teacher and the learner in any instance of teaching. This involves knowledge about the student's community and cultural assets, what they have previously been taught, and how they are motivated. Lampert (2001) referred to this relationship as one "'problem space' in the work of teaching" (p. 31), in which the teacher-student collaboration is the place in which teaching occurs. Similarly, an arrow between the teacher and the content signifies the educator's relationship with subject-specific knowledge that must exist in order for teaching to take place. Yet, teaching cannot lead to learning without the additional dynamic that must take place between the student and the content, represented by the vertical arrow. With regard to this latter element, Lampert claimed that one final relationship must be present, that between the teacher and the student-content relationship, which creates a fourth problem space with which teaching must be concerned. Three of these four problem spaces involve relationships in which the teacher is directly involved, illustrating the three prongs of practice that must simultaneously be managed by the teacher when teaching.

**Application of the Model to a Mathematics Methods Course**

Building upon this model, Wood and Turner (2015) applied Lampert's (2001) three-pronged model to the context of a mathematics methods course in a teacher education program. Instead of a teaching model based upon the goal of children learning mathematics, the model now shifts to focus on PSTs learning how to teach mathematics to students. Figure 8 illustrates how the vertices can be re-named to show this shift. The university teacher educator takes the place of the classroom teacher as the one managing three distinct relationships – one with the learner (the PST), one with the content (not simply the discipline of mathematics, but rather the complex relationship between teacher, child, and mathematics in classroom teaching), and one with the dynamic between the PST and the classroom interactions.

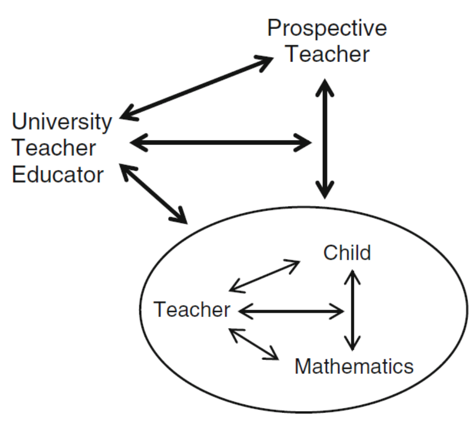


*Figure 8.* Wood and Turner's (2015) adaptation of Lampert's (2001) three-pronged model, showing the context of a mathematics methods course (p. 30). Reprinted with permission from Springer Nature: Springer Nature, *Journal of Mathematics Teacher Education*, Wood and Turner (2015).

Wood and Turner (2015) continued to build upon Lampert's (2001) three-pronged model "to explore the possible contributions of elementary classroom teachers to the learning-to-teach-mathematics experiences of PSTs" (Wood & Turner, 2015, p. 28). This resulted in an expanded model, shown in Figure 9, that represents the context of a mathematics methods course that includes field experience. Note that the left half of this model is the same model as shown in Figure 8; the right half of the model adds the dynamic involving the K-12 classroom teacher who hosts the PST's field placement. In this model, the PST is learning from both the mathematics teacher educator and the classroom mentor teacher, as well as from the hypothetical (generalized) classroom discussed in the methods course and the authentic classroom experienced in the field.

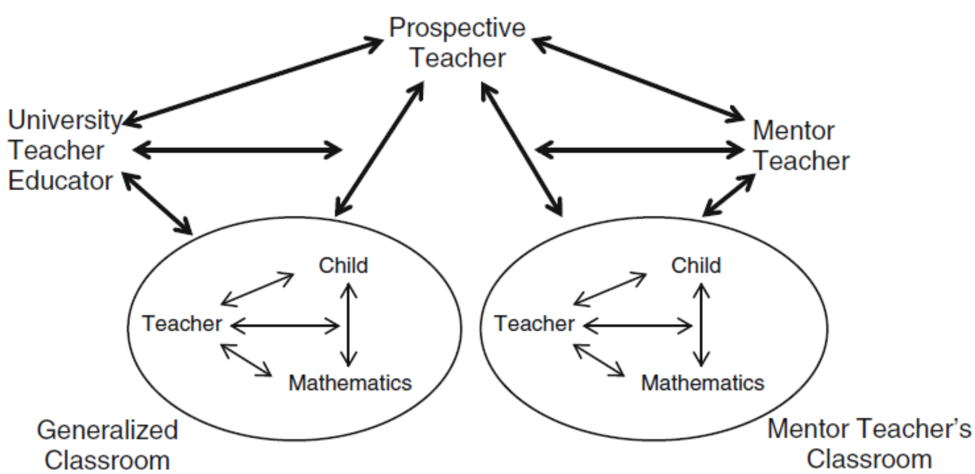


*Figure 9.* Wood and Turner's (2015) expanded adaptation of Lampert's (2001) three-pronged model (p. 30). This figure depicts both the coursework (left half) and field placement (right half) components of a mathematics methods course. Reprinted by permission from Springer Nature: Springer Nature, *Journal of Mathematics Teacher Education*, Wood and Turner (2015).

Wood and Turner (2015) used this complex model to study the impact of the classroom (mentor) teacher upon the PST's learning experience in a mathematics methods course that includes field placements. More specifically, Wood and Turner considered the potential contributions of the cooperating teacher to the formation of a hybrid space with the purpose of enhancing PSTs' building of connections between the theory learned in their mathematics methods courses and their experiences in an authentic classroom setting. The study determined that, in the context of a task involving student interviews, cooperating teachers can contribute valuable insights that further PST learning in a mathematics methods course.

**Application of the Model to the MFE**

Wood and Turner (2015) concluded that, although their study shed light upon the resources that the cooperating teacher can offer to a mathematics methods course with a field experience component, further research that focuses upon the PST is needed in order to better understand the gains potentially made in PST learning. The study that I conducted, consequently, focused upon the PST, particularly upon PSTs' reflections and perceptions of coherence between Mathematics Teaching Practices as discussed in the coursework of the mathematics methods course and as experienced in an authentic classroom in the field, as well as the identification of hybrid space entered into by the PST. Figure 10 is a re-creation of Wood and Turner's (2015) model, containing the same components, but specifically illustrating the elements of the present study. The space between the hypothetical classroom (bottom left) and the authentic classroom (bottom right) represents the disconnect that is often present in PST education, when coherence between methods coursework and field experiences is not achieved.

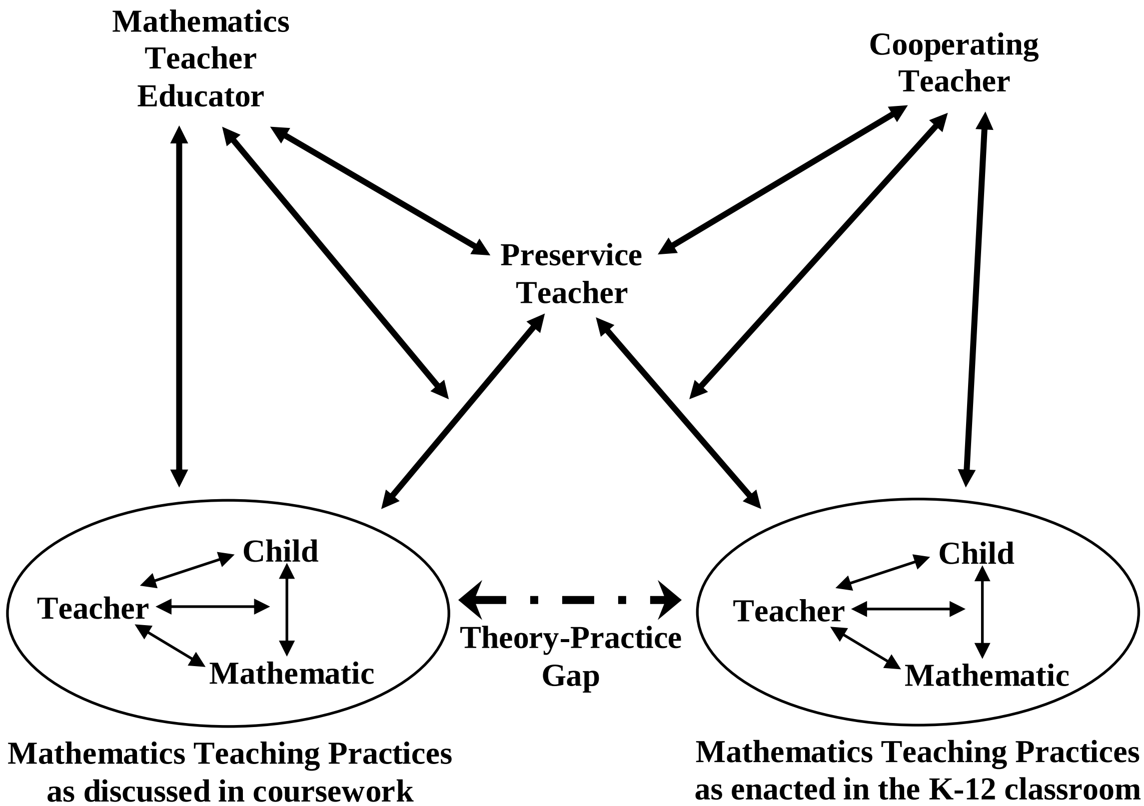


*Figure 10.* An adaptation of Wood and Turner's (2015) model of a PST situated in a typical mathematics methods course.

Although the mathematics teacher educator and the cooperating teacher in Wood and Turner's (2015) study did collaborate to some extent as they implemented a task involving student interviews, the mathematics teacher educator was not present in the classroom of the cooperating teacher during the actual field experience. The MFE, on the other hand, involves a deeper collaboration between the mathematics teacher educator and the cooperating teacher, as both are present and contribute to the learning of the PST during the various elements of the MFE. This collaborative relationship is modelled in Figure 11, which is an adaptation of Wood and Turner's (2015) adaptation of Lampert's

(2001) three-pronged model of teaching practice. I use this modified model as an analytical framework in order to better understand the coherence that PSTs perceive between coursework and field experience.

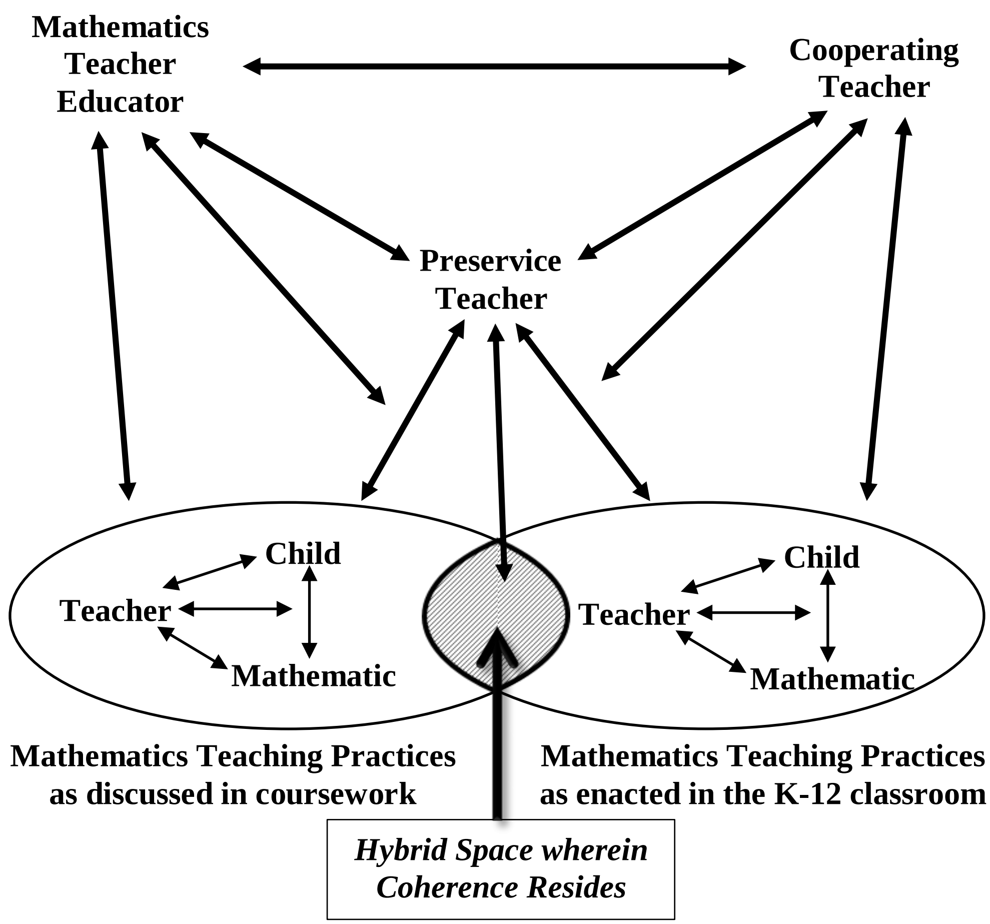


*Figure 11.* A model of an MFE. This figure shows the interactions between the mathematics teacher educator, the cooperating teacher, the PST, and learning-to-teach mathematics.

As shown in Figure 11, I hypothesized that in an MFE, the relationship between the PST and the hypothetical classroom as discussed in the methods coursework and the relationship between the PST and the actual authentic classroom of the cooperating teacher would begin to merge, as a hybrid space was formed between the PSTs' understanding of the hypothetical classroom and the actual classroom. I predicted that the PSTs would then experience a relationship with this newly-founded hybrid space, which merged the theoretical concepts learned in the methods course with the practical application of these concepts in an authentic classroom. This hybrid space could be considered the "place" wherein coherence resides. Note that this coherent hybrid space is "filling the gap" that had previously been present, thus diminishing, or potentially even eliminating, the theory-practice gap that had been present.

The overlap between the ovals representing the teaching content of the methods course—on the left, Mathematics Teaching Practices implemented in the hypothetical classroom as discussed in coursework and on the right, Mathematics Teaching Practices as actually enacted in an authentic K-12 classroom setting—allows for much variance. As the PSTs developed new connections between the binaries of abstract theory learned in coursework and practical application enacted in the classroom, the ovals began to merge. This resulted in increased overlap representing greater convergence between the component spaces, a more comprehensive hybrid space, and consequently a greater degree of coherency.

## Methods of Data Analysis

Data analysis was an ongoing process (Stake, 1995) throughout the study. Initial analysis occurred simultaneously with the data generation (Miles & Huberman, 1994). Throughout the duration of data collection, I kept a research journal to maintain an accurate account of the chronological order of the happenings of the class and the collection of data. I also noted in this journal my reflections regarding any notable comments or happenings related to the topic of this study. These notes were especially valuable for facilitating reference to the MFE artifacts and to the audio-recordings of coursework and MFEs, as I only transcribed sections of these audio-recordings that were pertinent to the study.

As the instructor of the course, I read each reflection and narrative as it was submitted by each PST. I made preliminary notes in my research journal about any comments that seemed especially relevant. I particularly focused upon ideas or comments from PSTs that referenced Mathematics Teaching Practices, noting the context in which these were made. After the final narratives were submitted, I then began to more formally code this data.

Following data collection, I transcribed each interview and wrote an interpretive commentary (Stake, 1995), so as to capture the key ideas from each interview. After all interviews were complete and transcribed, I coded the transcripts in a manner similar to that of the narratives.

The unit of analysis used for coding, upon which coding decisions were made, was typically a participant's response to a particular question or prompt. The post-prebrief prompt consisted of four distinct questions; each PST's response to each of these questions was considered a single unit of analysis. The post-lesson reflections varied in length but consisted of oral responses to a series of prompts (see Appendix C). Each PST response to a particular prompt was coded as a single unit of analysis. Each PST responded to a series of nine reflection questions in the post-debrief written narrative (see Appendix D); each response to a single question constituted a unit of analysis. One of the nine questions posed for the written narrative consisted of three parts; in this instance, three separate units of analysis were identified. I allowed for an individual unit of analysis to be assigned multiple codes at times, when appropriate. This particular choice of a unit of analysis for coding allowed for a broad enough data selection to retain the intended rich context of the data while also providing appropriate boundaries required for analysis of data.

I used the computer analysis software program ATLAS.ti (Version 8 for Windows) to code the data. Coding was done using a combination of inductive and deductive methods of analysis. I initially used the inductive approach of open coding accompanied by analytic memos (Miles & Huberman, 1994), seeking to identify instances in which the PSTs' reflections pertained to theoretical principles, the authentic classroom, or the hybrid space formed by the overlap of these two component spaces (see Figure 11). This preliminary open coding also had a deductive element, as it was informed by themes that began to emerge during my informal initial review of the data, before formal coding began. Some of these themes included PST discussions about hypothetical classroom settings versus actual student and classroom situations, different objects of PST reflection, the elements of the MFE, and the relationships represented by the arrows in Lampert's (2001) three-pronged model of teaching practice.

Data from all reflections, narratives, transcribed interviews, and transcribed prebrief and debrief sessions were coded, along with any relevant data from artifacts and audio-recordings of coursework and MFEs. As I progressed in analysis, I noted any new or prominent emerging themes (Merriam, 1998), reconfiguring coding as necessary, and grouping codes accordingly. After coding had been developed and refined, a second reading was conducted to ensure the consistency of codes throughout. I kept a record of the development of codes and code definitions. The codes that I ultimately used fell into five general categories, as illustrated in Table 4. To ensure accuracy and consistency in the coding process, I produced a codebook that included a full listing of the codes, along with a definition, description, and example for each (see Appendix J).

Table 4

*Overview of Codes Used*

| Category | Code | Brief Description |
|---|---|---|
| General Coherence | Coherence | Reference (direct or indirect) to coherence between theory/coursework and field experience |

(continued)

Table 4 Continued

| Category | Code | Brief Description |
|---|---|---|
| Mathematics Teaching Practices (MTPs) | Discourse: Field | Reference to MTP#4 (facilitating meaningful mathematical discourse) in the context of an authentic classroom |
| | Discourse: Theoretical | Reference to MTP#4 (facilitating meaningful mathematical discourse) in a theoretical context, considering students abstractly |
| | Questioning: Field | Reference to MTP#5 (posing purposeful questions) in the context of an authentic classroom |
| | Questioning: Theoretical | Reference to MTP#5 (posing purposeful questions) in a theoretical context, considering students abstractly |
| Elements of MFE | Reflect: Prebrief | Reflection on Prebrief |
| | Reflect: Lesson | Reflection on Classroom Lesson |
| | Reflect: Debrief | Reflection on Debrief |
| | Reflect: MFE | Reflection on MFE as a whole |

(continued)

Table 4 Continued

| Category | Code | Brief Description |
| --- | --- | --- |
| PST Reflections | Reflect on oneself | PST Reflection on Herself |
| | Reflect on teacher | PST Reflection on the Classroom Teacher |
| | Reflect on students | PST Reflection on the Students |
| | Reflect on other PST | PST Reflection on the Other PST |
| | Reflect on math content | PST Reflection on the Mathematical Content |
| | Reflect on class | PST Reflection on the Mathematics Methods Course |
| Lampert's Arrows | Teacher→Child | General teacher interaction with student*; no specific reference to mathematical concepts or content* |
| | Teacher→Math | Teacher interaction with mathematics |
| | Teacher→Child/Math | Teacher interaction with student regarding concepts and/or content specific to mathematics education |
| | Child→Math | Child interacting directly with math content |

To assist with the organization of data, I created document groups in ATLAS.ti. I made a separate document group for each individual participant, Maria and Lucy, containing only documents specific to that individual. I then created document groups for each of the elements of the MFE: prebriefs, classroom lessons, and debriefs. In these document groups, I included the corresponding personal reflections. I did not include the actual prebrief and debrief transcripts in these document groups, as my primary focus was the PSTs' reflections upon each element of the MFE rather than the actual happenings of the MFE itself.

Looking at the progression of MFEs, I decided to focus on the first, second, fourth, and fifth cycles of the MFE. Of the six cycles of MFEs conducted, I chose these four intentionally. One of the two participants did not submit a reflection for the third MFE, skewing the total number of reflections possible for that particular cycle of an MFE. Due to illness, the cooperating teacher was unable to participate in a prebrief for the sixth MFE, making both that MFE and the corresponding reflections incomplete. Data collected from the first, second, fourth, and fifth MFEs were complete representations of the elements of an MFE with a consistent number of type of reflections and narratives submitted for each.

To better determine the classification of PSTs' perceptions of Mathematics Teaching Practices, I analyzed the reflections of the PSTs based upon what was noted pertaining to the interactions between teacher and student, teacher and mathematics content, student and mathematics content, and teacher and the student-content relationship, as identified in Lampert's (2001) three-pronged model of teaching practice. Although the nodes in this model—namely the teacher, the student, and the content—

may be argued to themselves be also important, Lampert posited that "[e]lements of the work of teaching . . . occur along the arrows that make up the model, in the interactions where relationships develop" (p. 423). For this reason, only the arrows and not the nodes were included in the coding schema. I also analyzed the reflections of the PSTs in categories of reflection that were inductively developed, namely whether the PST was reflecting upon the class, herself personally, the other PST, the teacher, students, or mathematical content.

I used the framework of NCTM's (2014) Mathematics Teaching Practices as an analytical tool, enabling me to study perceived coherence, especially as effected by the MFE. The two chosen Mathematics Teaching Practices acted as constructs, assisting in data analysis. My coding also included reference to the component space(s) in which each comment occurred, whether it was in the field or in a context that was hypothetical or theoretical in nature. For example, in a post-lesson reflection, Lucy commented:

> [I]f teachers are able to pose purposeful questions, the students are more likely to be engaged within the subject matter being taught. And the students also will own up to their thought processes and be okay with making a mistake, but also proud and probably a higher self-efficacy when they arrive at an answer that is correct. (Lucy, MFE1, Post-Lesson Oral Reflection)

As the students referenced are hypothetical and not in the context of an actual classroom setting, this was coded as being a theoretical reflection on posing purposeful questions, one of the chosen Mathematics Teaching Practices. In contrast, Maria's post-lesson comment that "I thought that the number talk was effective, because I just used the students' questions as a lead to get them to think further into their math" (Maria, MFE2, Post-Lesson Oral Reflection) was coded as a comment on the same Mathematics Teaching Practice that references Maria's interactions with actual students, interactions that are facilitated by being in the field. These distinctions allowed me to more clearly delineate between PSTs' perceptions of Mathematics Teaching Practices as they were discussed in the coursework in the context of theoretical principles and as they were enacted in an authentic classroom in the field.

Concurrently with the development of themes and coding schemes, following the recommendation of Yin (2003), I created data displays in order to examine the data in different ways. The tool I used most often for this purpose was ATLAS.ti's networks of codes (see Figure 12). I created multiple such networks, many of which were invaluable in the analysis process as they allowed me to clarify distinctions in coding and discern patterns in the data. For example, I created a separate network for each element of the MFE, each of which contained all data coded as manifestations of any of the arrows included in Lampert's (2001) three-pronged model of teaching practice (the nodes of the network). This allowed me to visually sort the data depending upon which arrow(s) each coding illustrated. I was then able to discern patterns, indicated both by the data connected to each individual node and the data that was shared between certain nodes.

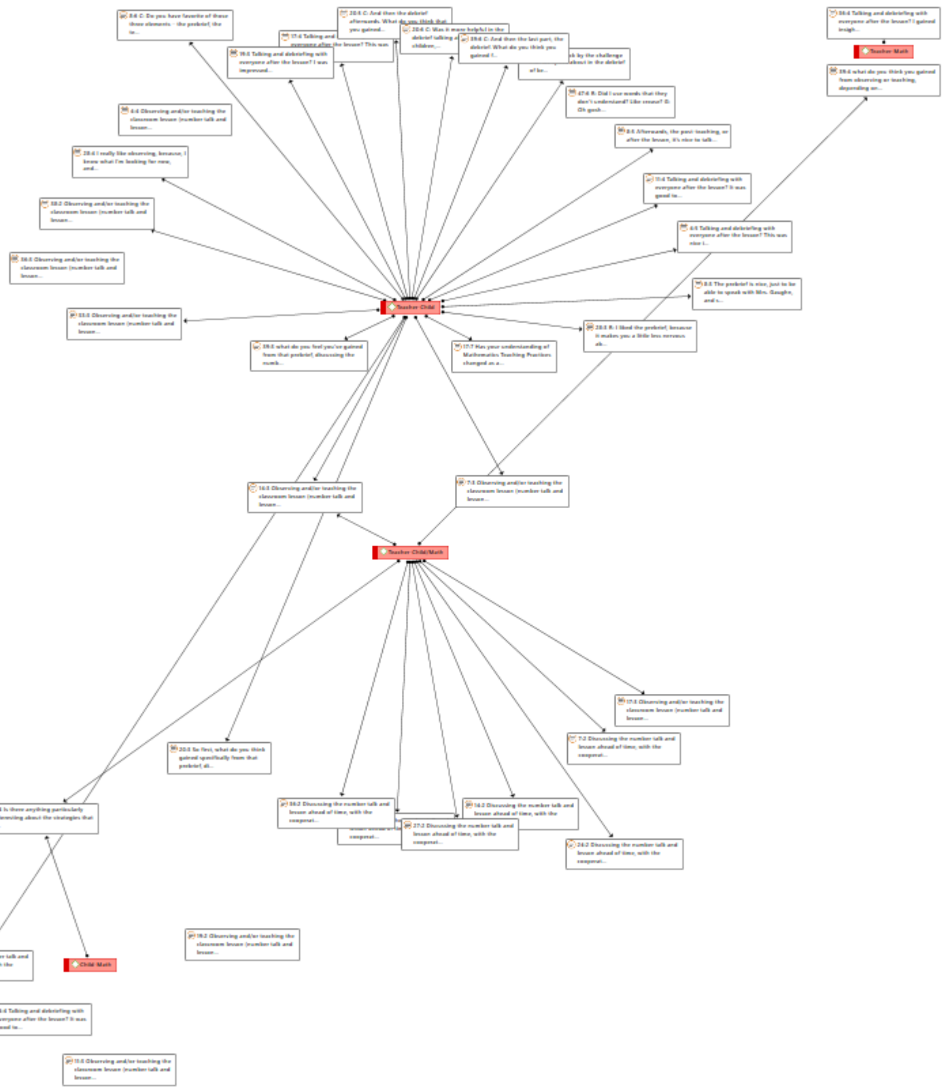


*Figure 12.* Network of codes created in ATLAS.ti. Central nodes represent the arrows in Lampert’s (2001) three-pronged model of teaching practice; other boxes represent elements of the MFE.

I used code-document tables (see Figure 13) and code co-occurrence tables (see Figure 14) to assist in the data analysis process. Code-document tables revealed the frequency of certain codes and code groups in particular documents or groups of documents. I examined combinations such as document groups for each particular MFE charted against each of six reflection codes, and document groups for each particular element of the MFE charted against codes for each of Lampert's (2001) arrows. Code co-occurrence tables showed how often certain combinations of codes were linked to the same piece of data. For example, I examined how many times coding overlapped between each pair of Lampert's (2001) arrows. I created over thirty combinations of these tables in ATLAS.ti, exporting each to an Excel document, where I could then format the tables appropriately. Since the totals were inconsistent between different items, I included percentages to assist in further data analysis. I analyzed all of these tables, noting patterns and items of interest in a series of analytic memos. These tables assisted me in identifying the patterns necessary to structure my findings, which are set forth in the next chapter.

| | MFE1 Gr=46; GS= | | MFE2 Gr=40; GS= | | MFE3 Gr=30; GS= | | MFE4 Gr=41; GS= | | MFE5 Gr=35; GS= | | MFE6 Gr=19; GS= | | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ○ Reflect -- | 8 | *19%* | 6 | *13%* | 2 | *10%* | 4 | *10%* | 3 | *6%* | 5 | *22%* | 28 |
| | *29%* | | *21%* | | *7%* | | *14%* | | *11%* | | *18%* | | |
| ○ Reflect -- on oneself Gr=37 | 3 | *7%* | 7 | *15%* | 0 | *0%* | 10 | *24%* | 5 | *10%* | 1 | *4%* | 26 |
| | *12%* | | *27%* | | *0%* | | *38%* | | *19%* | | *4%* | | |
| ○ Reflect -- on other PST Gr=9 | 0 | *0%* | 3 | *6%* | 0 | *0%* | 1 | *2%* | 3 | *6%* | 0 | *0%* | 7 |
| | *0%* | | *43%* | | *0%* | | *14%* | | *43%* | | *0%* | | |
| ○ Reflect -- on teacher Gr=30 | 17 | *40%* | 11 | *23%* | 5 | *24%* | 4 | *10%* | 9 | *18%* | 9 | *39%* | 55 |
| | *31%* | | *20%* | | *9%* | | *7%* | | *16%* | | *16%* | | |
| ○ Reflect -- on students Gr=48 | 13 | *30%* | 13 | *28%* | 10 | *48%* | 15 | *37%* | 19 | *37%* | 6 | *26%* | 76 |
| | *17%* | | *17%* | | *13%* | | *20%* | | *25%* | | *8%* | | |
| ○ Reflect -- on math content Gr=11 | 2 | *5%* | 7 | *15%* | 4 | *19%* | 7 | *17%* | 12 | *24%* | 2 | *9%* | 34 |
| | *6%* | | *21%* | | *12%* | | *21%* | | *35%* | | *6%* | | |
| **Totals** | 43 | | 47 | | 21 | | 41 | | 51 | | 23 | | 226 |

*Figure 13.* A code-document table showing reflection codes charted against document groups for each particular MFE; MFE3 and MFE6 were removed from further analysis.

| | Teacher-Child Gr=81 | | Teacher-Child/Math Gr=63 | | Teacher-Math Gr=2 | | Child-Math Gr=7 | | Total |
|---|---|---|---|---|---|---|---|---|---|
| Reflect -- on class Gr=47 | 14 | *10%* | 8 | *7%* | 0 | *0%* | 0 | *0%* | 22 |
| | *64%* | | *36%* | | *0%* | | *0%* | | |
| Reflect -- on oneself Gr=46 | 17 | *13%* | 8 | *7%* | 0 | *0%* | 1 | *8%* | 26 |
| | *65%* | | *31%* | | *0%* | | *4%* | | |
| Reflect -- on other PST Gr=10 | 2 | *1%* | 2 | *2%* | 1 | *33%* | 0 | *0%* | 5 |
| | *40%* | | *40%* | | *20%* | | *0%* | | |
| Reflect -- on teacher Gr=71 | 45 | *34%* | 24 | *21%* | 0 | *0%* | 1 | *8%* | 70 |
| | *64%* | | *34%* | | *0%* | | *1%* | | |
| Reflect -- on students Gr=88 | 51 | *38%* | 43 | *38%* | 0 | *0%* | 5 | *38%* | 99 |
| | *52%* | | *43%* | | *0%* | | *5%* | | |
| Reflect -- on math content Gr=34 | 5 | *4%* | 28 | *25%* | 2 | *67%* | 6 | *46%* | 41 |
| | *12%* | | *68%* | | *5%* | | *15%* | | |
| | 134 | | 113 | | 3 | | 13 | | 263 |

*Figure 14.* A code co-occurrence table showing reflection codes charted against codes representing Lampert's (2001) arrows.

Once coding distinctions were in place and tools such as data displays and table constructions were compiled, I was then able to expand analysis to consider how PSTs integrated theoretical principles and authentic classroom experience during the development and expansion of a hybrid space. By analyzing the development of this hybrid space, which is more clearly outlined in the following chapter, I gained insights regarding the nature of PSTs' perceptions of coherence and the elements of the MFE that serve to build and expand this space.

## Establishing Credibility and Trustworthiness

Knowing that as an instructor-researcher I bring much subjectivity to the study, I intentionally integrated methods by which I could more firmly establish the credibility and trustworthiness of this study. These methods included the use of triangulation of data, counterexamples, and member checking.

I collected data in a variety of forms, including written narratives, oral reflections, audio-recordings of coursework and MFEs, interviews, and artifacts. This data was collected over a nine-week period, a time period that allowed for generous collection of data. As I collected and analyzed data, I made use of a research journal (Borg, 2001) in order to accurately keep track of decisions made throughout the study. Triangulation of the various data sets contributed to the trustworthiness of this study, as consistency between the different data types increases confidence that the findings are substantial (Patton, 2015).

When analyzing data, I looked not only for instances in which PSTs indicated that they perceived coherence between coursework and field experience, but I also deliberately looked for instances in which PSTs perceived a lack of coherence. By actively seeking out counterexamples (George & Bennett, 2005), I added to the credibility of my conclusions. I also included rich descriptions of the circumstances of data collection, as well as the details involved in the process of analysis.

In the analysis of my data, I considered engaging in member checking (Patton, 2015) to ensure accuracy in my evaluation of the cases and to increase the credibility of my study. Due to the potential of power dynamics at play (due to my role as instructor of the course) affecting participants' responses, as well as what I chose to include in the written case (i.e., potentially sensitive information), I intentionally decided not to employ member checks until after final grades for the course had been submitted. Once students had accessed their final grades and I was no longer positioned in the role of instructor, I submitted portions of my analysis to the participants, requesting their feedback regarding accuracy of what was written. I took these comments into account in making revisions to the narratives.

In addition to making use of data triangulation and the active seeking out of counterexamples, I have been very explicit and transparent in my description of the methodology, including the processes of data collection and analysis, in order to increase both the credibility and trustworthiness of this study (Grossman, 2005).

## Limitations

Limitations of the study include factors outside of my control that restricted my methodology as well as my conclusions. Three primary limitations should be considered: sample size, subjectivity of data, and the large number of uncontrolled covariates.

First, one limitation of this study was the small sample size, consisting of only two PSTs. Due to this small sample size, as well as the natural limitations of qualitative research and the fact that I am drawing upon a convenience sample rather than a random sample, the results of my study are not generalizable to the larger population of PSTs in traditional teacher preparation programs. Rather, this qualitative study provides a thick description of the role of MFEs when integrated into a mathematics methods course.

Another limitation pertains to the type of data being collected. As all the data was subjective, based upon written and spoken responses of participants, if the participants failed to answer honestly and with candor, the resulting conclusions may not accurately reflect the effect of a series of MFEs on PSTs' perceptions of coherence and entry into hybrid space. Similarly, participants' writing skills may have posed a limitation on the quality of responses generated from written narratives and reflections.

The many covariates involved presented a further limitation. This study investigated how the different elements of the MFE may affect results regarding coherence between Mathematics Teaching Practices (NCTM, 2014) as discussed in coursework and as experienced in the field. However, many other variables, such as the structure of the lesson, the effectiveness of the mathematics teacher educator, the effectiveness of the cooperating teacher, and the relationship and communication between the mathematics teacher educator and the cooperating teacher, may also affect the results. In addition, the reflections that served as the majority of the data collected may themselves have affected and encouraged coherence, presenting yet another covariate.

Even though these factors posed limitations that are beyond the control of the researcher, valuable insights can nonetheless be obtained from the results of this study. The small convenience sample size, although unable to provide generalizable results, is sufficient to make a contribution toward Swartz, Billings, and colleagues' (2018) call for research that describes the effects of MFEs in various contexts. The subjectivity of the data and the propensity of covariates is not uncommon in the work of qualitative research; although providing certain shortcomings, the benefits accrued from qualitative studies oftentimes outweigh the unavoidable limitations, as qualitative research “makes the world visible in a different way” (Denzin & Lincoln, 2013, p. 7) than the more objectively-focused quantitative research.

## Delimitations

I have made certain decisions regarding factors that are under my control which serve as delimitations for this research, setting particular boundaries for this study. Six primary delimitations for this study include my decisions regarding the option chosen for investigating solutions to the theory-practice gap, the focus upon PSTs in particular, the logistics surrounding the course and the MFEs, the specific setting of the course, decisions made regarding data collection, and the instructional strategies and practices that were focused upon in the course.

My goal for this research has been to study how the theory-practice gap between PST coursework and fieldwork might be minimized. A variety of conceivable solutions could be investigated as ways in which one could attend to this challenge. I chose to focus upon just one particular pedagogy, the MFE, as a potential means by which this problem recognized in traditional teacher education could be addressed.

In my development of a research question, I chose to focus on coherence between coursework and field experience as perceived and reflected upon particularly by PSTs. The cooperating teacher and the mathematics teacher educator could also potentially offer valuable insights regarding coherence. In addition, the effect of the MFE on students in the classroom could also be a valid area of research. However, I was interested particularly in the experience and perceptions of the PST in this area. As a result, I only collected data from the PSTs.

Another delimitation involved the logistics of the course itself. I anticipated days of the week that would be maximally conducive for a teacher at Learning Academy to be involved in the prebrief and debrief, as well as allowing for PSTs to take part in classroom lessons. The school calendar for Learning Academy showed that Mondays during the timeframe in which I was hoping to collect data were often times for holidays or days devoted to teacher professional development, and faculty meetings were typically held on Wednesday afternoons. Hence, I arranged for the methods course to be scheduled to meet twice a week, in the mid-afternoon, on Tuesdays and Thursdays. Actual meeting days varied, as I chose to accommodate scheduling needs of all involved, but the meeting time remained consistent throughout, with each class meeting lasting a total of 80 minutes. I also limited the study to the first nine weeks of the mathematics and science methods course.

I chose to limit my context by conducting this study in a small faith-based liberal arts school that focuses on education. I chose a particular elementary school based upon the partnership that had previously been developed between the college and the school, the relationships that I had previously built with the administration of the school, the proximity of the school to the college, and the relatively diverse student population served. Because of the flexibility and open collaboration required of coordinating multiple cycles of MFEs within the settings of both the college and the elementary school, I chose a school that I felt confident would meet these criteria. Similarly, I chose to collaborate with a particular teacher whom I believed, based on my observations and data collected via the MCOP$^2$ (Gleason et al., 2015; see Appendix A), would provide a classroom that was relatively aligned with the goals for the methods course.

In considering the means by which I would collect data from the weekly course lesson and each element of the MFE, I chose to limit my data to exclusively audio recording, intentionally deciding against video recording. Although video recording could potentially capture useful non-verbal communications, obtaining permission to video record the children in the classroom would be difficult, likely resulting in the need to exclude certain children from the video, which could easily detract from the lesson itself. In an effort to maintain consistency of data collection, I therefore chose to make use of only audio recording, and not video recording, for all elements of the MFE as well as for the weekly course lesson.

A further delimitation involved the choices I made regarding the instructional strategies and teaching practices to be focused upon in the course. Because of their acceptance in the mathematics education community, I decided to make use of NCTM's (2014) Mathematics Teaching Practices in the course. In order to delve more deeply into particular practices, I chose just two of these Mathematics Teaching Practices upon which to focus. Although a plethora of instructional strategies conducive to the teaching of mathematics exist, I intentionally chose to focus upon just two of these strategies, namely number talks (Parrish, 2010) and Smith and Stein's (2011) Five Practices to Orchestrate Productive Mathematical Discussions. Both of these strategies are research-based and have been shown to promote the effective teaching and learning of mathematics.

I believe that the choices that I made effectively set reasonable boundaries for this study. This minimized the limitations, allowing me to make beneficial contributions to both the literature base that already exists regarding MFEs as well as that literature that addresses the building of conceptual coherence in teacher education programs.

## Conclusion

In this chapter, I set forth details regarding the methodological design of this study. I discussed the affordances that a case study approach provides for this particular study. I provided aspects regarding the context of the study, which included specifics about the setting of the study as well as initial information concerning the participants. I offered a detailed overview of the context of the learning environment, including the practices and instructional strategies upon which I focused and the characteristics of each element of the MFE. I then summarized the various means by which I collected data, and I set forth an analytical framework with which I analyzed my data. Finally, I stated specific ways in which I have addressed considerations of trustworthiness and noted limitations and delimitations to this study. The results of my analysis are reported in the following chapter.

# CHAPTER IV: FINDINGS

In this study, I sought to investigate the nature of preservice teachers' (PSTs') reflections as they engaged in a series of mediated field experiences (MFEs). By means of these reflections, I hoped to identify PST entry into hybrid space and the relation of this hybrid space to perceptions of coherence. The ultimate goal for this research has been to gain insights that could assist in narrowing the theory-practice gap that is prevalent in programs of teacher preparation (Darling-Hammond, 2008). To attain this goal, I have explored patterns and consistencies that are relevant to the questions posed (Stake, 1995), namely:

1. How, if at all, does the focus of PSTs' reflections evolve over the course of their participation in multiple cycles of MFEs?
2. How, if at all, does the content of PSTs' reflections differ amongst each individual element of the MFE?
3. As PSTs participate in multiple cycles of MFEs, how do characteristics of coherence between theoretical concepts and authentic classroom experiences reveal instances of PST entry into hybrid space?

This chapter describes the findings from this study, providing an analysis of the perceptions of two PSTs who participated in six cycles of MFEs. PSTs' written reflections in particular, as well as transcribed interviews, provide many insights and opportunities for analysis of PSTs' perceptions and understanding (Campbell, 2012). Analysis is provided in three sections. First, I analyze the nature of the PSTs' reflections as the MFEs progress chronologically. Each of the two PSTs is considered individually. Next, I provide an analysis of PSTs' reflections with respect to each of the three elements of the MFE. I employ two different lenses to analyze the reflections of the PSTs: first, the relationships described by Lampert's (2001) arrows in her three-pronged model of teaching practice, followed by disaggregating reflections by their nature insofar as they focus on theoretical principles and hypothetical situations or concrete situations encountered in the authentic classroom setting. Finally, I present PST reflections that exhibit characteristics of entry into hybrid space within the construct of each of the two Mathematics Teaching Practices (NCTM, 2014) focused upon in the experience. This includes a drawing out of the more direct references to coherence that can be found in each of the PSTs' reflections, considering individually each of the participants' experiences of coherence.

## Progression of MFEs

As PSTs participated in multiple cycles of MFEs, the nature of their reflections shifted. Notable patterns could be found in reflections upon the course, the teacher, the students, and the math content (see Table 5). In the first MFE, 59% of PST reflections were on either the course or the teacher (19% on the course and 40% on the teacher). By the fifth MFE, only 23% of PST reflections were on either the course or the teacher (6% on the course, 17% on the teacher). The opposite shift was reflected in the PSTs' focus on the students and the math content. In the first MFE, 35% of PST reflections were on the students or the math content (30% on students, 5% on math content). By the fifth MFE, 61% of PST reflections were on these same areas (38% on students, 23% on math content). The increase or decrease was relatively consistent in the progression of MFEs.

Table 5

*Overall Relation of Progression of MFEs to Object of Reflection*

| Reflect on: | MFE1 | MFE2 | MFE4 | MFE5 |
|---|---|---|---|---|
| Course | 8 (19%) | 6 (12%) | 4 (10%) | 3 (6%) |
| Oneself | 3 (7%) | 7 (14%) | 10 (24%) | 5 (10%) |
| Other PST | 0 (0%) | 3 (6%) | 1 (2%) | 3 (6%) |
| Teacher | 17 (40%) | 11 (22%) | 4 (10%) | 9 (17%) |
| Students | 13 (30%) | 15 (31%) | 15 (37%) | 20 (38%) |
| Math Content | 2 (5%) | 7 (14%) | 7 (17%) | 12 (23%) |
| Total | 43 | 49 | 41 | 52 |

These findings showed a shift from PST reflections focusing on the teacher and on coursework to instead focusing on the students and the mathematics content. Both Maria and Lucy individually, as well as collectively, demonstrated this shift.

**Maria's Progression**

Analysis of Maria's reflections alone (see Table 6) showed that in the first MFE, 63% of her reflections were on either the course or the teacher (27% on the course and 36% on the teacher). By the fifth MFE, only 28% of Maria's reflections were on either the course or the teacher (7% on the course, 21% on the teacher). Conversely, when analyzing Maria's focus on the students and the math content, data showed that in the first MFE, 23% of Maria's reflections were on the students or the math content (23% on students, 0% on math content). However, by the fifth MFE, 60% of Maria's reflections were on these same areas (31% on students, 27% on math content).

Table 6

*Relation of Progression of MFEs to Object of Reflection: Maria*

| Reflect on: | MFE1 | MFE2 | MFE4 | MFE5 |
|---|---|---|---|---|
| Course | 6 (27%) | 4 (14%) | 2 (8%) | 2 (7%) |
| Oneself | 3 (14%) | 3 (11%) | 9 (38%) | 3 (10%) |
| Other PST | 0 (0%) | 2 (7%) | 0 (0%) | 2 (7%) |
| Teacher | 8 (36%) | 8 (29%) | 2 (8%) | 6 (21%) |
| Students | 5 (23%) | 7 (25%) | 7 (29%) | 9 (31%) |
| Math Content | 0 (0%) | 4 (14%) | 4 (17%) | 8 (27%) |
| Total | 22 | 28 | 24 | 30 |

Supporting this quantitative finding of a focus on the teacher and coursework in the beginning of her experience, in her written narrative at the conclusion of the first MFE, Maria wrote:

> I think that what we learned through coursework helped me to better understand the point of view of the teacher, and not so much the point of view of the students. I could recognize what Ms. Ross was and was not doing because we had learned about different emphases in teaching mathematics. (Maria, MFE1, Post-Debrief Written Narrative)

This reflection illustrates Maria's focus both on the coursework, as she explicitly mentioned the connections she was making between coursework and field experience, and the teacher, as those connections were centered primarily around Ms. Ross, the classroom teacher.

Maria's focus on the teacher in her earlier reflections could also be found when asked what she thinks that "posing purposeful questions" will look like in an actual classroom setting. Maria wrote:

> I expect that the teacher will have to take the time to process their students' responses and then to ask them questions that have them go from the specific mathematical problem at hand to the bigger mathematical principle or skill which the problem seeks to instill. (Maria, MFE2, Post-Prebrief Written Reflection)

Maria again considered how the teacher would need to respond. Maria did refer to the students as well, but only insofar as considering students the object, not the subject, of developing mathematical understanding.

Both of these excerpts showed that Maria's thoughts tended to be centered on the teacher rather than the students in the classroom. Maria did not disregard the students, recognizing the importance of the teacher's interaction with the students; however, she showed a stronger tendency to consider the teacher as primary and the students only secondarily.

By the fourth MFE, Maria's focus had shifted more toward the students. When asked to respond to the prompt asking what the practice of facilitating meaningful mathematical discourse means to her, Maria responded that this means "helping the students to learn by giving voice to their mathematical reasoning and by having them explain and gain new insights from their peers' different reasoning strategies" (Maria, MFE4, Post-Prebrief Written Reflection). Maria's focus was entirely upon the students in her reply. Although the teacher's role in this process can by implied by considering who is the one "helping the students to learn," the emphasis in Maria's reflection was completely on the students themselves.

After the prebrief of the fifth MFE, Maria mentioned the teacher, but the content of her reflection was focused primarily on the students and was connected also to the mathematical content involved:

> In our pre-brief both Lucy and I learned from Ms. Ross that the students will be challenged by our questions and tasks because they have not yet seen a multiplication array or added fractions with different denominators. This was very much connected to facilitating meaningful mathematical discourse, because it is good for us to know where the students are coming from, what their strengths and weaknesses are, and how our goals might be achieved by scaffolding their understanding of math concepts. (Maria, MFE5, Post-Prebrief Written Reflection)

Maria mentioned both the teacher and the students in her reflection, but with a different outlook from earlier reflections. Here, the teacher was simply a means by which to learn more about the students, who were now seen as central. Maria's focus had shifted to the students, and in particular the students' mathematical understanding. In reflecting upon the Mathematics Teaching Practice of facilitating meaningful mathematical discourse, she considered how an understanding of the students and their mathematical background would be interconnected to the successful implementation of a lesson.

Following the lesson in the fifth MFE, Maria reflected upon her experience teaching a lesson:

> I was surprised by how the students didn't split up the rectangle into different parts. How they mostly did the eight times 25, and I don't think I was anticipating

> that as much, so I didn't know what to do with it, or how to get them beyond that, but I did enjoy just getting the students to explain other people's way of thinking, and kind of be open to directing a little differently. And I thought that they responded to that well, especially because they had many different answers. (Maria, MFE5, Post-Lesson Oral Reflection)

Maria's reflection had a strong focus on the students themselves, noting how they responded to her attempt to have students offer explanations, as well as on the mathematical content. Neither the teacher nor the coursework was referenced in any way.

Overall, the patterns identified illustrate Maria's shift over the course of the series of MFEs from focusing on the course and the teacher to instead giving attention primarily to the students and the mathematical content. We next turn our attention to the second PST, Lucy.

**Lucy's Progression**

Although not as pronounced as Maria's progression, Lucy showed a similar pattern in the focus of her reflections (see Table 7). In the first MFE, 43% of Lucy's reflections were on the teacher. By the fifth MFE, only 14% of Lucy's reflections were on the teacher. Lucy's focus on the students and the math content accordingly increased over time. In the first MFE, 48% of Lucy's reflections were on the students or the math content (38% on students, 10% on math content). By the fifth MFE, 68% of her reflections were on these same areas (50% on students, 18% on math content).

Table 7

*Relation of Progression of MFEs to Object of Reflection: Lucy*

| Reflect on: | MFE1 | MFE2 | MFE4 | MFE5 |
|---|---|---|---|---|
| Course | 2 (10%) | 2 (10%) | 2 (12%) | 1 (5%) |
| Oneself | 0 (0%) | 4 (19%) | 1 (6%) | 2 (9%) |
| Other PST | 0 (0%) | 1 (5%) | 1 (6%) | 1 (5%) |
| Teacher | 9 (43%) | 3 (14%) | 2 (12%) | 3 (14%) |
| Students | 8 (38%) | 8 (38%) | 8 (47%) | 11 (50%) |
| Math Content | 2 (10%) | 3 (14%) | 3 (18%) | 4 (18%) |
| Total | 21 | 21 | 17 | 22 |

At the beginning of her experience, Lucy strongly focused upon the teacher's role in the classroom. In her written narrative at the conclusion of the first MFE, Lucy wrote:

> [T]he teacher is hoping to guide students to a stronger use of their mental math skill. She wants the students to decompose the addition problem into manageable numbers for adding. In order for this to occur, she will have to ask questions of the students, questions which will allow for this technique to be explained. (Lucy, MFE1, Post-Debrief Written Narrative)

Lucy referenced the students, but only as objects of the teacher's questioning, not as subjects in and of themselves. Instead, Lucy's main focus was on the teacher's goals and how the teacher would attempt to accomplish these goals.

Already in the second MFE, Lucy had begun to transition from focusing primarily on the teacher to also considering student learning. In her written narrative following this

MFE, Lucy commented, "[P]osing purposeful questions not only allows the teacher to see if the student understands, it allows the student to take hold of the concept to a point of mastery at that level" (Lucy, MFE2, Post-Debrief Written Narrative). Lucy recognized the benefit of this practice to the student as well as to the teacher. This illustrates how Lucy was beginning to connect the role of this Mathematics Teaching Practice as it relates both to the teacher and the students.

Even within an individual component of a particular MFE, Lucy's reflections revealed the shift that continued to take place as she moved her focus from the classroom teacher to the students in the class. When reflecting upon what facilitating meaningful mathematical discourse meant to her following the prebrief of the fourth MFE, Lucy began by commenting upon the teacher's role, but she then quickly transitioned to considerations of the student:

> This practice currently means that the teacher will engage the students in conversation about the topic being learned . . . . The discourse, while facilitated by the teacher, should be allowed to occur among the students. In a classroom setting, this will probably mean that the student will begin to ask questions of each other's reasoning and why they arrived at certain answers. Hopefully the students will develop social skill which allow for differing opinions . . . it is essential that the teacher has prepared good questions which require a well-reasoned response from the students. (Lucy, MFE4, Post-Prebrief Written Reflection)

Lucy toggled back and forth between the role of the teacher and the role of the student, first considering more strongly the teacher, then focusing on the students, and finally settling upon a combination of both. However, Lucy's primary focus had shifted to the student, and her comments on the role of teacher were always related to student learning.

By her reflection at the conclusion of the fifth MFE, like Maria, Lucy had now shifted to reflect primarily upon not the teacher, but rather the student. Her reflections also included an illustration connected to the mathematical content of the lesson:

> In teaching the lesson, I was able to see that going to individual groups of students and helping them where they were does not mean just conveying my ideas to them. I had to stop and listen to what they were saying so as to figure out the best way to explain 2/4 being the same as 4/8. (Lucy, MFE5, Post-Debrief Written Narrative)

Lucy demonstrated a focus on increasing student understanding as she commented upon the particular mathematical content of equivalent fractions.

As the series of MFEs progressed, the students and their mathematical understanding became central to Lucy's reflections. She focused more heavily upon student thinking and how she could come to a deeper understanding of the students' mathematical understanding.

Both Maria and Lucy experienced a shift in the object of their reflections, moving from an earlier focus on the teacher and coursework to later reflections focusing more on the students and mathematical content. Reflections sometimes included multiple elements, further showing the shift that was progressing. Initial quantitative analysis assisted in the revelation of this pattern; analysis of actual reflections of both Maria and Lucy confirmed the significance of this finding throughout the progression of MFEs.

Having considered the focus of PST reflections over the course of multiple MFEs and noting certain patterns in this area, we next turn our attention to the individual elements of the MFE and any variation that may be found in the content of PST reflections between one element and another.

## Elements of the MFE

The three fundamental elements that are necessary to the composition of the MFE include the prebrief, the classroom lesson, and the debrief (Campbell, 2012; Horn & Campbell, 2015). Analysis revealed patterns both in the nature of the interactions identified within each element and also in the references made by the PSTs to either actual classroom experiences or a combination of theoretical principles and hypothetical situations, as were reflected upon directly following each element of the MFE.

### Relationships Represented by Lampert's (2001) Arrows

Analysis showed that throughout the various elements of the MFE, the PSTs focused primarily on two of the four relationships represented by Lampert's (2001) arrows: the interactions between the teacher and the child, and the relationship between the teacher and the child-mathematics interaction (see Table 8). In general, the PSTs very minimally focused on the interaction of the teacher with the mathematics itself and directed only a slight focus on the direct relationship between the child and mathematics.

Table 8

*Lambert's (2001) Relationships in the Elements of the MFE*

| | Prebriefs | Classroom Lesson | Debriefs |
|---|---|---|---|
| Teacher→Child | 14 (50%) | 11 (35%) | 40 (56%) |
| Teacher→Child/Math | 14 (50%) | 16 (52%) | 27 (37%) |
| Teacher→Math | 0 (0%) | 0 (0%) | 2 (3%) |
| Child→Math | 0 (0%) | 4 (13%) | 3 (4%) |
| Total | 28 | 31 | 72 |

The following sections describe an analysis more specific to each of the three elements of the MFE, including figures for each that illustrate these relationships in the context of Lampert's (2001) model.

**Prebrief.** An analysis of PST written reflections immediately following the prebrief in the context of Lampert's (2001) three-pronged model of teaching practice is illustrated in Figure 15. Considering the two primary relationships that emerge, the PSTs focused on the teacher→child interaction and the teacher→child/math interaction evenly, with 14 occurrences of each. However, when considering each individual PST, the prebrief reflections were no longer as evenly distributed. Lucy's prebrief reflections favored the teacher→ child interactions (70%) over the teacher→child/math relationship (30%), whereas Maria's prebrief reflections more heavily favored the teacher→child/math interactions (61%) over the teacher→child relationship (39%). In these prebriefs, the PSTs' reflections did not consider direct interactions between either the teacher or the child and the mathematics.

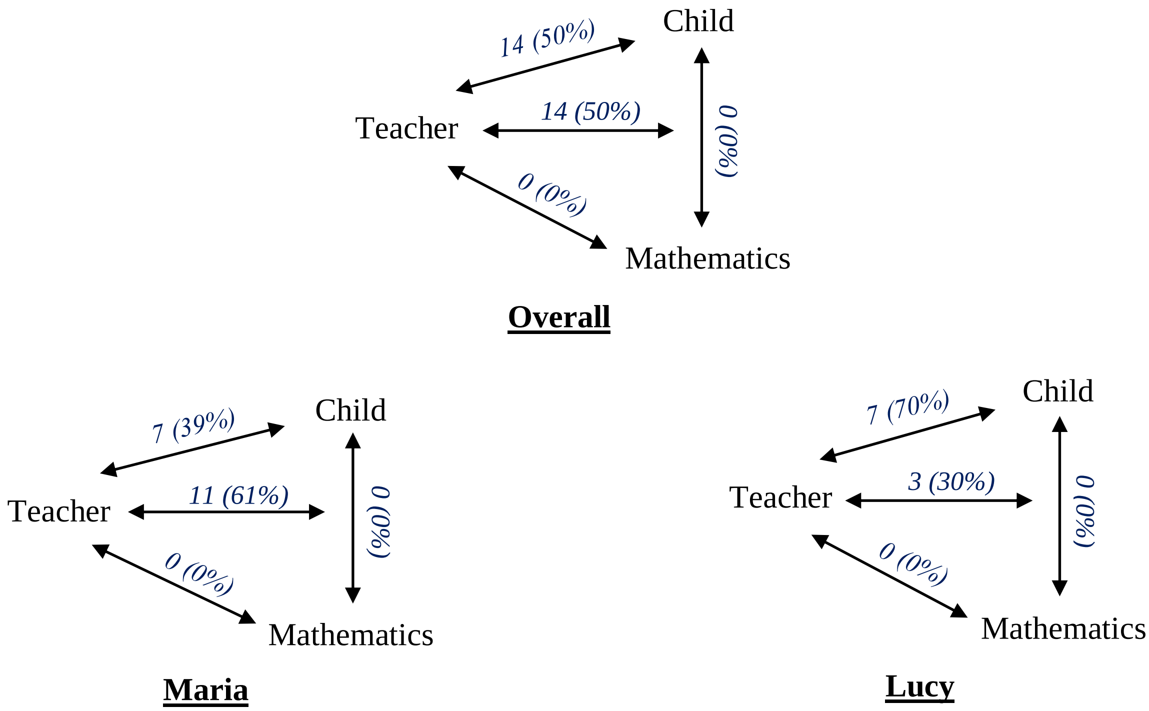


*Figure 15.* PST reflections for the prebrief of the MFE, shown in the context of Lampert's (2001) Model.

In her written reflection following the first MFE, Maria described what the Mathematics Teaching Practice of posing purposeful questions currently meant to her:

> Teachers are to listen and to respond consciously to how their students are mathematically reasoning . . . . The main purpose of the questions and answers is to have the students draw out the bigger math concepts which undergird the specific problem they are tackling and to expand their own ways of thinking of the problem by exposing them to other students' ways of thinking. (Maria, MFE1, Post-Prebrief Written Reflection)

These comments indicate that Maria was focusing primarily upon the teacher→child/math interaction. By her reference to math concepts and specific problems, she was considering not only the students themselves, but also how the teacher could connect specifically to the mathematical understanding of the students in the class. Almost two-thirds of Maria's post-prebrief reflections that were coded as illustrating Lampert's arrows were classified as focusing on this teacher→child/math relationship.

Similarly, reflecting upon the pre-brief during the fifth MFE, Maria commented, "A teacher can facilitate these moments of dialogue and draw out the meaning behind the math by posing questions that probe at bigger and deeper math concepts and by inviting the students to put their thinking into words" (Maria, MFE5, Post-Prebrief Written Reflection). Again, Maria considered how best to engage students, not in a general sense, but specifically in strengthening and deepening their understanding of mathematical concepts.

About half as many of Maria's post-prebrief reflections were coded to focus upon the teacher→child relationship as those showing teacher→child/math interactions. One example of Maria reflecting upon the teacher→child relationship during the post-prebrief reflection occurred in the third MFE:

> [W]hen they are in the midst of teaching, monitoring, or listening to student responses, the teacher needs to listen and to evaluate where the students are in the level of their understanding. From there, the teacher can then ask questions that can determine what the student does and does not comprehend. Then, the teacher can continue the discussion with the student, using the students' strengths and weaknesses to encourage their accomplishments and to guide their progress in their mathematical reasoning. (Maria, MFE3, Post-Prebrief Written Reflection)

Here, Maria reflected upon the teacher's need to interact with students through listening to, evaluating, asking questions of, and having discussions with the student. Other than a brief reference to mathematical reasoning at the very end, no mention was made of student understanding specific to the field of mathematics. Hence, this reflection was coded as an example of the teacher→child relationship.

Lucy's post-prebrief written reflections focused primarily on this teacher→child relationship. For example, following the prebrief of the fourth MFE, Lucy reflected on what the Mathematics Teaching Practice of facilitating meaningful mathematical discourse meant to her:

> [Facilitating meaningful mathematical discourse] means that the teacher will engage the students in conversation about the topic being learned. This conversation should expand the student's understanding of the concept. The discourse, while facilitated by the teacher, should be allowed to occur among the students. (Lucy, MFE4, Post-Prebrief Written Reflection)

Unlike what is found in many of Maria's reflections, Lucy did not consider any specifically mathematics-related content, although she did discuss the students' academic growth in general. This reflection demonstrated Lucy's focus on the teacher→child relationship, an interaction that Lucy tended to reflect upon the most often in her post-prebrief writing.

When reflecting upon the practice of posing purposeful questions, Lucy also tended to focus on the student in a manner that was not content specific. An example of this occurred after the prebrief of the third MFE, when Lucy wrote that posing purposeful questions consists in "[p]hrasing questions in such a way that the student must give a reasoned response. These responses should allow the students to, in a sense, think about their thinking, in order to clarify and organize their thoughts" (Lucy, MFE3, Post-Prebrief Written Reflection). Lucy did focus upon the interaction that was to occur between the teacher and the student in the asking of questions and receiving a response, but mathematical understanding was not itself directly considered.

In her post-prebrief reflections, Lucy only wrote about the teacher's interactions with both the students and the mathematical content a few times. One example could be found in Lucy's reflections following the prebrief in the first MFE:

> [T]he teacher is hoping to guide students to a stronger use of their mental math skill. She wants the students to decompose the addition problem into manageable numbers for adding. In order for this to occur, she will have to ask questions of the students, questions which will allow for this technique to be explained.

Here, Lucy considered how the teacher will reach the goal of not only interacting with the students in general, but how a specific mathematical goal can be reached, namely the decomposition of an addition problem. Hence, Lucy provided an example of the teacher→child/math relationship in this reflection.

Having considered the interactions reflected upon by both Maria and Lucy in their written reflections following the prebriefs, we next turn to analysis of the oral reflections that followed each classroom lesson.

**Classroom lesson.** In reflections immediately following the classroom lesson and preceding the debrief, Figure 16 illustrates how the PSTs tended to focus more heavily upon the teacher→child/math relationship (52%) than the teacher→child interactions (35%). Analyzing the verbal reflections of each individual PST immediately following the classroom lesson, neither favored the teacher→child relationship. Maria's reflections on the teacher→child interactions and the teacher→child/math relationship were evenly balanced, and Lucy tended strongly toward reflections on the teacher→child/math interactions (57%).

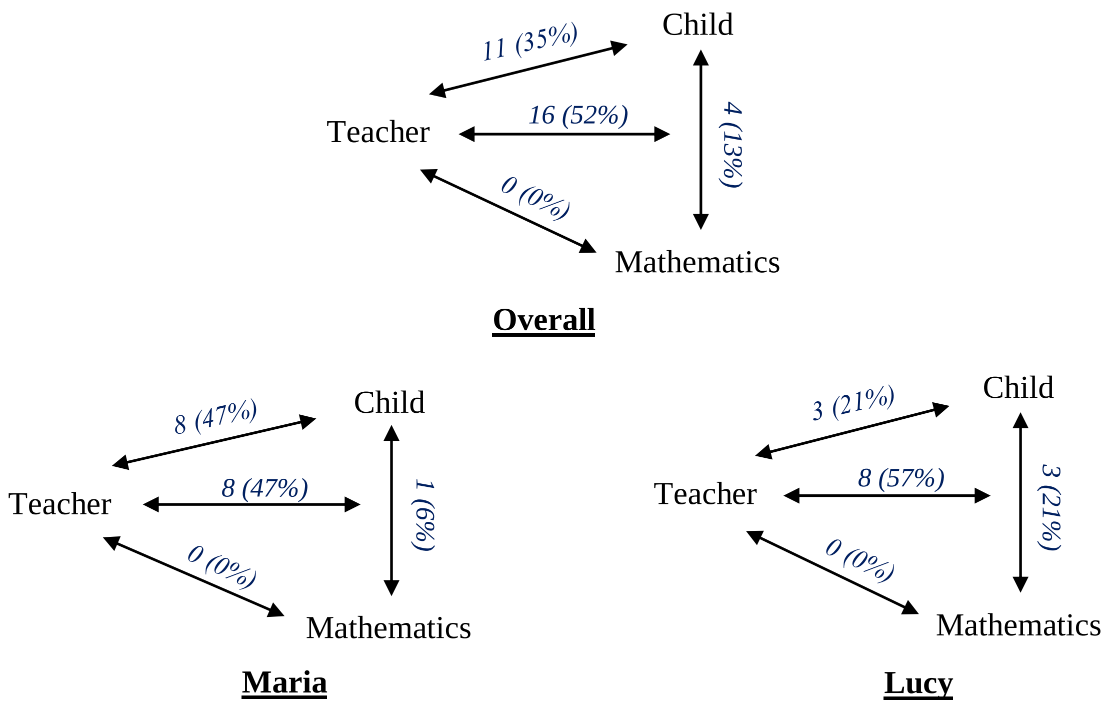


*Figure 16.* PST reflections for the classroom lesson of the MFE, shown in the context of Lampert's (2001) Model.

Over half of Lucy's reflections that were coded as illustrating one of Lampert's arrows displayed characteristics of the teacher→child/math relationship. For example, when commenting upon strategies used by the students in performing the number operation of 139 + 27 during the fourth MFE, Lucy related:

> I asked the students to explain this, and they provided a good understanding of their number sense, because they were able to say how one would change if you took three from one side and didn't add it back to the other side. (Lucy, MFE4, Post-Lesson Oral Reflection)

Lucy not only reflected on the students' general reaction, but also related evidence indicating her focus on the interaction of the students with the mathematical content of number sense.

After the lesson in the fifth MFE, Lucy again demonstrated the teacher→child/math relationship in sharing how she envisioned the practice of meaningful mathematical discourse:

> I think that this is done when the teacher is able to facilitate discussion, rather than just passing on information to the students. So she might, for instance, give a [math] problem, and rather than solving it, have the students solve the problem with partners or alone, but then having each share what their strategy was to arrive at the answer. (Lucy, MFE5, Post-Lesson Oral Reflection)

Lucy considered not just facilitating discussion in general with the students, but specifically how this applies to mathematical problem solving and considering possible strategies used to find a solution.

Lucy's reflections after the first MFE's lesson included two of the three instances of her focus upon the teacher→child interactions following a lesson. One of these examples addressed Lucy's views on how she envisioned the practice of posing purposeful questions:

> [I]f teachers are able to pose purposeful questions, the students are more likely to be engaged within the subject matter being taught. And the students also will own up to their thought processes and be okay with making a mistake, but also proud and probably a higher self-efficacy when they arrive at an answer that is correct. (Lucy, MFE1, Post-Lesson Oral Reflection)

Lucy reflected upon the students' engagement and their thought processes, but in a manner that is general enough that it could apply to most content areas. For this reason, this instance was coded as an example of a reflection focusing upon the teacher→child relationship.

Although Lucy's reflections focused more heavily upon the teacher→child/math relationship, Maria's reflections immediately following the classroom lesson were more balanced, divided evenly between teacher→child interactions (50%) and teacher→child/math interactions (50%). Maria interwove these two types of interactions, integrating both at times. The following response showed first a focus on the teacher→child/math interactions, then a shift to attending more to the teacher→child interaction:

> I thought that the number talk was effective, because I just used the students' questions as a lead to get them to think further into their math. I really liked how the students took ownership of their strategies and were very eager to share. I really thought it was effective that we went from the most common algorithm way of solving the equation to different ways of solving it that it required more mental math and number sense. I think it could have been made more effective, I don't know, maybe if I knew the students' names it would have been easier for me to

> make sure I called on each one and to get them to talk more about each other's strategies, but I think I did the best I could in that way. (Maria, MFE2, Post-Lesson Oral Reflection)

Maria began in a manner similar to the examples of teacher→child/math interactions provided by Lucy above. She commented on how she elicited student mathematical thinking, then included details about student ownership and the progression students followed in problem solving. Unlike Lucy, Maria then included thoughts on how she could have improved upon the lesson by strengthening non-mathematical components of relationship building with the students, such as learning the names of the students. This was integrated into the goal of facilitating student mathematical discourse, so it was relevant to the mathematics, albeit unrelated to the mathematical content itself.

Although Maria would often move between focusing on the teacher→child relationship and teacher→child/math interactions, some of her reflections were more clearly one or the other. For example, when asked whether she had used the teaching practice of posing purposeful questions in her number talk with the students, Maria replied:

> I think that posing purposeful questions did appear in my number talk, because I asked questions to get them to clarify their thinking, or when I encountered a student . . . I asked her questions to clarify what she was thinking and to ask other students to jump in, too. (Maria, MFE2, Post-Lesson Oral Reflection)

Although Maria did refer to the strategy of asking clarifying questions, this strategy is not specific to mathematics. Maria focused upon asking questions to clarify student thinking, which could be applied to any content area, and thus focused more on the teacher→child relationship rather than the teacher→child/math interactions.

After the lesson in the fifth MFE, Maria reflected upon how the students approached one particular problem:

> I was surprised by how the students didn't split up the rectangle into different parts. How they mostly did the eight times 25, and I don't think I was anticipating that as much, so I didn't know what to do with it, or how to get them beyond that. (Maria, MFE4, Post-Lesson Oral Reflection)

Here, Maria's interaction was not as much with the students themselves as with the students-interacting-with-mathematical-concepts. This is an example of the teacher→child/math relationship. Maria reflected upon her surprise at a particular mathematical strategy and her lack of preparedness on using this as a starting point for developing deeper mathematical understanding.

The oral reflections provided by Maria and Lucy offer a means to analyze which relationships the PSTs more intensely focused upon during the classroom lesson. We next consider what patterns were found in the narratives written by Maria and Lucy following the final element of the MFE, the debrief.

**Debrief.** In contrast to reflections following the classroom lesson, the PSTs focused more on the teacher→child dynamic (56%) than the teacher→child/math (37%) interactions in their narratives following the debrief sessions, as shown in Figure 17. When completing these written narratives, both Lucy's and Maria's reflections were more focused on the teacher→child relationship (Lucy 61%, Maria 50%) than the teacher→child/math interactions (Lucy 34%, Maria 41%).

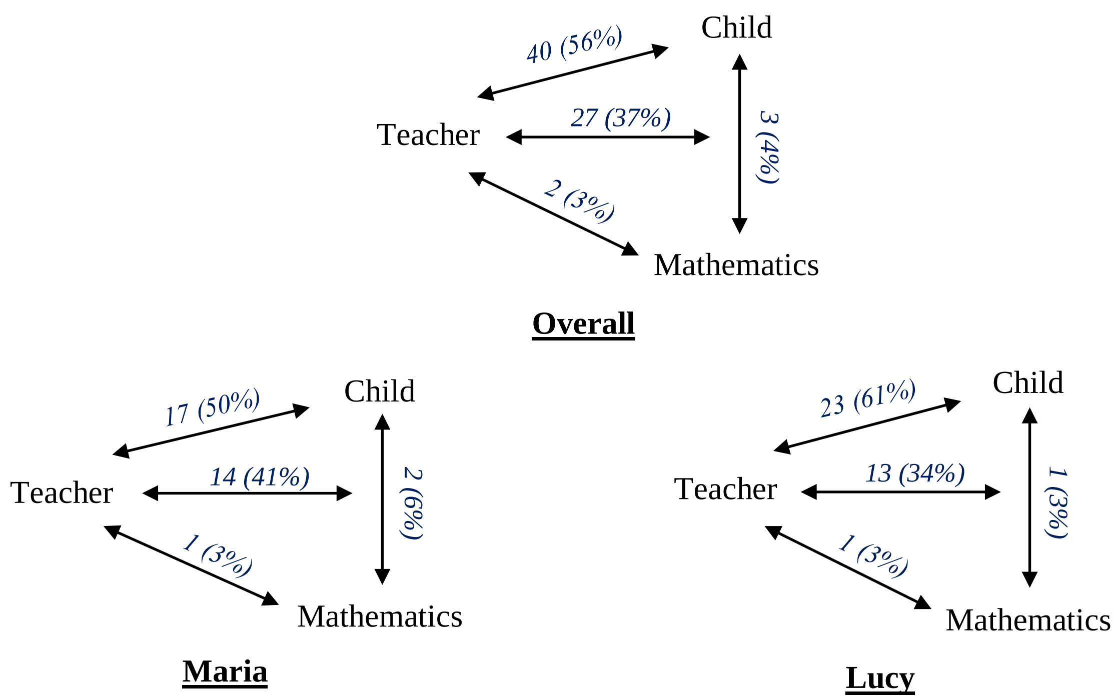


*Figure 17.* PST reflections for the debrief of the MFE, shown in the context of Lampert's (2001) Model.

Both PSTs focused especially on the teacher→child relationship in their written narratives following the debriefs. This was consistent throughout the progression of MFEs. At the conclusion of the first MFE, Maria wrote that, in envisioning the practice of posing purposeful questions, she believes that this practice means that

> teachers have to study their students and their classroom environment and to respond to them meaningfully. It is not just about getting finished from task to task, but it is about knowing each student individually and from that knowledge, guiding them to grow in their thinking. (Maria, MFE1, Post-Debrief Written Narrative)

This reflection provided an emphasis on knowing the students and helping students learn in general. This is a necessary component of mathematics education, as it is to education in every content area. Due to its lack of specificity regarding mathematical content, this reflection was coded as an example of a teacher→child interaction.

In her post-debrief narratives, Lucy often included responses that demonstrated a focus on the teacher→child relationship. After the second MFE, Lucy commented that after having taught a number talk, “I realized how necessary it is to carefully prepare in regards to anticipating their responses” (Lucy, MFE2, Post-Debrief Written Narrative). Building upon a conversation from the third MFE’s debrief, Lucy reflected how “[t]he children are eager to learn and share their way of thinking with the teacher, however, I hope to find a way to get them eager to share their method with their peers” (Lucy, MFE3, Post-Debrief Written Narrative). Considering how to encourage students to share their thinking with one another is a valuable reflection for any content area, including but not exclusive to mathematics education.

After the fourth MFE, Maria again responded to the prompt asking her to explain what is meant by the Mathematics Teaching Practice of facilitating meaningful mathematical discourse. Maria wrote, “I think this means that the teacher has the power to create a classroom environment where the students learn in a community. That is, they think together, share together, and grow together” (Maria, MFE4, Post-Debrief Written Narrative). Once again, Maria focused on important teacher→child interactions, although these were general in nature and not specific to building students’ mathematical understanding.

Following the sixth and final MFE, Lucy responded to a prompt asking whether what was learned through the MFE helped her to better understand what was taught in the course. Her response reflected on how "it is necessary to plan carefully, but be ready for a variety of answers that were not anticipated. If you don't understand what a student is saying, you can ask another child to explain his thoughts" (Lucy, MFE6, Post-Debrief Written Narrative). This response showed evidence of having considered the practice of facilitating meaningful discourse in the classroom, facilitating the teacher→child relationship, but not including components specific to the teaching of mathematics.

Although the majority of PST reflections following the debrief focused upon the teacher→child relationship, some also highlighted teacher→child/math interactions. For example, after the second MFE, Maria reflected upon the benefits of having discussed the number talk prior to conducting the classroom lesson:

> I understood better where the students were coming from (vertical, algorithmic math) and how we might be able to challenge them to think beyond that. We tested the waters, so to speak, with possibilities of expanding their mental math toolbox by asking Ms. Ross if we might introduce writing the problem horizontally and illustrating it using a number line. (Maria, MFE2, Post-Debrief Written Narrative)

Maria reflected upon how the teacher could challenge student thinking in the area of mental math, using a concrete example of a question she and Lucy asked of the classroom teacher about altering the method used in a mental math problem. Maria, learning to think of herself as teacher, was reflecting upon her interactions with the students specifically as students learning mathematical content; hence, this was coded as showing characteristics of a teacher→child/math relationship.

Lucy similarly exhibited reflections coded as signifying a teacher→child/math relationship, although these were much less frequently seen than examples of the teacher→child relationship. In her written narrative following the fifth MFE, Lucy considered what she had learned from her experience teaching the classroom lesson:

> I was able to see that going to individual groups of students and helping them where they were does not mean just conveying my ideas to them. I had to stop and listen to what they were saying so as to figure out the best way to explain 2/4 being the same as 4/8. (Lucy, MFE5, Post-Debrief Written Narrative)

Lucy reflected upon what she, as the teacher, needed to consider in order to help students increase their understanding of equivalent fractions, considerations that focused upon the student specifically as a learner of mathematics.

None of the elements of the MFE included any substantive proportion of comments regarding the interaction between the teacher with the mathematics itself or the interaction between the child and mathematics.

The nature of the interactions identified within each element, coded as instances of Lampert's arrows, exhibited patterns that shifted depending upon the element. Similarly, the references made by the PSTs to either actual classroom experiences or a combination of theoretical principles and hypothetical situations also revealed patterns across the various elements of the MFE. We next turn to this distinction between references to theory and practice in PST reflections throughout the MFE.

## Theoretical Concepts and Authentic Experiences

Instances when the PST referred to either of the two Mathematics Teaching Practices focused upon in the course were coded by whether the reflection was in terms of theoretical concepts and hypothetical situations or whether it indicated actual concrete experiences from the field. These instances yielded patterns when disaggregated by the element of the MFE in which they were situated. Findings are included in the following sections.

**Prebrief.** The prebrief reflections tended to focus on theoretical concepts much more than the authentic experiences in the actual classroom both when considering the Mathematics Teaching Practice of posing purposeful questions and the Mathematics Teaching Practice of facilitating meaningful mathematical discourse. Of the 20 times that prebrief reflections were coded as questioning, one instance was coded only as referring to an authentic field experience, 18 were coded only as theoretical, and one was coded as both (see Figure 18).

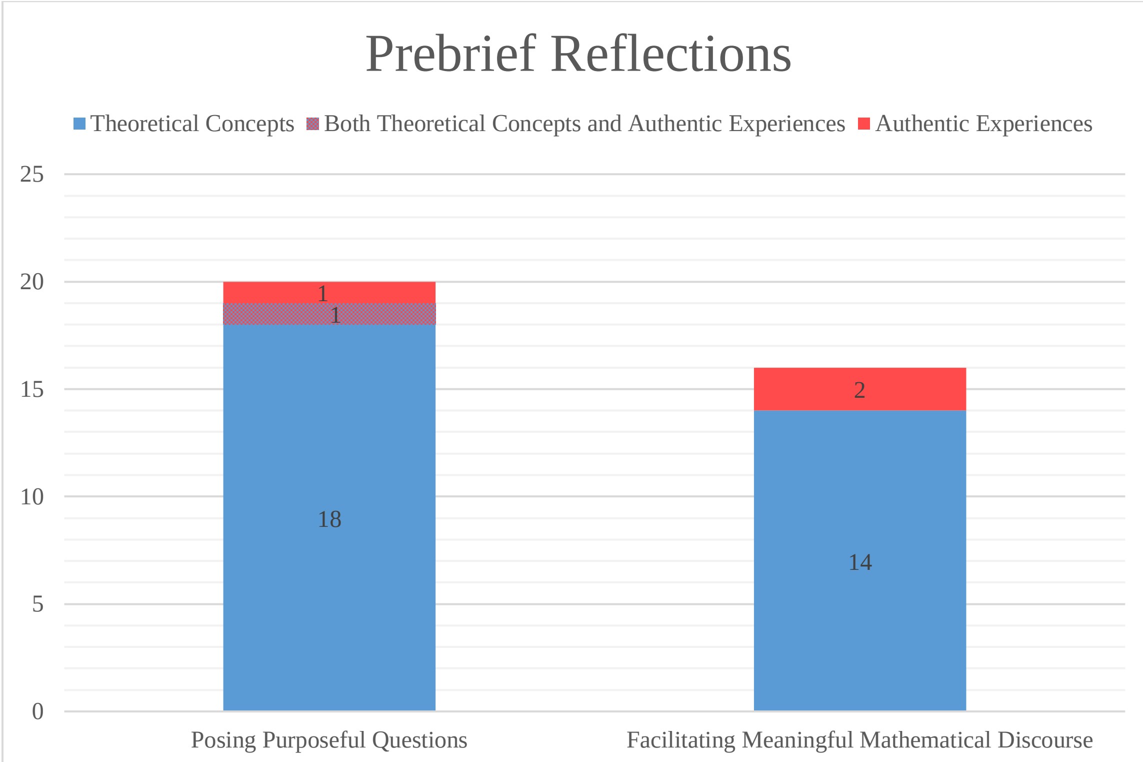


*Figure 18.* PST reflections on theory and practice following MFE prebriefs.

Only one instance was coded solely as reflecting upon authentic experience in the field. This was by Maria following the prebrief of the first MFE:

> We anticipated student strategies with Ms. Ross who shared that she expects the students to see the problem: 57 + 23 and to decompose the numbers. Her expectations reflect that she holds that the purpose of this math talk is not just to get the right answer from the students, but to challenge them to deepen their mathematical reasoning and number sense. She did not, however, go into further detail as to what kinds of questions she would ask. (Maria, MFE1, Post-Prebrief Written Reflection)

Maria referred to the classroom teacher's presentation of a concrete math problem to the students. Her reference to questioning was negative in the sense that it acknowledged the lack of detail provided on the type of questions planned to be asked by the classroom teacher. No direct connections to theory or to a hypothetical situation were included in this particular reflection.

The vast majority of reflections on the practice of questioning were coded as being theoretical or hypothetical in nature. In reflecting upon what facilitating meaningful mathematical discourse means in a classroom setting after the prebrief of the fourth MFE, Lucy considered the role of questioning. She reflected, "[T]his will probably mean that the student will begin to ask questions of each other's reasoning and why they arrived at certain answers. Hopefully the students will develop social skills which allow for differing opinions" (Lucy, MFE4, Post-Prebrief Written Reflection). Lucy's reference to questioning was slightly atypical, as she considered questions that students ask of one another rather than questions posed by the classroom teacher. However, as it did directly reference questioning, it was coded as such. The reflection is fully hypothetical in nature, making no reference to an authentic classroom situation.

Maria likewise had multiple instances of hypothetical reflections upon the practice of posing purposeful questions. One such episode occurred after the prebrief component of the fifth MFE. Similar to the previous reflection from Lucy, Maria also connected questioning with the practice of facilitating meaningful mathematical discourse: "A teacher can facilitate these moments of dialogue and draw out the meaning behind the math by posing questions that probe at bigger and deeper math concepts and by inviting the students to put their thinking into words" (Maria, MFE5, Post-Prebrief

Written Reflection). Unlike Lucy's previous reflection, Maria referred to questioning in the more traditional sense, as questions posed by the classroom teacher. No reference was made to any experience occuring in an authentic classroom environment.

The one instance coded as both theoretical and practical was a reflection made by Maria after the second prebrief:

> Because we had noticed from our first time observing Ms. Ross's class that she did not go deep with having the students explain their strategies or those of others, we wanted to see if we could spend more time on this. So, we tested the waters, so to speak, by asking Ms. Ross if the mental math strategies we hoped could give rise to asking purposeful questions could be accessible to the students. (Maria, MFE2, Post-Prebrief Written Reflection)

Here, Maria's mention of a concrete weakness of Ms. Ross that was observed during the first MFE was coded as referring to an authentic field experience. The reflection went on to consider how the PSTs might be able to spend more time on this particular area, making use of questioning strategies, which was coded as theoretical in nature.

The second Mathematics Teaching Practice, focusing upon facilitating meaningful mathematical discourse, showed more overlap between field-related comments and hypothetical comments in the MFEs overall. However, none of the prebrief reflections that were coded as discourse were double-coded as both field and hypothetical. Two instances of reflections focused on authentic classroom experiences, and 14 were theoretical in nature.

Both Maria and Lucy exhibited a number of theoretical reflections on the practice of facilitating meaningful mathematical discourse. After the prebrief of the fourth MFE, Lucy wrote: “We made the connection that in order to facilitate a meaningful discussion, it is essential that the teacher has prepared good questions which require a well-reasoned response from the students” (Lucy, MFE4, Post-Prebrief Written Reflection). Lucy touched upon the theoretical nature of facilitating discourse; no reference was made to any actual classroom situation.

After the prebrief of the fifth MFE, Maria explained what facilitating meaningful mathematical discourse meant to her:

> [T]his practice means having the class learn collaboratively instead of the teacher doing most of the talking and explaining during the class period. The teachers engage in dialogue with the students and the students engage in dialogue amongst themselves in order to strengthen their comprehension of the math concepts at hand. (Maria, MFE5, Post-Prebrief Written Reflection)

In another context, this reflection could refer to an authentic classroom encounter, in which both teacher-student and student-student dialogue occurs. However, Maria was not here making reference to any particular classroom occurrence, but rather generalizing the presence of discourse as a theoretical concept.

Both of the reflections on discourse that included reference to the authentic classroom were written by Maria following the prebrief of the second MFE. For example, Maria commented that “we had noticed from our first time observing Ms. Ross’s class that she did not go deep with having the students explain their strategies or those of others” (Maria, MFE2, Post-Prebrief Written Reflection). This concrete reference to a classroom observation included mention of the students’ lack of engagement in discourse and the absence of in-depth explanations of strategies used. Situations referencing some type of discourse, whether that discourse is actively engaged upon or not, fall under the coding for facilitating meaningful mathematical discourse.

Overall, the PSTs showed a strong tendency to reflect upon theory rather than concrete practice in their written reflections following the prebrief of the MFE. We next consider how PST reflections immediately following the presentation of the classroom lesson were either theoretical or practical in nature.

**Classroom lesson.** The reflections following the classroom lesson had a greater focus on the actual classroom. Reflections on the Mathematics Teaching Practice of discourse, in particular, included many instances in which the authentic classroom provided the context for reflection. A similar, albeit less predominant, focus on the actual field experience setting was observed in connection with the earlier Mathematics Teaching Practice of posing purposeful questions (see Figure 19). Of the 13 times that classroom lesson reflections were coded as questioning, six instances were coded as addressing only the concrete classroom setting, five were coded only as theoretical, and two were coded as both.

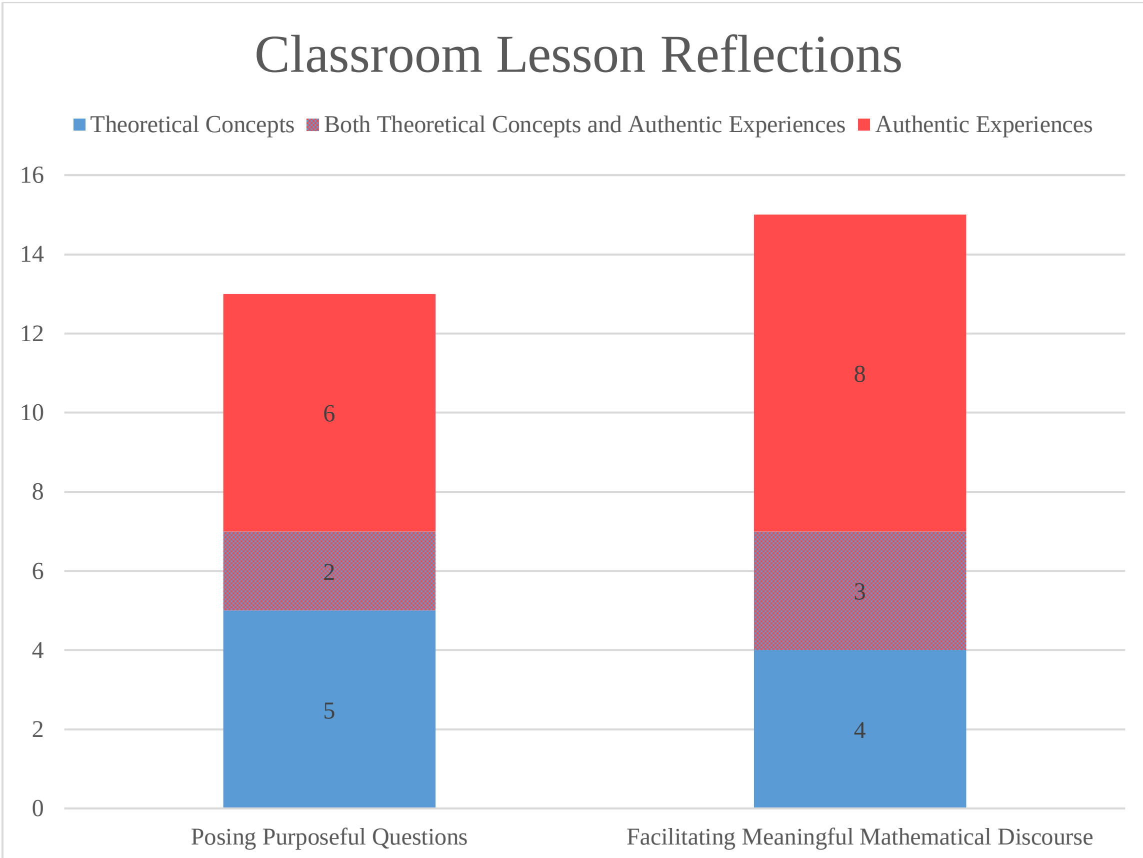


*Figure 19.* PST reflections on theory and practice following MFE classroom lessons.

Maria's reflection on the classroom lesson in the second MFE included both theoretical and practical elements. She began with a critique of Ms. Ross' style of questioning during that day's lesson:

> I am thinking that posing purposeful questions was not really present in the teacher's lesson, because she asked moreso for, okay, "What answer did you get? Did somebody get something different?" And I thought that it was just on an informational level, and not, like can you explain that deeper, and what does that mean, what does that illustration depict? (Maria, MFE2, Post-Lesson Oral Reflection)

Maria then immediately continued to contrast this authentic classroom experience with "what we've been talking about in class, not just asking to get information, but asking so that students can really enrich their understanding and deepen their grasp of the concepts of addition and subtraction" (Maria, MFE2, Post-Lesson Oral Reflection). After first considering what she saw as shortfalls in the actual classroom teaching, Maria then reflected upon a more theoretical understanding of posing purposeful questions, as had been discussed in coursework.

When asked after the classroom lesson in the fifth MFE what she believes is meant by the practice of facilitating meaningful mathematical discourse, Lucy replied that this is "the ability of students to explain with each other their process of thoughts and how they arrive at the answers, be able to have a dialogue with the teacher and the student, as well as the student-to-student" (Lucy, MFE5, Post-Lesson Oral Reflection). Although she had just engaged in interactions with students in an authentic classroom setting, Lucy's reflection did not include reference to any particular interactions or experiences from her classroom experience. Instead, she chose to keep her comments more general and theoretical in nature.

Following the same classroom lesson presented in the fifth MFE, Maria commented upon her experience attempting to foster meaningful mathematical discourse with the students in the classroom:

> I tried to facilitate meaningful math discourse by doing the turn-and-talk, but I had a limited amount of time, so I didn't really know if what the students were talking about was actually related to the topic. But the fact that they were eager to share and that they had a lot to say and many different answers was really a good

> indication that we're getting closer to them being able to defend different answers, even when it's incorrect, or trying to understand why the answer that's correct is correct. I had kind of a hard time, because there's so many incorrect answers that I didn't really know how to affirm thinking, but also lead the students into the right direction. (Maria, MFE5, Post-Lesson Oral Reflection)

Maria included a number of details on how she tried to incorporate discourse in this actual classroom setting. She did not directly refer to any theoretical concepts, keeping her reflections focused upon the concrete classroom dynamics she had just experienced.

Of the 15 times that classroom lesson reflections were coded as discourse, eight instances were coded only as authentic classroom experience, four were coded only as theoretical, and three were coded as both. Two of those coded as both were reflections by Lucy and one was by Maria. Lucy's reflection on the classroom lesson during the fourth MFE was one example of a reflection on mathematical discourse that included elements from both the authentic classroom experience and a hypothetical future classroom setting:

> For facilitating mathematical discourse, I think that it was a little difficult to have the students talking to each other, I'm not sure that that is necessarily something that they do in a whole group setting. So I think if that is begun from the beginning of the year, it will become more natural to the students, and they'll be more willing to share their ideas and their thought processes, ask each other questions, and be ready to answer each other's questions. (Lucy, MFE4, Post-Lesson Oral Reflection)

Lucy began by reflecting upon what she had experienced in her concrete experience in the classroom, namely the difficulties encountered by having students talk with one another during the classroom lesson. She then went on to hypothetically consider how adaptations in her future practice may address this difficulty and produce more positive results in the area of student discourse.

In the fifth MFE, Maria provided an example of a reflection on mathematical discourse that was purely theoretical in nature, with no reference to an authentic classroom setting:

> We are currently focusing upon the mathematics practice of facilitating meaningful math discourse. Currently this practice means to me that we as teachers can help students to engage in conversation with each other, and with the teacher, that is helpful for them to understanding the math concepts. (Maria, MFE5, Post-Lesson Oral Reflection)

Maria reflected upon what this particular practice meant to her, citing examples of both student-student and teacher-student discourse. No mention was made of any particular scenarios from the presentation of the classroom lesson that had taken place immediately preceding this reflection.

After the classroom lesson during the final MFE, Lucy provided comments regarding discourse that had no directly theoretical or hypothetical components, focusing solely on the authentic classroom setting. Lucy reflected:

> We are focusing upon facilitating mathematical discourse. This occurred within the lesson with the teacher walking around to the students and talking to them throughout the lesson, seeing what they were doing, but also when they were giving their answers, projecting them on the board, the teacher was able to further explain what they were doing. (Lucy, MFE6, Post-Lesson Oral Reflection)

Lucy began by clearly stating the mathematics practice under consideration. She then gave multiple examples of how this practice could be concretely found during different components of the lesson.

Both authentic classroom experiences as well as theoretical or hypothetical considerations were reflected upon by PSTs in their oral reflections immediately following the classroom lesson. However, reflections focusing upon actual classroom happenings predominated during this element of the MFE. We will next consider the focus of PST reflections following the debrief.

**Debrief.** The debrief reflections for the earlier Mathematics Teaching Practice of posing purposeful questions leaned strongly toward inclusion of theoretical concepts rather than considerations of the authentic field experience. This trend became less predominant with the later Mathematics Teaching Practice of discourse (see Figure 20). Of the 16 times that debrief reflections were coded as questioning, one instance was coded only as authentic classroom experiences, 14 were coded only as focused on theoretical concepts, and one was coded as both.

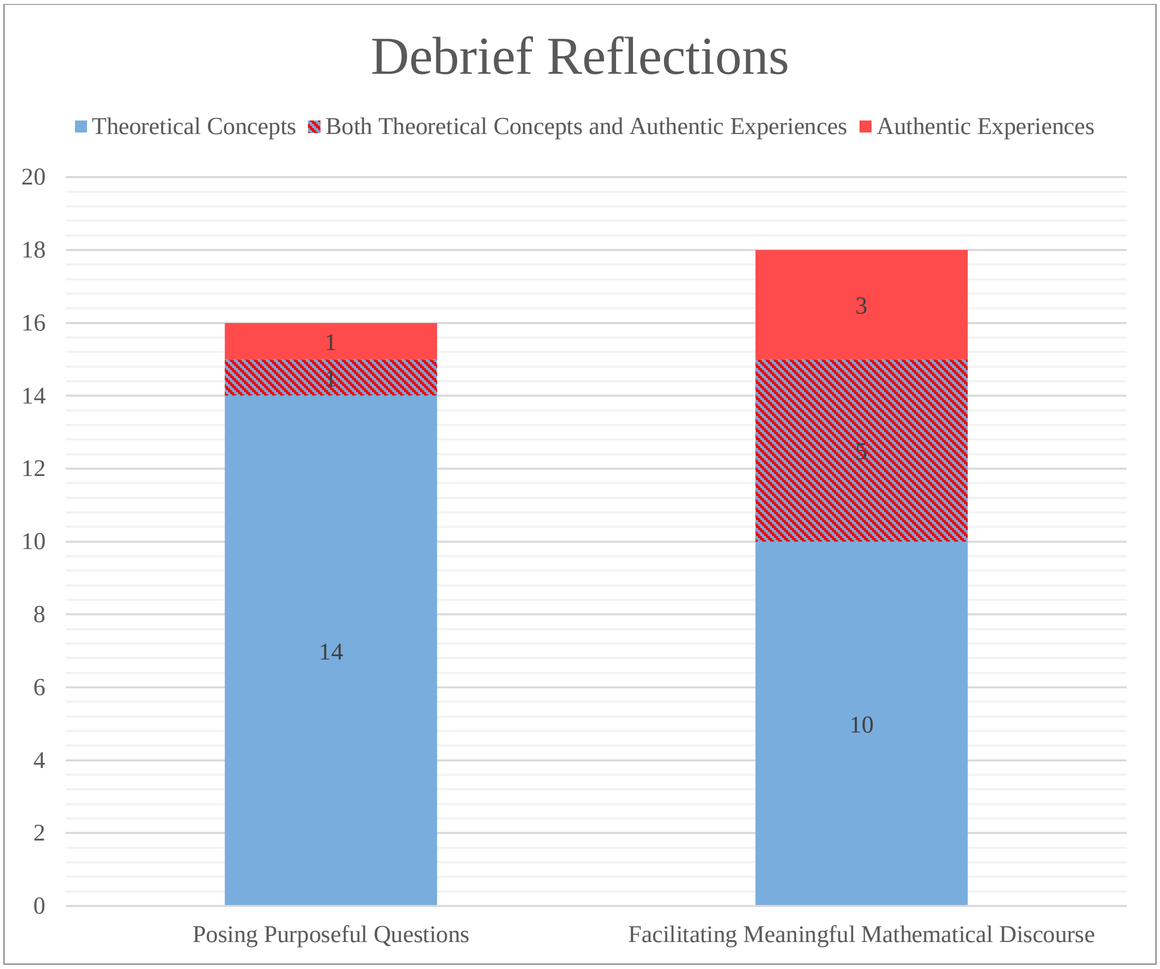


*Figure 20.* PST reflections on theory and practice following MFE debriefs.

When considering the practice of posing purposeful questions, most of the reflections of both PSTs following the debrief were primarily theoretical or hypothetical in nature. After the debrief of the first MFE, Lucy explained that posing purposeful questions "means posing questions to the students that require a well-reasoned response. The students should be able to respond to the question in such a way that they are able to explain their process of arriving at a particular answer" (Lucy, MFE1, Post-Debrief Written Narrative). This definition did not refer to any students in particular, but rather students in an abstract, theoretical sense.

Maria, in her narrative following the debrief of the second MFE, also used theoretical terms to describe what she considered the practice of posing purposeful questions to encompass:

> Posing purposeful questions . . . means asking questions that deepen students' number sense and comprehension of overarching math concepts. Currently, I envision that this practice entails allowing the students the time to think, prompting them to share their thinking processes, and doing so in a way that is not "funneling" their responses to the teacher's desired end, but being flexible and open enough to connect and integrate the different responses in a way that helps all the students advance their mathematical reasoning. (Maria, MFE2, Post-Debrief Written Narrative)

Here, Maria began by giving a theoretical definition of posing purposeful questions. She then explained further by offering a description of how students, in the abstract sense, benefit from the employment of this practice. No concrete examples from the field were included.

The only post-debrief narrative selection coded as including reference to questioning within the authentic classroom setting without mention of theory took place after the first debrief. Maria reflected upon the questioning employed by the classroom teacher during Maria's observation of her teaching:

> During our observation, I couldn't quite follow or evaluate each of the questions Ms. Ross asked to see where they were purposeful questions or not . . . she did not just ask for the answers or highlight only the students who were strong in math. (Maria, MFE1, Post-Debrief Written Narrative)

Maria reflected upon what she had noticed in the actual classroom during her time observing the classroom teacher. She noted the classroom teacher's actions in terms not of what was done, but also what was not done. This brought Maria to the conclusion that she was unable to determine whether the questioning strategy of the classroom teacher was in fact "purposeful."

The one reflection coded as including both theory and reference to the authentic classroom setting, as well as referencing both practices, was Maria's comments on her observation of Ms. Ross' successful implementation of both posing purposeful questions and mathematical discourse. Beginning with an acknowledgement of her experience observing in an authentic classroom setting, she wrote, "While observing Ms. Ross, I was struck by how much these two practices really become principles of teaching and how, if employed, they can guide and bolster a lesson, whether it be math or another subject" (Maria, MFE6, Post-Debrief Written Narrative). Maria went on to expand her reflection to include the recognition that Ms. Ross' "pedagogy and practices don't mirror the book perfectly" (Maria, MFE6, Post-Debrief Written Narrative), which integrates considerations of theory as learned from "the book" with the practical application of this theory.

Of the 18 times that debrief reflections were coded as discourse, three instances were coded only as focusing on the authentic classroom, 10 were coded only as referencing theory, and five were coded as both theory and practice. This differed from the debrief reflections coded as questioning in that PSTs gave increasing attention to examples from the authentic classroom setting. However, the emphasis continued to be on hypothetical or theoretical examples.

In her narrative following the debrief of the fourth MFE, Lucy provided an example of a reflection including situations from the authentic classroom as she commented upon her observation of a classroom lesson: “[I]t not only feels difficult to have students explain their work, but even when watching Maria one can observe that the students are not necessarily accustomed to sharing out the process of how they arrived at an answer” (Lucy, MFE4, Post-Debrief Written Narrative). This was an example of a reflection that is coded as focusing upon the authentic classroom. Lucy directly referenced her experience of observing during the actual classroom lesson to consider student discourse in “sharing out” their strategies.

Following the debrief of the fourth MFE, Maria commented on how she envisions the Mathematics Teaching Practice of facilitating meaningful mathematical discourse:

> I think this means that the teacher has the power to create a classroom environment where the students learn in a community. That is, they think together, share together, and grow together. What I envision of this practice is the teacher posing purposeful questions to her students individually, in pairs, small groups, or whole class discussions and then using their responses to delve into bigger mathematical concepts. I imagine that this will result in more student engagement as students give voice to the concepts they are trying to understand better. (Maria, MFE4, Post-Debrief Written Narrative)

Maria’s narrative was fully hypothetical in nature, reflecting upon how she envisioned how discourse can play out between the classroom teacher and the students in a hypothetical classroom setting.

Considering PST reflections on each of the two practices in all three elements of the MFE, reflections during the debrief that referenced the practice of facilitating meaningful mathematical discourse showed the greatest propensity toward including elements that were both theoretical in nature and also referred to authentic classroom interactions. Table 9 provides a summary of both the classroom and theoretical components of each of the five reflections that were considered to include both of these.

Table 9

*Debrief Reflections on Discourse Including Both Field and Theory Components*

| PST | MFE | Authentic Classroom | Theoretical Concepts |
|---|---|---|---|
| Lucy | 3 | Students eager to share thinking with teacher | Desire to foster eagerness in students to share thinking with one another |
| Lucy | 4 | Observed students not accustomed to explaining their thinking | Desire to cultivate student explanations from beginning of school year |
| Maria | 4 | Asked students to explain the work of one another | Expressed surprise at ease of application of what was learned in coursework |
| Maria | 5 | Reflected on failure to anticipate student difficulties | The need for proper scaffolding provided by teacher |
| Maria | 6 | Ms. Ross' use of MTPs | Recognition that Ms. Ross' "pedagogy and practices don't mirror the book perfectly" |

Each of the three elements of the MFE showed varying instances when the PST referred to theoretical concepts either abstractly or as how they could theoretically be applied to a future classroom situation, as well as classroom situations actually experienced in the field. Overall, the prebrief reflections focused heavily on theoretical concepts and the reflections following the classroom lesson focused primarily on experiences from the authentic classroom setting. The debrief reflection showed the most variance depending upon which Mathematics Teaching Practice was focused upon, leaning heavily toward theoretical concepts when considering how to pose purposeful questions in earlier MFEs, with the proportion of reflections including authentic classroom experiences increasing when reflecting upon how to facilitate meaningful mathematical discourse in later MFEs (see Figure 21).

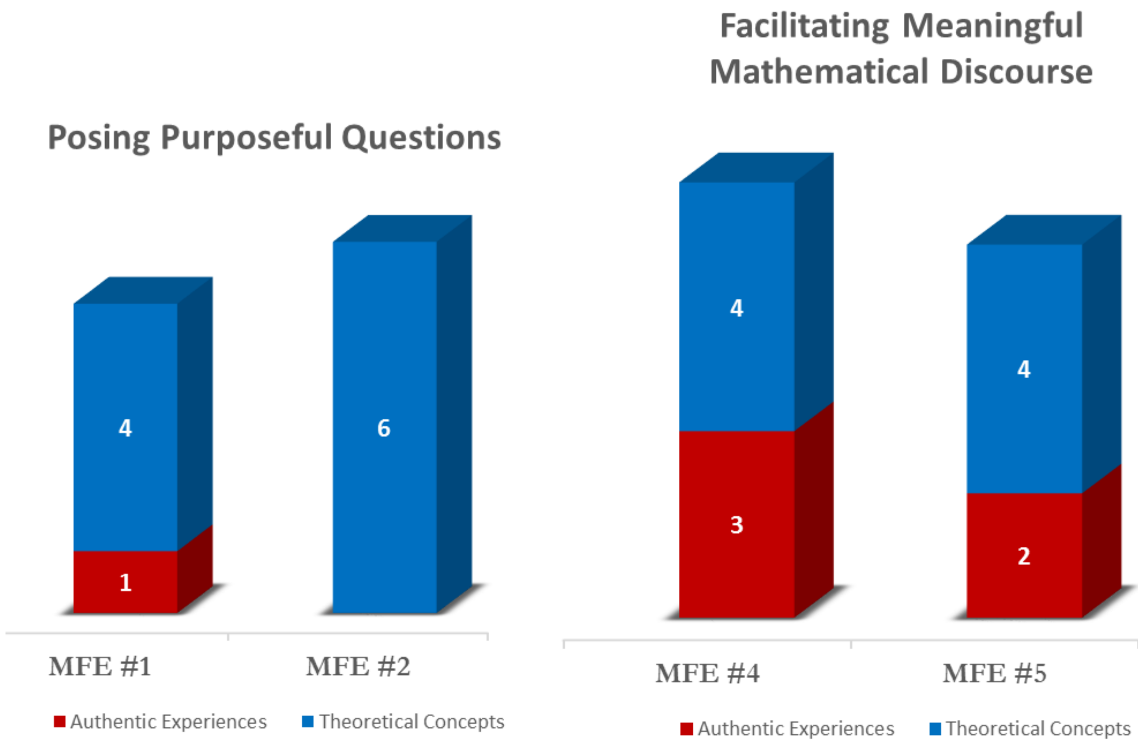


*Figure 21.* PST reflections on authentic field experience and theoretical concepts following MFE debriefs.

Having analyzed how the nature of PST reflections varied both in the progression of MFEs overall and in the various elements of the MFE, we now move into analysis that considers more specifically the construct of hybrid space.

**Entry into Hybrid Space**

Within the construct of two particular Mathematics Teaching Practices, analysis showed that the relationship between the PST and the theoretical principles as discussed in the methods coursework, and the relationship between the PST and the actual authentic classroom of the cooperating teacher, at times began to merge. The reflections of the PSTs exhibited a sense of integrity as these two domains begin to overlap. Although coherence was not often referred to by name, characteristics of coherence were found to be present throughout this merging of the hypothetical and authentic classroom experiences.

As discussed above in the section on theoretical concepts and authentic experiences in the analysis of elements of the MFE, reflections that were directly tied to one of the two Mathematics Teaching Practices were coded by whether the reflection was in terms of theoretical concepts and hypothetical situations or whether it indicated actual concrete experiences from the field. Some reflections exhibited characteristics of both theoretical and actual classroom situations and were thus double-coded with an overlap of these two codes. The following sections will use the two Mathematics Teaching Practices (NCTM, 2014) of posing purposeful questions and facilitating meaningful mathematical discourse as constructs in order to identify points at which the PSTs' reflections exhibit an overlap of theory and practice, illustrating entry into hybrid space.

It may be noted that numerical totals for the number of reflections coded were slightly higher than in the previous section that highlighted the different elements of the MFE. Each PST took part in a series of three interviews spaced throughout the experience, as described in Chapter 3. In addition to PST reflections after each element of the MFE, the transcriptions from these interviews were also considered for analysis in the following sections.

**Posing Purposeful Questions**

The first Mathematics Teaching Practice that was introduced in coursework was posing purposeful questions. The PSTs read a chapter from their textbook that introduced this practice and they verbally discussed the purpose of questions as part of coursework. Ms. Ross also offered reflections upon her strategies for posing questions to students.

Both Maria and Lucy included reflections upon this Mathematics Teaching Practice throughout their narratives and interviews. This construct provided a means by which to analyze the entry of Maria and Lucy into hybrid space, as they began to blend what they learned in theory with their experiences in the classroom setting.

As noted in Appendix J, excerpts from PST reflections were coded as Questioning: Theoretical when PSTs referenced posing purposeful questions in a theoretical and/or hypothetical context, considering students abstractly. This included references to theory, textbook, coursework, or expectations or predictions about authentic classroom setting. The code of Questioning: Field was applied for excerpts from PST reflections that referenced posing purposeful questions in the context of an authentic classroom. To be coded in this manner, the excerpt must provide reference to an actual concrete situation, child, or happening in an authentic classroom. For both of these Questioning codes, some type of questioning was required to have been referenced, although this could take various forms, such as considering student responses to questions or considering the questions themselves that are being asked by the teacher. As illustrated in Figure 22, a total of seven excerpts from PST reflections (two from Lucy and five from Maria) directly tied to posing purposeful questions were identified as exhibiting both theoretical and practical characteristics.

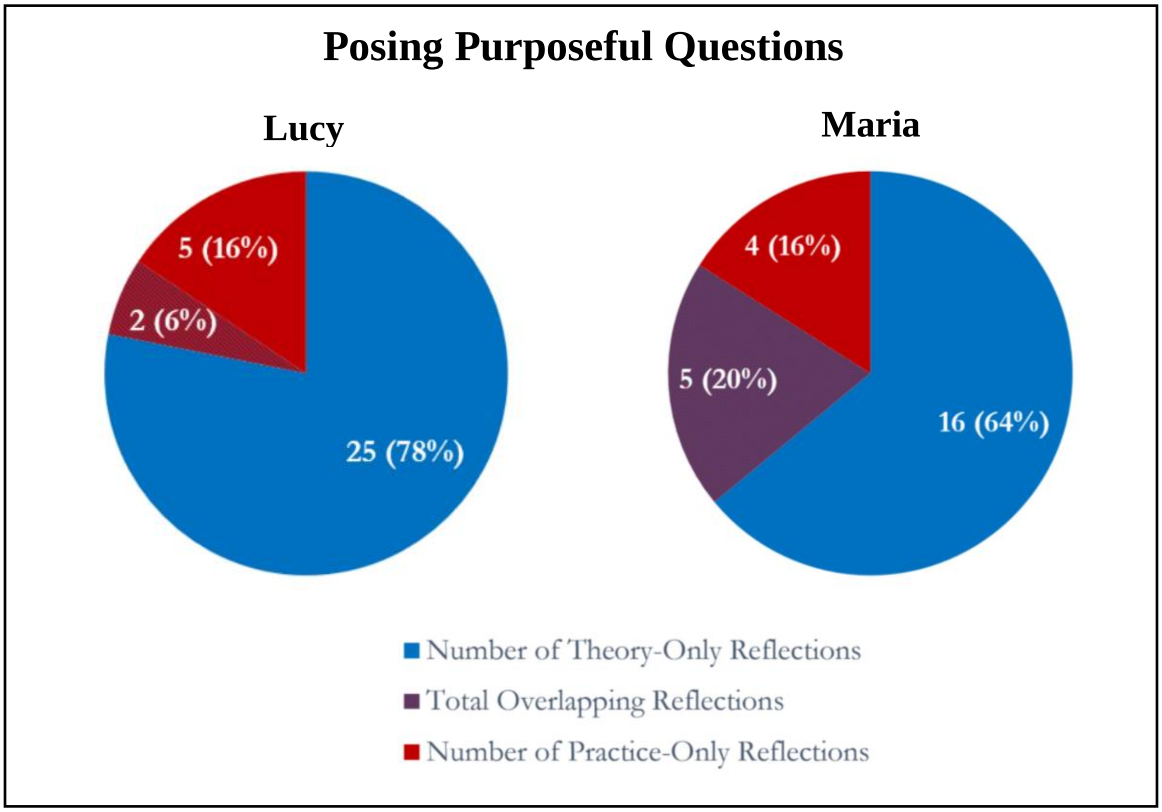


*Figure 22.* Overlapping theory and practice reflections signifying instances of entry into hybrid space within the construct of posing purposeful questions.

The majority of reflections on posing purposeful questions for both Lucy and Maria tended to be theoretical and not practical. For example, after the second MFE prebrief, Lucy wrote, “The teacher is largely responsible for posing questions which will become an avenue for the students to grow in their understanding of the math concept being learned as well as growth in number sense” (Lucy, MFE2, Post-Prebrief Written Reflection). Lucy showed that she had a goal for posing purposeful questions that she could articulate, although this was in an abstract, hypothetical context. She expected student growth, but was unable to provide concrete details beyond abstract concepts such as growth in number sense.

Another example of Lucy reflecting upon this practice in a theoretical context occurred after the fifth MFE. Lucy wrote that she envisioned posing purposeful questions as "allowing the students to engage in dialogue among themselves about their methods of arriving at an answer" (Lucy, MFE5, Post-Debrief Written Narrative). This was less abstract, yet still referred to hypothetical students without reference to any concrete situation in an authentic classroom setting.

Maria had fewer theoretical reflections on posing purposeful questions, with 16 instances (64%) coded in this manner. One example occurred in her post-lesson oral reflection after the first MFE. Maria commented that posing purposeful questions means that "the teacher is trying to understand the mathematical thinking of her students. And not just trying to get them to get the right answer but trying to understand how they got there and where their reasoning is going" (Maria, MFE1, Post-Lesson Oral Reflection). Here, Maria reflected upon the underlying purpose of posing purposeful questions. Her reflection focused upon the hypothetical classroom situation in which a teacher desires to understand student thinking and uses this practice to further understanding. No authentic classroom was referenced, causing this reflection to be considered theoretical in nature.

Following the prebrief of the third MFE, Maria reflected upon what she theoretically considered to be an important component of posing purposeful questions:

> [T]he teacher needs to know where the students are and what they can handle. If a teacher tries to give them something way beyond *the zone of their proximal development* [emphasis added], then the student will be overcome or too busy with the difficulty of the problem. A student who is discouraged or overwhelmed is not free enough to think about or to clarify their own thinking. Giving students

> just the right amount of a challenge, however, opens the door to posing purposeful questions because it strikes the balance between boredom and discouragement: two extremes that students can easily fall into if the problem that is given to them is mismatched with their mathematical ability and potential. (Maria, MFE3, Post-Prebrief Reflection)

Here, Maria incorporated knowledge that she learned outside of the current class—namely, Vygotsky's concept of the zone of proximal development. This integration allowed her to add details to her theoretical understanding of how best to pose purposeful questions. The students to which Maria referred were all hypothetical in nature, without any reference to actual students in Ms. Ross' classroom.

In contrast to those reflections that were purely theoretical or hypothetical in nature, both Lucy and Maria also reflected upon the practice of posing purposeful questions in the context of actual experiences from the authentic classroom setting. Lucy referenced her first experience teaching a number talk to a small group of students during the second MFE:

> I tried to ask the students not only to give me their answer, but to explain to me how they got their answer. And then I would write that on the board, and I would ask them to clarify if I was not sure what they had meant in a certain process, or to clarify for the other students as well. When I was explaining the number line, I tried to ask questions to see if the students were grasping and understanding, . . . for the students, to show, to pose questions to see if they were grasping the concept that there's a distance that must be maintained between the two numbers. (Lucy, MFE2, Post-Lesson Oral Reflection)

Here, Lucy described the actions of her students and herself in a concrete classroom situation. She named particular examples, including the context of an explanation of a number line, and a specific student's response.

Maria similarly commented upon her first experience teaching a number talk to a small group of students during the second MFE. Reflecting upon what she learned from observing a lesson taught by Ms. Ross, Maria connected the practice of posing purposeful questions concretely by noting what was not done:

> During our observation, *I couldn't quite follow or evaluate each of the questions Ms. Ross asked to see where they were purposeful questions or not* [emphasis added]. Although she did not just ask for the answers or highlight only the students who were strong in math, I wondered if she could have probed student thinking more deeply by having them explain strategies different from their own. From what I could tell, she did not select or sequence student strategies with the number talk about 57+23 and she did not encourage students to consider or explain different strategies. While she said this problem was an easy one, she could have gone a bit deeper with it instead of just getting the array of strategies and leaving it at that. (Maria, MFE1, Post-Debrief Narrative)

Maria reflected not upon her own use of posing purposeful question, but that of the classroom teacher as Maria observed a lesson. Maria highlighted a particular mathematical problem that the students were asked to consider in a number talk, describing both what was done in the lesson (the teacher told the students this was an easy problem and listed various strategies) and what could have been done to improve the manner of questioning, in the opinion of Maria (intentional selecting and sequencing of strategies, having students explain the strategies used by other students).

Following the lesson during the second MFE, during which time Maria had led a small group in a number talk, Maria commented:

> I thought that the number talk was effective, because I just used the students' questions as a lead to get them to think further into their math. I really liked how the students took ownership of their strategies and were very eager to share. I really thought it was effective that we went from the most common algorithm way of solving the equation to different ways of solving it that it required more mental math and number sense. (Maria, MFE2, Post-Lesson Oral Reflection)

Maria described a situation from her own teaching in which she employed the intentional posing of purposeful questions. Maria shared how the students responded and the particular sequencing that she employed as students explained their individual strategies.

In the fourth MFE, Lucy included an example of student thinking as a result of posing purposeful questions:

> I asked the students to explain this, and they provided a good understanding of their number sense, because they were able to say how one would change if you took three from one side and didn't add it back to the other side. (Lucy, MFE4, Post-Lesson Oral Reflection)

Again, Lucy included a concrete example of a student explanation. Lucy did not refer to her theoretical understanding of posing purposeful questions, but she did share details of results from her questioning of students from an authentic classroom experience.

One example of the theoretical and practical overlapping can be found in Maria's post-prebrief reflection during the second MFE. Maria wrote:

> [W]e had noticed from our first time observing Ms. Ross' class that she did not go deep with having the students explain their strategies or those of others, we wanted to see if we could spend more time on this. So, we tested the waters, so to speak, by asking Ms. Ross if the mental math strategies we hoped could give rise to asking purposeful questions could be accessible to the students. (Maria, MFE2, Post-Prebrief Written Reflection)

Here, Maria began with an observation of a concrete experience in the classroom setting, noting how students had not provided explanations of their strategies used to solve a problem. Maria then went on to relate how they had used this authentic experience to reflect with the classroom teacher on whether what they had learned in theory might be applicable to the classroom setting. In this way, the theoretical built upon an actual field experience.

Maria's lengthy reflection on first the consideration of theoretical principles, then putting them to use in the authentic classroom, provided an example of beginning entry into hybrid space:

> I think, just doing the reading from the textbook, and then reading through the samples and the dialogues, you taught us how to tell the difference between just asking questions to get information, and then asking questions to really deepen student understanding and to get them to think big concepts. *And then coming to Ms. Ross' class, I was able to use that knowledge to discern, like, what kind of question is she asking right now?* [emphasis added] Or what questions could she

> have asked, but, I was expecting her to ask, but she didn't. Because I could kind of listen to the students as well, and think in my mind, okay, where could this discussion go, based on what we read in the textbook . . . . I think it encouraged me to start where the kids are comfortable, so, what Ms. Ross usually does, like what's the answer? How do you get there? And that's usually where she stops. But then, the book and our readings were saying, like, you could do a little bit more with that. Like, get them to put another person's strategy in their own words, and explain each other's, or if you encounter something new, like one of the girls in my group did something new, I was like, Oh, I'm not following, could someone else help me? So the kids were able to talk about each other's strategies, and that's something that Ms. Ross hadn't, she didn't have them doing yet. (Maria, Interview 2)

Maria noted that she began with a theoretical understanding of the underlying principles involved in posing purposeful questions. She then used this as a basis for observing an authentic classroom setting. During the observation, Maria reflected upon how her theoretical knowledge influenced her analysis of the situation in the classroom. She then extended this to reflect upon how both of these elements—the principles learned through coursework and the classroom observation—influenced her own interactions with the students. As she continued this cycle of reflection upon the theoretical and application to the authentic classroom setting, Maria entered more fully into the hybrid space that was being formed and developed with each new experience.

When interviewed, Maria reflected upon how she was able to integrate the construct of posing purposeful questions not only into Ms. Ross' fourth grade class, but also into other courses she was taking at Teacher Preparation College. She explained:

> I was thinking about it even while I was sitting in my psychology class, behavioral interventions, and realizing like, my teacher right now is not asking purposeful questions. It's all just, like, information, she just wants information. Not that it's a bad thing to review. But I'm, like, can't we talk about this a little bit more? Like, reflecting on my own experiences as a student, I love where the teacher is posing purposeful questions, that's not just about information, but are about like, thinking about your thinking. (Maria, Interview 2)

This application to another course in which Maria was herself a student showed a further, unanticipated entry into hybrid space, adding an extra layer of coherence not only between the coursework for methods in mathematics and an authentic K-12 classroom setting, but also adding the additional dimension of experiencing the same integration in other college coursework.

Lucy, in her written narrative, also exhibited an integration of ideas that are consistent with the idea of entering into a hybrid space. Lucy easily alternated between what she had experienced in the classroom setting and what she had learned about posing purposeful questions in coursework:

> I think when I was teaching, I did ask the students to not only give me their answers but to explain how they got those answers. Which occurs with the posing purposeful questions, making sure the students are able to not only give me an answer but give a reasonable explanation about why they arrived at the answer. I

> do wish that I was able to have students explain each other's responses, so then I could see if the students' thoughts were following along with the other students. Then that tells me if they're able to grasp the concept in more than one way, expanding their number sense. (Lucy, MFE2, Post-Lesson Oral Reflection)

Here, Lucy began by relating her experience in the classroom. She then recollected her understanding of the practice of posing purposeful questions. Finally, Lucy extended this by combining her hypothetical understanding with her classroom experience to determine how she might enact this in an authentic classroom setting in the future.

At times, the PSTs' classroom experience conflicted with what they had learned about posing purposeful questions. This, too, provided a means by which the PSTs could enter into a hybrid space, showing that contradictions did not necessarily prevent coherence between hypothetical principles and actual experience in the classroom. Maria reflected upon two such experiences; the first took place in the second MFE:

> I am thinking that posing purposeful questions was not really present in the teacher's lesson, because she asked moreso for, okay, what answer did you get? Did somebody get something different? And I thought that it was just on an informational level, and not, like can you explain that deeper, and what does that mean, what does that illustration depict? And I was really struck with how different it was from my approach and also what we've been talking about in class, not just asking to get information, but asking so that students can really enrich their understanding and deepen their grasp of the concepts of addition and subtraction. (Maria, MFE2, Post-Lesson Oral Reflection)

Maria's recognition of the difference between what had been learned in the coursework and what she observed in Ms. Ross' class offered an entry point into hybrid space, wherein theory and practice began to intermingle. Maria provided a similar reflection at the conclusion of the sixth and final MFE, noting how Mathematics Teaching Practices such as posing purposeful questions had, in Ms. Ross' classroom, "really become principles of teaching and how, if employed, they can guide and bolster a lesson" (Maria, MFE6, Post-Debrief Written Narrative), even though Ms. Ross' "pedagogy and practices don't mirror the book perfectly" (Maria, MFE6, Post-Debrief Written Narrative). Maria noted the differences between theory learned and field experience observed, using these to integrate the practical with the theoretical.

**Facilitating Meaningful Mathematical Discourse**

The second Mathematics Teaching Practice introduced to the PSTs was facilitating meaningful mathematical discourse. As noted in the list of codes found in Appendix J, excerpts from PST reflections were coded as Discourse: Theoretical when PSTs referenced facilitating meaningful mathematical discourse in a theoretical and/or hypothetical context, considering students abstractly. This included references to theory, textbook, coursework, or expectations or predictions about the authentic classroom setting. The code of Discourse: Field was applied to excerpts from PST reflections that referenced facilitating meaningful mathematical discourse in the context of an authentic classroom. To be coded in this manner, the excerpt must provide reference to an actual concrete situation, child, or happening in an authentic classroom. In order to apply either of these Discourse codes, discourse must have been referenced either directly or indirectly, either as teacher-student discourse or student-student discourse. In the context of this coding scheme, discourse may be taken as either spoken or written. Figure 23 illustrates the number of theory-specific and field-specific codes applied to reflections by Lucy and Maria, as well as the overlap of excerpts from PST reflections that exhibit both theoretical and practical characteristics. As had previously been the case with posing purposeful questions, both Maria and Lucy were able to successfully use this construct to enter into a hybrid space that bridged the practical and the hypothetical.

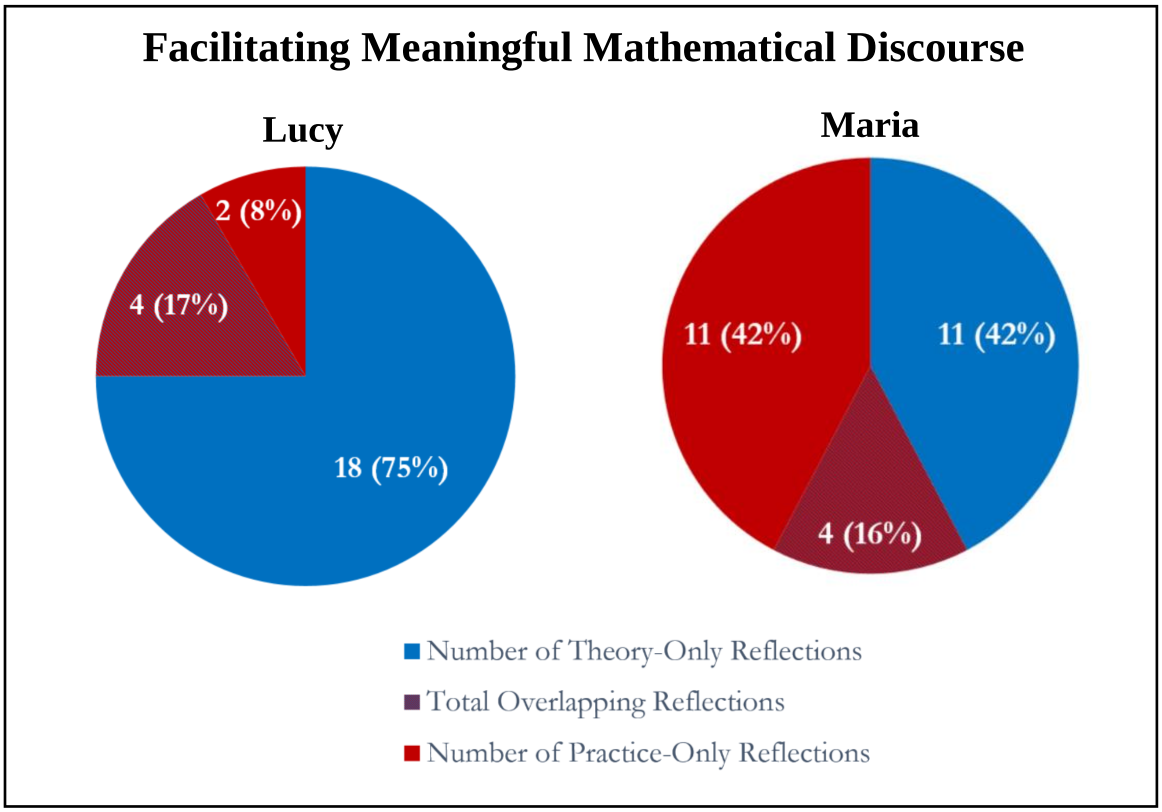


*Figure 23.* Overlapping theory and practice reflections signifying instances of entry into hybrid space within the construct of facilitating meaningful mathematical discourse.

Maria voiced a direct connection between the coursework and her time in the classroom:

> I was surprised at how while I was teaching I could immediately, naturally, and easily apply what we have been discussing in class. For example, I applied the suggestions of comparing the work of two different students side-by-side, of making it less of a show-and-tell by asking other students in the class to explain the work of their peers displayed on the screen, and of using math manipulatives when needed to help the students visualize the math concept. (Maria, MFE4, Post-Debrief Written Narrative)

Maria's reflection indicated a blending of what she had learned in theory with what she was able to apply in the classroom setting.

As the cycles of MFEs progressed, the PSTs made fewer direct references to the coursework. However, ideas and themes that had been discussed in a theoretical context became more evident in their personal reflections. Maria referred to her desire for "the students to talk more about each other's strategies, and to compare different strategies side-by-side" (Maria, MFE3, Post-Lesson Oral Reflection), and Lucy wrote of her hope "to find a way to get [the students] eager to share their method with their peers" (Lucy, MFE3, Post-Debrief Written Narrative). During the debrief, Maria further reflected:

> I was thinking, and how awesome would it be if I let one group stay, and then another group come, and put them side by side, and have them talk about what each other did. And then have the class chime in to make connections between, okay, could their equation here still relate to the drawing of another group? Just to have them cross-pollinate. (Maria, MFE3, Debrief)

Discussions during the coursework had introduced ideas such as these; in the context of the debrief, Maria integrated these theoretical strategies with what she had just observed in the classroom with the result of considering how she envisioned possible interactions with groups of students in the classroom. This provided another example of entry into hybrid space, as the lines delineating the hypothetical and the concrete began to blur.

Just as was seen in the first construct of posing purposeful questions, the PSTs also used shortcomings that they observed or experienced in the classroom to build connections to the practice of facilitating meaningful mathematical discourse. In the fourth MFE, Lucy noted the difficulty encountered when the students are not familiar with the practice of discussing their strategies, commenting that "it not only feels difficult to have students explain their work, but . . . one can observe that the students are not necessarily accustomed to sharing out the process of how they arrived at an answer" (Lucy, MFE4, Post-Debrief Written Narrative). She went on to recommend that "this practice of explaining one's thinking should be cultivated from the beginning of the year" (Lucy, MFE4, Post-Debrief Written Narrative). Although PSTs only minimally reflected upon one another, this was one instance in which Lucy reflected upon how her observation of Maria teaching had helped her to notice the students' discomfort in sharing with the class their thought processes when working mathematical problems.

Both constructs of posing purposeful questions and facilitating meaningful mathematical discourse provided opportunities for analysis of PSTs' entrance into hybrid space, integrating hypothetical principles learned via coursework with authentic classroom experiences at Learning Academy. Direct references to each component space were more prominent in the early cycles of MFEs, while the increased integration resulted in references becoming less direct as the experience continued. The hybrid space that increasingly dominated PST reflection was accompanied by a perceived sense of coherence, as will be further discussed in the following section.

**PST Perceptions of Coherence**

Although the concept of coherence could be found indirectly in analyzing many of the PSTs' reflections, the PSTs also directly addressed the idea of coherence at various times, both in their written and oral reflections and when interviewed. The instances of perceived coherence each suggested some level of entrance of the PST into hybrid space.

The first interview included a prompt asking each PST about the perceived coherence of past coursework and field experiences (see Appendix F). Lucy replied that although the past semester had been rather unconnected, the current semester felt more aligned, and that "everything is connected to what we're doing" (Lucy, Interview 1). Both PSTs commented on the lack of coherence during previous classroom observations. Maria observed:

> I think generally, I wouldn't say that they've all been perfectly connected, because at times I feel like the observation could have borne more fruit in class discussion or application, and sometimes it falls so late into the schedule that so many other papers and assignments are piling up that the observation, which is hard to get sometimes, that you have to wait that long, becomes more of a stressful thing than something you look forward to doing as a way of connecting the dots between the theory and application. (Maria, Interview 1)

This excerpt illustrated Maria's experience of a perceived lack of coherence between her past coursework and classroom observations. Lucy similarly commented:

> Some observations, I think, have been just extra work. It's just, like, you do an observation, you write a paper, which to me, those aren't as helpful, because it's just, yeah, it's just another observation I could do on my own. (Lucy, Interview 1)

Lucy noted how observations in past courses had not always seemed beneficial to her preparation as a future teacher. The PSTs both noted how they have had minimal experience thus far in the classroom setting beyond observing lessons.

During the MFEs, both PSTs reflected both orally and in written form at multiple points on the coherence they experienced. Each PST had a unique experience, but both noted opportunities in which coherence could be found between what they had learned in a theoretical context and what they saw and experienced in an authentic field experience.

**Maria's experiences of coherence.** Maria expressed gratitude for the principles and theoretical concepts that she had learned in the mathematics methods course. From early in the MFEs, Maria displayed a desire to integrate principles of teaching with the actual experience of teaching in a classroom setting. Already in her first written narrative, she wrote:

> Because I had the theory and principles in mind as a reference, I came to the classroom with expectations of the teacher and students and with the ability to evaluate reality. It helped me to know what to focus on and which things to look out for. (Maria, MFE1, Post-Debrief Written Narrative)

Maria began the course with an openness to connecting theory and practice, seeking ways to connect what she would find in an actual classroom with what she had already learned in theory.

Maria went on to link her perceptions of coherence more specifically to the role of the teacher than the viewpoint of the students, consistent with the findings above that illustrate her primary focus on the course content and the teacher in the early stages of the MFE. Accordingly, she wrote:

> I think that what we learned through coursework helped me to better understand the point of view of the teacher, and not so much the point of view of the students. I could recognize what Ms. Ross was and was not doing because we had learned about different emphases in teaching mathematics. (Maria, MFE1, Post-Debrief Written Narrative)

Maria emphasized the connections she had been able to make between the coursework and the role of the teacher, acknowledging the lack of connection between the coursework and the students themselves.

Maria made reference to the textbook, building upon the concepts introduced there. For example, she wrote, “I have learned more about what our readings have called giving students mathematical authority” (Maria, MFE2, Post-Debrief Written Narrative), then went on to expound upon her interpretation of mathematical authority based upon what she experienced in the authentic classroom setting. Maria also commented positively about the coursework, noting that the examples provided “gave me a set of experiences and knowledge that I could depend on even if I had very little from my own experience” (Maria, MFE2, Post-Debrief Written Narrative). She expressed gratitude for the “experience” that she was able to gain through reading about hypothetical experiences and the experiences of others in the textbook.

After first describing her apprehension about relating broad teaching principles to the particular classroom setting, Maria went on to relate that “the principles that we’ve been learning in class have actually been being fleshed out in the classroom, and that’s really deepening my understanding of the math practices we were talking about” (Maria, Interview 2). Citing an example from her recent experience at Learning Academy, Maria explained:

> Like, posing purposeful questions. I think, just doing the reading from the textbook, and then reading through the samples and the dialogues, you taught us how to tell the difference between just asking questions to get information, and then asking questions to really deepen student understanding and to get them to think big concepts. And then coming to Ms. Ross’s class, *I was able to use that knowledge to discern, like, what kind of question is she asking right now?* [emphasis added] Or what questions could she have asked, but I was expecting her to ask, but she didn’t. Because I could kind of listen to the students as well, and think in my mind, okay, where could this discussion go, based on what we read in the textbook . . . . I think it encouraged me to start where the kids are comfortable, so, what Ms. Ross usually does, like what’s the answer? How do you get there? And that’s usually where she stops. But then, the book and our readings were saying, like, you could do a little bit more with that. Like, get them to put another person’s strategy in their own words, and explain each other’s, or if you encounter something new, like one of the girls in my group did something new, I was like, Oh, I’m not following, could someone else help me? So the kids were

> able to talk about each other's strategies, and that's something that Ms. Ross hadn't, she didn't have them doing yet. (Maria, Interview 2)

This reflection showed how Maria experienced coherence between what she learned theoretically in her coursework and how this theoretical knowledge could then be incorporated into concrete actions in the classroom setting.

As the MFEs progressed, Maria continued to express satisfaction with the coherence she found between the theoretical principles learned during coursework and what she experienced in the authentic classroom. She commented, "I was surprised at how while I was teaching I could immediately, naturally, and easily apply what we have been discussing in class" (Maria, MFE4, Post-Debrief Written Narrative), and that "[m]y coursework has continued to help me better understand my time in the fourth grade classroom" (Maria, MFE5, Post-Debrief Written Narrative).

In particular, Maria appreciated the focus on the two particular Mathematics Teaching Practices that were emphasized in the course. She reflected on these practices:

> While observing Ms. Ross, I was struck by how much these two practices really become principles of teaching and how, if employed, they can guide and bolster a lesson, whether it be math or another subject. Although Ms. Ross's pedagogy and practices don't mirror the book perfectly, she has shown me that teachers can change as they adopt certain things that align with their goals and preferences. (Maria, MFE6, Post-Debrief Written Narrative)

Maria also later noted that as she has visited other classroom settings, she felt an increased ability to fully engage in the varied learning environments, due to the reinforcement she had received in these two Mathematics Teaching Practices. In her final interview, Maria expressed a desire to continue to learn about the remaining Mathematics Teaching Practices, commenting:

> [A]fter this semester, seeing how enriching the two practices we learned are, and can be, I really want to learn the other ones now. I see the value in all of them, that if these two are valuable, the others are probably really good, too. So I really want to go back and learn that myself. (Maria, Interview 3)

Maria's positive experience with learn about and applying two of the Mathematics Teaching Practices inspired her to want to continue learning about the remaining practices. She noted how her experience in an authentic classroom setting has whetted her appetite for continuing to learn more about the theoretical side of the methodology involved in teaching mathematics:

> I think the practice has reinforced my desire to just learn on my own and keep doing it on my own beyond the scope of this class. Like I really want to study more about methodology of teaching math, because I've experienced how helpful these things can be, and I can look for what would help me change or improve the way I teach. (Maria, Interview 3)

In this sense, the theoretical and practical aspects of teaching mathematics have fueled one another, creating a strong sense of coherence.

Maria went on to reflect upon the coherence she experienced not only between the coursework and field experience in this particular context, but also how this has led to greater coherence in other classroom contexts as well:

> The fact that we've been repeating this practice and the previous practice has really ingrained them into my mind that I have found myself working from them

> as a framework of thinking and working in educational experiences. Although laborious at times, the repetition of the question, "What teaching practice are we focusing on? What does this mean?" has actually helped me to internalize and value these practices as something valuable and perennial to teaching math and most probably all other subjects. (Maria, MFE6, Post-Debrief Written Narrative)

This expansion of recognition of teaching practices indicated an extended coherence that was more deeply internalized than one that was applied only to a more limited environment.

During her final interview, Maria related her experience of being in the early stages of learning how to teach. She expressed some of the challenges of a beginning teacher, noting that "it can be so overwhelming, abstractly, that when you get into the classroom you're, like, thinking too much, because you're trying, like, pull from these abstract, perfect ideals, and do it all exactly on the spot" (Maria, Interview 3). Again drawing upon the theme of applying principles as they are learned, Maria commented that in teaching, "it's important that we're not getting bombarded with all the information without the chance to apply it, or else it will just be overwhelming" (Maria, Interview 3). In addition, Maria drew upon analogies that are very useful, comparing the art of learning how to teach with the art of learning a trade:

> . . . like a carpenter can study all he wants about patterning, chairs, how to make tables, he can study the measurements, type of screws, all those little things, but if he doesn't get to it and just try, he won't . . . because it's learning by doing, in addition to in theory. (Maria, Interview 3)

Overall, Maria seemed to find a deep level of coherence in her experiences with the MFEs, which provided her with the opportunity to blend both overarching principles learned from the textbook and coursework with the experience of being in an authentic classroom setting. We next turn to Lucy and her experiences of coherence during the series of MFEs.

**Lucy's experiences of coherence.** From the first interview, Lucy expressed a desire to combine theory and practice in the art of teaching. She commented, "I'm really getting into, like, the actual teaching, like how you teach. I'm excited to learn that craft, and actually apply it, so I'm hoping that these classes will allow me to do that" (Lucy, Interview 1).

In the course of the MFEs, Lucy perceived an opportunity to combine what was learned in coursework with enacting certain practices in the classroom. She wrote:

> It was helpful to actually learn the mathematical practice, observe it and then put it into practice by applying it through teaching a Number talk. It has been helpful to craft problems together and go through in class the possible responses a student could give as well as reason through how to respond to the students. (Lucy, MFE2, Post-Debrief Written Narrative)

Here, Lucy indirectly referenced different elements of the MFE. The prebrief gave an opportunity for the PSTs to consider hypothetical student responses and how best to respond to various responses. The classroom lesson itself allowed PSTs to then enact (or observe the enactment of) the lesson.

Lucy directly addressed the benefits of the course textbook during her second interview:

> I think, like in most things . . . the book reading provides the foundation, but then there's the practicality of this is what it actually looks like, so, if I didn't read it in the book, I probably would be, like, treading water, like what exactly is a purposeful question? Through those little examples we saw, like, this is an example of just a basic question that's not leading anywhere. I wish I could remember the exact examples, but in the book there are different examples. So that was helpful to see, like, these are purposeful questions, these ones actually lead the student to explain more, explain their thinking, see how he got his answer. So that laid a foundation for me. And then, when we've been talking about it in class, that kind of helps even more in seeing it actually done, like when you do for us in class sometimes. (Lucy, Interview 2)

In her third and final interview, Lucy again mentioned the benefit of a textbook, now in the broader context of coursework:

> I think [my understanding of Mathematics Teaching Practices came] more in class, with you, and reading the textbook, and then that gave me an idea of what I'm actually looking for, and then you can see it in the classroom. Like, oh, there's a method to teaching, it's not just asking random things. There's actual structure within what's happening in a lesson, where it's, sometimes you wonder, you're like, how do I do a lesson for math? How do I do a lesson for science? So, once I knew what I was looking for from our book and for our class sessions. (Lucy, Interview 3)

Lucy credited the textbook and its content with providing an opportunity to build a foundation that would serve her well in the classroom. She was able to build connections and a sense of coherence from the attention she gave to her reading of the text.

In written reflections, Lucy noted that what she learned through coursework helped to make her "ready to anticipate the responses of the students" (Lucy, MFE4, Post-Debrief Written Narrative), helped her to "better understand the level at which fourth graders think" (Lucy, MFE5, Post-Debrief Written Narrative), and taught her that "questions should be planned ahead of time in order to be able to facilitate meaningful mathematical discourse" (Lucy, MFE6, Post-Debrief Written Narrative). In oral reflections, Lucy expressed the need to go beyond the coursework found in the college classroom, stating that "[i]n the classroom you learn things, so you learn, like, oh, this is a number talk. That's great in theory. But how do you actually do it?" (Lucy, Interview 3). She expressed satisfaction with her involvement in the MFEs, relating that what she learned in theory and what she experienced in the actual classroom "aligned pretty well" (Lucy, Interview 3).

Both Maria and Lucy exhibited multiple examples of perceived coherence, indicating possible entry into hybrid space. This, combined with an analysis of PST reflections that exhibit an overlap of theory and practice, revealed instances when PSTs exhibit characteristics of having entered into some stage of hybrid space.

## Conclusion

This chapter has provided an analysis of the perceptions of two individual PSTs who participated in a series of MFEs. It included how PSTs' reflections changed throughout the course of the MFEs, as well as an analysis of PST reflections within each of the respective elements of the MFE. The Mathematical Teaching Practices of posing purposeful questions and facilitating meaningful mathematical discourse were used as constructs to identify instances in which PST reflections exhibited entry into hybrid space. Finally, the concept of coherence, as found in PST reflections, was explored as it was manifested during the cycle of MFEs. The following chapter will provide a discussion of the results, corresponding implications for both research and practice, and suggestions for future research in related areas.

# CHAPTER V: DISCUSSION

A need exists in the field of teacher preparation for additional research on pedagogies that have the potential to bridge the gap between theoretical principles learned in coursework and the practical implementation of these principles in an authentic classroom setting (Baumfield, 2016; NCATE, 2010; Teacher Education Ministerial Advisory Group, 2014). In particular, the field of mathematics teacher education suffers from teacher preparation that is inadequate (National Mathematics Advisory Panel, 2008; National Research Council, 2010) due, at least in part, to its inability to overcome the theory-practice gap (Østergaard, 2013). The current study addressed this need in order to increase the level of integrity in traditional teacher preparation programs, specifically through the application of the pedagogy of the mediated field experience (MFE) in the setting of a course designed to instruct preservice teachers (PSTs) in mathematics methods.

In this final chapter, I first revisit the problem of the theory-practice gap and the purpose of this study, namely, to consider how the focus of PSTs' reflections evolve over the course of their participation in multiple cycles of MFEs; how the content of PSTs' reflections differ amongst each individual element of the MFE; and how characteristics of coherence between theoretical concepts and authentic classroom experiences reveal instances of PST entry into hybrid space during their participation in multiple cycles of MFEs. This, in turn, contributes to the larger overarching goal of exploring the MFE and its elements as a means to narrow the theory-practice gap by more coherently connecting PSTs' perceptions of Mathematics Teaching Practices as discussed in coursework to their encounters with Mathematics Teaching Practices as experienced in the field. I then summarize the results of this study, discussing the analysis provided in the previous chapter. Following this, I illustrate the contributions that this study makes to current research, as well as implications for practice, both for teacher educators and for those who design teacher preparation programs and corresponding coursework. Finally, I conclude with suggestions for further research that could continue to advance the field of teacher education.

## Building Coherence through the Mediated Field Experience

As was explained in the first chapter, the gap that can oft be found between theory and practice in the preparation of teachers has been recognized as a hindrance for many decades (Vick, 2006). Teacher preparation programs oftentimes lack pedagogy to provide PSTs with the opportunity to make deep connections between coursework and field experience (Feiman-Nemser, 2001). This results in PSTs often learning many principles and observing many lessons, but with a lack of coherence between these important elements (Grossman, Hammerness, & McDonald, 2009; Zeichner, 2010), which in turn results in a lack of integrity caused by a disunity between abstract theory and concrete experience in the process of teacher preparation.

This study examined how one particular pedagogy, that of the MFE, affects PST reflections and impacts the coherence that elementary PSTs perceive between theoretical coursework and practical field experience in a mathematics methods course. It also identified characteristics of the hybrid space entered into by PSTs in the merging of these component spaces. In the course of this study, I considered the reflections and perceptions of PSTs as they participated in a cycle of MFEs that was integrated into a mathematics methods course. I used the construct of two Mathematics Teaching Practices (NCTM, 2014) to provide a structure for analysis. Through an analysis of reflections by and interviews with PSTs, I addressed the following research questions:

1. How, if at all, does the focus of PSTs' reflections evolve over the course of their participation in multiple cycles of MFEs?
2. How, if at all, does the content of PSTs' reflections differ amongst each individual element of the MFE?
3. As PSTs participate in multiple cycles of MFEs, how do characteristics of coherence between theoretical concepts and authentic classroom experiences reveal instances of PST entry into hybrid space?

## Summary of Results

I situated the major findings of this study within my analytical framework that was built upon Wood and Turner's (2015) application of Lampert's (2001) three-pronged model of teaching practice. In contrast to Wood and Turner's use of their model to study the impact of the cooperating teacher upon the PST's learning experience in the field experience component of a mathematics methods course (see Figure 9), I made use of an adaptation of this model to study the impact of MFEs on PSTs' perceptions of coherence between coursework and fieldwork within the context of a mathematics methods course (see Figure 11).

### Progression of MFEs

The first finding involved the evolution of PSTs' reflections over the course of their participation in multiple cycles of MFEs. As PSTs participated in a series of MFEs, the nature of their reflections tended to shift from a focus on the teacher and the content of their college coursework toward a more intensified focus on the students and the mathematical content. This was evidenced in the reflections of both of the PSTs in this study. This shift from reflecting primarily upon the teacher at first, but then moving toward reflections more centered on the student, was consistent with past research findings, which showed that teachers who are not yet experienced tend to focus more heavily on the actions of teachers rather than those of students (Berliner et al., 1988). An increased focus on mathematical content over time has been found in certain previous studies, such as that of Star and Strickland (2008), but has not been consistently demonstrated (e.g., Star, Lynch, & Perova, 2011).

At the beginning of the experience, Maria directed her attention primarily to the classroom teacher. This was in line with the response Maria gave at the beginning of the course to a prompt asking what she hoped to learn in the course. Maria had replied: "I hope to learn how to teach math and science in a way that is developmentally appropriate, academically rigorous, and practical to students in grades K-5. I want to gain clarity and confidence as one studying to become a teacher" (Maria, Background Survey). Accordingly, she initially watched and reflected upon the practice of the teacher in the classroom. As the course progressed and Maria continued to participate in MFEs, references to the classroom teacher remained in her reflections, but the primary focus of her reflections shifted to the students in the class and the mathematical content with which they were engaged.

A similar, although less pronounced, pattern was found in Lucy's reflections. At first, Lucy's primary focus was on the classroom teacher. This quickly changed, as a sharp decrease in her attention to the teacher occurred after the first MFE. As Lucy personally began to first co-teach and then independently teach number talks and a class lesson, the students and their mathematical understanding became central to her reflections. She conveyed a realization that, as the teacher, her role was more than simply conveying information; rather, she needed to first understand the students' thinking in order to assist them in reaching the mathematical goals for the lesson.

This transition that was found in both Maria and Lucy may indicate a gradual shift in identity for the PSTs, as they progress from seeing themselves as learners of mathematics towards self-perceptions more focused on being teachers of mathematics. This is consistent with Olsen's (2008) description of teacher identity development as something fluid in nature. Korthagen (2004) highlighted the importance of the formation of teachers' professional identity and the role that reflection plays in this process. The continual reflection provided by the MFEs may assist in the transition and clarification of the PSTs' self-identities as future teachers.

This general transition of the nature of PSTs' reflections from focusing on the teacher and theoretical coursework toward a greater focus on the students, as well as the mathematical content, occurred over the progression of multiple cycles of MFEs, revealing a possible tendency of MFEs to foster this shift in the object of the PST's attention. Next, each of the individual elements of the MFE were considered, insofar as the PSTs' reflections showed differences after participating in each respective element.

**Elements of the MFE**

The second finding included how the content of PSTs' reflections differs amongst each individual element of the MFE. The integrity of the MFE is found in its three sequenced elements: the prebrief, the classroom lesson, and the debrief (Campbell, 2012; Horn & Campbell, 2015). The present study sought insights about the nature of PST reflections not only on the MFE as a whole, but also with regard to the individual elements of the MFE, in particular insofar as PST reflections differed amongst the various components of the MFE.

In this study, the prebrief always took place at the conclusion of a class meeting of the mathematics methods course at Teacher Preparation College. The mathematics teacher educator and the PSTs spent time during the class meeting discussing Mathematics Teaching Practices (NCTM, 2014) and preparing for the upcoming classroom lesson. Near the end of the class meeting, the cooperating teacher joined the PSTs and the mathematics teacher educator via videoconferencing to discuss the upcoming lesson. The classroom lesson took place at Learning Academy, where the PSTs had the opportunity to observe, co-teach, and teach lessons to students in a fourth-grade class. The field experience component was always a shared experience between the PSTs, the cooperating teacher, and the mathematics teacher educator (Horn & Campbell, 2015), providing the means for a focused debrief following each classroom experience. The debrief took place in the fourth-grade classroom about ten minutes after the conclusion of each lesson, after the students had departed.

Analysis of the PSTs' reflections following each of these three elements of the MFE showed the emergence of various patterns. A component upon which my analytical framework is built, Lampert's (2001) three-pronged model of teaching practice, considers four different relationships that involve the teacher, the student, and the mathematical content. For the purposes of this study, these relationships were termed as follows: Teacher→Child, Teacher→Child/Math, Teacher→Math, and Child→Math. The majority of the PSTs' reflections focused upon the first two of these relationships. However, each element of the MFE yielded a different resulting proportion. This study found that written reflections following the prebrief tended overall to be evenly split between Teacher→Child and Teacher→Child/Math, oral reflections following the classroom lesson tended to favor the Teacher→Child/Math relationship, and reflections written after the debrief focused most heavily upon the Teacher→Child relationship.

In terms of a focus upon the authentic classroom experience versus reflections that are more theoretical or hypothetical in nature, patterns could be found amongst the various elements of the MFE. As might be expected, the study found that reflections directly following the prebrief were focused more heavily on theoretical concepts, either considered abstractly or applied in a hypothetical situation, rather than consideration of the actual concrete classroom setting. The lesson being prepared had not yet been executed, thus the majority of PST reflections were focused upon a combination of underlying principles, theory, and considering hypothetically how students might respond.

The study also found that reflections immediately after the classroom lesson were focused more specifically on actual happenings in the classroom. This was also expected, as PSTs had just experienced the actual lesson and consequently reflected upon practice more than theory.

The debrief provided an opportunity for PSTs to collaborate with the cooperating teacher and the mathematics teacher educator and for open conversations regarding teaching practice to take place (Brown et al., 1989; Turunen & Tuovila, 2012). This study found that PST reflections following the debrief showed the most varied responses between the two teaching practices. Earlier cycles of the MFE, which focused on the Mathematics Teaching Practice of posing purposeful questions, showed a strong tendency for PSTs to reflect more heavily upon theoretical aspects than on the actual classroom. This was surprising, since the PSTs had just experienced an authentic classroom situation and their reflections immediately preceding the debriefs had focused more strongly on the actual classroom. Later cycles of the MFE, which placed a greater emphasis on the Mathematics Teaching Practice of facilitating meaningful mathematical discourse, resulted in reflections that included a much higher proportion of references to authentic classroom situations, yet the majority of PST reflections remained more theoretical than practical in nature.

**Entry into Hybrid Space**

The MFEs in this study included two separate learning environments: the college classroom at Teacher Preparation College and the fourth-grade classroom at Learning Academy. Each could be considered a component space (Moje et al., 2004), the former associated with theoretical principles and hypothetical situations, while the latter provided the enactment of a lesson in an authentic classroom. The goal of the pedagogy of the MFE is to integrate these two settings, minimizing the theory-practice gap by encouraging PSTs to enter into a hybrid space (Bhabha, 1990) that includes characteristics of both component spaces.

In the current study, I explored this hybrid space and how, over a series of multiple cycles of MFEs, characteristics of coherence between theoretical concepts and authentic classroom experiences were found to reveal instances of PST entry into hybrid space. I used the construct of two particular student-centered Mathematics Teaching Practices (NCTM, 2014) to bridge the component spaces of coursework and field experience. The use of these practices was perceived by the PSTs as a helpful tool to provide foundational principles that could be both observed and enacted in the classroom setting.

My conceptual framework for this study was built upon the incorporation of Mathematics Teaching Practices in both coursework and field experiences, as seen through the lens of coherence. As illustrated in Chapter 4, the use of the MFE in a mathematics methods course can increase coherence between the theoretical principles studied in coursework and the implementation of practice in an authentic K-12 classroom through entry into a hybrid space that includes elements of both component spaces. The results of this study indicated that the PSTs did, in fact, enter into hybrid space at various points, simultaneously engaging in both the theoretical principles learned through coursework and the realities of the actual classroom setting. Analysis of the PSTs' reflections revealed characteristics that indicated entry into hybrid space.

The PSTs, from their interviews and reflections, exhibited a desire to enter into hybrid space, albeit they did not have the terminology to refer to it as such. In the course of this study, both PSTs identified a number of situations in which coherence was perceived. Each of these presented an occasion in which the PST entered, in some degree, into a hybrid space, reconciling theoretical principles with authentic classroom experience and consequently narrowing the theory-practice gap. Reflections focused at times on the teacher and at times on the student. The course textbook, as well as the coursework more generally, was referred to a number of times as a foundational source of theory that could then be applied in the actual classroom setting. Both PSTs expressed a desire to integrate the theory learned through the course text into the actual classroom. As the PSTs began to participate in MFEs, full immersion in the hybrid space was not immediately exhibited, although beginning entry points were clearly seen through the overlap of references to authentic classroom experiences and to theoretical principles and hypothetical situations.

I had hoped to find evidence of the PSTs entering into hybrid space through their integration of theoretical principles with the enactment of lessons in the fourth-grade classroom. Unexpectedly, the PSTs, of their own accord, began to form a hybrid space between those same theoretical principles and other courses in which they were students. Although these were not pursued by this study, it is interesting to note that the creation of hybrid space was happening on a variety of levels, encompassing multiple environments.

Also unexpected was the finding that differences between what was learned through coursework and what was observed enacted in the classroom did not prohibit entry into hybrid space; at times these differences seemed to facilitate this entry as easily as when the hypothetical and actual environments were more directly aligned.

As PSTs recognized differences and contradictions, they were immersed more deeply into the commingling of theory and practice. One might expect these contradictions to widen the theory-practice gap, but at least in this study, in the context of a series of MFEs, even apparent contradictions served to narrow the theory-practice gap as PSTs found further coherence between principles learned and the corresponding enactment of these principles in a classroom setting. This is in line with Smeby and Heggen's (2014) distinction between coherence and consistency, claiming that consistency is not a prerequisite for coherence. Consistency mandates an absence of all contradiction; both Lucy and Maria included elements in their reflections making it clear that consistency was not always present. However, coherence allows for inconsistencies, tensions, and differences, which are to be expected when allowing for the varied experiences of all those involved in the classroom setting of the MFE. This is also in accord with Flessner's (2008) definition of third space as a place where conflicts and tensions between component spaces can be identified and reflected upon.

As PSTs continued with cycles of MFEs, their reflections exhibited a deeper entrance into hybrid space, as they blended their theoretical learning with the application of that theory in the authentic classroom setting. The underlying principles were directly referenced less often, although the theoretical strategies were still clearly found throughout the enacted lessons. Maria's comments regarding the helpfulness of repeating particular practices throughout the MFEs fit well with Weston and Henderson's (2015) definition of coherent experiences, showing a deliberate continuous effort to build PST competency in clearly defined particular areas.

In the context of the series of MFEs, both PSTs entered into newly-founded hybrid space, wherein merged the theoretical concepts of Mathematics Teaching Practices learned in coursework with the practical application of these concepts in an authentic classroom. The hybrid space, which could be considered the "place" wherein coherence resides, consequently diminished the theory-practice gap that had been present.

The findings of this study revealed that PST reflections evolved over the course of their participation in multiple cycles of MFEs, shifting from a focus on the teacher and the content of their college coursework toward a more intensified focus on the students and the mathematical content. Findings also showed that the content of PSTs' reflections differed amongst the elements of the MFE. Written reflections following the prebrief were split fairly evenly between Teacher→Child and Teacher→Child/Math, oral reflections following the classroom lesson showed a tendency toward the Teacher→Child/Math relationship, and reflections written after the debrief were focused primarily upon the Teacher→Child relationship. In addition, reflections directly following the prebrief were focused more heavily on theoretical concepts, reflections immediately after the classroom lesson were focused more specifically on actual happenings in the classroom, and reflections following the debrief favored theoretical aspects, although later debriefs moved toward a more even balance. Finally, the findings of this study identified and described instances of PST entry into hybrid space in terms of characteristics of coherence between PST engagement in both the theoretical principles learned through coursework and the realities of the actual classroom setting, as identified through PST reflections. We next consider how these findings contribute to research.

## Contributions to Research

The results of this study add to the research on traditional university-based teacher education, specifically to identify and describe structures that have the potential to counteract the theory-practice gap by more coherently connecting PSTs' perceptions of Mathematics Teaching Practices as presented in coursework to their encounters with Mathematics Teaching Practices experienced in the authentic classroom setting. The recent increased emphasis being placed on the centrality of field experiences in teacher education programs (e.g., American Association of Colleges for Teacher Education, 2018) has led to a need to determine how best to integrate field experiences with coursework being offered in the university setting (Conference Board of the Mathematical Sciences, 2012; AMTE, 2017). The results of this study highlight the MFE as one possible pedagogy that could help to address the theory-practice gap by integrating coursework with field experiences.

Cochran-Smith (2005) identified a lack of empirical research associated with PST perceptions of their preparation for teaching; this study consequently provides insights into these perceptions through the reflections provided by two PSTs enrolled in a traditional teacher preparation program. The results of this study increase the knowledge base available regarding PSTs' perceptions of the integration of theory and practice, in particular in the context of a series of MFEs that was part of a mathematics methods course.

The results of this study add to the literature of mathematics teacher education in particular. The use of NCTM's (2014) Mathematics Teaching Practices provided a construct for the study; subsequently, this study illustrates the coherence perceived by PSTs as they first learn about two of these Mathematics Teaching Practices in coursework, then experience these practices enacted in the field. The findings of this study make an important contribution to the literature on the use of Mathematics Teaching Practices in PST education.

Grossman and colleagues (2008) called for research that examines particular characteristics of coursework and field experience that can support the development of coherence. In addition, organizations such as NCATE (2010), the National Research Council (2010), and AMTE (2017) have called for increased research on elements of a pedagogy that can support a deeper synthesis of theory and practice within traditional university-based teacher education. Although the research base on MFEs continues to expand, studies previous to the current study had not considered the individual elements of the MFE and how these might contribute to aspects of the preparation of PSTs (Swartz, Billings, et al., 2018). The present study analyzed patterns found in the nature of PST reflections in each of the three structural elements of the MFE, comparing and contrasting the PSTs' perceptions of various relationships and lenses through which to view classroom interactions. The findings of this study provide insights on the nature of PSTs' reflections regarding these structural elements of the MFE. This study provides an important extension of what is already known about the affordances and constraints of the pedagogy of the MFE.

In addition, the results of this study provide further development in the understanding of hybrid space, in particular in relation to its connection to coherence. These findings indicate that hybrid space may provide a context within which coherence resides. These results also add to the research on how a hybrid space can be identified through analysis of PST reflections in the context of a methods course with a field experience component. In addition, past research has considered the role of the cooperating teacher (Wood & Turner, 2015) and the teacher educator (Williams, 2014) in a hybrid space environment with PSTs. The findings of this study make an important contribution by adding a consideration of the perceptions of the PST when interacting with the cooperating teacher and mathematics teacher educator in an environment conducive to creating a hybrid space.

Overall, the results of this study contribute in multiple ways to literature from past research, helping to establish a deep and broad knowledge base on the affordances and constraints of the MFE and its elements as a pedagogy to support the building of coherence between theory and practice in a hybrid space environment.

## Implications for Practice

The results of this study have practical implications, both for teacher educators and for those responsible for the design of teacher preparation courses. By applying these findings, the quality of preparation provided to teachers in a traditional teacher education program can potentially be increased. A higher level of integrity can be attained through the establishment of increased coherence between principles and practice. This integrity in a teacher preparation program is manifested in a certain internal integrity found in each individual element of the program, as well as by the dedication of teacher educators to reconcile the theoretical with the practical in the practice of teaching.

Taking place in the context of a mathematics methods course, this study has implications for practice in mathematics teacher education. However, its significance reaches wider than the field of mathematics education, as the pedagogy can be expanded to other education-related fields as well. The following sections will describe the implication first for teacher educators, then for those responsible for designing courses for teacher preparation programs.

**Teacher Educators**

The findings of this study suggest that teacher educators provide PSTs with multiple opportunities to make connections between the theory and principles learned during coursework and the authentic experience of a classroom setting. This allows for the strengthening of integrity that narrows, if not eliminates, the theory-practice gap.

Teacher educators would do well to concern themselves primarily with conceptual coherence (Canrinus et al., 2019), intentionally linking theory and practice in a purposeful manner, as is appropriate to each individual course. Methods course instructors in particular should include among their goals the promotion of an integrated wholeness in each of the PSTs, fostered by a blending of theoretical principles with the implementation of teaching practices in an authentic classroom experience. This study also implies that instead of extending the subject area over too broad an area, focusing on just a few key Mathematics Teaching Practices gives PSTs the opportunity to practice enacting these skills multiple times, reflecting upon the challenges and successes encountered, which enables them to grow in their comfort level.

As PSTs interact with the complexities of an actual classroom, they benefit from collaboration with both the cooperating teacher and the teacher educator. In the current study, through the enactment of a series of MFEs, PSTs engaged in consistent cycles of conversing with the cooperating teacher and mathematics teacher educator about planning lessons, then observing or actively enacting lessons through teaching or co-teaching, and finally reflecting upon these experiences through a debriefing session with the cooperating teacher and mathematics teacher educator. Experiences such as these, facilitated by the teacher educator, allow PSTs an opportunity to experience rapid growth in their internalization and enactment of key Mathematics Teaching Practices.

Teacher educators may want to consider the direction in which to lead the conversation with PSTs and cooperating teachers, in particular during the prebrief and the debrief. The mathematics teacher educator typically moderates both of these sessions. Ideally, the cooperating teacher and the PSTs would contribute equally to the conversation during both of these components. Depending upon the characteristics of the PSTs and the cooperating teacher, some individuals may tend to dominate the conversation. This may influence the PSTs' reflections and learning process during the MFEs. Consequently, the teacher educator may want to establish expectations for the dialogue during the prebrief and the debrief in order to facilitate contributions from each participant as deemed appropriate.

The types of questions asked, both by the mathematics teacher educator and by the PSTs, may also influence the results of the MFE on the PSTs. In a methods course, questions will likely focus on teaching. Hence, the interaction of the teacher with the mathematics itself may not be a primary focal point of the questions asked during the elements of the MFE, which may influence the PSTs to likewise not focus upon this interaction, giving more attention to the relationships between the teacher and either the student or the interaction between the student and the mathematical content. Similarly, in a content course, questions are more likely to focus upon the content, which would again influence the PSTs' focus of attention.

As bearing primary responsibility for the implementation of MFEs, the teacher educator has the opportunity to assist PSTs in strengthening connections between the theory and principles learned during coursework and the authentic experience of a classroom setting. The results of this study provide insights into this role of the teacher educator. However, the implications of this study also extend beyond teacher educators to those responsible for the design of teacher preparation courses.

**Design of Teacher Preparation Courses**

For teacher preparation programs in particular, structural coherence is essential. The design of the program and corresponding logistics must be considered in attempting to create a unified program that has a shared vision (Richmond, Bartell, Andrews, & Neville, 2019) and intentionally sequenced components designed to achieve this vision (Hammerness, 2006). Teacher preparation programs have a need to produce consistent connections between and within coursework and field experiences such that all experiences in the formation of PSTs together form a unified whole (Grossman et al., 2008). This allows for a coherence between the theoretical and practical aspects of teaching (Weston & Henderson, 2015), thus minimizing, or even eliminating, the theory-practice gap that is currently so problematic in teacher preparation programs (Baumfield, 2016; Darling-Hammond et al., 2017).

As Schmidt et al. (2011) noted, the goal of teacher preparation programs is none other than to prepare highly qualified teachers for the classroom setting. The results of this study suggest that intentionally designed opportunities for PSTs to enter into hybrid space may contribute positively to this goal. The use of MFEs in methods courses provides the purposeful underlying integrated structure that Grossman et al. (2008) suggested as necessary for PSTs to narrow the theory-practice gap. By allowing PSTs to integrate the component spaces of coursework that builds foundational theory and a classroom environment that allows for authentic interactions with students, the PSTs have the opportunity to enter into hybrid space. Within this hybrid space, coherence can be found, in which PSTs can experience integrity and wholeness, minimalizing the impact of the theory-practice gap. This experience of coherence, as Weston and Henderson (2015) noted, is necessary for the PST to successfully integrate abstract principles with the practice of teaching.

Teacher preparation programs are tasked not only with finding ways to increase coherence among components of their programs, but also to help PSTs to perceive intentional opportunities to build coherence, in particular between the areas of theory and practice (Grossman et al., 2008). This study considered the reflections of PSTs during a series of MFEs, illustrating PSTs' perception of coherence and how this can increase over the span of multiple cycles of MFEs in the context of a mathematics methods course.

Teacher preparation programs must include field experiences that have both clear objectives and purposeful connection to university coursework (Darling-Hammond, 2010). Forzani (2014) recommended that teacher preparation programs, and in particular methods courses, impart to PSTs an ability to make use of content-focused instructional pedagogies and instructional routines specific to mathematics. The findings of this study reveal how MFEs can be used as a tool to discuss, engage in, and implement instructional routines in a classroom setting, which the *Standards for Preparing Teachers of Mathematics* (AMTE, 2017) recommended as components integral to a mathematics methods course. This study provided a model of a structure conducive to practicing in a guided setting various strategies including NCTM's (2014) Mathematics Teaching Practices, the instructional routines of number talks (Parrish, 2010), and Smith and Stein's (2011) Five Practices to Orchestrate Productive Mathematical Discussions. Teacher preparation programs may want to consider integrating these practices and instructional routines as part of the preparation of K-12 teachers of mathematics.

## Suggestions for Future Research

Unlike Wood and Turner's (2015) adaptation of Lampert's (2001) three-pronged model of teaching practice, my adaptation of this model included a more highly collaborative relationship between the mathematics teacher educator and the cooperating teacher. However, the individuals upon which this research focused were the PSTs; both the mathematics teacher educator and the cooperating teacher were essential participants in the experience itself, but data was neither collected nor analyzed as directly relating to these individuals. Wood and Turner (2015) studied the contributions of the cooperating teacher to PSTs' learning experience in a model of hybrid space, and Williams (2014) considered the opportunities and challenges to the teacher educator when working in a hybrid space with PSTs and cooperating teachers. Zeichner and Conklin (2008) found that collaboration between the cooperating teacher and the teacher educator is beneficial in the preparation of PSTs. Value would be found in further research that focuses upon the perceptions of the mathematics teacher educator and/or the cooperating teacher, in particular when in the context of the pedagogy of the MFE.

In addition to considering the perceptions of the mathematics teacher educator and the cooperating teacher, the impact of the relationship between these two roles would be a worthy subject of consideration. Wood and Turner's (2015) model implied little collaboration between these roles, a collaboration that is an essential component of the MFE. Swartz, Lynch, et al. (2018) claimed that the opportunities provided by the MFE for structured collaboration between the cooperating teacher, the mathematics teacher educator, and PSTs can lead to increased integration of theory and practice. Research that investigates the effect of different levels of collaboration specifically between the cooperating teacher and the mathematics teacher educator would be an important addition to the general research surrounding the effectiveness of MFEs as part of the professional training and formation of PSTs.

Data collected for the present study primarily involved reflections of PSTs, both written and oral. These reflections provided valuable insight into the perceptions of PSTs, in particular with regard to the level of coherence that PSTs perceive while actively involved in an MFE. The reflections also identified points at which PSTs began entry into a hybrid space. Research using less subjective data than personal reflections would provide further insights into how the MFE may serve to lessen the theory-practice gap. Analysis of videos that capture PSTs' enactment of interacting with students or teaching lessons could provide another lens through which a deeper understanding of how the implementation of MFEs in a methods course does or does not increase the coherence between theory learned through coursework and the teaching involved in an authentic classroom setting.

Although not studied specifically, the use of instructional routines including number talks (Parrish, 2010) and Smith and Stein's (2011) Five Practices to Orchestrate Productive Mathematical Discussions provided a basis for PSTs to build their own personal teaching practice. Further research examining the type of instructional routine to include in experiences such as MFEs would be beneficial to the field of mathematics teacher education.

Also, further investigation of connections between the elements of the MFE with McDonald et al.'s (2013) learning cycle of enactment and investigation would be beneficial to the field. A disaggregation of elements of the prebrief that could be connected to each of the first two quadrants of this pedagogical cycle of learning could provide a means for greater synthesis with this particular model, as well as various other pedagogies available to teacher educators.

Finally, this study focused upon a series of MFEs used in the context of a mathematics methods course, with the intention of eliciting entry into a hybrid space. Extending the use of a similar cycle of MFEs in a mathematics content course would provide helpful knowledge of further extensions of use of the MFE in mathematics teacher education. The focus of the course and, in turn, the MFEs would be less on pedagogy and instead primarily on mathematical content. A study in this setting could provide a better understanding of how the type of course affects the nature of PST reflections and perceptions, such as the bearing this would have on the relationships signified by Lampert's arrows.

## Conclusion

This study has examined the nature of PSTs' reflections over the course of PST participation in a series of MFEs. These reflections have been considered both as they relate to the MFEs as a whole and as they relate to each individual element of the MFE. The study has also considered the nature of PSTs' perceptions of coherence between Mathematics Teaching Practices as discussed in a mathematics methods course and as enacted in an authentic elementary classroom. Finally, this study has identified PST entry into hybrid space in the context of these MFEs, highlighting characteristics of this hybrid space that consist of a blending of the component spaces of the theoretical learning of coursework and the practical implementation of the work of teaching in an authentic classroom environment.

This study, through its focus on the MFE, has attempted to answer the call of Grossman, Hammerness, and McDonald (2009) to reconceptualize teacher education in a way that may prove capable of reducing, or even eliminating, the theory-practice gap that exists between learning about theory in coursework and the actual implementation of practice in field experiences. As previous research has suggested, an intentional coordination between the theory learned in coursework and the practice gained through field experiences (Darling-Hammond & Hammerness, 2005) can help in the preparation of PSTs who are well-equipped to meet the challenges of teaching in a K-12 classroom. Integrating the pedagogy of MFEs seems to be one way to potentially increase the efficacy of teacher preparation programs in their goal of preparing highly qualified teachers.

The reflections of PSTs during their experience involving multiple cycles of MFEs show that theory and practice, which can be seen as binaries when considering the theory-practice gap, can come together in the formation of hybrid space in a way that enhances connectedness and builds integrity. By further establishing integrity in the teacher education program, and in particular in the context of the mathematics methods course, coherence in teacher education can be increased, and the growth in personal integrity of each individual PST can be fostered.

The findings of this study contribute to an increasing base of research conducted on MFEs as a pedagogy that has the potential of creating a hybrid space between coursework and field experience that subsequently leads to greater coherence between theory and practice for PSTs. The instruments and the theoretical framework developed and used for this study can serve as a tool for future research on MFEs and other pedagogies that seek to address the problematic theory-practice gap in teacher education.

# REFERENCES

Allen, J. M. (2009). Valuing practice over theory: How beginning teachers re-orient their practice in the transition from the university to the workplace. *Teaching and Teacher Education*, *25*, 647–654. doi:10.1016/j.tate.2008.11.011

Allen, J. M., & Wright, S. E. (2014). Integrating theory and practice in the pre-service teacher education practicum. *Teachers and Teaching: Theory and Practice*, *20*, 136–151. doi:10.1080/13540602.2013.848568

American Association of Colleges for Teacher Education. (2018). *A pivot toward clinical practice, its lexicon, and the renewal of educator preparation: A report of the AACTE Clinical Practice Commission*. Washington, DC: AACTE.

Anagnostopoulos, D., Smith, E. R., & Basmadjian, K. G. (2007). Bridging the university-school divide: Horizontal expertise and the "two-worlds pitfall." *Journal of Teacher Education*, *58*, 138–152. doi:10.1177/0022487106297841

Anthony, G., & Walshaw, M. (2009). Characteristics of effective teaching of mathematics: A view from the West. *Journal of Mathematics Education*, *2*, 147–164.

Association of Mathematics Teacher Educators. (2017). *Standards for preparing teachers of mathematics*. Raleigh, NC: Author. Retrieved from http://amte.net/standards

ATLAS.ti (Version 8 for Windows) [Computer software]. Berlin: Scientific Software Development.

Baldinger, E. E., Selling, S. K., & Virmani, R. (2016). Supporting novice teachers in leading discussions that reach a mathematical point: Defining and clarifying mathematical ideas. *Mathematics Teacher Educator*, *5*, 8–28. doi:10.5951/mathteaceduc.5.1.0008

Ball, D. L. (1989, March). *Breaking with experience in learning to teach mathematics: The role of a preservice methods course*. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Ball, D. L. (1993). With an eye on the mathematical horizon: Dilemmas of teaching elementary school mathematics. *Elementary School Journal*, *94*, 373–397.

Ball, D. L. (2000). Working on the inside: Using one's own practice as a site for studying teaching and learning. In A. E. Kelly & R. A. Lesh (Eds.), *Handbook of research design in mathematics and science education* (pp. 365–402). Mahwah, NJ: Lawrence Erlbaum Associates.

Ball, D. L. (2001). Teaching, with respect to mathematics and students. In T. Wood, B. S. Nelson, & J. Warfield (Eds.), *Beyond classical pedagogy: Teaching elementary school mathematics* (pp. 11–22). Mahwah, NJ: Lawrence Erlbaum Associates.

Ball, D. L., & Bass, H. (2002). Toward a practice-based theory of mathematical knowledge for teaching. In J. Holm & S. Mathieu-Soucy (Eds.), *Proceedings of the 2002 Annual Meeting of the Canadian Mathematics Association Study Group* (pp. 3–14). Squamish, British Columbia: Quest University.

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

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

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

Baumfield, V. (2016). Teachers for the twenty-first century: A transnational analysis of the role of the university in teacher education in the United Kingdom. In B. Moon (Ed.), *Do universities have a role in the education and training of teachers? An international analysis of policy and practice* (pp. 57–73). Cambridge, England: Cambridge University Press.

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, *13*, 544–559.

Berliner, D. C., Stein, P., Sabers, D. S., Clarridge, P. B., Cushing, K. S., & Pinnegar, S. (1988). Implications of research on pedagogical expertise and experience in mathematics teaching. In D. A. Grouws & T. J. Cooney (Eds.), *Perspectives on research on effective mathematics teaching* (pp. 67–95). Reston, VA: National Council of Teachers of Mathematics.

Bhabha, H. (1990). The third space. In J. Rutherford (Ed.), *Identity: Community, culture and difference* (pp. 207–221). London, England: Lawrence and Wishart.

Bhabha, H. K. (1994). *The location of culture*. London, England: Routledge.

Biro, K., & Dick, L. K. (2019). Anchoring number talks. *Ohio Journal of School Mathematics, 80*, 31–38.

Boaler, J., & Brodie, K. (2004). The importance, nature and impact of teacher questions. In D. E. McDougall & J. A. Ross (Eds.), *Proceedings of the 26th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 774–782). Toronto, Ontario: OISE/UT.

Boerst, T. A., Sleep, L., Ball, D. L., & Bass, H. (2011). Preparing teachers to lead mathematics discussions. *Teachers College Record*, *113*, 2844–2877.

Borg, S. (2001). The research journal: A tool for promoting and understanding researcher development. *Language Teaching Research*, *5*(2), 156–177. doi:10.1177/136216880100500204

Borko, H., & Mayfield, V. (1995). The roles of the cooperating teacher and university supervisor in learning to teach. *Teaching & Teacher Education*, *11*, 501–518.

Boyd, D. J., Grossman, P. L., Lankford, H., Loeb, S., & Wyckoff, J. (2009). Teacher preparation and student achievement. *Educational Evaluation and Policy Analysis*, *31*, 416–440. doi:10.3102/0162373709353129

Britzman, D. P. (2003). *Practice makes practice: A critical study of learning to teach*. Albany, NY: State University of New York Press.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*(1), 32–42.

Brown, R. E. (2019). Integrating mathematics and science methods classes with an afterschool STEM club. In T. E. Hodges & A. C. Baum (Eds.), *Handbook of research on field-based teacher education* (pp. 420–448). Hershey, PA: IGI Global.

Bruce, C. D., & Ladky, M. S. (2010). What's going on backstage? Revealing the work of lesson study with mathematics teachers. In L. Hart, A. Alston, & A. Murata (Eds.), *Learning together: Lesson-study research and practice in mathematics education* (pp. 1–11). New York, NY: Springer Press.

Buchmann, M., & Floden, R. E. (1992). Coherence, the rebel angel. *Educational Researcher*, *21*(9), 6–9. doi:10.3102/0013189x021009004

Campbell, S. S. (2012). *Taking them into the field: Mathematics teacher candidate learning about equity-oriented teaching practices in a mediated field experience* (Doctoral dissertation). University of Washington, Seattle, WA.

Campbell, S. S., & Dunleavy, T. K. (2016). Connecting university course work and practitioner knowledge through mediated field experiences. *Teacher Education Quarterly*, *43*(3), 49–70.

Canrinus, E. T., Bergem, O. K., Klette, K., & Hammerness, K. (2017). Coherent teacher education programmes: Taking a student perspective. *Journal of Curriculum Studies*, *49*, 313–333. doi:10.1080/00220272.2015.1124145

Canrinus, E. T., Klette, K., & Hammerness, K. (2019). Diversity in coherence: Strengths and opportunities of three programs. *Journal of Teacher Education*, *70*, 192–205. doi:10.1177/0022487117737305

Carr, D., Haldane, J., McLaughlin, T., & Pring, R. (1995). Return to the crossroads: Maritain fifty years on. *British Journal of Educational Studies*, *43*, 162–178.

Clarke, A., Triggs, V., & Nielsen, W. (2014). Cooperating teacher participation in teacher education: A review of the literature. *Review of Educational Research*, *84*, 163–202. doi:10.3102/0034654313499618

Clarke, D., Roche, A., Wilkie, K., Wright, V., Brown, J., Downton, A., . . . Worrall, C. (2013). Demonstration lessons in mathematics education: Teachers' observation foci and intended changes in practice. *Mathematics Education Research Journal*, *25*, 207–230. doi:10.1007/s13394-012-0058-z

Clift, R. T., & Brady, P. (2005). Research on methods courses and field experiences. In M. Cochran-Smith & K. M. Zeichner (Eds.), *Studying teacher education: The report of the AERA panel on research and teacher education* (pp. 309–424). Mahwah, NJ: Lawrence Erlbaum Associates.

Cochran-Smith, M. (2005). Student teacher education: What we know and need to know. *Journal of Teacher Education*, *56*, 301–306. doi:10.1177/0022487105280116

Cochran-Smith, M., & Zeichner, K. M. (Eds.). (2005). *Studying teacher education: The report of the AERA panel on research and teacher education*. Mahwah, NJ: Lawrence Erlbaum Associates.

Cohen, D. K. (2011). *Teaching and its predicaments*. Cambridge, MA: Harvard University Press.

Conference Board of the Mathematical Sciences. (2012). *The mathematical education of teachers II* (Vol. 17). Providence, RI: American Mathematical Society.

Cooper, S. B. (1996). Case studies of teacher education students in a field-based and a university-based elementary mathematics methods course. *Journal of Teacher Education*, *47*, 139–146.

Cottingham, J. (2010). Integrity and fragmentation. *Journal of Applied Philosophy*, *27*, 2–14. doi:10.1111/j.1468-5930.2009.00472.x

Council for the Accreditation of Educator Preparation. (2018). *CAEP 2018 K-6 Elementary Teacher Preparation Standards*. Washington, DC.

Cuenca, A., Schmeichel, M., Butler, B. M., Dinkelman, T., & Nichols, J. R. (2011). Creating a "third space" in student teaching: Implications for the university supervisor's status as outsider. *Teaching and Teacher Education*, *27*, 1068–1077. doi:10.1016/j.tate.2011.05.003

Cuypers, S. E. (2004). The ideal of a Catholic education in a secularized society. *Catholic Education: A Journal of Inquiry and Practice*, *7*, 426–445. doi:10.15365/joce.0704022013

Dani, D. E., Hallman-Trasher, A., Harrison, L. M., Diki, K., Felton-Koestler, M., Kopish, M., . . . Harvey, L. W. (2019). Affordances of a cyclical and content-specific model of collaborative mentoring. In T. E. Hodges & A. C. Baum (Eds.), *Handbook of research on field-based teacher education* (pp. 117–141). Hershey, PA: IGI Global.

Darling-Hammond, L. (2000). How teacher education matters. *Journal of Teacher Education*, *51*, 166–173.

Darling-Hammond, L. (2006a). Constructing 21st-century teacher education. *Journal of Teacher Education*, *57*, 300–314. doi:10.1177/0022487105285962

Darling-Hammond, L. (2006b). *Powerful teacher education: Lessons from exemplary programs*. San Francisco, CA: Jossey-Bass.

Darling-Hammond, L. (2008). The case for university-based teacher education. In M. Cochran-Smith, S. Feiman-Nemser, & D. J. McIntyre (Eds.), *Handbook of research on teacher education* (3rd ed., pp. 333–346). New York, NY: Routledge.

Darling-Hammond, L. (2009, February). *Charles W. Hunt lecture*. Paper presented at the meeting of the American Association of Colleges of Teacher Education, Chicago, IL.

Darling-Hammond, L. (2010). Teacher education and the American future. *Journal of Teacher Education*, *61*, 35–47. doi:10.1177/0022487109348024

Darling-Hammond, L., Burns, D., Campbell, C., Goodwin, A. L., Hammerness, K., Low, E. L., . . . Zeichner, K. (2017). *Empowered educators: How high-performing systems shape teaching quality around the world*. San Francisco, CA: Jossey-Bass.

Darling-Hammond, L., & Hammerness, K. (2005). The design of teacher education programs. In L. Darling-Hammond & J. Bransford (Eds.), *Preparing teachers for a changing world: What teachers should learn and be able to do* (pp. 390–441). San Francisco, CA: Jossey-Bass.

Decker, S., Fey, M., Sideras, S., Caballero, S., Rockstraw, L. (Rocky), Boese, T., . . . Borum, J. C. (2013). Standards of best practice: Simulation Standard VI: The debriefing process. *Clinical Simulation in Nursing*, *9*(6), S26–S29. doi:10.1016/j.ecns.2013.04.008

Denzin, N. K., & Lincoln, Y. S. (2013). Introduction: The discipline and practice of qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Collecting and interpreting qualitative materials* (4th ed., pp. 1–41). Los Angeles, CA: SAGE Publishing.

Dreifuerst, K. T. (2010). *Debriefing for meaningful learning: Fostering development of clinical reasoning through simulation* (Doctoral dissertation). Indiana University, Bloomington, IN.

Dudzinski, D. M. (2004). Integrity: Principled coherence, virtue, or both? *Journal of Value Inquiry*, *38*, 299–313. doi:10.1007/s10790-005-3337-z

Dufrene, C., & Young, A. (2014). Successful debriefing—Best methods to achieve positive learning outcomes: A literature review. *Nurse Education Today*, *34*, 372–376. doi:10.1016/j.nedt.2013.06.026

Elias, J. L. (1999). Whatever happened to Catholic philosophy of education? *Religious Education*, *94*, 92–110. doi:10.1080/0034408990940108

Empson, S. B., & Jacobs, V. R. (2008). Learning to listen to children's mathematics. In D. Tirosh & T. Wood (Eds.), *Tools and processes in mathematics teacher education* (pp. 257–281). Boston, MA: Sense Publishers.

Ericsson, K. A. (2002). Attaining excellence through deliberate practice: Insights from the study of expert performance. In M. Ferrari (Ed.), *The pursuit of excellence in education* (pp. 21–55). Mahwah, NJ: Lawrence Erlbaum Associates. doi:10.1002/9780470690048.ch1

Fanning, R. M., & Gaba, D. M. (2007). The role of debriefing in simulation-based learning. *Simulation in Healthcare*, *2*, 115–125. doi:10.1097/SIH.0b013e3180315539

Feiman-Nemser, S. (1990). Teacher preparation: Structural and conceptual analysis. In W. R. Houston, M. Haberman, & J. Sikula (Eds.), *Handbook of research on teacher education* (pp. 212–233). New York, NY: Macmillan.

Feiman-Nemser, S. (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. *Teachers College Record*, *103*, 1013–1055. doi:10.1111/0161-4681.00141

Feiman-Nemser, S., & Buchmann, M. (1985). Pitfalls of experience in teacher preparation. *Teachers College Record*, *87*, 53–65.

Fennema, E., Carpenter, T. P., Franke, M. L., Levi, L., Jacobs, R., & Empson, S. B. (1996). A longitudinal study of learning to use children's thinking in mathematics instruction. *Journal for Research in Mathematics Education, 27*, 403–434.

Flessner, R. (2008). *Living in multiple worlds: Utilizing third space theory to re-envision pedagogy in the field of teacher education* (Doctoral dissertation). The University of Wisconsin, Madison, WI.

Flessner, R. (2011). Pushing the field of practitioner research: Utilizing "reflective third spaces" to explore educational practice. In I. M. Saleh & M. S. Khine (Eds.), *Practitioner research in teacher education: Theory and best practices* (pp. 121–140). New York, NY: Peter Lang.

Flessner, R. (2014). Revisiting reflection: Utilizing third spaces in teacher education. *Educational Forum*, *78,* 231–247. doi:10.1080/00131725.2014.912711

Flick, M., & Kuchey, D. (2015). Contest corner: Increasing classroom discourse and computational fluency through number talks. *Ohio Journal of School Mathematics, 71,* 38–41.

Forzani, F. M. (2014). Understanding “core practices” and “practice-based” teacher education: Learning from the past. *Journal of Teacher Education*, *65,* 357–368. doi:10.1177/0022487114533800

Francis, A. T., Olson, M., Weinberg, P. J., & Stearns-Pfeiffer, A. (2018). Not just for novices: The programmatic impact of practice-based teacher education. *Action in Teacher Education, 40,* 119–132. doi:10.1080/01626620.2018.1424053

Gainsburg, J. (2012). Why new mathematics teachers do or don’t use practices emphasized in their credential program. *Journal of Mathematics Teacher Education, 15,* 359–379. doi:10.1007/s10857-012-9208-1

George, A. L., & Bennett, A. (2005). *Case studies and theory development in the social science*. Cambridge, MA: MIT Press.

Ghousseini, H. (2009). Designing opportunities to learn to lead classroom mathematics discussions in pre-service teacher education: Focusing on enactment. In D. Mewborn & H. Lee (Eds.), *Scholarly practices and inquiry in the preparation of mathematics teachers* (pp. 203–218). San Diego, CA: Association of Mathematics Teacher Educators.

Gleason, J., Livers, S. D., & Zelkowski, J. (2015). *Mathematics Classroom Observation Protocol for Practices: Descriptors manual*. Retrieved from http://jgleason.people.ua.edu/mcop2.html

Gleason, J., Livers, S., & Zelkowski, J. (2017). Mathematics Classroom Observation Protocol for Practices (MCOP$^2$): A validation study. *Investigations in Mathematics Learning*, *9*(3), 111–129. doi:10.1080/19477503.2017.1308697

Grant, C. A., & Secada, W. G. (1990). Preparing teachers for diversity. In W. R. Houston, M. Haberman, & J. Sikula (Eds.), *Handbook of research on teacher education* (pp. 403–422). New York, NY: Macmillan.

Greeno, J. G. (1998). The situativity of knowing, learning, and research. *American Psychologist*, *53*, 5–26. doi:10.1037/0003-066X.53.1.5

Grosser-Clarkson, D. L. (2016). *Examining secondary mathematics teacher candidates' learning and enactment of mathematics teaching practices: A multiple case study* (Doctoral dissertation). University of Maryland, College Park, MD.

Grossman, P. (2005). Research on pedagogical approaches in teacher education. In M. Cochran-Smith & K. M. Zeichner (Eds.), *Studying teacher education: The report of the AERA panel on research and teacher education* (pp. 425–476). Mahwah, NJ: Lawrence Erlbaum Associates.

Grossman, P., Compton, C., Igra, D., Ronfeldt, M., Shahan, E., & Williamson, P. W. (2009). Teaching practice: A cross-professional perspective. *Teachers College Record*, *111*, 2055–2100. doi:10.3184/030823407x237821

Grossman, P., Hammerness, K., & McDonald, M. (2009). Redefining teaching, re-imagining teacher education. *Teachers and Teaching: Theory and Practice*, *15*, 273–289. doi:10.1080/13540600902875340

Grossman, P., Hammerness, K. M., McDonald, M., & Ronfeldt, M. (2008). Constructing coherence: Structural predictors of perceptions of coherence in NYC teacher education programs. *Journal of Teacher Education*, *59*, 273–287. doi:10.1177/0022487108322127

Grossman, P., & McDonald, M. (2008). Back to the future: Directions for research in teaching and teacher education. *American Educational Research Journal*, *45*, 184–205. doi:10.3102/0002831207312906

Guardini, R. (1954). Die Verantwortung des Studenten für die Kultur. In R. Guardini, W. Dirks, & M. Horkheimer (Eds.), *Die Verantwortung der Universität: Drei Vorträge* (pp. 5–35). Würzburg: Werkbund-Verlag.

Gutiérrez, K. D., Baquedano-López, P., & Tejeda, C. (1999). Rethinking diversity: Hybridity and hybrid language practices in the third space. *Mind, Culture, and Activity*, *6*, 286–303.

Gutiérrez, K. D., Baquedano-López, P., & Turner, M. G. (1997). Putting language back into language arts: When the radical middle meets the third space. *Language Arts*, *74*, 368–378.

Gutiérrez, K., Rymes, B., & Larson, J. (1995). Script, counterscript, and underlife in the classroom: James Brown versus Brown v. Board of Education. *Harvard Educational Review*, *65*, 445–471.

Guyton, T. R., & McIntyre, D. J. (1990). Student teaching and school experiences. In W. Houson, M. Haberman, & J. Sikula (Eds.), *Handbook of research on teacher education* (pp. 514–534). New York, NY: MacMillan.

Hammerness, K. (2006). From coherence in theory to coherence in practice. *Teachers College Record*, *108*, 1241–1265. doi:10.1111/j.1467-9620.2006.00692.x

Hammerness, K., Darling-Hammond, L., & Bransford, J. (2005). How teachers learn and develop. In L. Darling-Hammond & J. Bransford (Eds.), *Preparing teachers for a changing world: What teachers should learn and be able to do* (pp. 358–389). San Francisco, CA: John Wiley.

Honan, E. (2007). Teachers engaging in research as professional development. In T. Townsend & R. Bates (Eds.), *Handbook of teacher education: Globalization, standards and professionalism in times of change* (pp. 613–624). Dordrecht, The Netherlands: Springer. doi:10.1007/1-4020-4773-8_20

Honig, M. I., & Hatch, T. C. (2004). Crafting coherence: How schools strategically manage multiple, external demands. *Educational Researcher*, *33*(8), 16–30. doi:10.3102/0013189x033008016

Horn, I. S., & Campbell, S. S. (2015). Developing pedagogical judgment in novice teachers: Mediated field experience as a pedagogy for teacher education. *Pedagogies*, *10*, 149–176. doi:10.1080/1554480X.2015.1021350

Huinker, D., & Bill, V. (2017). *Taking action: Implementing effective mathematics teaching practices in K-Grade 5*. Reston, VA: National Council of Teachers of Mathematics.

Huinker, D., & Hedges, M. (April, 2015). Comparison of student and teacher perceptions of mathematics teaching practices. Paper presented at the 93rd Annual National Council of Teachers of Mathematics Research Conference, Boston, MA.

Humphreys, C., & Parker, R. (2015). *Making number talks matter: Developing mathematical practices and deepening understanding, grades 4-10*. Portsmouth, NH: Stenhouse Publishers.

Inagaki, K., Hatano, G., & Morita, E. (1998). Construction of mathematical knowledge through whole-class discussion. *Learning and Instruction*, *8*, 503–526. doi:10.1016/S0959-4752(98)00032-2

Jacobson, E. D. (2017). Field experience and prospective teachers' mathematical knowledge and beliefs. *Journal for Research in Mathematics Education*, *48*, 148–190. doi:10.5951/jresematheduc.48.2.0148

Jenset, I. S. (2017). *Practice-based teacher education coursework: An examination of the extent and characteristics of how teacher education coursework is grounded in practice across six teacher education programs in Finland, Norway and California, US* (Doctoral dissertation). University of Oslo, Norway.

Jenset, I. S., Hammerness, K., & Klette, K. (2019). Talk about field placement within campus coursework: Connecting theory and practice in teacher education. *Scandinavian Journal of Educational Research*, *63*, 632–650. doi:10.1080/00313831.2017.1415968

Johnson, A., & Partlo, A. (2014). *The impact of regular number talks on mental math computation abilities*. Retrieved from Sophia, the St. Catherine University (St. Paul, MN) repository website: https://sophia.stkate.edu/maed/93

Johnson, L. L., & Barnes, M. E. (2018). Mediating the "two-worlds" pitfall through critical, project-based clinical experiences. *The New Educator*, *14*, 270–291. doi:10.1080/1547688X.2017.1411999

Jones, S., & Tanner, H. (2002). Teachers' interpretations of effective whole-class interactive teaching in secondary mathematics classrooms. *Educational Studies, 28*, 265–274. doi:10.1080/0305569022000003

Kallenbach, W. W., & Gall, M. D. (1969). Microteaching versus conventional methods in training elementary intern teachers. *Journal of Educational Research*, *63*, 136–141.

Kelly, M. A., Hager, P., & Gallagher, R. (2014). What matters most? Students' rankings of simulation components which contribute to clinical judgement. *Journal of Nursing Education*, *53*, 97–101.

Kessels, J., Koster, B., Lagerwerf, B., Wubbels, T., & Korthagen, F. A. J. (2001). *Linking practice and theory: The pedagogy of realistic teacher education*. Mahwah, NJ: Lawrence Erlbaum Associates.

Klein, E. J., Taylor, M., Onore, C., Strom, K., & Abrams, L. (2013). Finding a third space in teacher education: Creating an urban teacher residency. *Teaching Education*, *24*, 27–57. doi:10.1080/10476210.2012.711305

Koerner, M., Rust, F. O. C., & Baumgartner, F. (2002). Exploring roles in student teaching placements. *Teacher Education Quarterly*, *29*(2), 35–58.

Korthagen, F. A. J. (2004). In search of the essence of a good teacher: Towards a more holistic approach in teacher education. *Teaching and Teacher Education*, *20*(1), 77–97. doi:10.1016/j.tate.2003.10.002

Korthagen, F. A. J., & Kessels, J. P. A. M. (1999). Linking theory and practice: Changing the pedagogy of teacher education. *Educational Researcher*, *28*(4), 4–17. doi:10.3102/0013189X028004004

LaBoskey, V. K., & Richert, A. E. (2002). Identifying good student teaching placements: A programmatic perspective. *Teacher Education Quarterly, 29*(2), 7–34.

Laman, T. T., Davis, T. R., & Henderson, J. W. (2018). “My hair has a lot of stories!”: Unpacking culturally sustaining writing pedagogies in an elementary mediated field experience for teacher candidates. *Action in Teacher Education*, *40*, 374–390. doi:10.1080/01626620.2018.1503979

Lampert, M. (2001). *Teaching problems and the problems of teaching*. New Haven, CT: Yale University Press.

Lampert, M. (2005, March). *Preparing teachers for ambitious instructional practice: Learning to listen and to construct an appropriate response*. Paper presented at the annual meeting of the American Educational Research Association, Montreal, Canada.

Lampert, M. (2010). Learning teaching in, from, and for practice: What do we mean? *Journal of Teacher Education*, *61*, 21–34. doi:10.1177/0022487109347321

Lampert, M., Beasley, H., Ghousseini, H., Kazemi, E., & Franke, M. (2010). Using designed instructional activities to enable novices to manage ambitious mathematics teaching. In M. K. Stein & L. Kucan (Eds.), *Instructional explanations in the disciplines* (pp. 129–141). New York, NY: Springer. doi:10.1007/978-1-4419-0594-9_9

Lampert, M., & Graziani, F. (2009). Instructional activities as a tool for teachers’ and teacher educators’ learning. *The Elementary School Journal*, *109*, 491–509. doi:10.1086/596998

Lederman, L. C. (1992). Debriefing: Toward a systematic assessment of theory and practice. *Simulation & Gaming, 23*, 145–160.

Lee, J., Lim, W., & Kim, H. (2016). Lesson planning: How do pre-service teachers benefit from examining lesson plans with Mathematics Teaching Practices as an analytical lens? *Education of Primary School Mathematics*, *19*, 211–222. doi:10.7468/jksmec.2016.19.3.211

Leinhardt, G., & Steele, M. D. (2005). Seeing the complexity of standing to the side: Instructional dialogues. *Cognition and Instruction, 23*, 87–163. doi:10.1207/s1532690xci2301

Leinwand, S., Huinker, D., & Brahier, D. (2014). Principles to Actions: Mathematics programs as the core for student learning. *Mathematics Teaching in the Middle School*, *19*, 516–519.

Levine, A. (2006). Educating school teachers. Retrieved from http://www.edschools.org/teacher_report.htm

Lewis, C. C. (2002). *Lesson study: A handbook of teacher-led instructional change*. Philadelphia, PA: Research for Better Schools, Inc.

Lotter, C., Smoak, K., Blakeney, W. R., & Plotner, S. (2019). Four perspectives on the benefits of an early field experience for high school teacher candidates. In T. E. Hodges & A. C. Baum (Eds.), *Handbook of research on field-based teacher education* (pp. 471–493). Hershey, PA: IGI Global. doi:10.4018/978-1-5225-6249-8.ch020

Lustgarten, A., & Matney, G. T. (2019). Examining number talks with secondary preservice teachers. *Ohio Journal of School Mathematics, 80*, 22–30.

Maritain, J. (1943). *Education at the crossroads*. New Haven, CT: Yale University Press.

Maritain, J. (1962). *The education of man*. Garden City, NY: Doubleday.

Mason, J., & Waywood, A. (1996). The role of theory in mathematics education and research. In A. J. Bishop, K. Clements, C. Keitel, J. Kilpatrick, & C. Laborde (Eds.), *International handbook of mathematics education* (Vol. 2, pp. 1055–1089). Dordrecht, The Netherlands: Kluwer.

McDonald, M., Kazemi, E., & Kavanagh, S. (2013). Core practices and pedagogies of teacher education: A call for a common language and collective activity. *Journal of Teacher Education*, *64*, 378–386. doi:10.1177/0022487113493807

McDonald, M., Kazemi, E., Kelley-Petersen, M., Mikolasy, K., Thompson, J., Valencia, S. W., & Windschitl, M. (2014). Practice makes practice: Learning to teach in teacher education. *Peabody Journal of Education*, *89*, 500–515. doi:10.1080/0161956X.2014.938997

Merriam, S. (1998). *Qualitative research and case study applications in education* (2nd ed.). San Francisco, CA: Jossey-Bass.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, CA: SAGE Publishing.

Moje, E. B., Ciechanowski, K. M., Kramer, K., Ellis, L., Carrillo, R., & Collazo, T. (2004). Working toward third space in content area literacy: An examination of everyday funds of knowledge and discourse. *Reading Research Quarterly*, *39*, 38–70.

Moon, B. (Ed.). (2016). *Do universities have a role in the education and training of teachers? An international analysis of policy and practice*. Cambridge, England: Cambridge University Press.

Moyer, P. S., & Milewicz, E. (2002). Learning to question: Categories of questioning used by preservice teachers during diagnostic mathematics interviews. *Journal of Mathematics Teacher Education, 5,* 293–315. doi:10.5840/tpm20156951

Muller, J. (2009). Forms of knowledge and curriculum coherence. *Journal of Education and Work, 22,* 205–226. doi:10.1080/13639080902957905

Murata, A., & Pothen, B. E. (2011). Lesson study in preservice elementary mathematics methods courses: Connecting emerging practice and understanding. In L. C. Hart, A. S. Alston, & A. Murata (Eds.), *Lesson Study Research and Practice in Mathematics Education: Learning Together* (pp. 103–116). New York, NY: Springer. doi:10.1007/978-90-481-9941-9

Myhill, D. (2006). Talk, talk, talk: Teaching and learning in whole class discourse. *Research Papers in Education*, *21*, 19–41.

Nabb, K., Hofacker, E. B., Ernie, K. T., & Ahrendt, S. (2018). Using the 5 practices in mathematics teaching. *The Mathematics Teacher*, *111*, 366–373. doi:10.5951/mathteacher.111.5.0366

National Council for Accreditation of Teacher Education. (2010). *Transforming teacher education through clinical practice: A national strategy to prepare effective teachers. Report of the Blue Ribbon Panel on Clinical Preparation and Partnerships for Improved Student Learning*. Washington, DC: Author.

National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (1991). *Professional standards for teaching mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2000). *Principles and standards of school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all*. Reston, VA: Author.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common core state standards for mathematics*. Washington, DC: Author. Retrieved from http://www.corestandards.org/assets/CCSSI_Math Standards.pdf

National Mathematics Advisory Panel. (2008). *Foundations for success: The final report of the National Mathematics Advisory Panel*. Washington, DC: U.S. Department of Education.

National Research Council. (1989). *Everybody counts: A report to the nation on the future of mathematics education*. Washington, DC: National Academy Press.

National Research Council. (2002). *Adding it up: Helping children learn mathematics*. (J. Kilpatrick, J. Swafford, & B. Findell, Eds.). Washington, DC: National Academy Press. doi:10.17226/9822

National Research Council. (2010). *Preparing teachers: Building evidence for sound policy*. Washington, DC: National Academy Press.

O'Connor, C., Michaels, S., Chapin, S., & Harbaugh, A. G. (2017). The silent and the vocal: Participation and learning in whole-class discussion. *Learning and Instruction*, *48*, 5–13. doi:10.1016/j.learninstruc.2016.11.003

Okamoto, Y. (2015). *The implementation process and impact of a six-week number talk intervention with sixth-grade middle school students in a large urban middle school* (Doctoral dissertation). University of California, Los Angeles, CA.

Olsen, B. (2008). *Teaching what they learn, learning what they live: How teachers' personal histories shape their professional development*. Boulder, CO: Paradigm Publishers.

Østergaard, K. (2013). Theory and practice in mathematics teacher education. In *Proceedings of the IVth international congress on the anthropological theory of didactics (ATD)* (pp. 1–22). Toulouse: IVe congrès international sur la TAD.

Parrish, S. (2010). *Number talks: Helping children build mental math and computation strategies, grades K–5.* Sausalito, CA: Math Solutions.

Parrish, S. D. (2011). Number talks build numerical reasoning. *Teaching Children Mathematics*, *18*, 198–206.

Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). Los Angeles, CA: SAGE Publishing. doi:10.15713/ins.mmj.3

Paul, J. L. (2005). *Introduction to the philosophies of research and criticism in education and the social sciences*. Columbus, OH: Prentice-Hall/Merrill.

Pianalto, M. (2012). Integrity and struggle. *Philosophia*, *40*, 319–336. doi:10.1007/s11406-011-9334-5

Putnam, J., & Grant, S. G. (1992). Reflective practice in the Multiple Perspectives program at Michigan State University. In L. Valli (Ed.), *Reflective teacher education: Cases and critiques* (pp. 82–98). Albany, NY: State University of New York Press.

Rall, M., Manser, T., & Howard, S. K. (2000). Key elements of debriefing for simulator training. *European Journal of Anaesthesiology*, *17*, 516–517. doi:10.1046/j.1365-2346.2000.00724-1.x

Ralph, E. (1999). Developing novice teachers' oral-questioning skills. *McGill Journal of Education*, *34*, 29–47.

Rendtorff, J. D. (2015). Integrity, concept of. In H. ten Have (Ed.), *Encyclopedia of Global Bioethics* (pp. 1–7). Cham, Switzerland: Springer International Publishing. doi:10.1007/978-3-319-05544-2

Richmond, G., Bartell, T., Andrews, D. J. C., & Neville, M. L. (2019). Reexamining coherence in teacher education. *Journal of Teacher Education, 70*, 188–191. doi:10.1177/0022487119838230

Samaras, A. P., Frank, T. J., Williams, M. A., Christopher, E., & Rodick, W. H. (2016). A collective self-study to improve program coherence of clinical experiences. *Studying Teacher Education: Journal of Self-Study of Teacher Education Practices*, *12*, 170–187. doi:10.1080/17425964.2016.1192033

Scherrer, J., & Stein, M. K. (2013). Effects of a coding intervention on what teachers learn to notice during whole-group discussion. *Journal of Mathematics Teacher Education*, *16*, 105–124. doi:10.1007/s10857-012-9207-2

Schmidt, A. W., Blömeke, S., Tatto, M. T., Hsieh, F., Cogan, L. S., Houang, R. T., . . . Schwille, J. (2011). *Teacher education matters: A study of middle school mathematics teacher preparation in six countries*. New York, NY: Teachers College Press.

Sfard, A., Nesher, P., Streefland, L., Cobb, P., & Mason, J. (1998). Learning mathematics through conversation: Is it as good as they say? *For the Learning of Mathematics*, *18*, 41–51.

Sherin, M. G. (2000). Facilitating meaningful discussion of mathematics. *Mathematics Teaching in the Middle School*, *6*, 122–125.

Sherin, M. G. (2002). A balancing act: Developing a discourse community in a mathematics classroom. *Journal of Mathematics Teacher Education*, *5*, 205–233. doi:10.1023/A:1020134209073

Sherin, M., Jacobs, V., & Philipp, R. (Eds.). (2011). *Mathematics teacher noticing: Seeing through teachers' eyes*. New York, NY: Routledge.

Shulman, L. S. (2004). *The wisdom of practice: Essays on teaching, learning, and learning to teach*. San Francisco, CA: Jossey-Bass.

Silver, E. A., & Herbst, P. G. (2007). Theory in mathematics education scholarship. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 39–67). Reston, VA: National Council of Teachers of Mathematics. doi:10.4065/81.11.1423

Smeby, J. C., & Heggen, K. (2014). Coherence and the development of professional knowledge and skills. *Journal of Education and Work*, *27*, 71–91. doi:10.1080/13639080.2012.718749

Smith, M. S., & Stein, M. K. (2011). *5 practices for orchestrating productive mathematics discussions*. Reston, VA: National Council of Teachers of Mathematics.

Soja, E. W. (1996). *Thirdspace: Journeys to Los Angeles and other real-and-imagined places*. Cambridge, MA: Blackwell Publishers.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: SAGE Publishing.

Star, J. R., Lynch, K., & Perova, N. (2011). Using video to improve preservice mathematics teachers' abilities to attend to classroom features: A replication study. In M. G. Sherin, V. R. Jacobs, & R. A. Philipp (Eds.), *Mathematics teachers' noticing: Seeing through teachers' eyes* (pp. 117–133). New York: Routledge. doi:10.4324/9780203832714

Star, J. R., & Strickland, S. K. (2008). Learning to observe: Using video to improve preservice mathematics teachers' ability to notice. *Journal of Mathematics Teacher Education*, 11, 107–125. doi:10.1007/s10857-007-9063-7

Stein, M. K., Engle, R. A., Smith, M. S., & Hughes, E. K. (2008). Orchestrating productive mathematical discussions: Five practices for helping teachers move beyond show and tell. *Mathematical Thinking and Learning, 10*, 313–340. doi:10.1080/10986060802229675

Stein, M. K., Engle, R. A., Smith, M. S., & Hughes, E. K. (2015). Orchestrating productive mathematical discussions: Helping teachers learn to better incorporate student thinking. In L. Resnick, C. Asterhan, & S. Clarke (Eds.), *Socializing intelligence through academic talk and dialogue* (pp. 375–388). Washington, DC: American Educational Research Association. doi:10.3102/978-0-935302-43-1_29

Steinberg, R. M., Empson, S. B., & Carpenter, T. P. (2004). Inquiry into children's mathematical thinking as a means to teacher change. *Journal of Mathematics Teacher Education*, *7*, 237–267. doi:10.1023/b:jmte.0000033083.04005.d3

Stephan, M. L. (2014). Establishing standards for mathematical practice. *Mathematics Teaching in the Middle School*, *19*, 532–538.

Stockero, S. L., Leatham, K. R., Ochieng, M. A., Van Zoest, L. R., & Peterson, B. E. (2019). Teachers' orientations toward using student mathematical thinking as a resource during whole-class discussion. *Journal of Mathematics Teacher Education*, 1–31. doi:10.1007/s10857-018-09421-0

Swartz, B. A., Billings, E. M., Knapp, M., Virmani, R. K., Sharpe, C., Woods, D., . . . Pinter, H. H. (2018). Working to understand mediated field experiences and study their impact. In T. E. Hodges, G. J. Roy, & A. M. Tyminski (Eds.), *Proceedings of the 40th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 1487–1496). Greenville, SC: University of South Carolina & Clemson University.

Swartz, B. A., Lynch, J. M., & Lynch, S. D. (2018). Embedding elementary teacher education coursework in local classrooms: Examples in mathematics and special education. In D. Polly, M. Putman, T. M. Petty, & A. J. Good (Eds.), *Innovative practices in teacher preparation and graduate-level teacher education programs* (pp. 262–292). Hershey, PA: IGI Global. doi:10.4018/978-1-5225-3068-8.ch015

Teacher Education Ministerial Advisory Group. (2014). *Action now: Classroom ready teachers*. Australia: Author. Retrieved from http://www.studentsfirst.gov.au/teacher-education-ministerial-advisory-group

Turunen, T. A., & Tuovila, S. (2012). Mind the gap: Combining theory and practice in a field experience. *Teaching Education*, *23*, 115–130. doi:10.1080/10476210.2012.669751

Van Zoest, L. R., Peterson, B. E., Leatham, K. R., & Stockero, S. L. (2016). Conceptualizing the teaching practice of building on student mathematical thinking. In M. B. Wood, E. E. Turner, M. Civil, & J. A. Eli (Eds.), *Proceedings of the 38th Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 1281–1288). Tucson, AZ: The University of Arizona.

Vick, M. (2006). "It's a difficult matter": Historical perspectives on the enduring problem of the practicum in teacher preparation. *Asia-Pacific Journal of Teacher Education*, *34*, 181–198. doi:10.1080/13598660600720579

Virmani, R. (2014). *Rehearsal and enactment for teaching in urban school settings: A qualitative study investigating the connections between a math methods course and fieldwork* (Doctoral dissertation). The University of San Francisco, San Francisco, CA.

Virmani, R., Taylor, M. W., & Rumsey, C. (2018). Bringing mathematics methods into classrooms. In S. E. Kastberg, A. M. Tyminski, A. E. Lischka, & W. B. Sanchez (Eds.), *Building support for scholarly practices in mathematics methods* (pp. 233–248). Charlotte, NC: Information Age Publishing.

Wallach, T., & Even, R. (2005). Hearing students: The complexity of understanding what they are saying, showing, and doing. *Journal of Mathematics Teacher Education*, *8*, 393–417. doi:10.1007/s10857-005-3849-2

Walshaw, M., & Anthony, G. (2008). The teacher's role in classroom discourse: A review of recent research into mathematics classrooms. *Review of Educational Research, 78*, 516–551.

Weiland, I. S., Hudson, R. A., & Amador, J. M. (2014). Preservice formative assessment interviews: The development of competent questioning. *International Journal of Science and Mathematics Education*, *12*, 329–352. doi:10.1007/s10763-013-9402-3

Weston, T. L. (2019). Improving coherence in teacher education: Features of a field-based methods course partnership. In T. E. Hodges & A. C. Baum (Eds.), *Handbook of research on field-based teacher education* (pp. 166–191). Hershey, PA: IGI Global. doi:10.4018/978-1-5225-6249-8.ch007

Weston, T. L., & Henderson, S. C. (2015). Coherent experiences: The new missing paradigm in teacher education. *Educational Forum*, *79*, 321–335. doi:10.1080/00131725.2015.1037514

Williams, J. (2014). Teacher educator professional learning in the third space: Implications for identity and practice. *Journal of Teacher Education*, *65*, 315–326. doi:10.1177/0022487114533128

Wood, M. B., & Turner, E. E. (2015). Bringing the teacher into teacher preparation: Learning from mentor teachers in joint methods activities. *Journal of Mathematics Teacher Education*, *18*, 27–51. doi:10.1007/s10857-014-9269-4

Yin, R. K. (2003). *Case study research: Designs and methods* (3rd ed.). London, England: SAGE Publishing.

Yow, J. A., Waller, P., & Edwards, B. (2019). A national effort to integrate field experiences into secondary mathematics methods courses. In T. E. Hodges & A. C. Baum (Eds.), *Handbook of research on field-based teacher education2* (pp. 395–419). doi:10.4018/978-1-5225-6249-8.ch017

Zeichner, K. M. (2005). A research agenda for teacher education. In M. Cochran-Smith & K. M. Zeichner (Eds.), *Studying teacher education: The report of the AERA panel on research and teacher education* (pp. 737–759). Mahwah, NJ: Lawrence Erlbaum Associates.

Zeichner, K. M. (2010). Rethinking the connections between campus courses and field experiences in college- and university-based teacher education. *Journal of Teacher Education*, *61*, 89–99. doi:10.1177/0022487109347671

Zeichner, K. M., & Conklin, H. G. (2008). Teacher education programs as sites for teacher preparation. In M. Cochran-Smith, S. Feiman-Nemser, & D. J. McIntyre (Eds.), *Handbook of research on teacher education* (3rd ed., pp. 269–289). New York, NY: Routledge.

# APPENDICES

# Appendix A: Mathematics Classroom Observation Protocol for Practices (MCOP2)

## Mathematics Classroom Observation Protocol for Practices (MCOP$^2$)

**1) Students engaged in exploration/investigation/problem solving.**

| SE | | Description | Comments |
|---|---|---|---|
| 3 | | Students regularly engaged in exploration, investigation, or problem solving. Over the course of the lesson, the majority of the students engaged in exploration/investigation/problem solving. | |
| 2 | | Students sometimes engaged in exploration, investigation, or problem solving. Several students engaged in problem solving, but not the majority of the class. | |
| 1 | | Students seldom engaged in exploration, investigation, or problem solving. This tended to be limited to one or a few students engaged in problem solving while other students watched but did not actively participate. | |
| 0 | | Students did not engage in exploration, investigation, or problem solving. There were either no instances of investigation or problem solving, or the instances were carried out by the teacher without active participation by any students. | |

**2) Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent concepts.**

| SE | | Description | Comments |
|---|---|---|---|
| 3 | | The students manipulated or generated two or more representations to represent the same concept, and the connections across the various representations, relationships of the representations to the underlying concept, and applicability or the efficiency of the representations were explicitly discussed by the teacher or students, as appropriate. | |
| 2 | | The students manipulated or generated two or more representations to represent the same concept, but the connections across the various representations, relationships of the representations to the underlying concept, and applicability or the efficiency of the representations were **not** explicitly discussed by the teacher or students. | |
| 1 | | The students manipulated or generated one representation of a concept. | |
| 0 | | There were either no representations included in the lesson, or representations were included but were exclusively manipulated and used by the teacher. If the students only watched the teacher manipulate the representation and did not interact with a representation themselves, it should be scored a 0. | |

**3) Students were engaged in mathematical activities.**

| SE | | Description | Comments |
|---|---|---|---|
| 3 | | Most of the students spend two-thirds or more of the lesson engaged in mathematical activity at the appropriate level for the class. It does not matter if it is one prolonged activity or several shorter activities. (Note that listening and taking notes does not qualify as a mathematical activity unless the students are filling in the notes and interacting with the lesson mathematically.) | |
| 2 | | Most of the students spend more than one-quarter but less than two-thirds of the lesson engaged in appropriate level mathematical activity. It does not matter if it is one prolonged activity or several shorter activities. | |
| 1 | | Most of the students spend less than one-quarter of the lesson engaged in appropriate level mathematical activity. There is at least one instance of students' mathematical engagement. | |
| 0 | | Most of the students are not engaged in appropriate level mathematical activity. This could be because they are never asked to engage in any activity and spend the lesson listening to the teacher and/or copying notes, or it could be because the activity they are engaged in is not mathematical – such as a coloring activity. | |

**4) Students critically assessed mathematical strategies.**

| SE | TF | Description | Comments |
|---|---|---|---|
| 3 | 3 | More than half of the students critically assessed mathematical strategies. This could have happened in a variety of scenarios, including in the context of partner work, small group work, or a student making a comment during direct instruction or individually to the teacher. | |
| 2 | 2 | At least two but less than half of the students critically assessed mathematical strategies. This could have happened in a variety of scenarios, including in the context of partner work, small group work, or a student making a comment during direct instruction or individually to the teacher. | |
| 1 | 1 | An individual student critically assessed mathematical strategies. This could have happened in a variety of scenarios, including in the context of partner work, small group work, or a student making a comment during direct instruction or individually to the teacher. The critical assessment was limited to one student. | |
| 0 | 0 | Students did not critically assess mathematical strategies. This could happen for one of three reasons: 1) No strategies were used during the lesson; 2) Strategies were used but were not discussed critically. For example, the strategy may have been discussed in terms of how it was used on the specific problem, but its use was not discussed more generally; 3) Strategies were discussed critically by the teacher but this amounted to the teacher telling the students about the strategy(ies), and students did not actively participate. | |

# Mathematics Classroom Observation Protocol for Practices (MCOP$^2$)

**5) Students persevered in problem solving.**

| SE | Description | Comments |
|---|---|---|
| 3 | Students exhibited a strong amount of perseverance in problem solving. The majority of students looked for entry points and solution paths, monitored and evaluated progress, and changed course if necessary. When confronted with an obstacle (such as how to begin or what to do next), the majority of students continued to use resources (physical tools as well as mental reasoning) to continue to work on the problem. | |
| 2 | Students exhibited some perseverance in problem solving. Half of students looked for entry points and solution paths, monitored and evaluated progress, and changed course if necessary. When confronted with an obstacle (such as how to begin or what to do next), half of students continued to use resources (physical tools as well as mental reasoning) to continue to work on the problem. | |
| 1 | Students exhibited minimal perseverance in problem solving. At least one student but less than half of students looked for entry points and solution paths, monitored and evaluated progress, and changed course if necessary. When confronted with an obstacle (such as how to begin or what to do next), at least one student but less than half of students continued to use resources (physical tools as well as mental reasoning) to continue to work on the problem. There must be a road block to score above a 0. | |
| 0 | Students did not persevere in problem solving. This could be because there was no student problem solving in the lesson, or because when presented with a problem solving situation no students persevered. That is to say, all students either could not figure out how to get started on a problem, or when they confronted an obstacle in their strategy they stopped working. | |

**6) The lesson involved fundamental concepts of the subject to promote relational/conceptual understanding.**

| TF | Description | Comments |
|---|---|---|
| 3 | The lesson includes fundamental concepts or critical areas of the course, as described by the appropriate standards, and the teacher/lesson uses these concepts to build relational/conceptual understanding of the students with a focus on the "why" behind any procedures included. | |
| 2 | The lesson includes fundamental concepts or critical areas of the course, as described by the appropriate standards, but the teacher/lesson misses several opportunities to use these concepts to build relational/conceptual understanding of the students with a focus on the "why" behind any procedures included. | |
| 1 | The lesson mentions some fundamental concepts of mathematics, but does not use these concepts to develop the relational/conceptual understanding of the students. For example, in a lesson on the slope of the line, the teacher mentions that it is related to ratios, but does not help the students to understand how it is related and how that can help them to better understand the concept of slope. | |
| 0 | The lesson consists of several mathematical problems with no guidance to make connections with any of the fundamental mathematical concepts. This usually occurs with a teacher focusing on procedure of solving certain types of problems without the students understanding the "why" behind the procedures. | |

**7) The lesson promoted modeling with mathematics.**

| TF | Description | Comments |
|---|---|---|
| 3 | Modeling (using a mathematical model to describe a real-world situation) is an integral component of the lesson with students engaged in the modeling cycle (as described in the Common Core State Standards). | |
| 2 | Modeling is a major component, but the modeling has been turned into a procedure (i.e. a group of word problems that all follow the same form and the teacher has guided the students to find the key pieces of information and how to plug them into a procedure.); <u>**or**</u> modeling is not a major component, but the students engage in a modeling activity that fits within the corresponding standard of mathematical practice. | |
| 1 | The teacher describes some type of mathematical model to describe real-world situations, but the students do not engage in activities related to using mathematical models. | |
| 0 | The lesson does not include any modeling with mathematics. | |

# Mathematics Classroom Observation Protocol for Practices (MCOP$^2$)

**8) The lesson provided opportunities to examine mathematical structure. (symbolic notation, patterns, generalizations, conjectures, etc.)**

| TF | Description |
|---|---|
| 3 | The students have a sufficient amount of time and opportunity to look for and make use of mathematical structure or patterns. |
| 2 | Students are given some time to examine mathematical structure, but are not allowed adequate time or are given too much scaffolding so that they cannot fully understand the generalization. |
| 1 | Students are shown generalizations involving mathematical structure, but have little opportunity to discover these generalizations themselves or adequate time to understand the generalization. |
| 0 | Students are given no opportunities to explore or understand the mathematical structure of a situation. |

Comments

**9) The lesson included tasks that have multiple paths to a solution or multiple solutions.**

| TF | Description |
|---|---|
| 3 | A lesson which includes several tasks throughout; or a single task that takes up a large portion of the lesson; with multiple solutions and/or multiple paths to a solution and which increases the cognitive level of the task for different students. |
| 2 | Multiple solutions and/or multiple paths to a solution are a significant part of the lesson, but are not the primary focus, or are not explicitly encouraged; **or** more than one task has multiple solutions and/or multiple paths to a solution that are explicitly encouraged. |
| 1 | Multiple solutions and/or multiple paths minimally occur, and are not explicitly encouraged; **or** a single task has multiple solutions and/or multiple paths to a solution that are explicitly encouraged. |
| 0 | A lesson which focuses on a single procedure to solve certain types of problems and/or strongly discourages students from trying different techniques. |

Comments

**10) The lesson promoted precision of mathematical language.**

| TF | Description |
|---|---|
| 3 | The teacher "attends to precision" in regards to communication during the lesson. The students also "attend to precision" in communication, or the teacher guides students to modify or adapt non-precise communication to improve precision. |
| 2 | The teachers "attends to precision" in all communication during the lesson, but the students are not always required to also do so. |
| 1 | The teacher makes a few incorrect statements or is sloppy about mathematical language, but generally uses correct mathematical terms. |
| 0 | The teacher makes repeated incorrect statements or incorrect names for mathematical objects instead of their accepted mathematical names. |

Comments

**11) The teacher's talk encouraged student thinking.**

| TF | Description |
|---|---|
| 3 | The teacher's talk focused on **high levels** of mathematical thinking. The teacher may ask lower level questions within the lesson, but this is not the focus of the practice. There are three possibilities for high levels of thinking: analysis, synthesis, and evaluation. ***Analysis*** *:* examines/ interprets the pattern, order or relationship of the mathematics; parts of the form of thinking. **Synthesis**: requires original, creative thinking. **Evaluation**: makes a judgment of good or bad, right or wrong, according to the standards he/she values. |
| 2 | The teacher's talk focused on **mid-levels** of mathematical thinking. **Interpretation**: discovers relationships among facts, generalizations, definitions, values and skills. **Application**: requires identification and selection and use of appropriate generalizations and skills |
| 1 | Teacher talk consists of **"lower order"** knowledge based questions and responses focusing on recall of facts. **Memory**: recalls or memorizes information. **Translation**: changes information into a different symbolic form or situation. |
| 0 | Any questions/ responses of the teacher related to mathematical ideas were rhetorical in that there was no expectation of a response from the students. |

Comments

**12) There were a high proportion of students talking related to mathematics.**

| SE | Description |
|---|---|
| 3 | More than three quarters of the students were talking related to the mathematics of the lesson at some point during the lesson. |
| 2 | More than half, but less than three quarters of the students were talking related to the mathematics of the lesson at some point during the lesson. |
| 1 | Less than half of the students were talking related to the mathematics of the lesson. |
| 0 | No students talked related to the mathematics of the lesson. |

Comments

# Mathematics Classroom Observation Protocol for Practices (MCOP²)

**13) There was a climate of respect for what others had to say.**

| SE | TF | Description |
|---|---|---|
| 3 | 3 | **Many** students are sharing, questioning, and commenting during the lesson, including their struggles. Students are also listening (active), clarifying, and recognizing the ideas of others. |
| 2 | 2 | The environment is such that **some** students are sharing, questioning, and commenting during the lesson, including their struggles. Most students listen. |
| 1 | 1 | Only a **few** share as called on by the teacher. The climate supports those who understand or who behave appropriately. **Or** Some students are sharing, questioning, or commenting during the lesson, but most students are actively listening to the communication. |
| 0 | 0 | No students shared ideas. |

Comments

**14) In general, the teacher provided wait-time.**

| SE | | Description |
|---|---|---|
| 3 | | The teacher **frequently** provided an ample amount of "think time" for the depth and complexity of a task or question posed by either the teacher or a student. |
| 2 | | The teacher **sometimes** provided an ample amount of "think time" for the depth and complexity of a task or question posed by either the teacher or a student. |
| 1 | | The teacher **rarely** provided an ample amount of "think time" for the depth and complexity of a task or question posed by either the teacher or a student. |
| 0 | | The teacher **never** provided an ample amount of "think time" for the depth and complexity of a task or question posed by either the teacher or a student. |

Comments

**15) Students were involved in the communication of their ideas to others (peer-to-peer).**

| SE | | Description |
|---|---|---|
| 3 | | **Considerable** time **(more than half)** was spent with peer to peer dialog (pairs, groups, whole class) related to the communication of ideas, strategies and solution. |
| 2 | | **Some** class time **(less than half, but more than just a few minutes)** was devoted to peer to peer (pairs, groups, whole class) conversations related to the mathematics. |
| 1 | | The lesson was primarily teacher directed and little opportunities were available for peer to peer (pairs, groups, whole class) conversations. A few instances developed where this occurred during the lesson but only lasted less than 5 minutes. |
| 0 | | No peer to peer (pairs, groups, whole class) conversations occurred during the lesson. |

Comments

**16) The teacher uses student questions/comments to enhance conceptual mathematical understanding.**

| | TF | Description |
|---|---|---|
| | 3 | The teacher **frequently** uses student questions/ comments to coach students, to facilitate conceptual understanding, and boost the conversation. The teacher sequences the student responses that will be displayed in an intentional order, and/or connects different students' responses to key mathematical ideas. |
| | 2 | The teacher **sometimes** uses student questions/ comments to enhance conceptual understanding. |
| | 1 | The teacher **rarely** uses student questions/ comments to enhance conceptual mathematical understanding. The focus is more on procedural knowledge of the task verses conceptual knowledge of the content. |
| | 0 | The teacher **never** uses student questions/ comments to enhance conceptual mathematical understanding. |

Comments

Additional Notes: Preservice or Inservice. Live or Video. #Students, Grade Level, topic/subject, date, other demographics, school, etc.

**Published February 16, 2015. Disclaimer: This instrument may be used for evaluative educational purposes with consent from the authors. Details can be found at http://jgleason.people.ua.edu/mcop2.html**

## Appendix B: Observation Protocol for Lesson

**Step 1: Anticipating.** What potential student responses and strategies for the given mathematical task were identified ahead of time? What potential misconceptions were predicted?

**Step 2: Monitoring.** What did you notice about the teacher's monitoring of student responses during work time?

**Step 3: Selecting.** How many student responses were selected? Did the teacher select the student responses that you anticipated?

**Step 4: Sequencing.** In what order were the student responses sequenced? What were the benefits of this particular sequencing? How might a different sequencing have yielded different effects?

**Step 5: Connecting.** How did the teacher use questioning and focusing techniques to build connections between different student responses?

## Appendix C: Reflection Questions for PSTs Following Classroom Lesson

Please reflect upon today's classroom lesson. Audio record your responses. Please reference the number of each question as you respond to it. You may want to make a few written notes about anything you would like to discuss further during the debrief. In your recorded reflection, please begin with the question(s) indicated by the instructor, then proceed to answer any other questions of your choice.

**Mathematics Teaching Practice:**

1. What is the Mathematics Teaching Practice that we are currently focusing upon? Explain what you think this means. How do you currently envision this practice?

**Lesson:**

2. What strategy (or strategies) did the students use? Had you predicted that this strategy might have been used? Was there anything particularly interesting about the strategies that the students used?

3. What did the students understand? How do you know this?

4. Did the students display any misconceptions or confusion about math concepts at any time during the lesson (in their work, talk, and/or behavior)? If so, what were these?

5. What was the objective of the lesson? Was this objective met?

6. Did anything about the lesson or the student responses surprise you? If so, explain.

7. Did you think that the lesson was effective? Why or why not? How could it have been made more effective?

8. What student misconceptions or difficulties may need to be focused upon in the next lesson?

9. How did the Mathematics Teaching Practice that we are currently focusing upon appear in the lesson?

**Number Talk:**

10. What strategy (or strategies) did the students use? Had you predicted that this strategy might have been used? Was there anything particularly interesting about the strategies that the students used?

11. How did the number talk make thinking visible?

12. How did the teacher respond to students' thinking?

13. Did anything about the number talk or the student responses surprise you? If so, explain.

14. Did you think that the number talk was effective? Why or why not? How could it have been made more effective?

15. How did the Mathematics Teaching Practice that we are currently focusing upon appear in the number talk?

## Appendix D: Reflection Questions for Written Narrative

Please reflect upon the mediated field experience that we just finished, including the prebrief from last class, today's classroom lesson, and our debrief. In your reflection, please include the following:

1. What do you see as the purpose of this mediated field experience?
2. What did you gain from:
    a. Discussing the number talk and lesson ahead of time, with the cooperating teacher present?
    b. Observing and/or teaching the classroom lesson (number talk and lesson)?
    c. Talking and debriefing with everyone after the lesson?
3. What have you learned about teaching from this experience?
4. What Mathematics Teaching Practice are we currently focusing upon? Explain what you think this means. How do you currently envision this practice?
5. Has your understanding of Mathematics Teaching Practices changed as a result of these mediated field experiences? If so, in what way? Has any particular element of the mediated field experiences been particularly helpful or unhelpful?
6. Did what you learned during the mediated field experience help you better understand the information you learned during coursework? If so, in what way?
7. Did what you learned through coursework help you better understand your time spent in the fourth grade classroom? If so, in what way?
8. How might this cycle of a mediated field experience have been improved upon?
9. Is there anything else you would like to comment upon regarding the mediated field experience?

***NOTE:*** Questions 6 and 7 are adapted from Weston, T. L. (2019). Improving coherence in teacher education: Features of a field-based methods course partnership. In T. E. Hodges & A. C. Baum (Eds.), *Handbook of research on field-based teacher education* (pp. 166–191). Hershey, PA: IGI Global.

## Appendix E: Background Survey

Name ______________________________________________

Age _____________

Ethnicity (check one) ❑ Hispanic or Latino ❑ Not Hispanic or Latino

Race / Ethnicity (check any that apply) ❑ White ❑ African American

❑ Asian ❑ Other: __________________________________

Semester you anticipate student teaching _______________________

Explain your experience as a student in math classes when you were growing up. Include any college experience(s) of math class.

What makes a good teacher?

What makes a good *mathematics* teacher?

How do you think one learns to become a teacher?

What do you hope to learn in this methods course?

***NOTE:*** Survey items adapted from Campbell, S. S. (2012). *Taking them into the field: Mathematics teacher candidate learning about equity-oriented teaching practices in a mediated field experience* (Doctoral dissertation). University of Washington, Seattle, WA.

## Appendix F: Initial PST Semi-Structured Interview Questions

1. What types of field experiences have you experienced so far? Have these been requirements of particular coursework?
2. In what ways have your field experiences aligned with what you have learned in your coursework? Please provide concrete examples if possible.
3. In what ways have your field experiences been disconnected from what you have learned in your coursework? Please provide concrete examples if possible.
4. Overall, have you felt that your coursework and your field experiences have been coherent, directly supporting one another? Explain.
5. Do you have anything else you would like to add?

## Appendix G: Mid-Point PST Semi-Structured Interview Questions

1. What do you see as the purpose of our mediated field experiences?
2. What have you gained from:
    - Discussing the number talk and lesson ahead of time, with the cooperating teacher present?
    - Observing and/or teaching the classroom lesson (number talk and lesson)?
    - Talking and debriefing with everyone after the lesson?
3. Which of the above three elements of the mediated field experiences is your favorite? Why?
4. How did the Mathematics Teaching Practice that we are currently focusing upon appear in the mediated field experiences so far?
5. Has your understanding of Mathematics Teaching Practices changed as a result of these mediated field experiences? If so, in what way? Has any particular element of the mediated field experiences been particularly helpful or unhelpful?
6. Has the teaching that you did/observed during the mediated field experience enabled you to make links between what you have learned in coursework and what you have experienced in the field? Explain.
7. Has what you have learned in the mediated field experiences so far helped you to better understand the information you have been learning in the rest of the course? If so, explain.
8. Is there anything you’re especially looking forward to with regards to the mediated field experiences?

9. Is there anything you're nervous about with regards to the mediated field experiences?
10. Do you have anything else you would like to add?

***NOTE:*** Question 6 is adapted from Allen, J. M., & Wright, S. E. (2014). Integrating theory and practice in the pre-service teacher education practicum. *Teachers and Teaching: Theory and Practice, 20,* 136–151. Question 7 is adapted from Weston, T. L. (2019). Improving coherence in teacher education: Features of a field-based methods course partnership. In T. E. Hodges & A. C. Baum (Eds.), *Handbook of research on field-based teacher education* (pp. 166–191). Hershey, PA: IGI Global.

## Appendix H: Final PST Semi-Structured Interview Questions

1. What do you see as the purpose of our mediated field experiences?
2. What have you gained from:
   - Discussing the number talk and lesson ahead of time, with the cooperating teacher present?
   - Observing and/or teaching the classroom lesson (number talk and lesson)?
   - Talking and debriefing with everyone after the lesson?
3. Has your understanding of Mathematics Teaching Practices changed as a result of these mediated field experiences? If so, in what way?
4. Has any particular element of the mediated field experiences been particularly helpful or unhelpful in building a deeper understanding of Mathematics Teaching Practices?
5. How, if at all, has your understanding of student thinking changed as a result of these mediated field experiences?
6. How, if at all, has your thinking regarding teaching changed as a result of the mediated field experiences?
7. What theories, strategies, and techniques did you learn about in this course? Did the mediated field experiences allow you to try out any of these? Explain.
8. When you observed lessons in the classroom, did the person teaching use the same theories, strategies, and techniques that you were learning about in the methods course? Explain.
9. Do you think you will be able to apply anything from these mediated field experiences to your classroom when you are a teacher? If so, what?

10. Has what you learned in the mediated field experiences helped you to better understand the information you learned in the rest of the course? If so, explain.
11. Did what you learned through coursework help you better understand your time spent in the fourth grade classroom? If so, how?
12. How much of an opportunity did you have to make connections between educational theory and your experience in teaching and observing in an actual classroom? Explain.
13. Did you find that what you learned in coursework and what you learned during your time in the field conflicted with one another or showed a correspondence with one another? Explain.
14. How might the mediated field experiences have been improved upon?
15. Do you have anything else you would like to add?

***NOTE:*** Questions 7, 8, 12 and 13 are adapted from Canrinus, E. T., Klette, K., & Hammerness, K. (2019). Diversity in coherence: Strengths and opportunities of three programs. *Journal of Teacher Education*, *70*, 192–205. Questions 10 and 11 are adapted from Weston, T. L. (2019). Improving coherence in teacher education: Features of a field-based methods course partnership. In T. E. Hodges & A. C. Baum (Eds.), *Handbook of research on field-based teacher education* (pp. 166–191). Hershey, PA: IGI Global.

# Appendix I: License for Use of Figures

**SPRINGER NATURE LICENSE**
**TERMS AND CONDITIONS**

Sep 27, 2019

This Agreement between Sister Cecilia Anne Wanner ("You") and Springer Nature ("Springer Nature") consists of your license details and the terms and conditions provided by Springer Nature and Copyright Clearance Center.

License Number: 4677110025622

License date: Sep 27, 2019

Licensed Content Publisher: Springer Nature

Licensed Content Publication: Journal of Mathematics Teacher Education

Licensed Content Title: Bringing the teacher into teacher preparation: learning from mentor teachers in joint methods activities

Licensed Content Author: Marcy B. Wood, Erin E. Turner

Licensed Content Date: Jan 1, 2014

Licensed Content Volume: 18

Licensed Content Issue: 1

Type of Use: Thesis/Dissertation

Requestor type: academic/university or research institute

Format: print and electronic

Portion: figures/tables/illustrations

Number of figures/tables/illustrations: 2

Will you be translating? no

Circulation/distribution: 1 - 29

Author of this Springer Nature content: no

Title: NARROWING THE GAP: THE MEDIATED FIELD EXPERIENCE AS A PEDAGOGY TO IDENTIFY AND BUILD COHERENCE BETWEEN PRESERVICE TEACHERS' PERCEPTIONS OF MATHEMATICS TEACHING PRACTICES AS STUDIED IN COURSEWORK AND AS EXPERIENCED IN THE FIELD

Institution name: Middle Tennessee State University

Expected presentation date: Sep 2020

Portions:
Figure 1 on page 29
Figure 2 on page 30

Requestor Location:
Sister Cecilia Anne Wanner
801 Dominican Drive
NASHVILLE, TN 37228
United States
Attn: Sister Cecilia Anne Wanner

Total: 0.00 USD

**Terms and Conditions**
Springer Nature Customer Service Centre GmbH
Terms and Conditions

This agreement sets out the terms and conditions of the licence (the Licence) between you and Springer Nature Customer Service Centre GmbH (the Licensor). By clicking 'accept' and completing the transaction for the material (Licensed Material), you also confirm your acceptance of these terms and conditions.

Grant of License

The Licensor grants you a personal, non-exclusive, non-transferable, world-wide licence to reproduce the Licensed Material for the purpose specified in your order only. Licences are granted for the specific use requested in the order and for no other use, subject to the conditions below.

The Licensor warrants that it has, to the best of its knowledge, the rights to license reuse of the Licensed Material. However, you should ensure that the material you are requesting is original to the Licensor and does not carry the copyright of another entity (as credited in the published version).

If the credit line on any part of the material you have requested indicates that it was reprinted or adapted with permission from another source, then you should also seek permission from that source to reuse the material.

Scope of Licence

You may only use the Licensed Content in the manner and to the extent permitted by these Ts&Cs and any applicable laws.

A separate licence may be required for any additional use of the Licensed Material, e.g. where a licence has been purchased for print only use, separate permission must be obtained for electronic re-use. Similarly, a licence is only valid in the language selected and does not apply for editions in other languages unless additional translation rights have been granted separately in the licence. Any content owned by third parties are expressly excluded from the licence.

Similarly, rights for additional components such as custom editions and derivatives require additional permission and may be subject to an additional fee. Please apply to Journalpermissions@springernature.com/bookpermissions@springernature.com for these rights.

Where permission has been granted free of charge for material in print, permission may also be granted for any electronic version of that work, provided that the material is incidental to your work as a whole and that the electronic version is essentially equivalent to, or substitutes for, the print version.

An alternative scope of licence may apply to signatories of the STM Permissions Guidelines, as amended from time to time.

Duration of Licence

A licence for is valid from the date of purchase ('Licence Date') at the end of the relevant period in the below table:

| Scope of Licence | Duration of Licence |
|---|---|
| Post on a website | 12 months |
| Presentations | 12 months |
| Books and journals | Lifetime of the edition in the language purchased |

Acknowledgement

The Licensor's permission must be acknowledged next to the Licenced Material in print. In electronic form, this acknowledgement must be visible at the same time as the figures/tables/illustrations or abstract, and must be hyperlinked to the journal/book's homepage. Our required acknowledgement format is in the Appendix below.

Restrictions on use

Use of the Licensed Material may be permitted for incidental promotional use and minor editing privileges e.g. minor adaptations of single figures, changes of format, colour and/or style where the adaptation is credited as set out in Appendix 1 below. Any other changes including but not limited to, cropping, adapting, omitting material that affect the meaning, intention or moral rights of the author are strictly prohibited.

You must not use any Licensed Material as part of any design or trademark.

Licensed Material may be used in Open Access Publications (OAP) before publication by Springer Nature, but any Licensed Material must be removed from OAP sites prior to final publication.

Ownership of Rights

Licensed Material remains the property of either Licensor or the relevant third party and any rights not explicitly granted herein are expressly reserved.

Warranty

IN NO EVENT SHALL LICENSOR BE LIABLE TO YOU OR ANY OTHER PARTY OR ANY OTHER PERSON OR FOR ANY SPECIAL, CONSEQUENTIAL, INCIDENTAL OR INDIRECT DAMAGES, HOWEVER CAUSED, ARISING OUT OF OR IN CONNECTION WITH THE DOWNLOADING, VIEWING OR USE OF THE MATERIALS REGARDLESS OF THE FORM OF ACTION, WHETHER FOR BREACH OF CONTRACT, BREACH OF WARRANTY, TORT, NEGLIGENCE, INFRINGEMENT OR OTHERWISE (INCLUDING, WITHOUT LIMITATION, DAMAGES BASED ON LOSS OF PROFITS, DATA, FILES, USE, BUSINESS OPPORTUNITY OR CLAIMS OF THIRD PARTIES), AND

WHETHER OR NOT THE PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. THIS LIMITATION SHALL APPLY NOTWITHSTANDING ANY FAILURE OF ESSENTIAL PURPOSE OF ANY LIMITED REMEDY PROVIDED HEREIN.

Limitations

BOOKS ONLY:Where 'reuse in a dissertation/thesis' has been selected the following terms apply: Print rights of the final author's accepted manuscript (for clarity, NOT the published version) for up to 100 copies, electronic rights for use only on a personal website or institutional repository as defined by the Sherpa guideline (www.sherpa.ac.uk/romeo/).

Termination and Cancellation

Licences will expire after the period shown in Clause 3 (above).

Licensee reserves the right to terminate the Licence in the event that payment is not received in full or if there has been a breach of this agreement by you.

Appendix 1 — Acknowledgements:

**For Journal Content:**
**Reprinted by permission from [the Licensor]: [Journal Publisher (e.g. Nature/Springer/Palgrave)] [JOURNAL NAME] [REFERENCE CITATION (Article name, Author(s) Name), [COPYRIGHT] (year of publication)**

For Advance Online Publication papers:
Reprinted by permission from [the Licensor]: [Journal Publisher (e.g. Nature/Springer/Palgrave)] [JOURNAL NAME] [REFERENCE CITATION (Article name, Author(s) Name), [COPYRIGHT] (year of publication), advance online publication, day month year (doi: 10.1038/sj.[JOURNAL ACRONYM].)

For Adaptations/Translations:
Adapted/Translated by permission from [the Licensor]: [Journal Publisher (e.g. Nature/Springer/Palgrave)] [JOURNAL NAME] [REFERENCE CITATION (Article name, Author(s) Name), [COPYRIGHT] (year of publication)

Note: For any republication from the British Journal of Cancer, the following credit line style applies:

Reprinted/adapted/translated by permission from [the Licensor]: on behalf of Cancer Research UK: : [Journal Publisher (e.g. Nature/Springer/Palgrave)] [JOURNAL NAME] [REFERENCE CITATION (Article name, Author(s) Name), [COPYRIGHT] (year of publication)

For Advance Online Publication papers:
Reprinted by permission from The [the Licensor]: on behalf of Cancer Research UK: [Journal Publisher (e.g. Nature/Springer/Palgrave)] [JOURNAL NAME] [REFERENCE CITATION (Article name, Author(s) Name), [COPYRIGHT] (year of publication), advance online publication, day month year (doi: 10.1038/sj.[JOURNAL ACRONYM])

For Book content:
Reprinted/adapted by permission from [the Licensor]: [Book Publisher (e.g. Palgrave Macmillan, Springer etc) [Book Title] by [Book author(s)] [COPYRIGHT] (year of publication)

Other Conditions: Version 1.2

Questions? customercare@copyright.com or +1-855-239-3415 (toll free in the US) or +1-978-646-2777.

## Appendix J: List of Codes

| Code | Definition | Description | Example |
|---|---|---|---|
| **Coherence** | Reference (direct or indirect) to coherence between theory/ coursework and field experience | May also include non-coherence, as long as a connection is made, either explicitly or implicitly, between theory/coursework and field experience. | *"I was surprised at how while I was teaching I could immediately, naturally, and easily apply what we have been discussing in class. For example, I applied the suggestions of comparing the work of two different students side-by-side, of making it less of a show-and-tell by asking other students in the class to explain the work of the peers displayed on the screen, and of using math manipulatives when needed to help the students visualize the math concept." (33:8)* |
| **Discourse: Field** | Reference to MTP#4 (facilitating meaningful mathematical discourse) | A quotation must reference an actual concrete situation, child, or happening in an authentic classroom to be coded as "Field." | *"I was surprised by how the students didn't split up the rectangle into different parts. How they mostly did the eight times 25, and I don't think I was anticipating that as much, so I didn't know what to do with it, or how* |

| | | | |
|---|---|---|---|
| | in the context of an authentic classroom | Discourse, either teacher-student or student-student, must also be present in order to be coded as "Discourse." | *to get them beyond that, but I did enjoy just getting the students to explain other people's way of thinking, and kind of be open to directing a little differently. And I thought that they responded to that well, especially because they had many different answers." (35:2)* |
| **Questioning: Field** | Reference to MTP#5 (posing purposeful questions) in the context of an authentic classroom | A quotation must reference an actual concrete situation, child, or happening in an authentic classroom to be coded as "Field." Some type of questioning must be referenced, although this could be in various contexts, such as considering student responses to questions, or considering the | *"During our observation, I couldn't quite follow or evaluate each of the questions Ms. Ross asked to see where they were purposeful questions or not. Although she did not just ask for the answers or highlight only the students who were strong in math, I wondered if she could have probed student thinking more deeply by having them explain strategies different from their own." (24:9)* |

| | | | |
|---|---|---|---|
| | | questions themselves that are being asked by the teacher. | |
| **Discourse: Theoretical** | Reference to MTP#4 (facilitating meaningful mathemati-cal discourse) in a theoretical and/or hypothetical context, considering students abstractly | Quotations may include references to theory, textbook, coursework, or expectations or predictions about authentic classroom setting. Discourse must be referenced (although not necessarily using that term), either as teacher-student discourse or student-student discourse. Discourse may be taken as either spoken or written. | *"Currently, we're focusing on the Mathematics Teaching Practice of facilitating meaningful mathematical discourse . . . . What I envision of this practice is the teacher posing purposeful questions to her students individually, in pairs, small groups, or whole class discussions and then using their responses to delve into bigger mathematical concepts. I imagine that this will result in more student engagement as students give voice to the concepts they are trying to understand better."* (33:6) |
| **Questioning: Theoretical** | Reference to MTP#5 (posing | Quotations may include references to theory, textbook, coursework, | *"Trying to pose purposeful questions myself has certainly enriched my understanding of the practice. I* |

| | | | |
|---|---|---|---|
| | purposeful questions) in a theoretical and/or hypothetical context, considering students abstractly | or expectations or predictions about authentic classroom setting. Questioning must be referenced (although not necessarily using that term). | *realized that in order to pose purposeful questions, you also need to listen purposefully, attentively, and humbly so that you can grasp not only if the students are getting the right answer but also how they are coming to their answers and where they might be strong or weak in their reasoning." (27:7)* |
| **Reflect: MFE** | Reflection on the MFE as a whole | Any reflections on the MFE that were broader than just the prebrief, lesson, or debrief. This includes what was learned through the MFE, reflections on the purpose of MFEs, suggestions for MFEs, and any other reflections on the MFE as a whole. | *"I think you did [MFEs] so that we wouldn't be as afraid of teaching, and so that the gap between what we learn in class and what we're expected to do in the classroom is lessened. Because I think there's a lot of anxious buildup as you're in the teacher education program, because you're learning the content, and I went through a lot of content classes, and then eventually you take methods classes, and eventually you do practicum, and I* |

| | | | |
|---|---|---|---|
| | | | *think that this class is just a good in-betweener to boost your confidence, because you're wetting your feet and doing what you're going to be expected to do later, but with a lot of training wheels. Because you were there throughout it all, and we were working as a team, and I never felt like I was doing it by myself." (39:1)* |
| **Reflect: Prebrief** | Reflection on Prebrief | Any reflection that references, either explicitly or implicitly, the prebrief element of the MFE. | *"I liked the prebrief, because it makes you a little less nervous about coming in to the classroom. Because it's, like, right before we go, we get to talk about what we hope to do, and then, for me, just seeing how relaxed she is about us coming in to her classroom, gets me a little less nervous and puts the stakes lower. Like, she knows what we're going to do, and she's okay with it. And then even her talking about what she expects the students, like how she expects them to respond, is really* |

| | | | |
|---|---|---|---|
| | | | *helpful. Because before she says that, we've already written out what we expect from the students." (28:3)* |
| **Reflect: Lesson** | Reflection on Classroom Lesson | Any reflection that references, either explicitly or implicitly, the classroom lesson element of the MFE. | *"I loved the chance to teach a 12-minute number talk. I was surprised by how confident I was even in my nervousness. I think this confidence came from having observed Ms. Ross do a number talk with the students, prepping with our instructor and Lucy beforehand, reading the textbook, and studying on my own. It was also nice to have only half of the class in the corner of the room so that I could experience what it was like to introduce a problem and to listen to various strategies." (27:3)* |
| **Reflect: Debrief** | Reflection on Debrief | Any reflection that references, either explicitly or implicitly, the debrief element of the MFE. | *"It was helpful to take time and think about how we taught. And to see how I could have adjusted my teaching skills or how someone else could have adjusted their teaching skills. But also* |

| | | | |
|---|---|---|---|
| | | | *just take time and realize the reality of each student in the classroom and how we're responding to them."* (20:5) |
| **Reflect -- on oneself** | PST Reflection on Herself | Reflections by the PST on herself, her personal teaching style, her emotions, her strengths and weaknesses, and/or her personal reflections. | *"Although I was a bit nervous about teaching the lesson alone, I knew that I was ready and I felt supported by Ms. Ross, the instructor, and Lucy. At the same time, I was very glad to have the independence to teach the class on my own. Knowing that I was on my own pushed me to be a stronger leader and to be more proactive as I taught the class this time than I had done previously when Lucy and I were co-teaching. I experienced what it was like to take the responsibility of leading the class, assessing their comprehension, and then redirecting them if they needed clarification."* (33:10) |
| **Reflect -- on teacher** | PST Reflection | Reflections on the methods, practices, and | *"Although Ms. Ross' pedagogy and practices don't mirror the book* |

| | | | |
|---|---|---|---|
| | on the Classroom Teacher | person of the regular classroom teacher (does not include the PST acting as teacher). | *perfectly, she has shown me that teachers can change as they adopt certain things that align with their goals and preferences. She is a great example of being a reflective and intentional teacher who knows her students and is humble enough to own up to her strengths and weaknesses." (38:4)* |
| **Reflect -- on students** | PST Reflection on the Students | Reflections on students, either concretely in an authentic classroom setting or hypothetically in a more abstract sense. This may include reflections on just the students themselves, as well as reflections on the students in relation to the teacher. | *"In regards to observing the lesson, it was nice to see the variety of levels of thinking among the students, as some were at a much higher level than others." (4:4)* |

| | | | |
|---|---|---|---|
| **Reflect -- on other PST** | PST Reflection on the Other PST | Reflections on the other PST, either when teaching or when reflecting upon and discussing the classroom experience. | *"And then when we each took turns doing it separately, I thought that was really helpful, because I wasn't teaching for the whole class period, so I could take a breather and watch Lucy and learn from what she was doing and be encouraged by how she was succeeding, doing the things that we were learning." (39:5)* |
| **Reflect -- on math content** | PST Reflection on the Mathemati-cal Content | Reflections on mathematical content. This may include reflections on the math itself as well as reflections on math pedagogy, but must include reference (at least implicit) to content specific to mathematics. | *"Because my main goal of the lesson was for them to better conceptualize equivalent fractions, I knew I needed to intervene and facilitate their progress towards this goal. So, I took the instructor's suggestion and showed the paper-folding demonstration to one pair who then showed it to the rest of the class. While I am not completely confident that the way I did this was the most effective way, I tried to redirect the students' thought* |

| | | | |
|---|---|---|---|
| | | | *processes to the goal of the lesson."* *(33:7)* |
| **Reflect -- on class** | PST Reflection on the Math Methods Course | Reflections on the EDU coursework, theory, course discussions, course instructor, and/or textbook/readings. | *"I think it was more in class, with you, and reading the textbook, and then that gave me an idea of what I'm actually looking for, and then you can see if in the classroom. Like, oh, there's a method to teaching, it's not just asking random things. There's actual structure within what's happening in a lesson, where it's, sometimes you wonder, you're like, how do I do a lesson for math? How do I do a lesson for science? So, once I knew what I was looking for from our book and for our class sessions."* *(20:12)* |
| **Teacher-Child** | Lampert's arrow: General teacher | Reflects on or describes the interaction between the teacher (either the classroom teacher or the PST acting as | *"There is a necessity to cultivate an environment, from the beginning of the school year, in which the student in the class learn to articulate what they are* |

| | | | |
|---|---|---|---|
| | interaction with student | teacher) and the student. The interaction must either be non-math specific or easily generalizable to general content areas. | *thinking and how they arrived at their answer." (19:4)* |
| **Teacher-Math** | Lampert's arrow: Teacher interaction with mathematics | Reflects on or describes the interaction between the teacher (either the classroom teacher or the PST acting as teacher) and the actual mathematical content. | *"I gained insight as to why the number talk was more difficult than anticipated and different ways that it may be improved." (36:4)* |
| **Teacher-Child/Math** | Lampert's arrow: Teacher interaction with student regarding math content | Reflects on or describes the interaction between the teacher (either the classroom teacher or the PST acting as teacher) and the student that specifically involves mathematical content. The | *"I wanted to show Grace and Mike's first, because they had the misconception that some of the other students had, with the school, and then running in a circle. But then they had, after their equation, one of the rectangle bar graphs, a horizontal bar graph, and I thought that that was great, that they could sympathize with* |

| | | | |
|---|---|---|---|
| | | mathematical content must involve more than the word "math" being used; it must involve specific math content and/or math pedagogy (may include use of MTPs). | *the kids who did the circle thing, but also like, I understand what that means, by showing them a graph. That's why I thought they were great to go first." (47:8)* |
| **Child-Math** | Lampert's arrow: Child interacting directly with math content | Reflects on or describes the students' direct interaction with the mathematical content. | *"And a lot of them were talking very algorithmically in terms of the equation, whereas some of them were actually being able to get the concept straight of grouping the twelves into three parts." (32:2)* |

## Appendix K: IRB Approval Letter

**IRB**
**INSTITUTIONAL REVIEW BOARD**
Office of Research Compliance,
010A Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129

MIDDLE TENNESSEE STATE UNIVERSITY

### IRBN001 - EXPEDITED PROTOCOL APPROVAL NOTICE

Tuesday, December 17, 2019

| | |
|---|---|
| Principal Investigator | **Sarah Wanner (Sister Cecilia Anne)** (Student) |
| Faculty Advisor | Alyson Lischka |
| Co-Investigators | NONE |
| Investigator Email(s) | *sjw3u@mtmail.mtsu.edu; alyson.lishka@mtsu.edu* |
| Department | Mathematical Sciences |
| Protocol Title | ***Narrowing the gap: The mediated field experience*** |
| Protocol ID | **20-2083** |

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU Institutional Review Board (IRB) through the **EXPEDITED** mechanism under 45 CFR 46.110 and 21 CFR 56.110 within the PRIMARY category *(7) Research on individual or group characteristics or behavior* and a SECONDARY category *(6) Collection of data from media*. A summary of the IRB action and other particulars in regard to this protocol application is tabulated below:

| | | | |
|---|---|---|---|
| IRB Action | APPROVED for ONE YEAR | | |
| Date of Expiration | 12/31/2020 | Date of Approval | 12/17/19 |
| Sample Size | 25 (TWENTY FIVE) | | |
| Participant Pool | Target Population 1:<br>Primary Classification: **General Adults (18 or older)**<br>Specific Classification: **Preservice teachers enrolled in EDU 336: Methods of Math and Science Instruction (Aquinas College)**<br>Target Population 2:<br>Primary Classification: NONE<br>Specific Classification: NONE | | |
| Exceptions | 1. Contact information allowed for coordinating research interactions.<br>2. Audio recording of participant responses is allowed. | | |
| Restrictions | **1. Mandatory ACTIVE adult informed consent.**<br>**2. Approved for direct interaction only; NOT approved for online data collection.**<br>**3. Identifiable data, such as, audio/video data, photographs, handwriting samples, financial information, personal address, driving records, social security number, and etc., must be destroyed after data processing**<br>**4. Mandatory final report (refer last page).** | | |
| Approved Templates | MTSU templates: Adult informed consent scripts and<br>Non-MTSU format recruitment email script | | |
| Comments | NONE | | |

## Post-approval Actions

The investigator(s) indicated in this notification should read and abide by all of the post-approval conditions (https://www.mtsu.edu/irb/FAQ/PostApprovalResponsibilities.php) imposed with this approval. Any unanticipated harms to participants, adverse events or compliance breach must be reported to the Office of Compliance by calling 615-494-8918 within 48 hours of the incident. All amendments to this protocol, including adding/removing researchers, must be approved by the IRB before they can be implemented.

Continuing Review **(The PI has requested early termination)**

Although this protocol can be continued for up to THREE years, The PI has opted to end the study by 12/31/2020 **The PI must close-out this protocol by submitting a final report before** 12/31/2020 **Failure to close-out may result in penalties including cancellation of the data collected using this protocol.**

Post-approval Protocol Amendments:

***Only two procedural amendment requests will be entertained per year.*** *In addition, the researchers can request amendments during continuing review. This amendment restriction does not apply to minor changes such as language usage and addition/removal of research personnel. .*

| Date | Amendment(s) | IRB Comments |
|---|---|---|
| NONE | NONE. | NONE |

Other Post-approval Actions:

| Date | IRB Action(s) | IRB Comments |
|---|---|---|
| NONE | NONE. | NONE |

**Mandatory Data Storage Requirement**: All research-related records (signed consent forms, investigator training and etc.) must be retained by the PI or the faculty advisor (if the PI is a student) at the secure location mentioned in the protocol application. The data must be stored for at least three (3) years after the study is closed. Subsequently, the data may be destroyed in a manner that maintains confidentiality and anonymity of the research subjects.

**The MTSU IRB reserves the right to modify/update the approval criteria or change/cancel the terms listed in this letter without prior notice.** Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University

Quick Links:

- Post-approval Responsibilities: http://www.mtsu.edu/irb/FAQ/PostApprovalResponsibilities.php
- Expedited Procedures: https://mtsu.edu/irb/ExpeditedProcedures.php