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PERCEPTIONS AND IMPLEMENTATIONS OF STANDARDS FOR MATHEMATICS TEACHER PREPARATION PROGRAMS

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Abstract

The development and use of standards have become a key aspect of education. Significant research has been conducted to understand the perceptions and implementations of standards in PK-12 school settings. There exists significantly less research focused on the understanding of standards for teacher preparation, especially within the field of mathematics teacher preparation.

In the field of mathematics teacher preparation, multiple standards documents are available to inform practice. Among these include the standards used for accreditation purposes produced by the National Council of Teachers of Mathematics (NCTM) in partnership with the Council for the Accreditation of Educator Preparation (CAEP), the *Standards for Preparing Teachers of Mathematics* produced by the Association of Mathematics Teacher Educators (AMTE), and the *Mathematical Education of Teachers* (MET) documents produced by the Conference Board of the Mathematical Sciences (CBMS). While these represent the most well-known standards for mathematics teacher educators, other standards such as standards for PK-12 teachers including the Common Core State Standards are also related to the work of mathematics teacher preparation. In this complicated space of multiple standards from multiple perspectives, it is necessary to better understand the influence of these standards with mathematics teacher educators by better understanding how they are perceived and implemented.

In this case study, eight mathematics teacher educators shared how they perceived and implemented standards within their programs. The findings of this research included navigating standards, standards as tools of accountability and compliance, the intersection of standards and curriculum, collaborating for enacting the standards, and care for students and their experiences.

In these findings, participants shared how standards related to ideas of best practice. These ideas about standards being drawn from ideas of best practice are related to issues of compliance in accreditation as well as an indirect correlation with curriculum choices in program development and maintenance. In practice, this work was not done in isolation, but required interdepartmental collaboration as well as consideration for the needs of individual students.

Keywords: Teacher Education, Standards, Mathematics, Accreditation

Chapter 1: Introduction

Mathematics education has seemingly undergone several different variations of reform over the past century (Brumaugh & Rock, 2006; Schoenfeld, 2016). The current era of reform is centered on standards. Lappan (1998), in describing what a standard is, stated that the National Council of Teachers of Mathematics (NCTM) "views standards as statements of criteria for excellence in school mathematics programs" (p. 1). Standards have also been described as "statements about what is most valued" (Sriraman & Pizzulli, 2005, p. 431). Since the reform efforts for how mathematics is taught have changed rapidly, it has been difficult for research to determine the effectiveness of the methods. Standards-based education has been the primary reform approach for the past several decades. It is necessary then to determine how these "criteria for excellence" have impacted education.

This study focused on how mathematics teacher educators understand and operate within two reform movements: standards-based reform and accountability reform. A brief history of the reform movements for PK-12 and higher education will be provided. Following this, both reform movements will be related to the space in which mathematics teacher educators work and develop programs.

Research Problem

Accountability in PK-12 Education

Since the passage of No Child Left Behind (NCLB), education efforts have largely been motivated by ideas and notions of accountability (Brumaugh & Rock, 2006; Green, 2013; Noddings, 2007). There has been significant emphasis on holding teachers accountable for specific learning outcomes for students which has resulted in an increase in monitoring to ensure

that teachers are teaching what they "should" be teaching. These policies are seemingly established on the presupposition that teachers are not teaching appropriate or rigorous curriculum necessitating systematic methods to identify and rectify such cases. While it seems reasonable this occurs in some cases, there has been substantial deliberation as to the effectiveness of an accountability emphasis in identifying and rectifying these occurrences. Copious research has been generated both in defense and in criticism of these accountability reform practices, particularly within PK-12 education (Green, 2013; Lovett & Lee, 2017; Manouchehri, 1997; Noddings, 2007).

A fundamental concern that has been broached is that the prominence of accountability practices repositions teachers from a space of professionalism and responsibility to a space of managerialism and compliance (Green, 2013). This is most visible in how assessments have transformed in PK-12 education. Less relevance has been rendered to assessments constructed by teachers as well as formative assessments which compels standardized and summative assessments to become the bastions of learning evaluation. This shift has possibly brought about a phenomena which is commonly referred to as "teaching to the test."

Likewise, accountability-reform practices have intensified in higher education. This is most palpable in the accreditation process, where universities are compelled to demonstrate suitable teacher preparation systems to have certified programs. Akin to the PK-12 accountability campaigns, standardized and summative assessments are mainstays in this process, usually administered to pre-service teachers during or upon completion of their teacher preparation program.

Accountability in Higher Education: Accreditation

PK-12 teachers are undoubtedly affected by accountability practices such as being compelled to meet the specific requirements laid out by teaching standards and being monitored extensively through standardized assessment systems, yet others such as teacher educators are affected. Not only are PK-12 teachers required to demonstrate that they have adequately prepared students, but teacher educators must also demonstrate that they have adequately prepared teachers for the profession (NCTM, 2012).

The concept that teacher educators ought to demonstrate that their curriculum and instruction prepares teachers for the field is not original to this modern movement. The conversations about what is crucial for effective teacher preparation in the United States date back to at least 1892, when the Committee of Ten outlined essential secondary school curriculum as well as desirable aspects of teacher preparation (Goertz, 2010; Noddings, 2007). Subsequently, the *Cardinal Principles of Secondary Education* also presented an alternative viewpoint of education in 1918, with a focus on the student rather than content subjects (Goertz, 2010). While these organizations and manuscripts provided the initial exemplars for effective preparation of teachers, programs nevertheless varied considerably across states in the early twentieth century (Burgess, 1921).

The influence from these committees as well as subsequent research would instigate numerous endeavors to establish a system of national accreditation. Following a myriad of organization formations and mergers, these accreditation systems culminated into the formation of the National Council for Accreditation of Teacher Education (NCATE) in 1952. NCATE would serve as one of the foremost sources for accreditation of education programs in the United

States for over five decades. Other notable organizations such as the Teacher Education Accreditation Council (TEAC), founded in 1997, would compete with NCATE as an alternative accrediting source.

By the early 2000's NCATE and TEAC were the only nationally recognized accreditation programs in the United States. In 2009, they began the merging process had successfully merged to form the Council for the Accreditation of Educator Preparation (CAEP) in 2013 (CAEP, 2018). At that point, CAEP became the only accrediting body for teacher education programs in the United States until 2017 when the Association for Advancing Quality in Educator Preparation (AAQEP) was founded. While the AAQEP appears to be expanding in recognition, CAEP maintains a clearly dominate presence in the accreditation domain. This undoubtedly underscores the standards adopted by CAEP as a determining factor for what standards mathematics teacher educators will adopt. Analogous to the consequences from PK-12 education, these standards and their enforcement have a variety of effects, both intended and not.

One suggested concern about a singular accrediting body is that there exists the possibility of excessive uniformity among teacher education programs (Bowers, 1957). Since most programs seek national accreditation through the same accrediting body, they are striving to realize identical goals in content and performance standards, creating a homogenizing effect (Skolnik, 2016), although some differences across state and regional boundaries do exist. A positive aspect of this congruence is that it permits teachers trained in disparate locations to share a common background, providing more continuity for students, which was one of the original reasons for creating a national teacher accreditation body (Armstrong, 1960).

Consequences are not only related to the curriculum for the preparation of prospective teachers but are also dependent regional and institutional needs and requirements such as cost and time (Groves, 2019). In higher education, institutions are obliged to develop programs that appeal to their potential student base. A typical approach for appealing to potential students is to reduce the number of hours required for a degree plan and thereby reducing the potential financial burden to the student. While all the content standards provided by CAEP represent vital knowledge, it is often not feasible for an institution to focus on each of the required aspects of the curriculum in the depth that would be expected. For example, if a program increases its emphasis on content development of university mathematics for mathematics education students, there is correspondingly less time spent exploring the depth of school level mathematics, possibly resulting in teachers teaching content they had not seen in at least four years.

Education majors may have either more program requirements than other majors or have less options for their program requirements due to the need for all students to meet the enumerating standards. In some cases, the education requirements are partitioned into separate degrees so that students earn a bachelor's degree in mathematics followed by a master's degree in education. It has been suggested that this could escalate the quantity of alternatively or emergency certified teachers, since alternative pathways such as these could be completed either faster and cheaper outside of an accredited education program (Ludlow, 2011).

Another possible outcome of accountability emphasis in higher education is a refocusing from professionalism to managerialism. There becomes a shift in focus from the teacher educator being responsible for prospective teacher knowledge to becoming a "tic box" educator, simply verifying all the appropriate boxes for accreditation are checked (Green, 2013). While the latter

is held accountable for what is taught, they bear no responsibility for the end outcome since they were only doing what was required of them.

For example, one CAEP standard requires that the graduates of a program must be documented as impacting student achievement. While a noteworthy goal for any program, this is an extraordinarily difficult item to document since it would require access to information about students of graduates from the education program (Groves, 2019). Cases such as these raise the question as to whether accreditation is attaining the purposes it was designed for or if it is just giving teacher educators one more box to check.

There exists the possibility for both positive and negative effects from the accreditation process, there also seems to still be significant support for such a process to exist. While the word accreditation may seem synonymous to labor intensive documentation, it could also serve as a method to prevent institutions from creating recognized programs that do not meet the minimum guidelines. The mathematics education community has seen a time when there was no accreditation process and there does not seem to be a desire in the community to return to that era. However, there is significant concern on how to best mitigate the consequences of having such a necessary system.

History of Standards in School Mathematics

There has been a struggle within the mathematics education community for the better part of a century as to the best approaches to the teaching of mathematics. Frequently, there are two factions involved within the debate: traditionalists and reformers. The traditionalist approach is usually focused on processes and often involves an emphasis on the memorization of facts. The reformed approach is usually focused on concepts and often involves emphasis on reasoning and

problem solving. While this is an over simplification and both sides include at least some instruction involving processes, concepts, memorization, reasoning, and problem solving; these approaches tend to mark the extreme aspects of the spectrum.

Historically, these two different approaches have alternated in leading American curriculum changes over spans of approximately a decade. For example, "new math," which more closely aligned with reformed approaches, was introduced in the 1960's. Eventually, new math gave way to a more traditionalist approach labeled "back-to-basics" in the 1970's (Schoenfeld, 2004). *A Nation at Risk* in 1983, highlighting the issues that had arisen as a result of the previous curriculum changes (United States Deparment of Education, 1983). This document would lead to numerous changes in the field, especially prompting NCTM to publish a series of documents including *An Agenda for Action*, *Standards*, *Everybody Counts* and the *Addenda Series* (Brumaugh & Rock, 2006; Burrill, 1997; National Research Council, 1989; Schoenfeld, 2004) as well as the establishment of the National Board for Professional Teaching Standards (NBPTS, 2010).

The NCTM standards documents would be vigorously debated over the following years in what would be coined as the "math wars" culminating to a compromise between the traditional emphasis on process and the reformed emphasis on concepts. This compromise was exemplified by the publishing of another set of standards by NCTM titled *Principles and Standards for School Mathematics* (NCTM, 2000). This work would become pivotal in establishing school mathematics curriculum and would eventually set the precedent for the concept of a national curriculum. Using NCTM's work as its basis, the Common Core State

Standards serve as a nationally recognized curriculum, being adopted in most of the United States (Common Core, 2009).

Standards for Mathematics Teacher Education

Standards have unquestionably become an instrumental aspect of school mathematics and is viewed as an initial approach for reform in that field. While standards have become a vital element of school mathematics, they have likewise been pivotal in mathematics teacher preparation. Standards have been created and implemented through various organizations detailing what is considered the best practices for the training of teachers. Frequently these were published by national accrediting bodies such as NCATE or TEAC or by state-level administrations. These standards are inextricably tied to the accrediting process.

Currently, NCTM has partnered with CAEP to produce the specialized professional accreditation (SPA) standards that are used to determine CAEP accreditation eligibility. For mathematics education programs in institutions of higher education to attain national level accreditation, they must satisfy the NCTM SPA standards as well as the more general CAEP professional standards. Currently, the NCTM SPA standards and CAEP professional standards are the only nationally recognized standards used specifically for secondary mathematics accreditation purposes.

Other organizations have also published sets of standards and recommendations that are not used for accreditation purposes. Among these are the standards created under the leadership of the Association of Mathematics Teacher Educators (AMTE) titled *Standards for Preparing Teachers of Mathematics*. Also, the documents titled *The Mathematical Education of Teachers I* and *II* (MET I and II) were produced by Conference Board of the Mathematical Sciences

(CBMS) as guidelines for mathematics education programs. It should be noted that several organizations were involved in the making of each of these standards including NCTM, the American Mathematical Society (AMS), and the Mathematical Association of America (MAA).

To clarify what set of standards are being referred to since each organization had a role in each document, the primary mathematical organization listed will be given as the title for the standards or the name of the document in which they are recorded. In other words, the content standards for accreditation will simply be referred to as the NCTM SPA standards and CAEP standards will refer to the general professional standards for national accreditation. The recommendations created by CBMS will be referred to as MET I and MET II. The *Standards for Preparing Teachers of Mathematics* will be referred to as the AMTE standards.

While it is noted that there are three prominent sets of national standards for the mathematics content for teacher education programs, there are other standards documents that mathematics teacher educators are likely to be familiar with and use. Among these include local institution, state, and regional standards. While it might be assumed that national standards and recommendations would take precedence over local or state standards, it is relevant that NCTM's policy is to support local or regional leadership, as a former NCTM President states that their standards work "gives a national vision and direction to help focus local efforts, not to preempt them" (Lappan, 1998, p. 1). Despite this mindset regarding national standards and that states and local agencies are not required to adopt any specific standards, it should be expected that NCTM's standards are likely quite influential.

It is also noteworthy that the PK-12 standards and history mentioned previously can be significant for teacher education programs. States typically determine standards for PK-12 education, so different approaches can be taken depending on the state involved. The Common

Core State Standards are the most common, having been adopted in 41 states (Common Core, 2018). It is also important to recognize that many of the state standards that are not officially Common Core State Standards are often very closely related to them.

Each of these documents provides different perspectives as to the approaches that could be taken. Irrefutably, there is a copious collection of knowledge and resources for mathematics teacher educators to employ. Mathematics teacher educators have much to consider as they plan and create learning spaces for future teachers.

Significance of the Study

As stated previously, there has been significant research as to how accountability reform has impacted PK-12 education, especially since the passage of NCLB. However, there has been less research focused on how accountability practices have impacted teacher educators. Among the research that was found, much was not conducted in the United States. (Solbrekke & Sugrue, 2014; Bourke, Ryan & Ould, 2018). Accreditation practices have been significantly impacted by the relatively recently merger of TEAC and NCATE in 2013 into CAEP (CAEP, 2018) and there has been little time for research to determine the impact of this on the education community.

While there is less research on teacher education programs and their interactions with accreditation and standards, there is even less focus specifically on mathematics teacher preparation programs. Mathematics teacher preparation standards have undergone various stages of changes. NCTM SPA standards have received periodic updates and the MET II document is an updated version of the MET I document. Additionally, the AMTE standards are very recently released. While some research was found based on some of these documents (Graham & Fennell, 2001; Newton, et al, 2014), there were none found that specifically researched how mathematics

teacher educators understand and implement the combination of these documents within their programs.

While it may be beneficial to have several standards documents to support planning and instruction, it could also be confusing. How do mathematics teacher educators manage this space, do they narrow to one set of standards or consider all of them? Are these standards working together in a well-coordinated harmony or are they a cacophony of disconnected noises? How do mathematics teacher educators bring the standards into their programs of instruction, if at all? These and other questions are the ideas that this research is designed to understand.

Research Questions

It is the purpose of this research, then, to seek out how these various standards are being implemented or not implemented within successful mathematics education programs. To determine this, the following research questions were used as guidelines for inquiry:

1. What are mathematics teacher educators' perceptions and understandings of the mathematics teacher preparation standards?
2. How do standards for mathematics teacher preparation inform the development and maintenance of mathematics teacher preparation programs?

KEY TERMS:

Accountability: Reform movement designed to hold teachers and educators responsible for teaching certain content, usually monitored through standardized assessment

AMTE standards: Standards published by AMTE in 2017 titled *Standards for Preparing Teachers of Mathematics*

In-service teachers: Teachers who are currently in the teaching profession

Mathematics teacher educators: University faculty who teach courses within the Mathematics education coursework. This can include courses such as content courses specific to education majors or methods of teaching mathematics courses

MET I and II: Recommendations for mathematics teacher education programs published by CBMS

NCTM SPA standards: Content standards for mathematics teacher education programs published in partnership with the CAEP accrediting body

Pre-service teachers: Teachers who are university students who are training to enter the teaching profession

Standards: statements of criteria for excellence in school mathematics programs

Chapter 2: Literature

In order to understand how mathematics teacher educators perceive and use standards designed to inform their practice and their programs, it is necessary to be aware of the current state of both the accreditation process and the school mathematics standards movement. For this purpose, a discussion of the history of the field of mathematics education and how that has led to the standards-based reform will be provided as well as a review of standards for school mathematics that are currently prominent. Subsequently, the discussion will shift to a focus on higher education institutions and, more specifically, the standards for mathematics teacher educators. Since a large section of these standards are focused on teacher knowledge, a review of literature on mathematics knowledge for teaching is also provided. This will culminate in a natural progression to accreditation and literature relating it to the practice of teacher educators.

History of Standards-based Reform

In the early 1920's, the field of education was still feeling the effects of World War I. The draft had removed numerous teachers from their positions as well as those who were being prepared to be teachers. Much of what had been taught previously was dependent on what was needed in the war effort, as one researcher reported, the education department had become the war department (English, 1920).

By the time the end of the 1920's and early 1930's, the country had recovered from World War I and the field of education had growing interest. In fact, a surplus of teachers including mathematics teachers were available to teach in the classroom (L.W.W., 1930; Reeve, 1934). However, there were still very few specifics as to what was necessary to qualify as a teacher. For example, very little if any training was required to teach mathematics as it was

suggested that the only requirement was "a vacant period at the time the algebra class is scheduled" (Reeve, 1934, p. 151). Likewise, while concerns were raised about subject matter expertise, there were also concerns that teachers had received little to no training on what it means to be a professional educator (L.W.W., 1930).

The late 1930's to the mid 1940's were greatly influenced by World War II. During this time, the army had found the mathematics training of its personnel insufficient for even managing supplies among other issues and began its own training for officers (Kline, 1973; Mallory & Fehr, 1942). Prior to the war, it was not uncommon for students to "graduate from high school without having studied one single hour of any mathematics" (Mallory & Fehr, 1942, p. 291). Also, Mallory and Fehr argued (1942) the emphasis was placed heavily in pure mathematics prior to the war and that courses were being unsuccessfully redesigned for the war effort. They argued for "straight mathematics" that could be applied to multiple situations beyond wartime conditions.

While these issues brought mathematics education to the forefront of discussion, significant changes to the curriculum would not happen at that time (Schoenfeld, 2004). However, the concern over the weakened state of mathematics education in the United States had become public knowledge and seeded the thoughts of how it might be done better. Should school mathematics be taught as pure or applied mathematics? Should emphasis be put on reasoning or quick, mental calculations? As mathematics would become a more integral part of the curriculum again, how it was to be taught would become a much more prominent question.

While World War II served to spark interest in the state of mathematics education, the Cold War would have significant impact on how the curriculum would be enacted. In 1957,

Sputnik was launched, which also launched a new direction for the field of mathematics education in the United States, which is commonly referred to as new math or in some cases discovery math (Brumaugh & Rock, 2006; Noddings, 2007; Schoenfeld, 2004). While new math was met with mixed reactions (Brumaugh & Rock, 2006), some found the increased depth of the curriculum refreshing and inventive (Noddings, 2007), while others were hesitant of the radical change to the curriculum and the direction of that change (Kline, 1973; Moore, 1973).

The most noteworthy critic of new math was Morris Kline who published *Why Johnny Can't Add* in 1973. In his criticism of new math, he argued that the traditional curriculum had severe deficiencies in that it did not appeal to students since it focused on material mostly seen as irrelevant for most students (Kline, 1973). Morris called for an emphasis on application of mathematics in real scenarios instead of artificial situations usually given in textbooks, a persistent issue even today. One of his issues with new math was an emphasis on abstraction over application, which the former was well understood by academic mathematicians and the latter was not (Moore, 1973). Moore even goes so far as to say, "conventionally trained academicians find themselves lost in the interdisciplinary void with few stars to guide them" (p. 168).

New math was also plagued with concerns about how it was implemented that has served as an example for modern reform movements. One such problem that occurred with the implementation of new math, was an insufficient amount of research to determine the effects of the differences in curriculum and instruction at that time (Kline, 1973; Romberg, 1969; Schoenfeld, 2004). This sparked organizations to push more academic research within the field through a variety of means such as beginning the Educational Studies in Mathematics (ESM)

journal in 1968 and Journal for Research in Mathematics Education (JRME) in 1970 (Foster & Inglis, 2018; Romberg,1969; Willoughby, 2010).

Another problem related to the implementation of new math was the preparation of teachers. Many current teachers of the time had not been trained in the mathematics that was to be used in the classroom. This resulted in a loss of many teachable moments caused by teacher confusion about what they were teaching. For example, Kline described a poorly taught mathematics lesson in an elementary classroom where the teacher argued that seven was not a number. Even those who found success with the new math curriculum related that their success largely had to do with the fact that they had more mathematical training in modern mathematics methods than other teachers (Noddings, 1992).

The groundswell against new math was significant, both broadly by the public and politically (Noddings, 2007; Schoenfeld, 2004). There was a considerable push for curriculum and instruction that was focused more on theories of behaviorism, such as programmed instruction (Eigen, 1963) with bold predictions stating, "Within ten years every industrial country on this earth…will be utilizing programed instruction to some extent to further the mathematical education" (p. 253). Ironically, while Kline's writing is often cited as a cause for the end of new math and a beginning of the "back to basics" movement (Romberg, 2010; Schoenfeld, 2004), his criticisms of the traditional method of mathematics teaching were largely ignored as the emphasis would once again shift back to the computational methods he deplored as useless.

Opponents to new math were greatly concerned with the advanced levels of mathematics taught in the curriculum and in turn pushed for a focus on arithmetic. As one author described it,

"They mean that school mathematics should concern itself primarily with teaching Johnny to add, subtract, multiply, and divide, and even more particularly with teaching him to do so in the good old American way, the way his granddaddy did it" (Offner, 1978, p. 110). Offner continued to describe that while basic computation is important, the same computation used prior to the new math experiment would not be useful to the students of that day. The back to basics movement was seen as a simple and extreme reaction to the new math curriculum that was popularized in the general public (Hill, Rouse, & Wesson, 1979).

By the end of the 1970's it had become apparent that the quality of mathematics education in the United States was still lacking (Hill, Rouse, & Wesson, 1979; Offner, 1978; Rouse, 1977; Schoenfeld , 2004). This was made explicit publicly with the publication of *A Nation at Risk* in 1983. Within this report, it was highlighted that there were areas of teacher shortage, especially in mathematics and that many mathematics teachers at that time were not properly prepared. The effects from this were argued as being lower SAT scores in mathematics and increased enrollment in remedial mathematics courses (United States Deparment of Education, 1983).

While the report ignored other factors such as a larger population attending college and taking SAT examinations in its analysis, it served a positive purpose. First, it brought awareness of issues that had traditionally and continually plagued the field of mathematics education. It also called for reform as well as establishing mathematics as a key element of school curriculum that needed proper emphasis (Allen-Fuller, Robinson, & Robinson, 2010). Further, this report spurred the mathematics education community to push for new approaches in the field. One response was the formation of a task force by the Carnegie Forum on Education and the Economy which

led to the publication of *A Nation Prepared: Teachers for the 21st Century*. This document called for stronger teaching standards and led to the formation of the National Board for Professional Teaching Standards (NBPTS) in 1987 (NBPTS, 2019).

In response to *A Nation at Risk*, the National Council of Teachers of Mathematics (NCTM) published *An Agenda for Action*. The purpose of this document was to bring about a change in how the mathematics curriculum was taught, changing the focus from only basic mathematics content to include mathematical processes such as problem solving (NCTM Research Advisory Committee, 1984). Eventually this led to the publication of NCTM's *Standards* as well as supporting documents such as *Everybody Counts* and the *Addenda Series*, which suggested standards for mathematical content as well as mathematical processes (Brumaugh & Rock, 2006; Burrill, 1997; National Research Council, 1989; Schoenfeld , 2004).

While this fell short of a national curriculum like other previously failed initiatives, it formed a pivotal point in mathematics education history. This effectively sparked a national debate as to what is the best approach to teaching mathematics. Was the focus of school mathematics to be on traditional methods and basic computations or ideas of problem solving and reasoning? The battle lines were drawn, the math wars had begun (Lambdin & Preston, 1995; Schoenfeld, 2004).

Whatever the perspective one takes within the persistent debate in mathematics education, the consensus seems to be that the "math wars" began in California (Klein, 2007; Schoenfeld, 2004; Vogel, 1997). The state had recently adopted state standards heavily influenced by NCTM's recently proposed standards. Backlash from the community led to the removal of these standards and a refocusing in the state on more procedural knowledge and

traditional methods based on the theories of Hirsch (Klein, 2007; Schoenfeld, 2004). During this time, the research community was less than congenial about differences of opinion about what should or should not be included within a mathematics curriculum (Klein, 2007; Schoenfeld, 2004). For example, a list of derisive terms used to describe standards-based reforms to mathematics included new-new math, fuzzy math, Mickey Mouse math, placebo math, MTV math, and new-new mush-mush math, among others (Mathematically Correct, 1996).

As the decade of the 1990's ended, standards had become common among the states. While each state had adopted standards and the NCTM standards had become well recognized, the issue remained that much of what was actually being taught was not significantly based on standards for a variety of reasons including issues with teacher preparation (Burrill, 1997). However, by this point, it was well recognized that some balance was needed between "basics" and "problem solving" since "A focus on 'process' without attention to skills deprives students of the tools they need for fluid, competent performance" (Schoenfeld, 2004, pp. 280-281).

Similarly the back to basics mentality was an extreme that could not be returned to, as Burrill states, "The *Teaching Standards* consider many facets of teaching, and in particular, suggest that teachers think carefully about the way they design and implement their lessons, paying attention to the ways in which students think about mathematics and engaging students in discussions about their thinking and their strategies to promote understanding" (pp. 335). Although critics of the NCTM standards movement would argue that the standards were more political in nature than mathematical (Klein, 2007).

Within this setting, it was decided that the standards needed to be updated to reflect such a balance and bring some balance to the heated arguments of the math wars. In 2000, NCTM

published *Principles and Standards for School Mathematics* (NCTM, 2000). These standards drew on the discussions of the previous decade and updated the language of the standards to show the advances made in the reformed curriculum from that work (Brumaugh & Rock, 2006; Schoenfeld, 2004).

While these mathematics standards were recommended by NCTM, states determined which standards were implemented within schools. While some states adopted NCTM standards more readily, others were not as quick to accept a national standardization. In 2009, a group of state superintendents and governors began working to develop a national curriculum that could be used across state lines, which eventually became what is known today as the Common Core State Standards (Common Core, 2018). As in the past, the Common Core State Standards were not universally accepted as a useful initiative. Critics often cited that they were confusing and that adults could not understand them. Ironically, this was an issue during the development of the NCTM *Standards* as well, in which the myth of "What was good enough for me is good enough for my child" was countered by saying "Today's world is more mathematical than yesterday's and tomorrow's world will be more mathematical than today's." (National Research Council, 1989, p. 45)

The continued expansion and use of standards have prompted significant research as to the effectiveness of the standards. One noteworthy approach to determining the influence of these standards was distributed by the National Research Council (2002). This document was described as a framework "designed to guide inquiry into the influence of standards on various parts and levels of the education system" (p. 36). In this framework, there were three aspects of education that were "channels of influence" for standards: teacher development, curriculum, and

assessment & accountability (p. 6-8). Four key questions were also provided as a method for determining a standards document's effectiveness:

1. How are national developed standards being received and interpreted?
2. What actions have been taken?
3. What has changed as a result?
4. Who has been affected and how? (p. 5-6)

A conceptual diagram was provided to illustration these relationships (see Figure 1).

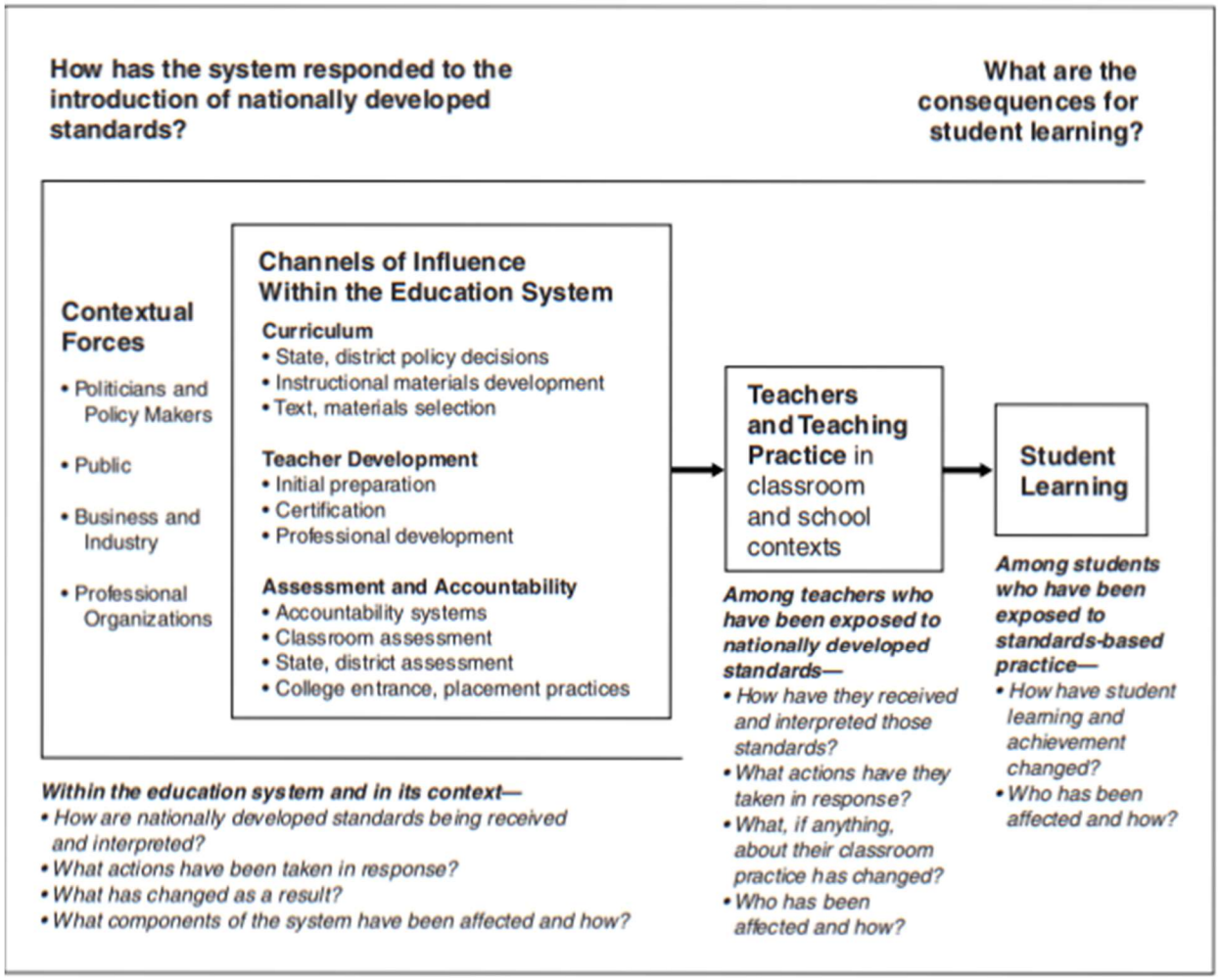

Figure 1. Framework of standards influence illustration (National Research Council, 2002).

Mathematics Teacher Standards

Since teacher standards are determined at the state level, looking at each state's individual teacher standards is outside the scope of this manuscript. However, there are sets of standards that have certainly been impactful on the mathematics education community. Among these are the progression of NCTM standards mentioned earlier as well as the Common Core State Standards. While these have not been officially adopted universally across the United States, both have had significant impact either by officially being adopted or by serving as an example to state level decision making (see Figure 2). Both these sets of mathematics standards are a vital part of a mathematics teacher educator's work and need to be considered when exploring how they use and perceive mathematics teacher preparation standards.

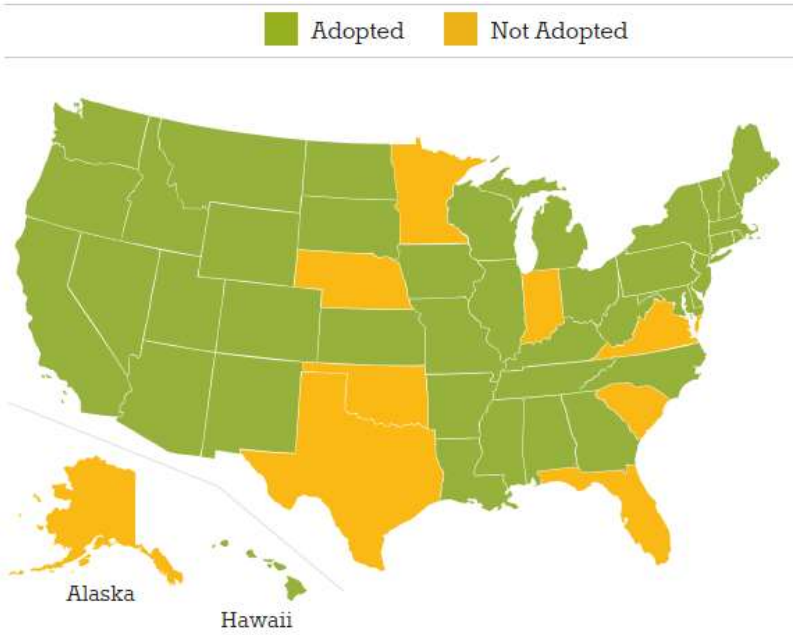

Figure 2. Common Core State Standards adoptions. Darker shading indicates states that have adopted Common Core standards (Common Core, 2019).

As discussed earlier, the NCTM standards as they are known today have a long history within the field of mathematics education. Currently the standards are guided by six principles:

equity, curriculum, teaching, learning, assessment, and technology. There are five content standards: number & operations, algebra, geometry, measurement, and data analysis & probability. There are five process standards as well: problem solving, reasoning & proof, communication, connections, and representation (NCTM, 2000). Each of these standards detail what students need to be able to do by different grade bands.

The Common Core State Standards for Mathematics were created with the goal of having focused and coherent standards. They are divided into two main sections: standards for mathematical practice (SMP) and standards for mathematical content (SMC). The SMP section is heavily dependent on the work of NCTM and the National Research Council as they are described as follows:

> The first of these are the NCTM process standards of problem solving, reasoning and proof, communication, representation, and connections. The second are the strands of mathematical proficiency specified in the National Research Council's report *Adding It Up*: adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematical concepts, operations and relations), procedural fluency (skill in carrying out procedures flexibly, accurately, efficiently and appropriately), and productive disposition (habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy) (Common Core, 2009, p. 6).

The SMC section is separated into grade bands describing the mathematics content students should learn in each. It is emphasized that "these standards do not dictate curriculum or teaching methods" and that "these standards are not intended to be new names for old ways." (Common Core, 2009, p. 5).

Clearly, the NCTM standards had a significant influence on the Common Core State Standards since the first five standards are the NCTM process standards, however, there are certainly organizationally different aspects between the sets of standards. It is worth noting that the purposes behind the documents are somewhat different since the Common Core State Standards were designed to be the national curriculum, while the NCTM standards were laying the groundwork for a national curriculum. As was stated previously, there are three purposes for standards: "to ensure quality, to indicate goals, and to promote change" (NCTM, 2000, p. 6). While both documents serve these purposes, the approaches and emphasis may be considered different.

Standards-based reform movements have not only been a factor within PK-12 mathematics. Similarly, standards have been developed and implemented in teacher preparation as well. As with mathematics teacher standards, states may have their own versions of standards for mathematics teacher preparation. However, there are a few national sets of standards and recommendations that are nationally recognized.

Mathematics Teacher Educator Standards

There are several sets of standards that have been developed to inform the practice of mathematics educators: the NCTM specialized professional accreditation (SPA) standards, the Mathematical Education of Teachers documents (MET I and II), and the Association of Mathematics Teacher Educators (AMTE) standards being the most prominent. While there were many of the same contributors for the different documents, each was formed for different purposes and with different leading organizations.

NCTM SPA

NCTM was formed in 1920, leaning on the committees convened by the Mathematical Association of America (MAA) and the Chicago's Men's Mathematics Club, which were tasked with "the improvement of mathematics as taught in the secondary schools" (Hlavaty, 1970, p. 134). As discussed previously, NCTM has been highly influential since its formation, especially in the context of the improvement of school mathematics such as the efforts of standards-based reform (Brumaugh & Rock, 2006; Hlavaty, 1970; Schoenfeld, 2004). NCTM has also partnered with accrediting agencies such as the Council for the Accreditation of Educator Preparation (CAEP) to develop standards for mathematics teacher preparation.

The NCTM SPA standards are the only standards used for accreditation purposes for secondary mathematics education programs as they were written in partnership with CAEP explicitly for that purpose. Due to their relationship to accreditation processes, these standards are directly related to the assessment process as well, as NCTM (2019) officially states, "The NCTM CAEP Standards serve as the basis for programs to determine which required assessments provide evidence of candidate mastery of the standards." These standards for secondary mathematics education are organized into categories: content knowledge, mathematical practices, content pedagogy, mathematical learning environment, impact on student learning, professional knowledge and skills, and field experiences/clinical practices (NCTM, 2012).

For each standard there is a detailed description of pre-service teacher behaviors that are expected to align with each standard. Standard 1, which is the content knowledge standard, is further elaborated in an addendum to the standards and is expanded into six different content

areas: number and quantity, algebra, geometry and trigonometry, statistics and probability, calculus, and discrete mathematics. Each content area is further expanded into five to ten competencies that pre-service teachers are expected to learn in that content area.. For example, the number and quantity standard includes competencies in mathematical structures, number theory, quantitative reasoning, vector and matrix operations, and historical development.

MET II

Prior to the publishing of the current NCTM SPA standards, MET I (CBMS, 2001) and its updated version MET II (CBMS, 2010) were published by the Conference Board of the Mathematical Sciences (CBMS). CBMS is an umbrella organization for professional associations based in the sciences that was formed in 1960 "to promote understanding and cooperation among these national organizations so that they work together and support each other in their efforts to promote research, improve education, and expand the uses of mathematics" (CBMS, 2019). It was initially conceived through a committee formed by the American Mathematical Society (AMS) and the MAA in 1942 and has since grown to include eighteen professional organizations including AMS, MAA, NCTM, and AMTE (CBMS, 2010; CBMS, 2019)

MET II was described as a report that "makes recommendations for the mathematics that teachers should know and how they should come to know that mathematics" as well as "urges greater involvement of mathematicians and statisticians in teacher education" (p. xi). This report was published in cooperation with multiple mathematics education associations including NCTM and AMTE but was primarily influenced by organizations specifically within the mathematics

discipline: AMS and MAA. Coming from the perspective of the content discipline, there is a clear emphasis on what mathematics knowledge is needed for teachers of mathematics.

In these recommendations there is an emphasis on the idea that there is "intellectual substance in school mathematics" and a firm knowledge of that substance is needed for successful teaching, however, mathematics beyond just school mathematics is also needed. Within the report, suggestions were made regarding the content different levels of mathematics educators need to understand as well as a suggested coursework for developing that understanding. These suggestions are based on the following recommendation summaries:

- teachers need to have a strong understanding of the mathematics they teach;
- coursework develops "reasoning, explaining, and making sense of the mathematics that prospective teachers will teach" (p. 18);
- more professional development in mathematics, emphasis on "habits of mind of a mathematical thinker and problem-solver" (p. 19) should be emphasized in coursework and professional development; and
- more interaction between the education and mathematics departments in teacher training.

AMTE

AMTE was officially established in 1992 with 132 members, building from a small group of mathematics teacher educators from an NCTM regional conference in Baltimore that originally met in 1991. Since then, the organization has grown in both size and visibility (AMTE, 2012). AMTE not only originated from an NCTM group, but also moved to become an NCTM affiliate in 1999 as well as a member of CBMS. Susan Gay was cited describing their

membership in this organizations, emphasizing the importance of collaborating with each of these organizations,

> As a member organization [of CBMS], we will work with other professional societies to promote research, improve education, and expand the uses of mathematics. As with our affiliation with NCTM, AMTE's membership in CBMS gives us more national exposure and additional opportunities to participate in the national dialogue impacting mathematics education (AMTE, 2012, p. 14).

Mark Spikell, as the first AMTE President, was quoted describing the organization's purpose,

> To provide a national forum for mathematics educators, mathematicians and school based personnel responsible for K-12 school based staff development programs in mathematics or undergraduate and graduate academic credit courses and programs in methods and related courses in elementary, middle and secondary school mathematics to discuss issues of mutual professional concern [and to] share ideas on effective ways of promoting the NCTM Standards, NCSM and MAA recommendations on teaching school mathematics and developing programs to improve the mathematics education of practicing and future teachers (AMTE, 2012, p. 3).

To further elaborate as to the purpose of the organization, the official goals of AMTE are to promote:

- Effective mathematics teacher education programs and practices;
- Communication and collaboration among those involved in mathematics teacher education;
- Research and other scholarly endeavors related to mathematics teacher education;
- Professional growth of mathematics teacher educators;

• Effective policies and practices related to mathematics teacher education at all levels; and

• Equitable practices in mathematics teacher education, including increasing the diversity of mathematics teachers and teacher educators (AMTE, 2012, p. 53).

Clearly, there are influences of other organizations such as NCTM and other organizations that work under the CBMS umbrella, however, AMTE also brings a unique emphasis on teacher preparation.

The AMTE standards titled *Standards for Preparing Teachers of Mathematics* (AMTE, 2017) were produced in response to the idea that "no single, comprehensive document addresses the initial preparation of mathematics teachers across Pre-K–12" and maintains the goal was to "provide a clear, comprehensive vision for initial preparation of teachers of mathematics" (p. xii). This document, like the MET II recommendations, was created with partnerships among multiple organizations including AMS, MAA, and NCTM and was written by lead researchers in the field of mathematics education. Unlike the MET II, the emphasis of these standards was more on the overall development of mathematics teachers and not a focus on content specific information. The report was based on five assumptions:

- Ensuring the success of each and every learner requires a deep integrated focus on equity in every program that prepares teachers of mathematics.
- Teaching mathematics effectively requires career-long learning.
- Learning to teach mathematics requires a central focus on mathematics.
- Multiple stakeholders must be responsible for and invested in preparing teachers of mathematics.

- Those involved in mathematics teacher preparation must be committed to improving their effectiveness in preparing future teachers of mathematics. (p. 1-2)

These assumptions seem to reiterate some of the previous themes mentioned such as emphasis on professional development and involvement of multiple stakeholders. Building on these assumptions, the report described what knowledge, skills, and dispositions are needed in pre-service teachers as well as describing characteristics of programs that develop these. These two aspects are further elaborated on by grade levels including early childhood, upper elementary, middle level, and high school. A section on assessment was also included after these elaborations of the standards. Mathematics content expected of teachers was cited in relation to the MET II document for early childhood through middle level. Also, vignettes were provided throughout to give examples as to how the standard might look in an actual program or classroom setting. While the NCTM SPA standards mentioned issues of equity and was nearly omitted in the MET II document, equity served as a major theme in the AMTE standards.

MTEP

Another set of recommendations was produced by the Association of Public and Land-Grant Universities (APLU) under a partnership titled Mathematics Teacher Education Partnership (MTEP) with goals articulated as follows:

> The MTE-Partnership aims to build a national dialogue around guiding principles for the preparation of mathematics teachers; promote partnerships among all sectors throughout the teacher development process, with a focus on promoting institutional change; develop and coordinate a networked research and development agenda; serve as a clearinghouse for model programs and practices; and advocate for change at university, state and national levels. The MTE-Partnership goals are well-aligned with the 2017 *Standards for*

Preparing Teachers of Mathematics (Association of Mathematics Teacher Educators) (MTEP, 2019).

These recommendations are based on several guiding principles, similar to the AMTE standards, including: partnerships as the foundation; commitments by institutions of higher education; commitments by school districts and schools; candidate's knowledge and use of mathematics; candidates' knowledge and use of educational practices; professionalism, advocacy, and leadership; clinical experiences; students recruitment, selection, and support; beginning and in-service teacher support; and tracking success (MTEP, 2014).

A key aspect of this partnership is the use of Research Action Clusters (RACs) designed "to develop solutions to particular problems in secondary mathematics teacher preparation" (MTEP, 2019) described as follows:

(a) clinical experiences of candidates;

(b) mathematical experiences of candidates (and others) in introductory mathematics courses;

(c) particular mathematical needs of future mathematics teachers;

(d) recruitment and retention of candidates; and

(e) retention of new graduates in the field. (MTEP, 2019)

While these recommendations may not be formal standards for teacher education programs, they are positions describing what is considered "best practice" for the preparation of teachers.

Standards Influences

It is necessary to note that not only are each of the organizations currently affiliated with each other, but also the standards documents have been constructed in a way that is cognizant of the work of conducted in the construction of previous standards by other groups. This can be

evidenced by each organization being represented in all the standards documents as well as frequent citations of other organizations' standards documents. On the other hand, it is striking that despite this apparent influence there exists differences in perspective and emphasis.

A key difference for the NCTM SPA standards is an emphasis on measurable outcomes of teacher behavior and knowledge due to the accrediting nature of the standards. A key distinction of the AMTE standards is an emphasis on teacher knowledge instead of behaviors as well as a focus on equity. The MET II differs from the other standards in that they are more program guidelines than standards based on teacher knowledge or behaviors. Also, the document was strongly influenced by organizations that are mathematics organizations instead of education organizations like NCTM and AMTE, giving a difference in perspective as well.

Since each of these documents forms a set of guidelines as to what knowledge a pre-service mathematics teacher needs to be exposed to prior to entering the field, it is necessary to consider specifically what knowledge is needed. Each of these documents supports training of teachers that includes mathematics content, pedagogy, and content pedagogy, although to varying degrees and emphasis. Since each of these documents are mathematics based, the knowledge discussed is specifically the mathematics knowledge (both content and pedagogy) that is necessary for successful teaching.

Each of the standards extensively reference the research literature that was available, including other standards documents. However, there is very little literature pertaining to how these standards are being utilized within programs. While some literature was found pertaining to MET I and II as well as to NCTM standards, no literature was found in reference to the AMTE standards except some examples on AMTE's website. This lack of literature is not surprising due to its recent publication.

Graham and Fennell (2001) relates the information from MET I with NCTM's *Principles and Standards for School Mathematics* (2000). While not specifically researching how programs were using the information, they found several implications relevant to teacher education programs. First, they raised concern about the separation of mathematics departments and mathematics education departments. Content courses were typically taught by the former and methods courses by the latter. They also specifically noted that MET I encouraged alternative models to developing pedagogical content knowledge and encouraged pre-service teachers to "make connections between undergraduate-level mathematics and the mathematics they may be teaching" (p. 322).

Since Graham and Fennell's work, CBMS also released the MET II document to update language and reiterate several themes, including the need to focus on the connections between undergraduate and PK-12 mathematics. To determine if the recommendations of MET I and II were being carried out, Newton, et al (2014) surveyed several institutions about their programs. In their study, they found that it was still a consistent issue that many institutions did not include mathematics content courses specifically for the teaching of mathematics. Thirteen years later, there was still a disconnect between the mathematics teachers were learning and the mathematics they would be teaching, despite the MET recommendations. Other than this study, no other studies were found that specifically considered how mathematics educators use standards in the United States.

Teacher Knowledge

Manouchehri (1997) states the critical issues underlying how teacher preparation can help mold pre-service teachers into using less traditional methods is by focusing on teacher beliefs and knowledge. This knowledge specifically includes both content and pedagogical content

knowledge. In her words, "if teachers are to choose to teach according to the visions of the mathematics reform, they must be convinced of their value and have exposure to similar learning environments firsthand as learners" (p. 205).

Mathematics knowledge for teaching (MKT) is based on Shulman's work with pedagogical content knowledge or PCK (Shulman, 1986). PCK and MKT emphasize that there is knowledge about content, or more narrowly mathematics in the case of MKT, that is specific to teaching. A defining characteristic of PCK and MKT is an emphasis on deep knowledge of school mathematics for teachers (Ball, 1990; Ball, Thames, & Phelps, 2008; Blomeke, Suhl, & Kalser, 2011; Hill, Ball, & Schilling, 2008; Krauss, Baumert, & Blum, 2008).

MKT is seen as a pivotal aspect of mathematics teacher preparation. As Ma (1999) explains, there is a cyclical relationship among schooling, teacher preparation, and teaching. A weakness in one link of the cycle affects the rest of the cycle, as does a strength. As Ma indicates, this means the cycle can spiral up into positive educative results within a system or spiral down to negative results and "teacher education is a strategically critical period during which change can be made" (p. 149). A key aspect of teacher preparation that needs to be considered is focusing on what type of knowledge teachers need to develop—what do teachers need to know in order to be effective teachers (Ball, 1990; Baumert, et al., 2010; Chapman, 2013; Herbst & Kosko, 2014; Hill & Ball, 2004; Hill, Ball, & Schilling, 2008; Hill, Schilling, & Ball, 2004; Hill & Ball, 2009; Krauss, Baumert, & Blum, 2008; McCrory, et al., 2012)?

There seems to be a consensus that content, pedagogy, and pedagogical content knowledge are necessary branches of teacher training preparation since all three are included within the previously mentioned standards. For example, the entire third standard for the NCTM SPA (2012) standards is titled "Content Pedagogy" and describes effective teachers as being able

to “apply knowledge of curriculum standards for mathematics and their relationship to student learning within and across mathematical domains” (p. 2). Likewise, MET II (CBMS, 2010) refers to “mathematical knowledge for teaching” which described research focused “on identifying kinds of knowledge relevant for teaching mathematics knowledge, rather than mathematical knowledge in general” (p. 12). In Standard C.2, the AMTE (2017) standards described well-prepared teachers as those who can “draw upon their knowledge of mathematics content, processes, and curriculum and blend it with effective and equitable mathematics teaching practice” (p. 12).

The idea that knowledge that combines teaching knowledge and subject area knowledge is to be valued among teacher educators is clearly supported by the standards for mathematics teacher preparation. However, it is important to notice that there were also subtle differences in the wording which recognize differences in research background for each of the standards. For example, NCTM referred to content pedagogy, CBMS to mathematical knowledge for teaching, and AMTE referred to blending subject knowledge with curriculum knowledge.

Much research has been conducted within this field, such as subdividing MKT into a spectrum of subdivisions ranging from subject matter knowledge (SMK) to PCK. These have been labeled as common content knowledge (CCK), knowledge at the mathematical horizon, specialized content knowledge (SCK), knowledge of content and students (KCS), knowledge of content and teaching (KCT), and knowledge of curriculum. It is also noteworthy that MKT is the overarching theme, which is then subdivided into SMK and PCK, with each further subdivided into three categories (Ball, Thames, & Phelps, 2008; Hill & Ball, 2009; Hill, Ball, & Schilling, 2008). Figure 3 is a visualization of the relationships of the different kinds of knowledge.

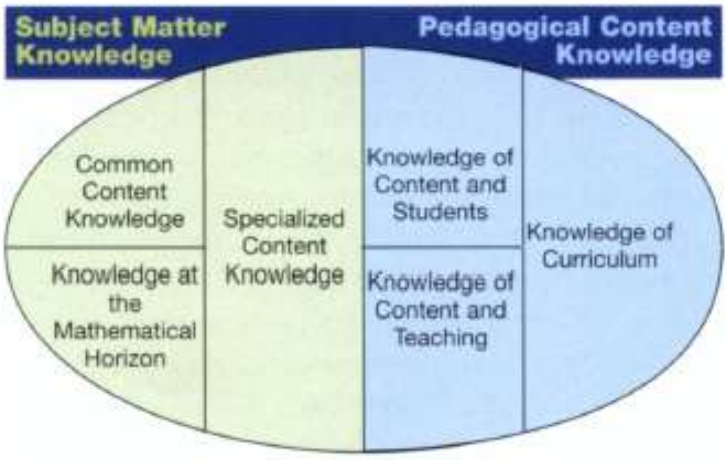

Figure 3. Mathematical content knowledge subdivisions (Hill & Ball, 2009).

While this type of knowledge was a key aspect of each of the standards provided for mathematics teacher educators, there was significantly less detail about how this knowledge is to be developed. For example, in describing content knowledge required, specific courses are often outlined as well as specific types of mathematical problems teachers are expected to be able to solve are often provided. For pedagogical knowledge, specific ideas are referenced as well, such as lesson planning, technology use, among others. However, the descriptions for MKT are much broader, leaving a significant space for interpretation as to how pre-service teachers are to develop this knowledge.

History of Accreditation in the United States

The conversations about what is necessary for effective teacher preparation in the United States date back to at least 1893, when the Committee of Ten outlined what needed to be taught in secondary school as well as how teachers should be trained (Goertz, 2010; Noddings, 2007). Following the Committee of Ten, the *Cardinal Principles of Education* presented an alternative view of what education should look like with a focus on the student more than the subject (Goertz, 2010). While these organizations and documents gave some ideas as to what was

needed for effective preparation of teachers, programs varied greatly from state to state (Burgess, 1921).

Standards for teacher preparation were determined by various groups that led to confusion about what exactly was required for teachers to teach. In fact, teacher certification was so minimally monitored in some states by the early 1920's that a significant percentage of teachers did not even have a normal or college education (Burgess, 1921). The ideas of standards for instruction were also relatively new to the field and viewed cautiously by some in the field, although supporters deemed some form of standards to be necessary and advocated accordingly (Buckingham, 1924). The concern about differences in education programs led to the first national accrediting body being formed in 1927, the American Association of Teachers Colleges (AATC). Even though it was an innovative approach to standardizing education, it's membership greatly underrepresented the population of practicing teachers which affected the impact of the organization but set the groundwork for the establishment of an accrediting body (Bowers, 1957).

While AATC was the first accrediting body for teacher education in the United States, many more would follow, and these new organizations would merge into larger and larger accrediting bodies (Bowers, 1957). Due to World War II, the population of the United States became more mobile, so teachers trained in one state were beginning to move to different states to teach. Differences in teacher training between states was becoming more apparent and state agencies began to look for more and better ways to compare accreditation standards across state lines (Bowers, 1957). This need to have a "free flow of teachers across state lines" was a primary

concern and would be cited as one of the main benefits of having a national recognized accreditation program (Armstrong, 1960, p. 14).

To meet these changes and needs of a more mobile society, AATC merged with two other organizations in 1948 to form the American Association of Colleges for Teacher Education (AACTE) and began accepting liberal art teacher training programs into membership. By 1949, the AACTE began working with the National Education Association's newly formed National Commission on Teacher Education and Professional Standards and other organizations in developing a "national accrediting agency for teacher education" (Bowers, 1957, p. 113). This would lead to the development of the National Council for Accreditation of Teacher Education (NCATE) in 1952 which would take over accreditation from the then dissolved AACTE in 1954 (Bowers, 1957).

While in general, it seems the literature is supportive of an accrediting body for teacher education, there was, and still is, some debate about what should or should not be included in the accreditation process. For example, early in the beginnings of NCATE, some concern was raised about how the education field was being presented, whether it is a craft best learned by practice or a profession with a body of theory that supports decisions made within the profession. This was argued as being a slippery slope for the preparation of teachers:

> Next will come the claim that a liberal arts degree plus some student teaching is enough…If teaching is merely a craft, then sooner or later the apprenticeship pattern of training will displace all others, because we learn a craft by doing it (Broudy, 1957, p. 109).

Broudy's concerns about NCATE's original omissions of emphasis for professional education would be taken seriously and a professional sequence of courses would be recommended. However, it does demonstrate that early in the establishment of the accreditation system, there were concerns about what should and should not be included. Some of these concerns persist even today.

In defense of NCATE, Bowers (1957) argued that it was not within NCATE's mandate to dictate curriculum to universities and colleges, but only to require institutions to justify the courses that were required. However, even as a supporter of NCATE, Bowers expressed some valid concerns such as asking the question: "Will it preserve institutional individuality and permit experimentation, or will it tend to establish the deadly uniformity of a rigidly defined national pattern of teacher education?" (p. 116). While he was convinced of sufficient safeguards against this eventuality were put in place by founding members of NCATE, it remains a valid concern for accreditation programs today.

Rising above critics, NCATE became the primary provider for accreditation of teacher education programs for many decades. Another group, Teacher Education Accreditation Council (TEAC), was founded in 1997 and also offered accreditation for programs in competition with NCATE (Council for the Accreditation of Educator Preparation, 2018). TEAC accreditation was based on a standard of quality and emphasized four principles to the accreditation process: continuous improvement, driven by scholarly inquiry, external audits of programs, and cost efficiency (TEAC, 2009). For more than a decade these institutions would serve as the primary sources for accreditation in the United States.

In 2009, the NCATE and TEAC boards of directors began a merging process which eventually led to the formation of the Council for the Accreditation of Educator Preparation (CAEP) in 2013 (Council for the Accreditation of Educator Preparation, 2018). At that point, CAEP became the only accrediting body for teacher education programs in the United States. In 2017, the Association for Advancing Quality in Educator Preparation (AAQEP) was founded as an alternative to CAEP accreditation. While AAQEP is gaining member institutions, CAEP remains soundly in control of the accreditation process.

Accreditation Literature

While a very limited number of studies were found discussing how mathematics educators use standards in the United States, there were two studies found that were focused on how teacher educators in general utilized professional standards. While neither of these studies were conducted in the United States, the countries in which the studies were conducted had similar education structures for accreditation.

One study was conducted in Ireland with a program that had recently undergone an accreditation review (Solbrekke & Sugrue, 2014). In their study they found a theme of responsibility versus accountability, built on Green's idea of managerial accountability (Green, 2013). They likened the work for accreditation to a play production. The documentation was the "script" that was to be "performed" before the committee. Certain people were selected for the interviewing process that would say what was needed to be said for the correct marks to be made, which the authors referred to as the "cast." The authors suggested there are "multiple scripts" that are present during the process that are not necessarily aligned with each other. For example, one script could be the managerialism of the accrediting committee such as documentation and check boxes, whereas another script might be the actual classroom practices

that were happening. Due to changes in policy and issues of time and energy, the authors found that the overall strategy was compliance, “to create the script that policy-makers want to see” (p. 18).

Another similar study was conducted with teacher educators in Australia using Foucault’s discourse analysis and was an extension of the research of Solbrekke and Sugrue (Bourke, Ryan, & Ould, 2018). Bourke, et. al defined two different types of dominant discourses formed using standards: developmental discourse and regulatory discourse. This is similar to Green’s description of responsibility and accountability (Green, 2013). In other words, standards were either designed as a guide for developing programs or as a regulation for making sure programs met certain criteria. The discourses the authors found in their research were compliance, accountability, no choice, performance, and researchable agenda. These were supporting a dominant discourse of being regulatory.

Compliance corresponded to using “standards to fulfill the requirements of accreditation purposes” (p. 90). The discourse of performance related to how standards were used within their teaching program such as in lectures, assessments, and other classroom activities. The no choice discourse was evidenced by educators who responded that certain aspects of the program were done because it was required by the accrediting body and the corresponding standards. In other words, standards were used primarily because they were required. The discourse of researchable agenda referred to educators who used the standards as a basis for their research, including research into what might be missing in one’s own teaching. These themes could be summarized as follows (p. 90):

> "It becomes clear that these teacher educators use standards to fulfil the requirements of accreditation purposes (discourse of compliance) as well as using them in lectures, publications, workshops, resource materials, instruction for professional experience placements, university-based assessments (discourse of performance), and in research (discourse of a researchable agenda). Some participants under pressure from administration and recent accreditation activities felt that they had no other choice."

Regarding counter discourses, resistance and reinterpretation of standards were dominant themes. To support these themes, there were examples of educators who used standards as a beginning point and re-wrote them to accomplish more than was just described in the standards. Non-compliance was a counter to the discourse of compliance, where educators would make decisions counter to the ideas promoted by the accrediting body.

In their final analysis they found that "The complete discourse analysis revealed that quality was seen predominantly in terms of quality assurance rather than quality teaching, and that being professional (in the graduate standards) equated to a regulated technician rather than a discipline expert" (p. 87). In their final recommendations, they suggested that "tick box professionals conforming to quality assurance procedures do not make graduates who are classroom ready" (p. 91) but recommended critical thinking and reflection as teacher educators creatively use standards in ways that enhance programs.

In both studies, both effective and ineffective uses of standards were found. Both studies were consistent in their findings that simply using standards as checks to be marked is an ineffective, but commonly used approach to standards-based education. There were several creative and effective approaches mentioned as well, such as the reinterpreting of standards. A

possible issue with the current studies that have been conducted is that each study was focused on only one teacher education program. While this develops a deep understanding of that program, it does not give a general view of how programs elsewhere might be utilizing standards.

Conclusion

In this chapter, a review of the history of standards-based education in the field of mathematics was reviewed. Likewise, the development of the current accreditation system was discussed. These histories were related to current research in the field such as notions of teacher knowledge as well as consequences of accreditation. It seems apparent from such literature that it is vital that teachers not only have knowledge of strictly mathematical content but also knowledge of teaching strategies and knowledge of mathematical content specific to the field of teaching. It is also suggested from the literature that while there are certainly benefits to accreditation processes, there are inherent negative consequences to regulatory processes which includes a feeling of forced compliance and a focus on a checklist approach to teaching rather than one imbued with thoughtful reflection.

In the next chapter, the methods employed in the implementation of this research will be discussed. In this discussion, the researcher's theoretical lens will be articulated as well as an in-depth description of participant selection, data collection, and data analysis.

Chapter 3: Methods

Introduction

In the previous chapter, the literature in which this study was grounded was discussed. In this chapter, the methods for conducting the study will be elaborated. To begin, the theoretical understanding of the researcher will be analyzed which will be supportive of the choice to pursue a qualitative study. Once the basis for the methodology is established, the specific methods used to conduct the research will be given. This will include a discussion of participant selection, data collection, data analysis, validity of the study, and reflections on the weaknesses and strengths of the study design.

Theoretical Framework

Curriculum is recognized as emerging from a diverse range of perspectives. One author partitioned these various viewpoints into four principal clusters of thought: scholar academic, student-centered, social efficiency, and social reconstruction (Schiro, 2013). Each perspective has a unique philosophical position reinforcing decisions made about curriculum and instruction. For instance, the principle thought supporting the scholar academic perspective is to maintain and perpetuate the discipline, which contrasts with ideas from other perspectives such as social reconstruction which stems from the desire to bring about change in society. Similarly, social efficiency is often guided by the desire for accountability while a student-centered perspective is driven predominately by student choices grounded in their interests and abilities.

Whereas, Schiro justifiably advocates that all four perspectives are vital to effective education programs, various works emphasize certain perspectives. Since standards documents, such as the NCTM SPA standards, the AMTE standards, and the MET II recommendations

articulate content requirements, it seems logical that they would hold a viewpoint substantially aligned with the scholar academic perspective. Each was informed by the mathematics discipline, promoting an aspiration to align mathematics teacher education programs with the mathematics discipline. This is substantiated by the repeated calls to have more input from mathematicians (CBMS, 2010; AMTE, 2017). Also, due to CAEP being an accrediting body and the NCTM SPA standards being developed for the purpose of accreditation, there was necessarily a social efficiency perspective inherent within those standards. While the researcher for this study recognized the significance of each perspective, the primary perspective taken by this researcher was that of student-centered, while also considering the benefits of each of the other perspectives.

A prominent student-centered theory is the ethic of care. According to this theory, school curriculum should be concentrated on centers of care as opposed to intellectual ideas (Noddings, 1992). These centers include self; the inner circle; strangers and distant others; animals, plants, and the earth; the human-made world; and ideas. As students explore what it means to care in these contexts, they would be guided by their interests and abilities to ascertain what topics to contemplate, rather than being constrained by curriculum calendars and academic content that educators are frequently obligated to follow.

Teaching that is grounded in the ethic of care necessitates a distinctive method of teacher preparation from what is traditionally utilized, especially within secondary education programs. Noddings (1992) contends, “Teachers, like students, need a broad curriculum closely connected to the existential heart of life and to their own special interest. They should be able to provide an intelligent approach to the legitimate needs of students” (p. 177). She also acknowledges that

such an approach is not likely to occur in teacher preparation programs without dramatic changes to how programs are constructed.

The influence of accountability practices and academic disciplines remains prevalent despite other possibilities such as those created around an ethic of care, implying a discourse exists that perpetuates the prominence of these viewpoints. A discourse has been described as a structure that is "seen as natural and self-evident, accurately representing a world of knowledge" (Dimitriadis & Kamerelis, 2006, p. 113). Further, "Discursive knowledge regulates, among other things what constitutes right and wrong, and what counts for knowledge in the first place. In short, discourse "establishes and controls knowledge" (p. 113). Among the core goals for composing standards for mathematics teacher educators is to exemplify what knowledge pre-service teachers are expected to achieve during a program of study, undoubtedly there exists a correlation to the notion of discourse.

An early approach to understanding discourses in society is the archaeology of knowledge (Dimitriadis & Kamerelis, 2006; Foucault, 1970). Much of discourse analysis is based on the concepts of power. However, power is comprehended more as a relationship of power structures and resistance to those power structures, moreover, how power is regarded fluctuates depending on perspective (Dimitriadis & Kamerelis, 2006). If one were to accept the assumption that standards-based education is a power structure, there are different elements of power operating depending on perspective. Consider for a moment the NCTM SPA standards, these have tremendous power to regulate what is being taught and what is included and valued in teacher preparation programs due to accreditation. Nevertheless, other organizations publishing standards still influence policies and procedures that affect teacher education due to the

prominence of the organizations and other influences. Despite national level guidelines, local educators also maintain a level of power in the educational system by choosing what curriculum to enact within their classrooms.

Certain research from the literature was conducted as discursive analysis. The aim of these studies was to better comprehend how teacher educators interact with the power structures operating within standards-based education and accreditation systems. Their results revealed various types of interactions such as staging a show with a cast and scripts (Solbrekke & Sugrue, 2014), educators lacking choices, and educators who reshape standards to what is necessary for their programs (Bourke, Ryan, & Ould, 2018). Analogously, the theoretical approach to this study was to better fathom the discourses that influence what is enacted within a mathematics teacher preparation curriculum and to recognize the teacher educator's role within those power constructs.

The philosophical perspective utilized in this study was to assume a position that accepts a realist ontology with a constructivist epistemology. This category of philosophical thought is commonly referred to as critical realism (Maxwell & Mittapalli, 2010). While this approach resembles a pragmatic approach in utility, it differs in that it acknowledges that although both stances allow for approaches to research to "be informed by one or more of a number of paradigms…we believe that the pragmatist position underestimates the actual *influence* of philosophical assumptions on research methods" (p. 147). A critical realism philosophical stance permits the researcher to employ multiple research techniques as tools and are not limited to choosing between quantitative or qualitative methods (Creswell & Plano Clark, 2018; Maxwell & Mittapalli, 2010).

Research Design

Building from the theoretical framework previously described, this study was designed to better comprehend how mathematics teacher educators perceive and use standards for mathematics teacher preparation. Specifically, the research questions were as follows:

1. What are mathematics teacher educators' perceptions and understandings of the mathematics teacher preparation standards?

2. How do standards for mathematics teacher preparation inform the development and maintenance of mathematics teacher preparation programs?

Despite the philosophical approach informing this study permitting a variety of methodologies to be employed, this study utilized a qualitative design owing to the nature of the research questions. As Merriam (2009) depicted, qualitative research is "understanding how people interpret their experiences, how they construct their worlds, and what meaning they attribute to their experiences" (p. 5). More narrowly, qualitative case study design was selected.

Case study can be described as "a research method that involves investigating one or a small number of social entities or situations about which data are collected using multiple sources of data and developing a holistic description through an iterative research process" (Easton, 2010, p. 119). Similarly, it may be described as "an in-depth description and analysis of a bounded system" (Merriam, 2009, p. 40). For a case study, it is essential to define what the case is and how it is bounded.

Creswell (2007) supports that the case itself can be studied or cases can be selected to study an issue. In this study, the latter was chosen. The issue in this instance is the space that has been created by the availability of multiple sets of standards documents to inform mathematics

teacher educators and the need to understand how this space can be navigated as well as what influences that navigation. To better understand this issue, the researcher opted to analyze multiple cases of mathematics teacher educators that served as examples to study for this issue. The cases were bounded by selecting only mathematics educators from peer institutions of the University of Oklahoma that had undergone an accreditation process. An advantage of selecting multiple cases is that varying perspectives would be included, possibly enabling more generalizable results (Creswell, 2007; Merriam, 2009).

Regarding the philosophical standpoint of critical realism, it has been contended that case study research pairs well with that philosophy. As one author articulated, "Critical realism is particularly well suited as a companion to case research. It justifies the study of any situation, regardless of the numbers of research units involved, but only if the process involves thoughtful in-depth research with the objective of understanding why things are as they are." (Easton, 2010, p. 119).

A key difference in analysis from a critical realist perspective is the inclusion of causal language using retroduction. Retroduction emphasizes answering the question, "What must be true in order to make this event possible?" (Easton, 2010, p. 123). In other words, the critical realist case study research is concerned with asking "Why?" Since our understanding of reality is fallible, it is necessary to have a method to determine if explanations are "good" or "true enough."

In summary, a philosophical stance of critical realism affected this study by bringing a focus on the why. This is like a pragmatic ideology in the sense that "what works" is what is sought after with the exception that "what works" is assumed to work because it is closer to truth

than other possibilities under consideration. Specifically, a goal of this research is to understand exemplar applications of standards in mathematics teacher education. A portion of the analysis of this information was a discussion as to why a certain theme might be a "good" application of the standards.

Participants

The initial criteria for selecting participants was to consider medium to large sized public institutions with mathematics education programs. According to College Board (2018), there existed about 143 such programs in the United States at the time of the study. Since the purpose of the study was to determine how educators perceive and utilize the mathematics teacher preparation standards, participants needed to also demonstrate experience with the standards and recommendations. To ensure participants were familiar with the NCTM standards, the criteria for participants was initially narrowed to specifically CAEP accredited programs (CAEP, 2018).

While this certainly ensured familiarity with the NCTM standards, there was no indication that there would be any familiarity with the MET II recommendations or the AMTE standards. It was assumed that at large, research-based institutions that are considered peer institutions to the University of Oklahoma, potential participants would likely be more aware of each of the documents, although the possibility of participants not being familiar with the documents still existed. Peer institutions for the University of Oklahoma would include schools from the Big Ten and Big Twelve athletic conferences due to their similar size and structure.

Unfortunately, restricting participant selection in this manner resulted in an insufficient pool of participants. To allow for inclusion of more participants, the list of the top 60 universities in undergraduate teaching (U.S. News and World Report, 2018) and the list of CAEP nationally

recognized programs (CAEP, 2018) were compared. While adding this criterion did increase the number of possible participants, too few participants were available. So, other approaches for developing a reasonable number of participants were considered.

Since the CAEP accreditation process was relatively new and some states had opted out of pursuing CAEP accreditation, it seemed reasonable to include programs that had accreditation through one of the accrediting agencies that were involved in the CAEP merger: NCATE or TEAC. The Big 10 and Big 12 institutions were narrowed once again this time including NCATE or TEAC accreditation.

For each of the institutions that matched the criteria above, the researcher searched the institution's website for contact information for mathematics education faculty and forwarded an initial contact letter via e-mail to each faculty member holding the rank of assistant professor or above. If faculty contacted responded with recommendations of other faculty that might fit the criteria of the study better, they were also contacted. This method resulted in selecting six participants. The initial objective was to have seven to ten participants for the study and the number of responses suggested the necessity for more participants.

To expand the search, the researcher originally chose to include nationally accredited programs from the top 100 schools according to U.S. News and World Report. While the plan was to allow for NCATE or TEAC accreditation, the CAEP website no longer appeared to post those records publicly, so the criterion was limited to only CAEP accreditation. The same process was used as previously discussed to determine appropriate faculty as possible participants and they were contacted via e-mail. This process did not result in any new participants for the study.

The search for more participants was expanded once again to include other athletic conferences, beginning with the Southeastern Conference. The same process was repeated as stated earlier and this resulted in two more participants for the study, raising the total number of participants to eight. This was within the specified parameters described previously for the study and as such, recruitment of participants was ceased until an analysis of data could confirm data saturation with this pool of participants.

The participants' identities have been kept anonymous using pseudonyms with the exception of one case. Gerald Goldin requested that his data not be presented anonymously as he did not want to be viewed as an anonymous critic and he specifically requested to be able to approve any quotations chosen before being included in the findings. He also requested to include the following statement describing this choice,

> After careful thought I have asked for my comments to be included in this study with attribution, rather than anonymously. Some of my experiences support positive effects that mathematics standards have had, but many of my observations are critical. The latter include some constructive criticisms of the teacher education program in which I participate at my university. I believe it is important for knowledgeable faculty – especially those of us with the safeguards afforded by academic tenure – to inform the wider community of our perspectives as honestly and openly as possible. And as a mathematics educator and mathematical scientist, I want to stand by the professional opinions and evaluations I'm expressing. I hope the data gathered here ultimately help inform and influence those who shape policy with respect to standards and standards implementation for students and for teacher preparation in mathematics.

All other participants' real names and identifying information have been removed.

Each of the participants came from different backgrounds. Every participant was from a different state and was currently involved in the preparation of teachers of mathematics. Four participants were situated in the college of education only, one in the mathematics department only, and two were split between mathematics and education departments. Participants interacted with a broad range of pre-service teachers including elementary, middle-level, and secondary teachers. Participants also came from undergraduate and masters level training programs, depending on the certification paths offered by their different institutions.

Bob is a professor of clinical practice in the college of education at University Alpha. He is currently the chair of the elementary education program and he teaches mathematics methods courses in that department. He is an experienced elementary classroom teacher with an education background in education with an emphasis in mathematics. He is actively involved in research in standards in mathematics education and has participated in standards writing on the national level. His program has national level accreditation through TEAC which is recognized by CAEP.

Gloria is an assistant professor in the mathematics department and the mathematics coordinator for the STEM education center at University Beta. Her academic background is focused on the mathematics discipline; however, she typically works with pre-service elementary and middle level teachers in mathematics content courses for teachers. University Beta is CAEP accredited.

Richard is a professor of mathematics and has taught mathematics content courses for teachers at University Gamma. He was originally trained as a mathematician but found education research and teacher training interesting and relevant and began to focus attention in that

direction. He is currently serving as a department chair in the college of education, working with middle-level pre-service teachers. University Gamma has national level accreditation through NCATE which is recognized by CAEP.

Scott is an associate professor in the college of education at University Delta. His academic training and research stem from the field of education. He is the program coordinator for the secondary mathematics program. University Delta has NCATE accreditation through NCTM standards which are recognized by CAEP. His program has multiple certification pathways that include both an undergraduate and a master's program.

Wanda is an associate professor in the college of education at University Epsilon. Her academic training is within the field of mathematics education and she is an experienced secondary mathematics teacher. She currently works with pre-service teachers primarily in middle-level and secondary mathematics methods courses. Her program includes both undergraduate and graduate courses for teacher training and is CAEP accredited through the NCTM standards. She is actively involved in research in standards for mathematics education.

Becky is an assistant professor in the college of education at University Theta. Her academic training is primarily focused within the field of education. She works primarily with middle-level pre-service teachers in methods courses at the undergraduate level. University Theta's program was accredited by NCATE using the NCTM standards and is recognized by CAEP.

Rose is an associate professor in the college of education at University Kappa. She is academically trained in the field of education and is an experienced secondary mathematics teacher. She is the coordinator for the secondary mathematics education program and teaches

middle-level and secondary methods courses within that program. University Kappa offer multiple pathways to certification that include both an undergraduate and a master's program. Both programs are CAEP accredited using the NCTM standards.

Gerald Goldin is a distinguished professor of mathematics education, mathematics, and physics at Rutgers and has experience teaching graduate coursework in each of those departments. His academic training is in mathematics and physics mostly but has noteworthy experience working with pre-service teachers in mathematics methods courses as well as content courses specifically designed for teachers. While he is currently in the mathematics department, he had been part of the education council at Rutgers up to the time the research was conducted. Rutgers has national accreditation through TEAC which is recognized by CAEP.

Table 1 summarizes the various backgrounds of the participants. It is possible that participants involvement could be broader than what is reported in this table, however, this the best record possible based on interview discussions, faculty biographies from institution's websites, and CAEP accreditation postings.

Table 1

Participant backgrounds

Name:	**Accreditation**	**Department**	**Grade Band Focus**	**Program Level Taught**
Bob	TEAC	Education	Elementary	Unspecified
Gloria	CAEP	Mathematics	Elementary/Middle	Undergraduate
Richard	NCATE	Mathematics/Education	Middle	Undergraduate
Scott	NCATE	Education	Secondary	Undergraduate/Graduate
Wanda	CAEP	Education	Middle/Secondary	Undergraduate/Graduate
Becky	NCATE	Education	Middle	Unspecified
Rose	CAEP	Education	Middle/Secondary	Undergraduate/Graduate
Gerald	TEAC	Mathematics/Education	Unspecified	Graduate

Data Collection

Qualitative data can emerge from numerous configurations including documents, observations, and interviews (Merriam, 2009). Since the research questions are focused on perspectives about standards and their influence on programs, observations of classrooms and teaching would furnish minimal data to corroborate responses to these questions. Travel costs in conjunction with the limited data that would be collected from observations made this aspect of qualitative research infeasible as an aspect of this study, therefore observation data was not collected, however, data were collected from both interviews and documents.

The primary source of data was from interviews. Since participants were from various settings throughout the United States, in-person interviews were not feasible. Instead, interviews were conducted and recorded using an online conferencing program called Zoom. The interviews were also recorded using the Zoom recording feature. All interviews were transcribed verbatim. Two interviews were conducted with each participant. Both interviews were semi-structured with the intention to ensure that research questions would be addressed while still allowing participants freedom to impart concepts they reasoned as relevant to the study. Some sample questions from the first interview are as follows:

- Have you found each of that standards you are familiar with useful? If so, how? If not, why not?
- How have resource availability and institutional goals, strengths, and limitations affected the implementation of standards?
- If you could change any of the standards, what would you change and why?

Once an initial interview was conducted with a participant and transcribed, it was examined to aid in informing questions for the follow-up interview. Therefore, the questions for

the second interview differed for each participant. The primary purpose of these interviews was to either clarify data from the first interview or fill in any gaps in information that may have arisen after review of the first interview.

Another source of data was documents. The first set of documents used were the three sets of national standards published as guidelines for effective mathematics teacher preparation previously mentioned, one of which is required for a program to be accredited. Documents were also accumulated from the institutions of the selected participants. Program descriptions, courses taught, recommended and required courses of students, and other supplementary information is frequently posted on institution websites and these were used in analysis as well. Furthermore, additional information was requested directly from participants including syllabi, institutional standards documents, documents and videos prepared as illustrations of standards, and other documents recommended by participants throughout the study.

Data Analysis

Initially, the standards documents as well as other documents of public record were reviewed prior to interviews. Standards documents were compared and contrasted as discussed in chapter two. Recommended course schedules and degree plans for institutions were also analyzed as well as participants' published research.

Once interviews were conducted and transcribed, data were analyzed using within-case analysis (Creswell, 2007). This process began by coding the data using an open coding process (Merriam, 2009). This process was originally conducted by reading and rereading each transcript and initially recording notes, referred to as open codes, in the margins to summarize sections of the data.

These open codes were transferred to an Excel spreadsheet along with their location and the text that inspired them as recommended by Hahn (2008) as level 1 coding. These codes and text were then examined and related to possible themes under which those summaries might be categorized. A master list of these possible themes was created. Each of the open codes were then reexamined and were assigned to relevant themes. If an open code did not correspond to any of the themes, a new theme was formed. This phase coincides with what Creswell (2007) and Merriam (2009) refer to as axial coding and Hahn (2008) refers to as level 2 coding.

Axial codes were reinforced by the maximum number of data sources possible and tentative themes were formed based on evidence supported by these sources that supported answers to the research questions. Each data unit was assigned to only one theme and all relevant data units were assigned. The themes were also determined to be "conceptually congruent," or at the same level of abstraction (Merriam, 2009, p. 186).

The initial process was predominantly inductive, identifying patterns that were occurring within the data. As more data were analyzed, the process transformed to being more deductive, testing the themes to see if information was consistent with prior results or if new themes were necessary (Merriam, 2009). This process of axial coding was iterative and required repeated examinations of the data before final themes were constructed. Once all data was coded for themes from each participant, the data were analyzed between participants in order to compare and contrast across programs in perceptions and implementations of the standards described, this is what Creswell describes as cross-case analysis (2007).

Reflections

Traditional quantitative methods of validity and reliability are different within the context of a qualitative study. To lend credibility to the study, however, three methods were used that are advocated by qualitative researchers: triangulation, member checking, and thick description (Creswell, 2007; Merriam, 2009). This surpasses the minimum recommendation asserted by Creswell (2007).

To accomplish triangulation for this study, documents were used to triangulate the data collect from interviews. Also, a second interview was conducted with each participant to clarify positions. For member checking, each participant was contacted via electronic mail for confirmation that data referenced correlated with the themes they were categorized with. For thick description, a considerable amount of quotations and other data are provided thus providing depth as well as capturing the participant's ideas and understandings in their own words.

A strength of this study was that it utilized data from a variety of settings, providing a vision of what was transpiring in successful programs throughout the United States. As frequently occurs, this strength was significantly correlated to the weakness of the study. Since the study was national, the researcher was unable to travel to the institutions of the participants and was not able to gather observational data for the study.

Similarly, since the study involved several institutions with a limited number of participants, it was impossible to attain a comprehensive viewpoint for each site. Instead, one vantage point was captured from each participating site. An advantage of this approach is that it can be seen how standards are being understood and implemented in a variety of settings. A weakness of this approach is that a single participant is most likely not aware of all the perceptions and implementations of standards at a site. For example, one participant may not use

the NCTM SPA standards because they do not work with accreditation specifically, but other personnel who are more directly involved in accreditation processes would likely use them more without the participant being aware of such work.

A typical criticism of case studies is that the criteria is so narrowly focused, that copious amounts of the findings are not transferable to other circumstances. While increasing the number of cases used increases the likelihood of transferability, this also decreases the quantity of description that can be included to make the report manageable (Creswell, 2007). For these reasons, more cases than are typically selected for case study were used, but a small enough quantity was used that an in-depth description of the data would still be plausible.

Since the goal of case selection was to identify programs that are currently integrating national teacher education standards, it is probable this study would be of benefit to anyone trying to accomplish such a task. However, it is worth noting that these programs come from various demographics and will likely not yield the same results in every context. Nevertheless, it is the researcher's aim that readers may find inspiration of possibilities for how these ideas might be accomplished within their own settings.

Conclusion

In summary, the study conducted was a qualitative case study conducted from the vantage point of a critical realist with a focus on ideas of discourse and an ethic of care. Participants were drawn from various research universities in the United States that were deemed the most probable participants to have knowledge of the standards for mathematics teacher preparation. The primary form of data collected were interviews with supporting data collected in the form of documents. To confirm the validity of data, participants were asked to confirm if

data supported the themes produced. Subsequent to this account of the methods used in conducting this study is a report of the themes produced in the data analysis as well as the data supporting each of the themes.

Chapter 4: Findings

Introduction

In this chapter, the data collected will be presented as well as the themes the analysis of the data produced. Since much of the data collected were from interviews with participants, the data supporting themes will primarily be presented in the words of the participants. Supporting documents provided will be referenced when appropriate and will be provided in the appendices.

As data were collected and analyzed, themes emerged to provide answers to the two research questions for this study:

1. What are mathematics teacher educators' perceptions and understandings of the mathematics teacher preparation standards?
2. How do standards for mathematics teacher preparation inform the development and maintenance of mathematics teacher preparation programs?

Five themes emerged as critical issues for consideration in response to these questions: navigating standards, standards as tools of accountability and compliance, the intersection of standards and curriculum, collaborating for enacting the standards, and care for students and their experiences. The first theme highlights "how" educators work with standards while the themes of accountability and curriculum represent key influences of education that standards may impact. One might consider them as the "what" of the work with standards. The last two themes emerged as the "who" of standard work. Who is involved in the implementation teacher educator standards and what is the nature of their connection with the work of mathematics teacher educators? The findings will be presented in order of these themes.

Navigating Standards

The first major theme that emerged from the data is how mathematics teacher educators navigate and work with the standards that are available to them and imposed on them. Several participants described issues of time as well as the quantity of information for mathematics teacher educators to process. Rose suggested,

> My classroom math teacher colleagues…they don't have time to think about their teaching, because they're teaching all the time. Often, I could probably use that same analogy for me. I'm having to do research, I'm having to teach, and do all the things which I love to do and I enjoy doing, but that doesn't give me a lot of time to reflect like I would like to reflect on the standards to improve the program."

Becky echoed Rose's sentiments by commenting "I feel like we have so many different things that we are always trying to align. It becomes too much." Likewise, Bob described the challenge of merging what the different standards documents say about what is needed,

> But I guess I would say that I don't see the standards necessarily as being in conflict. As much as I see them having different ways of being articulated. It's just as big a problem as conflict, that sort of spread or expansion of what you're supposed to be responsible for. And then you just have to figure out how those work in tandem or in concert so that your work can be reasonably happening within the space defined by those standards and honestly, just knowing that some of the standards you are not going to be hitting as strongly as others and making your peace with that.

Participants expressed concern about time limitations and the quantity of standards in other ways as well. Not only are there significant amounts of information for teacher educators to

process, but time with students was also described as an issue for meeting standards. Wanda expressed the challenges of meeting these expectations while also working to teach future teachers all that is entailed with quality teaching. She stated,

> I think time is always a factor, you're trying to teach them how to write learning goals and how to develop lessons and how to implement lessons and how to write assessments and writing rubrics. And it's a lot…Teaching is a lot. That's the reality. There's a lot to learn.

Gloria's sentiments are in concert with Wanda. Gloria shared,

> But it's easy to sit here and say that's what our elementary curricular needs to do or that's what elementary teachers need to do. But when you are teaching them, the teachers, you feel completely obligated to cover everything that they're going to see and you just can't do a fair job about that.

Similarly, Bob revealed, "I think mostly the challenge is trying to narrow it enough to be able to actually work on them in the limited amount of time that we have with folks." Scott, however, suggested that he had enough time with students to meet the expectations of the standards but related an understanding about his colleagues' perspectives,

> But as far as aligning to the standards, because we have multiple courses of methods courses and content courses, we really haven't had any of those issues… But my colleagues at other institutions have shared some things with me…they have to teach their math and science methods of teaching in a semester…I don't know how you can align to those standards and say you've covered taking kids from teacher candidates, from novice lesson planners to unit planners before they're student teachers. I don't believe

> you can actually authentically say that could be done well in two semesters, even the best math teacher educators.

In agreement with Scott, Richard viewed his time with students as sufficient to accomplish necessary goals, “I don't see a constraint in what I do here with these groups, our degree plans are for twenty-four credit hours of mathematics and so I believe that's enough to do what we need to do. So, I don't see an issue there.”

As the participants shared about the quantity of information in the limited time available to them, they also shared how they navigate that space. A common choice for navigating the space was to focus primarily on one set of standards. For example, Bob’s program focused around standards his university developed,

> One set of standards that I think has been particularly pivotal and guiding what it is that we do in teacher education here within our own institution and that has been our articulation of high leverage practices, content knowledge for teaching, and ethical obligations that we're trying to aim our program at...those standards are pretty pivotal on a day to day kind of basis and probably semester to semester, as we sort of look at how our program is doing and look at that data together and talk about it.

More commonly, the NCTM SPA standards were the focus of programs. Rose elaborated, “I would love to take all those documents and align our program to all three. But given time, I can only say that our program is aligned to the CAEP.” Becky also supported this view, “NCTM is our national organization, so we definitely gravitate more to that…than other standards…For the NCTM standards…our program's aligned to those across the board.” In unison with these thoughts, Gerald also emphasized these standards at his university,

> I think our focus in Teacher Education at the Rutgers GSE this year has been almost exclusively on the CAEP standards, and on New Jersey's newly required edTPA portfolio submission; not on NCTM or other standards. When I call this "our focus," I mean it has been the focus at the programmatic level of complying and documenting compliance with standards.

Scott also depicted a focus on these standards and their relationship to state standards,

> I do think probably the CAEP standards carry the most power because for a lot of states. They're either required or…if you've gone through the NCTM SPA accreditation process cleanly and without conditions or anything, you basically don't have to do the state review. So essentially, I think those carry the most weight.

While still expressing that one set of standards was prominent, Gloria emphasized the impact of the MET II document instead,

> I would say that (MET II) probably has had more influence on the development of our programs because our classes have been around for a little while. So that document really kind of played a role in making sure that when we offer these classes for teachers, they have real connections to the classroom, a real sense of the studying math that underlies the elementary curriculum or the high school curriculum.

While some participants did not discuss relating the standards together and only used the set of teacher preparation standards that they were focused on, some did use the similarities of standards to bring the different viewpoints together into a coherent space. For example, Scott elaborated on a relationship he had noticed between the AMTE standards and other standards, "I think a lot of that stuff you capture very easily if you're aligning to the SPA and MET II

standards, AMTE standards basically aligns very well with that." Similarly, Bob recognized a relationship between the standards documents,

> I think the MET I and MET II standards did a whole bunch to influence the way that NCTM developed their SPA standards and the way that we've articulated the content standards in the AMTE document. So, in a good way, we're trying to build on other standards efforts in order to keep the field moving in a productive direction.

While he saw a connection between the national level documents, he also elaborated on how his program connected those documents to their locally created standards using crosswalks,

> We have a crosswalk there that explains how those things work, but we don't really use the sort of language of the (state) standards on a day to day basis or with our interns very often or even within conversations with each other. The times that those that those standards come into play is when we're talking to people from the (state department of education) and using our crosswalk to help them to see that we are meeting the standards that they have articulated, etc. And I could make the same kind of a statement about the CAEP standards…when the time rolls around to do CAEP accreditation, we do have the data. We have had the conversations. We just have to do a more or less translation in order to turn that kind of work into something that is in the language of the accrediting agency.

In contrast to participants who focused primarily on one set of standards or recommendations, some other mathematics teacher educators took a different approach to the space. Wanda's approach was to "pick and choose" from the different standards documents depending on what task or topic she is working with,

> So, I guess I would say I'm grateful that we have such a range of documents because it allows me to pick and choose from various places and also a lot of the documents reinforce one another… I appreciate that there are kind of multiple perspectives.

Taking an approach opposite from Wanda, Richard revealed that he had little contact with standards documents,

> I'm not terribly familiar with any of them (mathematics teacher preparation standards) …a lot of our courses are based on, it was materials from the MET document, from the CBMS…they had a couple of documents on the mathematical preparation of teachers…so in a kind of a very loose sense, I would think courses look at that…it's more as I said, loosely following those guidelines because I can't say I'm familiar with any specific set of teacher education standards.

Not only did the participants describe having to navigate standards written specifically for mathematics teacher educators, but several also described how teacher standards such as the Common Core State Standards intersected with their work in their programs. In fact, Richard expressed more use for the standards for K-12 students than the standards developed for teacher education, "The things I'm more familiar with are the actual student's standards. The {state} equivalent. It takes its equivalent of the Common Core." Similarly, Gloria clarified that she often used standards such as the Common Core State Standards when deciding on topics for a course,

> Mostly I used the Common Core. I know that [my state] hasn't really formally adopted them, but their state standards really are based on Common Core…So, we looked at that and where they are in some of the local school districts where some of the content appears and base decisions (on what to include in curriculum) on that.

Similarly, Gerald elaborated on how he also used Common Core State Standards among other standards in his decision making at the course level,

> I presently teach both pre-service teachers and active teachers of mathematics (in the same courses). I also teach one section of an introductory course taken by prospective K-12 teachers of all subjects. In my own teaching, of course, I incorporate many sets of standards – the Common Core State Standards in Mathematics, the NCTM professional teaching standards and curriculum standards, the New Jersey Professional Standards for Teachers, and the CAEP standards. Students in our program learn about both process and content standards. Actually, the process standards have a lot more to do with what the teachers are actually learning in my classes, because they have studied considerable mathematical content in other required courses.

While describing the use of her state's standards, Becky related their dependence on the NCTM standards and the Common Core State Standards,

> When I read the {my state} academic standards, because I'm much more familiar with NCTM standards. I could definitely see that someone who created those used NCTM, because I could I could see them align, but I could see that with the Common Core as well. A lot of it is aligned with those.

Wanda regarded the Common Core State Standards as being directly associated with the standards for teacher preparation,

> I can't really separate standards for mathematics teacher educators from standards for mathematics teachers and students because in the end, my work is to prepare teachers to do the work of teaching in the ways that are described in standards…So, for me, those all

just fit together in this tiered system, right? That is kind of at the student level, things like SMP's, then also at the teacher level, the professional standards out of NCTM, the MTP's out of NCTM and this other level, like what should this program look like, what should we do.

How the participants used standards may also depend on the context of that use. Some of the participants discussed what they saw as the purposes of standards in general as well as variations of purposes depending on which document was being considered. Rose described standards, especially accreditation standards, as a minimum expectation, "I see accreditation as the minimum, right? That's kind of what I said, the bar, right? So that's the minimum." Harmonizing with Rose's notion of a standard, Scott elaborated, "I sort of look at the standards as minimum criteria, and I'm always pushing beyond those." Gloria similarly understood standards as criteria for programs as she described, "CBMS was more like for higher ed institutions to make sure that their program has the big components." Becky described an additional use of helping to see the program level organization instead of individual class curriculum, "I think it does kind of force you to look big picture across the program rather than just focusing on the one class because you know you're not going to do all the standards in one class." Wanda identified different purposes for different sets of standards when responding to how standards aligned with topics that she felt were important,

I think it depends which standards you're looking at…MET II doesn't really address equity or communication. It's not really what it's about…It's more about math content…So, I feel like it doesn't really address it as much, but I'm not sure I would expect it to, I, there are other places that do it. I think the new MAA document, that one

> really has a lot of equity in it, which is really a nice change. AMTE, I like that they have good attention to equity from a quite a critical perspective, which I appreciate. CAEP standards…I think equity's in there, but probably not.

In unison with Wanda's point of view, Bob emphasized distinct purposes for each collection of standards,

> I guess different ones have different uses at different points in time or with different populations… my sense is that the AMTE standards…was to be more of a one stop shop, more of a complete perspective on some ideas that could be guiding your work in mathematics teacher education…The MET II, MET I. Those were, in some ways articulations of mathematical content, mathematical knowledge for teaching that could be developed through various experiences, including in content courses or in methods courses… They (NCTM SPA standards) are a necessary evil...You have to have an articulation of what standards are guiding the CAEP process.

As the last quote suggests, it is quite impossible to think about the NCTM SPA standards without also taking into consideration thoughts about accountability and accreditation. This also was a major theme that emerged from the findings.

Standards as Tools of Accountability and Compliance

As suggested earlier, it is difficult to think about standards for mathematics teacher preparation without including discussion on accountability practices. For some, the issue of accountability was one of the primary difficulties that arose from the use of standards. Becky explained,

> I don't really have a problem with the standards…it's the other layer of accreditation on top of that that makes it challenging…I think that's where we have conflict, not with standards but with accreditation…how to make things mesh when it doesn't mesh well…we want to do these things but we're restricted by having to do this, what we've said we have to do as a state, what we have to do for accreditation. That I see conflict between, but not within the standards.

Similarly, Gerald expressed support for the standards but that a significant issue with standards is accountability,

> Professionally speaking, I generally agree with the content of what most of the standards documents say, although I sometimes think their emphases need shifting. They describe things we should indeed be doing in our teacher education programs, and mostly they are descriptive of what we – as professors who are mainly experts in our fields – are actually doing in our courses… Where the value of standards has been best has been in the development of new courses or emphases that help meet real needs or implement genuinely needed improvements… At their best, standards have also strengthened the hand of experts in achieving commitments of resources that we would like to push for…Where the value of standards has fallen short is in the extent to which course content and program priorities can be badly distorted by efforts to comply with their letter but not with their spirit. I believe this has also been occurring in our program. There have been a number of what I judge to be misconceived efforts, mandated by our program, to comply with CAEP standards and edTPA requirements in a way that has been actually harmful to quality.

As these statements from Gerald imply, one of the common issues with accountability practices centered around standards is that of compliance. Similarly, Becky went on to describe having to comply with standards, "There's some limitations in that and what we know so that we make that fit, but it's exactly what we're doing, we're making it fit, it's not really I think what it's intended to be representative of." Similarly, Bob related periodically having to match his program's information to accreditation language,

> They (NCTM SPA standards) aren't used as sort of a foundational element for the design of our programs. They're more like every, you know, a certain number of years, we better look at them to make sure that stuff is still in line with them because we're going to get evaluated in light of them. But I guess we always feel like if we're doing good work and doing thoughtful work and making good connections then we should be in good shape with respect to those standards.

Scott also confessed that although he collected data for accreditation, it often did not drive decision making within his program,

> We obviously go by the state quality teaching standards InTASC standards, CAEP standards that are general, not discipline specific. But that's for us to be able to collect data for all secondary ed programs. I'll be honest. I don't believe that any of that data helps me inform or make any changes to our program. Other than maybe things I want to delete from the program.

In concert with other participants, Rose spoke at length about issues of compliance. She questioned the authenticity of the work centered on accreditation,

> You're making sure your program is marking those boxes. But it is sometimes frustrating, trying to make sure, feeling like the standards are kind of a living document, something that's really for everybody's benefit versus kind of an impediment… I guess I mean we're just doing it to tick a box…artificial versus authentic practice.

Rose continued by giving an example of a case where what was happening in her program was not measurable for accreditation and resulted in changes to comply with the standards to match the way the standards were arranged,

> We do have components of mathematics history and culture in our program, but because it doesn't fit currently under one specific content area, we don't get credit for it. I hate to say it that way, but it's a part of our program that I think I like and it's a good feature, but it doesn't fit the way that they're now broken down…I still think it's a downfall of our program. I wouldn't argue that, but I think it's not as big of a downfall as it comes across in the standards, because we just there's not a standard that one standard that it falls under. So therefore, it's not seen by the reviewers.

She later continued her explanation and explained how she complied with what was being asked,

> I looked at all as I was told to do, I looked at all the exemplars that were on the CAEP site and basically cut and pasted because I asked if I could do this because…I was getting a lot of feedback about language I was using. And I said, you know what? These are exemplars and these are what apparently is successful…I mean, it was all stuff I was saying, but I just use their language…but you're just using their language right to say This is stuff I'm doing. You call it this. This is how we call it.

Similarly, Becky elaborated how she felt limited by having no choice but to comply with accreditation standards,

> I actually find it quite frustrating sometimes to have accreditation because I feel like it forces us to have to do some things that we may not have done otherwise just because we have to meet those checks…I feel like it's still related to accreditation right now, I feel like sometimes it can also be a limitation, because we are very stuck to what we have to model…I mean there's value in them, but there's also limitations…it restricts us a bit on having to model those different things and maybe not focus on some things.

In complying with the requirements of state mandates for assessments, Becky described having to discard an assessment at her university that she perceived as effective and replace it with a state-mandated version that does not relate as well to the work of teachers,

> I have been told that this (the PPAT) is a state mandate…that's going to replace one of those tests. And so, we have no choice…we had to think of other ways to do it when the way we were doing it was really kind of neat because they were creating these lesson portfolios based off different content areas and different experiences they had, rather than all focusing on one class and making it part of one class. Which I thought that's much more well-rounded and more aligned to what teachers are going to be experiencing.

Complying with state assessment mandates was an especially common theme. The two most common assessments mentioned were the Praxis Performance Assessment for Teachers (PPAT) which is designed by the Educational Testing Service (ETS) and the Teacher Performance Assessment—Education (edTPA) which is designed by Pearson. While overall, Richard claimed

to have very little involvement in accreditation he did relate a need to be aware of the teacher certification assessments,

> We also have to be cognizant as well that there is a teacher content knowledge exam that pre-service teachers have to take before they begin their student teaching. So, we kind of have to keep an eye on that as well in the hope that it holds true that in all our courses, we covered the material that they're likely to meet in their actual state content exam. It's on that sense we are being driven a small bit by that as well, just to make sure we have the topics covered.

Becky specifically mentioned working with the PPAT. While she describes issues in aligning the assessment with standards, she did clarify that there are benefits to the assessment as well,

> We are now required to do the PPAT which…it's very limiting to us because it's not aligned to our NCTM standards at all. It's not content specific…we have to…align all that ourselves and I feel it limits what we do because we're so focused on all these accreditation checkmarks that we can't just focus on what good teaching looks like and helping our students to do that…I know there's some good things about it (the PPAT) that I do like in general. It's just frustrating that they didn't keep in mind that every content is very unique and that we have to think about our program in terms of what they're teaching.

Analogously, Wanda conveyed how it felt when she was required to implement edTPA as well as some of the more positive elements that came about from the assessment,

> If you know anything about edTPA, it's just impossible to have students do edTPA in effective ways and have a good experience with it in a short time frame…it allowed us to

> get the conversation started (for program change) because we could say that because of edTPA, we needed these changes and in reality it's going to serve our students in lots of ways…it's torture, but actually there's some really good parts to it now that we have time to do it. When we didn't have time to do it well, it was very stressful. But now that we have expanded our methods courses, I feel like it's less stressful.

Scott also mentioned changes that were brought about by implementing the edTPA assessment,

> So, when we implemented edTPA as a pilot…we noticed two specific things…we saw that they were not scoring well on providing student feedback...not many were getting threes because they were not providing quality feedback that related to the mathematical goals of the lesson. They were providing feedback, but it wasn't related to the goals of the lesson...We basically implemented a one week module in our course where we gave them student work to assess with the mathematical goals and create an assignment where they basically had to write high quality feedback that would give students the opportunity, if they read it, to actually learn something by reading the feedback…they actually could read it and realize this is what they didn't learn mathematically or this is what they needed to kind of tweak mathematically because it connected to the goals. The second thing we noticed was is that our lesson planning scores were lower than the implementation...we learned by talking to the teacher candidates that got two's, that they're like, 'Well, I didn't spend as much time on that part.' That's what we really learned by talking to them...we now moved the date forward where they have to submit all of the task one lessons two weeks before they're actually going to implement it. So

> that they have to write all of those things up and then they basically have to reflect on them themselves.

Gerald also discussed the implementation of edTPA in New Jersey,

> One of the controversial issues over the past couple of years has been New Jersey's requirement for what is called edTPA. This is a portfolio that new teachers need to submit and have approved, in order to qualify for their certification by the state. It is evaluated by a private company (Pearson). I regard this as a kind of mandated test the teachers must pass in order to receive their certificate. In certain ways, important aspects of this are not related to effective teaching, but more related to effective videography and effective ability to write up the activities that the teacher has done using the words that are required in order to meet the criteria in a rubric. So, training for edTPA submission is different from the teaching and practice of methods for teaching mathematics effectively.… Although most of us at Rutgers don't agree with this criterion for certification, we need to handle it. It is state policy. The way in which the Teacher Education Committee has chosen to handle this has been by requiring instructors in the methods courses to assign portions of the edTPA portfolio in their courses, to score this according to the rubrics in the handbook, and to make that a major project of the course. The submitted artifacts and scores then also would serve to meet standards for gathering and evaluating student work required by CAEP… In my view, this mode is one of rote compliance with requirements, rather than finding thoughtful ways of solving the problem created by a mandated requirement.

Gerald elaborated that some of the issues that arise with program assessments were the purposes and ideology behind the assessments, "As a mathematics educator, I am convinced that the concept that each item in a curriculum standard translates into an assessment item on a test is badly, badly flawed."

Another common criticism that surfaced was a frustration with changes in expectations, referencing standards for accreditation as a moving target. Wanda expressed her frustration by stating, “They keep changing the NCTM standards, so we passed our SPA’s a couple or a few years ago, then last year we just did exactly what we did then and didn’t pass because there were changes made.” Likewise, Rose agreed with this sentiment, “Trying to align our program to a moving target is also a challenge.” In support of this idea, Becky also described how the process had changed,

> Rubrics that we’ve used and things like that in the past are no longer considered acceptable. They want to change a lot of things that were covered to understand before, no longer meet…We sent in this evidence that's no longer counted as the things that we're accountable for.

Clearly it can be seen that accreditation and state assessments play an integral factor in the implementation of standards for the preparation of mathematics teachers. As Wanda states, it is “Hard to imagine a world without accreditation.” While accreditation was one aspect of the “what” of standards influence, another critical aspect for consideration is curriculum. While the curriculum choices being made are not independent of accreditation, curriculum in the broader sense was also discussed.

The Intersection of Standards and Curriculum

The connections between standards and curriculum are numerous and complex. Elements of curriculum that will be discussed within this theme are classroom tasks and resources, topics and coursework, field placements, methods for enacting the curriculum, and motivators for curriculum choices. However, it is important first to note that many of the participants do not view standards as directly impacting curriculum choices they have made within their programs and courses, but rather having a more indirect relationship.

Bob elaborated on this sentiment, "When you're the mathematics teacher educator, it's not just that you're thinking about how we're addressing these standards over here, but there are standards that are embedded in lots of the things that you do or you're having pre-service teachers learning." Likewise, Becky suggested standards do not play a direct role in the selection of course resources such as textbooks, but relies more on the ideas of best practice,

> When I think of textbooks, I usually think with best practice. I don't think so much of standards as informing my decision because standards talk about content specifically, but they don't tell you how to teach. And usually for students, a lot of what I think we overcome a little bit is their experiences in learning as a student in math is very traditional. So, I want to find textbooks that support more that non-traditional type of teaching.

While she did not say if standards affected her choice or not, Gloria recognized how a textbook she uses in her classroom relates to the standards,

> The textbook that we use is Sybilla Beckmann's book for elementary teachers of mathematics and so in there they have there are built in tasks where (the pre-service

> teacher is given) ‘Here's what a student wrote and as a response to this question using your math knowledge, how do you respond to the student or have you correct the students error? How do you take the student from where they are to the next level?’ So, there's a lot of questions about that throughout the text, and then we include those kinds of questions on the test. You know, how do you correct, a lot of it, too, is you know, we don't want to stay here, tell the students the right way to do things, it's more, ‘What is the student thinking? How can you take the students idea and make it valid?’ So…at every section there are questions about that connecting it back to what they're going to see their students do…we're using such a good book by, Sybilla Beckmann that I think it already kind of builds in some of what the standards were trying to make sure that now content courses include. So, it's just it's a reminder to make sure that we include that.

Richard mentioned the same resource as an example of good practice as opposed to an alignment with a standard,

> There's a number of people around like that who have devoted a lot of time looking at the nature of mathematics in elementary school. There's a woman who's written a textbook down in Georgia, Sybilla Beckmann. These kinds of people, I probably find myself part of that community, and we're more interested, as they said in the deep understanding of mathematics by the students and only maybe peripherally or loosely tied to standards documents and things like that and if the standard says you must do something.

While participants perceived that textbooks and resources are only peripherally related to the standards, several did acknowledge a relationship between required courses and standards. There was special interest in mathematics content courses specifically designed for teachers. Wanda

suggested, “We're not giving enough opportunities for students to engage with the mathematics that they'll be teaching, but at a deeper level.” She went further to describe issues she had observed as prevalent through research and interactions with colleagues,

> Almost all of them meet the content requirement recommendations (of MET II), almost all of them meet the methods recommendations, which is really only one or two methods classes. But the thing…that programs are really missing out are math for teachers courses. That we’re not giving candidates opportunities to delve into mathematics that they will be teaching and to really understand that mathematics really well.

She went on to elaborate how that particular issue was exemplified within her own institution and conveyed an approach that had been implemented within her program as a response to this concern,

> Like our students at University Epsilon, they go all the way through abstract algebra, they can do all kinds of amazing advanced mathematics but in terms of connecting that to their teaching and/or just looking at the things they’re going to teach and delving into it deeply, we don’t do a lot of that. The one thing we do at University Epsilon, which I love, which not a lot of schools do, is that our students do that as part of a course… it’s in our math department and {my colleague} teaches it and she has a seminar with them three days a week so they’re teaching college algebra and they’re meeting as a group to reflect on their teaching and I really feel like our students do really well when they go to take their state tests for content and the Department of Ed asks us what we are doing. And the thing we can point to is that course, because that course gives them opportunities to think about college algebra topics, which face it are high school topics, in deeper ways,

> because they have a seminar that goes along with it where they actually talk about their teaching…I think {my colleague} and I have hypothesized that that's why our students do so well on the content course test in {my state} because they have this opportunity to dig deeper and to teach, right? Like when you teach something, you often then have a better, deeper understanding of it.

Along the same lines, Gerald noted the importance of having pre-service teachers study more deeply the mathematics content they will be teaching and related this to a course offered at Rutgers,

> One of the issues raised in the report (MET II) is the disconnect in the teachers' experience between their college majors in mathematics, and the mathematics actually needed for teaching high school mathematics. In our program, we have a course which is informally titled "Connections". It is a course in mathematics devoted precisely to that issue: making connections between the topics in college mathematics, and the high school mathematics that the teachers will be teaching. It's a course taken by the majors in mathematics who are part of our Teacher Education program. I taught that course, I think twice in the past, and it is still given each year although I am not presently teaching it. The course deals with topics such as the geometrical meanings of matrix transformations, relationships with trigonometric functions, and many, many other specific topics connecting the high school and college mathematics levels.

A syllabus for the Connections course was posted on the Rutgers website and a portion of it that describes the course goals is included in Appendix A.

While the participants cited a need to have courses with this purpose in mind, Richard viewed such courses as the primary piece of curriculum within his program for middle school mathematics teachers,

> They usually take college algebra. And sometimes if they have trouble taking our specialized, finite math course, we let them take a standard elementary introduction to statistics course. But other than that, all of the courses are developed and focused specifically for the middle school pre-service teacher…we're interested in the pre-service teacher understanding deeply the actual mathematics that they will teach in middle school. In other words, fundamental understanding of the structure of numbers, fundamental understanding of the concepts in geometry, these types of things.

Rose discussed a desire to have a course that was aligned with the concept of teaching secondary mathematics content in a deeper way, but confessed to having difficulty attaining approval for such a course,

> I think having a content math course for teachers would totally align with CAEP standards as well, we just, our program doesn't have it…One of the new courses we were proposing was a capstone course…it's called for the standards. It's good practice. And so certainly we cited the MET. We cited the AMTE…because additional to just knowing that that's smart, it's called for in standards.

Scott also supported the need for capstone courses for mathematics content for teachers and shared how his program structured these courses and their relationship to the standards,

> Now when you bring in the MET standards and you think about the content that teachers are going to take. That's a whole another story, because I'm talking from the college of ed

side now, my colleague in the math department, we have three capstone math courses for our teacher candidates that focus on the depth of that content that they need to know. So, I think that to be able to accomplish that within a math major (requires) a minimum of two courses. We had two for the longest time and just started a third last year. So, I think that two courses is possible if you have a good statistics component in there but three courses, we basically created a new data analysis/statistics/probability course that shadows our other capstone geometry and algebraic connections courses. So, I think those two are probably the most important now that AMTE standards have come out. I basically think that AMTE standards just does an excellent alignment of putting those two things together (MET II and CAEP NCTM SPA) and saying what needs to be said from the from AMTE. So, I think it sort of is a good guidance. They actually recommend that you need to have nine credit hours of advanced content specifically for math teachers. They recommend multiple semesters of clinical experiences and methods courses. So, a lot of that I think what I have said that we sort of implemented before the AMTE standards came out.

Scott continued by describing how the three capstone courses were initially conceptualized at University Delta and how he used standards within that process,

> But when I first got here, we had one math content course for teachers specifically, it was a geometry for teachers course. We had a history of math class, it was mostly taken by our teacher candidates. And we turned that course into an advanced algebraic connections course, where content sort of moves across understanding number systems all the way to maybe a little bit of analysis and group and ring theory sort of content. And then we

> started a third course with the data analysis. They don't happen overnight. But as we collected data on all of these standards and content for our SPA accreditation, we used the results as leverage for showing where our weak areas were to get new courses and show how well they aligned to those standards to be able to get that to happen. As far as for the math methods courses, we had three math education courses. One was really a how to use technology to learn mathematics and I turned it into how to use technology to teach mathematics and made that the very first course. Then we have a curriculum lesson planning course, and then we have a methods course and where they teach in the schools a lot, we go out and observe them. And that's more on unit planning and instructional sequencing. So that's sort of the way that ours works.

While the content courses specifically for teachers was a significant theme throughout the conversations, other coursework was related to standards as well. Gerald related a relationship of courses required and the standards,

> I think that the specific mathematical content highlighted in the report (MET II) is important for teachers. Typically, the courses in mathematics that address this content are on the required list or the recommended list for our prospective math teachers. And they do take them: courses in probability, courses in statistics, and so forth. I think these courses were implemented in response to state level requirements, rather than specifically in response to the Conference Board report. But the mathematics requirements of our secondary Teacher Education program are generally in line with that report, and I think they are very strong and of high quality.

Similarly, Rose referenced standards in relation to other courses such as statistics and geometry in the program of study at University Kappa,

> This is actually because of CAEP. They come out with at least one, maybe two stat classes because that's part of our accreditation...But I often suggest that they take an additional one..., I guess that's just also my experience as a previous math teacher, knowing they have to know stats. But if I need to point to a standard now, that would be in AMTE standards and then the MET II standards with the content…And so, with the current CAEP standards, technically, students don't have to have a geometry class that that makes it like they do. But they think that long as they can pass the Praxis, that ticks all the boxes for CAEP. I can probably support that by multiple research, I feel like they need a geometry class, so that's a required part of their undergraduate mathematics. So, I think there's nothing that can point to standards but and certainly have the research to back it up. But as a person who is at a research one, I would hate to just say because I know it is good practice because you need research to back it up. But I think it is part of that, too.

More narrowly than choosing what courses were to be included in the program of study, some participants elaborated on how they used standards to determine content that is needed for their classes. Gloria mentioned using teacher standards such as the Common Core State Standards specifically,

> I was finding that they (course instructors) were going through each lesson one at a time and would not necessarily even get to the point where they had time to address division at all. And yet this is our elementary, the one class where we fully address number sense

> and operations. So, to not talk about, you know, division is a huge, gaping hole. So, I looked at the standards. They're well, we call them the {my state} standards, but they're really based on Common Core. And I looked at Common Core, too, because not all of our teachers stay in {my state} and I looked at, 'Okay, where do some of these topics come up and in what grade levels are they emphasized' and anything that was only emphasized on sixth grade and higher than I said, 'Okay, we have to spend less time on some of those because we cannot skip division.' So, they were used to make accommodations, are used to make the class content, allowed us for more time to address something like division…I feel like the standards allowed me to cut out some of the breadth in order to a focus on some depth on the more important content.

Other topics that were pivotal in courses offered but not specifically related to content were also communicated such as issues involving equity. Wanda stressed the importance of understanding the needs of struggling students,

> I would say I probably put more emphasis in some areas, like almost every single thing we talk about in my class, we try to think about it from an equity perspective. So, what does this thing we're talking about mean for the most vulnerable students in your classroom? So, you know, what does this mean for students who are maybe struggling students? Or what does this mean for students who are English language learners?

Similarly, Bob emphasized the impact of equity standards on what is taught within his program's courses,

> The social context of mathematics, teaching, learning around equity, the access we have, decades and decades worth of opportunity gap research that show us that way haven't

> been successful and we still aren't being successful. And so my guess is that even if you thought you otherwise had just the best teacher education program in the world, you probably still have a bunch more to do on that front, because as a nation, we're just failing…I would say that the consideration of the social context of standards have been pretty useful to us in terms of trying to think about what readings, what practices, what assignments, etcetera that we're giving to our students.

He also gave further evidence of these changes by providing an old version of a course syllabus and a newer version (see Appendices B and C), highlighting the increased emphasis on equity. In contrast, Scott provided a different view on how issues of equity might be addressed within coursework,

> I think the only thing is that if you're teaching teacher candidates to teach math from an equitable perspective, there are a lot of things in there that just happen that you don't have to worry about where they're just going to happen because you're authentically teaching them how to teach all kids and be cognizant of it. I think those things will just happen. And so I don't know that I dig down in there and feel like I'm not doing that because I think I've spent enough time reading through them and aligning when we did the SPA accreditation, and we'll do that again in a couple more years that I feel like if you're teaching them to design good mathematical tasks and keep students in mind for the context of those tasks. I think all of those other things sort of just happen, at least with us.

Gerald also observed recent changes to curriculum regarding issues of equity, but suggested state mandates as opposed to standards instigated such alterations in the curriculum,

> Another change has been an emphasis on language, mandated by the state. Teacher Education students now take a course concurrent with their methods course at Rutgers. It's a course in the functions of language and is given by a language educator who is very, very good. The prospective teachers get a perspective on what it means to be a non-English speaking student in the public schools, learning English as a second language. They see how different languages express ideas differently. This opens the door to a discussion in my methods course, which I've been able to have, on how different countries with different cultures use different mathematical algorithms for so-called routine operations, and what to do about this in classrooms. What about the student who comes in saying they've learned to do division in a different way? How should a teacher handle that? I would say this was certainly a result of a mandate and a standard; it's not specifically a mathematics standard as it was applied here, but this has probably been a positive benefit for the mathematics Teacher Education program.

Not only did participants relate ways that standards were connected to their courses and the content taught within those courses, but there was also discussion on how that content would be delivered in relation to the standards. Bob emphasized that it was important to not look at standards as separate pieces in a program but each occurring in the curriculum throughout the program,

> We try to layer though that coursework so that over a semester you have many times to work on something at increasing degrees of sophistication instead of plop, plop, plop and hope that something sticks…we're working on these standards in integrated ways, not in separated strands that are parallel to each other.

Scott specifically considered mathematics content courses and how they could be taught considering the NCTM SPA standards,

> It is in the NCTM SPA standards, but how you learn the mathematics, the methods in which you get instruction and engage with the mathematics…But I don't know that is that heavily enforced during SPA reviews. You could do those things in methods courses and sort of have an activity. But I think the content courses themselves, those math courses. A good chunk of them need to be taught where teacher candidates are engaged in a learning like that, and I don't know that that's necessarily true at most institutions. We're very fortunate to have the math education math professors that we do at University Delta who teach those courses that way. But you take for example, probability, it could be nothing but a 50-minute talk and chalk three days a week, and they don't actually engage in any mathematical practices while they're learning it during class. I think that's another thing, but I do believe the AMTE standards do call that out about learning the mathematics in the math content courses through those mechanisms that we're trying to teach them on how to teach mathematics.

While focusing specifically on content courses, Gerald supports these thoughts in his remarks, "Learning is not simply carrying out procedures because they're required for testing purposes, but rather based on genuine deep development of understanding and connections--developing meaning for mathematics in the students." Speaking from the perspective of a mathematics content professor, Gloria seems to corroborate this perspective regarding content courses by teaching content courses using research-based strategies, "Normally, I really try to get them to work in groups and share, and I have students show different ways of thinking." She also

detailed some assignments and tasks that she uses in her classroom such as habits of mind problems,

> We assign what we call a habits of mind kinds of problems, which is just one of those sort of low threshold, high ceiling kind of problems. For example, you have chicken nuggets problem…Can you make all numbers with chicken nugget boxes of sizes six, nine and fifteen. So, it's a problem where they can easily read it and understand what's being asked and get started thinking about it. But you can really take that to a high level if you're going to thoroughly solve that. So, we assigned problems like that all the time, with the idea of if they're understanding themselves as problem solvers and developing good habits, learning good practices for solving problems, then they are able to do that and embody that in practice…that informs what kind of tasks they choose for their students someday, that they know what kind of habits to instill in their students.

Gloria provided examples of these habits of mind problems that she utilized in her courses, and these are provided in Appendices D-F. She also described using videos of pre-service teachers giving explanations and then having teachers perform a self-evaluation,

> One assignment I had seen someone present on: interviewing pre-service teachers about how they would teach something and then going through the course and then at the end of the semester, having a follow up interview and finding those very impactful. And so, I was not really able to get an interview with all 30 of my students before and after, but instead I had them do a self-reflection. So, I had them create a video of themselves just explaining a subtraction problem where there's some regrouping and what that would look like at the beginning this semester, and then we went through the whole semester,

> and they're learning more about what it means to regroup in base 10 and so on. And then at the end, I have them go back and watch that, and then tell me what they would do differently. And so, it's not that I can have this assignment match some of the standards. It's more, if I do this assignment, look, that will also help them, you know that. And other people who have created these standards would agree that this is a helpful tool.

While much of the discussion was focused on what courses are required, what content is in these courses, and how that content is delivered, there was also discussion about aspects of the curriculum outside this context including field placements and grant writing. Gerald described the standards' influence on the clinical aspects of teacher preparation,

> At various times, standards have been more useful in advocating for policy or program changes. For example, one set of mandates that has led to big changes has been New Jersey's state requirements for the number of hours prospective teachers need to spend in schools as part of their teacher education preparation, and the nature of those school visits. Observations, visits, school participation, student teaching, and so forth have all been greatly increased. Thus, a much more clinical emphasis has been implemented in our Teacher Education program, which I consider to be a positive effect of the standards.

He goes on to illustrate specifically how these changes have been implemented in New Jersey,

> In their first field experiences, taking place in their sophomore year, students visit four different schools. They should have experiences in classrooms that are elementary, secondary, special ed, and multilingual. That's a nice cross section with diversity of experiences. This has required the GSE to set up a whole network of field connections, well beyond the traditional cooperating teacher/student teacher connections which had

> existed before that. I think those experiences are indeed valuable to the new teachers. The fact that we can discuss some concurrent field experiences during their methods courses enriches the methods course in mathematics, which I have been teaching. So, I would say this is quite positive…However, on the negative side, there's not a close connection between the apparatus set up for the field experiences of the teachers and the faculty who are teaching methods courses in mathematics. This is a difficulty one must strive to overcome.

Rose, likewise, emphasized the importance of field experiences, describing how those experiences not only relate directly to standards but also indirectly serving as a bridge from strong mathematics content knowledge to sound pedagogy,

> They have been trained mathematicians…but that bridge, the teaching of mathematics that they've learned to their students really comes, I think, in their field experience. Because that's where the rubber meets the road and they're trying to figure out, that they can't really stand up there and lecture to kids. I mean, they can, right, but they're not, it's not going to translate. And so that's why we spend a lot of time on inquiry practices and trying to think about teaching of mathematics that looks different than probably they've seen most of their life.

Several participants elaborated on the necessity for identifying and recruiting cooperating teachers who teach in ways that align with what the standards promote. Becky described frustration with having standards pre-service teachers had difficulty meeting because not all field placements were conducive to such tasks,

> They have a professionalism standard that talks about professional development…I think sometimes that's kind of difficult for new teachers. One, because they could have a very restricted environment that they're teaching in (and) may not allow for that to easily be done…it depends sometimes on the placement and what they can do.

Similarly, Bob described the need to find placements that support issues within standards such as equity,

> So, there's multiple elements to our work in that area (field placements). So, one part is to trying to identify the knowledge practices, dispositions that we need to be nurturing here amongst the people who are going to be teaching mathematics. And so, there are pieces that will impact restructuring the coursework that we have, the readings that we choose, the practices that we feature. And then there will also be elements that are related to our assessments. Like what assessments do we have that allow us to see people's growth in those areas? And being able to document, to give feedback on that kind of thing is kind of challenging. And so, we have to be thinking about that. We also have to be thinking about the nature of our field placements or we do also quite a bit of work with embedding our courses at school sites. So how are those partnerships or how are those school sites supportive of working on these things with respect to diversity, equity, and inclusion?

Corroborating these concerns, Scott described difficulties in finding cooperating or mentor teachers for his pre-service teachers or interns to work with as well,

> We have a very tough problem trying to find, what we have 16 interns, 16 teachers who are excellent mentors. That is a problem, to have high-quality teachers who are willing to

> have interns in their classroom and release a lot of their class teaching time. That's sometimes a problem when we have a high number of interns.

He continued to describe how recognizing this as an issue, he specifically worked on a grant focused on understanding the impact of these teachers,

> So, when we wrote this Master Teacher Fellowship NSF (National Science Foundation) grant, we really catered to this program design that we have for our teacher candidates. And that one missing component is that we don't have a lot of high-quality data on is the impact of our mentor teachers on their practices with our student teachers. So that is why we wrote that grant. So, I don't know that I specifically mentioned specific standards, but I did mention how well our program is aligned to…those things, that we were nationally accredited with the CAEP SPA standards.

This last statement not only described how field placements are related to standards but also describes how grant writing is involved in the process of change as well. Several of the participants also mentioned grant writing in their attempts to work with standards. Gerald described an NSF grant for professional development,

> We conducted a multi-year program at Rutgers funded by the NSF, the New Jersey Partnership for Excellence in Middle School Mathematics, for practicing teachers. In this program we offered a sequence of mathematics courses and education courses for several cohorts of teachers from partner school districts. The sequence was oriented toward mathematical content, embodying a lot of emphasis on discovery, finding patterns, identifying mathematical principles, and so on – also on strategies for student motivation

> and engagement. I think there were sixteen districts involved at its peak. I taught courses in this program. It was one of our most successful programs.

He continued to describe the importance that he saw in grant writing as an influence of standards,

> I think they (the standards) have influenced us more profoundly through the grant awarding process then they have through direct compliance requirements. And the influence through the grant awarding process has probably been more authentic and more positive. In the grant awarding process, when you are developing a grant proposal to, let us say, create a partnership or work with teachers, there's a lot more flexibility offered by management at the institution. This is because the university is taking the money to do the project, and thus they want you to implement the project the way you proposed to implement it – and the way you proposed to implement it was the way the National Science Foundation specified in its RFP, and the National Science Foundation has specified those things because they were greatly influenced by standards. So that's a different path of influence. But I would say it is an important one, not to be neglected, maybe in some ways at least as influential as direct compliance.

While other participants referenced grants, they emphasized that they were not directly connected to grants, but peripherally. Richard related how the Common Core State Standards were related to his grant writing proposals, "In general, if I am looking for an NSF grant, I would probably have to talk about how to align with Common Core unless it's very specifically something for {my state}, which has its own standards." Similarly, Rose focused more on what the grantor was looking for,

> Practically if I'm writing a grant, I'm looking for what the grantor values and what they're interested in. And certainly if I'm applying for that grant, they probably value and they're interested in the same things that our program is, hence why I am doing a grant to that…when writing those, I don't explicitly speak to standards other than to speak to the fact that our that our programs…are nationally recognized through CAEP because certainly that's something that is of interest to grants.

There are numerous factors related to the connections between standards and curriculum. Scott noted that while some of these factors are easily recognized in most programs, many programs are quite unique in structure,

> I would assume everybody had folks reading the NCTM *Principles and Standards* and those kinds of things. So, I think probably there are some common things but as far as what lessons, what activities, what assignments, I still think that is really up to the individual teaching those classes and there's really not a shared consensus even though there's been some work in that area in the last ten to fifteen years. I still think individuals do what they think or feel is most important and that is very different from institution to institution.

Several participants provided syllabi for methods courses, some key components such as required textbooks and professional memberships listed in these syllabi are provided in Appendix G. In response to being asked how he decides what aspects of the standards need to be emphasized within curriculum and what does not need as much emphasis, Bob concluded that this process cannot occur in isolation,

> I think you don't make decisions about that by yourself. You make decisions about that with your colleagues. And so, you're not just sort of shooting from the hip and making a decision just based on your own insight into mathematics, teaching or the state of the field or the that's needs that schools have right now for teachers who know when are able to do particular things. You are working with your faculty colleagues, the field instructors who also teach your students in real school settings, your mentor teachers, your administrators, etcetera out in school sites to try to get some input on what sorts of things they're really looking for in a teacher or what sorts of things they're noticing. Our teachers are particularly needing help to be working on and, I guess in other ways, we need to be doing a better job of figuring out what people come to us already knowing instead of just trying to teach everything from scratch.

As Bob related, the people involved in enacting the curriculum are vital aspects in understanding how standards are being perceived and implemented. The next two themes relate to how mathematics teacher educators merge interactions with other people involved in the education process and the standards.

Collaboration for Enacting Standards

Participants reinforced collaboration as integral to the enacting of the curriculum that is informed by standards. Wanda described the necessity to collaborate in order to accomplish goals, “You have to divide and conquer in order to get everything done. So, {my colleague} is the one who kind of does more of our accreditation stuff and I just do the little pieces that she tells me to do.” Bob emphasized that program change cannot occur without collaboration, “I think it's important for when you when you do need to make changes, that you have a

relationship that was already ongoing because change is one of the hardest things to be asking anyone to do. And if you don't have already relationship there could be it is unlikely that you'll be successful."

The theme of collaboration emerged in some form in each of the conversations with participants. In some cases, what was shared was affirming how a strong relationship with related departments enabled the program to better enact standards. In other cases, situations were described as to how issues of not having collaboration between departments made enacting standards more difficult.

Gloria proposed that at her university there was substantial collaboration between departments, "We have a lot of collaboration between the math department and the teacher education department." She further elaborated how that collaboration took place by describing instances in which pedagogical and content classes were merged,

> I teach the math content classes. They're paired with a pedagogy class, so they're taught one after the other in the same room. And generally, we are all both in the room together the entire time. So, they really are partnered in a very strong, real way. And sometimes {my colleague} and I have actually co-taught some of the lessons. Like she'll do part of it, then I'll step in and she'll do part then I'll step in and so on… So normally, like the first hour, first seventy-five minutes is pedagogy, the second seventy-five minutes is math. But on those days when we work together, we are we're completely intermixing our time…we have been very intentional about a mixing content and pedagogy.

Gloria provided a syllabus from this combined course to aid in illustrating aspects of the course and key pieces of the syllabus are provided in Appendix H. Comparably, Wanda described

working with the mathematics department at her university to expand the number of methods courses in their program,

> We always thought it was impossible because everyone always told us it was impossible. They always said you can't fit it in and there's too many courses, blah, blah, blah. We sat down with the department chair of math and the advisors and there were two electives and they said we are just going to get rid of those for math education students, those two electives will become those two additional courses and we were able to do it really painlessly. But we originally just thought it was impossible but when we really sat down and talked to people, it wasn't impossible at all…I think that that sometimes we may think that is impossible to increase the number of math education or math for teachers courses because there's not enough time but I think sometimes if we really sit down with the right people, and look at the plan of study, there might be more wiggle room.

Becky also discussed working with standards across departments, including both science education and mathematics. Regarding science education she explained,

> Our education department is very close knit. We do a lot of discussing…I implemented one of the tasks for the first time and across the hall was doing the same thing. So, you could have the conversations about, 'What are you doing?', 'How are you assessing different things?', or 'What are you looking for?', and 'How you are connecting your standards to what their asking?'.

She went on to describe how the mathematics education faculty interacted with mathematics faculty at her university,

> We have a huge replication program here at University Theta and that's a partnership between the education department and College of Arts and Sciences…we communicate very much about making sure of the math department…what they're doing and making sure it meets our standards… I think a lot of programs you have faculty…very siloed to their class and so there's not a lot of that bigger discussion. It happens here a lot…we share syllabi, we share goals, we share standards that are being covered…We're all about, 'Tell us, let's talk about what's happening. Let's talk about what we're actually doing on the assignments we're assigning' and making sure we're not overlapping on top of each other on things like that.

Specifically, she explained that a colleague who was split between the mathematics and education departments served a vital role in the collaboration process, "A colleague…has a very close connection with the math department…they communicate really well…we were able to talk and have conversations about what we need and how we would meet the needs of our students and the accreditation." Bob also emphasized a strong relationship with the mathematics department,

> We have a pretty healthy relationship with our math department here on campus. And so, we meet with them routinely to be thinking about the mathematics that's being taught in content courses that our students are taking as well as to share with them some of the mathematics and pedagogies that we're working on in our methods classes here at the school of education. So, I think one of the key ways we work on this is to have that good partnership and relationship of folks in the math department.

He went on to further describe how the relationship with the mathematics department has been specifically beneficial for implementing the standards within the program,

> When there needs to be re-articulating the standards around which different learning goals that different courses are organized that you don't have to, it's very hard to be doing that kind of change work if you don't already have in place some way of working together. So, I was just sharing with you a little while ago how {my state} is now going to be changing the grade banding for certification, and they are re-articulating standards to fit within that new framework. And so, we have been meeting with our colleagues from the math department to try to figure out what those might look like in the content courses that they had been teaching our pre-service teachers. Which new courses we might need to develop and or which courses might not have a good shelf life any more. So, there is the design kind of work that has to happen and you have to have good relationships.

Not only does Bob see collaboration as necessary for program changes, but he also contends that this partnership is necessary in building content for courses so that they can build upon each other instead of working parallel to each other,

> Let's just use that as an example so that when they're working in a content course on the content, they could be working with the pre-service teachers, developing these high-quality arguments or explanations of certain content. And then when we're working later with them in the methods courses, we can be building on that same framework instead of trying to establish a whole new one. So, there is a lot of importance to be trying to build on each other's work instead of the presumption that I'm starting from scratch every time

> I teach a class. And you can't have that kind of connection unless you've been nurturing those relations.

While Richard did not emphasize collaboration as much, he did explain how the mathematics department related to the education department,

> When I was in the math department, we were constantly talking to people, a lot of it was logistical stuff. Which course (should be taught) or why should this course be (taught) this way. And so, we had a lot of dialogue about how a course should be taught, things like that. But of course, again, we have to maintain this independence that ultimately we're teaching mathematics. We're not teaching them how to teach.

In some cases, it was discussed that collaboration was not being utilized as well as it could be. Wanda acknowledged possible issues that can occur in programs,

> If a math educator is teaching the math course, they're more likely to do those things, right? But like at University Epsilon and at lots of really big universities, you've got the people like me who are the math educators, there's not very many math educators in the math department. In some of those bigger schools, they tend to sometimes be in the college of education. And so, the math department has less interest in that. So, I think it's these conversations across departments…having hard conversations and working on curriculum together and that kind of thing and unfortunately, maybe we're all so overloaded that those kinds of things don't rise to the top.

Comparably, Rose admitted to having limited conversations with personnel in the mathematics department but was hopeful for more communication with recent additions of mathematics educators to the faculty,

> It would take a lot of work for our math department to, in my experience, allow us to have a class like that, that would have a math prefix and not an education prefix...So that having those math educators in the math department will allow us to maybe carve out a class like that in the future.

She further explained how she viewed standards as being influential in conversations that do occur with the mathematics department,

> I'm not sure how that would work in practicality, but it would certainly help me explain to the math department because I have these standards that we have to have that, yes, we have to have a course like this and negotiate (that) space with them so that we're both comfortable, right? That they're comfortable with the math content and I'm comfortable with the teacher's part…The MET II standards would probably be seen as, I think they would help me more, I guess, in the math department. I think they would have more credibility in the math department.

Gerald also expressed some frustration in communicating within the education department at Rutgers, even to the point of resigning a position,

> With great reluctance, in April 2019 I decided to no longer teach the Secondary Mathematics Methods course. It is a course I have taught many times successfully, with much satisfaction. It is central to my professional expertise in mathematics education. I also decided to no longer participate in the Teacher Education Committee, because as a member of the TEC, I haven't felt the committee takes adequate account of expertise drawn from mathematics education (or other disciplines) in their choices about a strategy for standards compliance. What we should be doing is having thoughtful discussions on

how better to achieve the substance embodied in standards, rather than focusing on mechanically documenting compliance.

He also related that significant portions of the conversations that existed within the Teacher Education Committee were based on superficial compliance rather than thoughtful discussion of practices,

> For example, we are mandated by CAEP to gather and evaluate students' work and to make use of data in program improvement. These, of course, are perfectly sensible and valid requirements for a high-quality program. To comply, however, the TEC schedules a meeting called "data retreat" in which data are presented at a coarse level that in my view is not informative or helpful in improving the mathematics program content. There is some discussion of these data, following which faculty must write down how we are going to use the data to change what we have been doing, for the record. I feel this is a kind of fiction, as we have had no substantive discussion of course content, of genuine problems, or of student feedback, except at the most superficial managerial level. On balance, I feel that standards compliance processes have damaged rather than facilitated collaboration within our program. Demanding documented compliance with standards does not necessarily encourage movement toward quality education, and sometimes may harm it.

In summary, all the participants advocated for strong relationships with connected departments, especially between education and mathematics. In some cases, these positive relationships served as strengths for implementing standards in powerful and creative ways. In

other cases, these relationships were challenges that needed to be dealt with. Relationships with people are an important aspect of the implementation of standards.

Care for Students and their Experiences

Faculty and staff are not the only people involved in the use of standards in education. Participants also expressed concern for students and their growth as individuals as priority above standards. While limited quantities of data were collected that were directly attributable to this theme, it serves as an undercurrent throughout the data collected. The statements that directly relate to the participants care for students being prioritized will be given to highlight the elements of care that permeated most of the conversations throughout the interview process.

Some participants revealed their care for students by demonstrating frustration about pressure that standards and accreditation seem to place on students. Gloria expressed concern about overwhelming students while maintaining high standards,

> But some of the components that they felt like they could only fit into the program during our semester really have made things very stressful on the students during the time that we see them. So, then you try to balance, not stretching or spreading them too thin, but still maintaining high standards and high expectation without completely over burning them…So we've been trying to find out how to overlap these things so that we're not putting undue stress on our poor teachers. They're student teaching and they're doing all this stuff at the same time, it's just overwhelming. And so, we're trying to figure out how to align those things better to help limit that submitting multiple types of portfolios or products to meet their certification requirements…And so it's a little bit frustrating because we have to think about the students too.

In the same way, Becky expressed concern about overwhelming students in an effort to meet accreditation requirements and state mandates, "Our students are overloaded this year because they're having to meet accreditation. The pilot, PPAT, and our old accreditation…but we really feel like we have no choice, kind of mandated to do that." Likewise, Gerald exhibited frustration with systems that promoted compliance over authentic learning, "The focus is on complying with the letter of requirements without regard to what that might do to the quality of the program."

The participants also demonstrated their care for students by describing how the process of implementing standards was dependent upon their students. Bob discussed how he learned more about his students and how that enabled him to better apply the standards to their specific needs,

> We used to give an assessment on explaining how a particular figure represented a particular fraction and had a piece of student thinking where the students said that it showed one third when, really, because it wasn't split equally, it was really one fourth. They were just kind of counting the sections or whatever. And we gave that assessment multiple times and one of the messages that we learned from that…is that even at the very, very entry into the program, people already understood that equal partitioning is very important when you think about a fraction. But very few people talked about the connection of the partitions to the greater whole, so really defining the whole and making those partitions. It's taking them in connection with the whole. There was almost no discussion about the whole. It was just all about equal pieces, and then something would happen. And then you know, this is how you prepare, you make the explanation. So, we don't talk as much about equal partitioning anymore as if it's like a new idea. It's like, oh,

> yeah, you get that already. So, we know that you get that part. But, hey, this thing about the whole really matters and let's spend some time thinking about what that looks like and how kids might talk about it and how you might teach about that or whatever? So, I think the better the information that we have about the people we're teaching, the better we can tailor what it is that we're going to work on with them.

More generally, Bob concluded that understanding students and where they are is a key aspect to the implementation of standards,

> It's not an individual decision. It's a decision that should be based on what we know about interns, our pre-service teachers. It's a decision that should be based on what we know can be happening and other places within their education, and not just think about your own course, as that's the totality of their development.

In the same way, Gerald described how knowing his students helped him better understand where they were and what they understood,

> I take a lot of personal interest in my students. I meet with every student individually, at least once each semester in an office hour, and frequently more often. I try hard to find out more about what each student thinks, what they're doing in their field work, how the program is going for them, and so on. In this way, I gain valuable information that influences my teaching every semester.

In written communication about the research being conducted, Gerald further described how he viewed his relationship with students,

> Students often express difficulties relating to organizational requirements connected to standards (e.g., rigid requirements that might not be appropriate in specific circumstances). I have often advocated on behalf of students who encounter such difficulties, encouraging institutional flexibility without loss of quality. I think my students feel I am "on their side."

Richard also discussed maintaining credibility with his students by being actively involved in the local schools,

> I have a kind of credibility with students because spending a lot of time in the classroom, you know, doing after school math activities or presentations to kids. I have a good sense of being in the K-12 classroom...working in the school's gives that perspective in a way that maybe enough is not true for every mathematics professor.

Some participants described how they teach within their programs. While the approaches mentioned aligned well with standards and research, the emphasis was on developing students as learners. Gloria discussed how she utilized group work to help support each of her students,

> We think about how are we supporting all of the students in the classroom? When we put them in groups, how are we organizing them in groups or do we make it so every student has a chance to interact in a positive way, and then we want students to present solutions? Are we making sure that every student in there has an opportunity to feel successful presenting solutions? And then are we sharing a lot of different visuals or ways to understand a topic so that people with different learning styles can find one of them that they identify with and could learn from. And that's very intentional. And we do that very

> carefully. But I don't know that I look at this, go through and kind of scour the standards as much as make sure that I'm aware of, that I'm incorporating those things.

Bob emphasized that both content focus and care for students are necessary for student growth and needs to be considered in the construction of a program's curriculum,

> We are pulling those threads of content and caring about kids and getting better at practices and the dispositions they need to have across the activities that we have and in a way that is explicit and aimed at improvement over time.

While each of the participants supported the use of standards in mathematics teacher preparation, Becky expressed the prioritization of students is vitally necessary and needs to be considered in conjunction with standards,

> I think that sometimes they use their standards for everything they do in the classroom. And I don't think that's best practice because teaching is an art. It is very much based on who you have your classroom, their needs what going to help them grow as learners. And if all I did was focus specifically on my standards and not the big picture, I think that it would be detrimental.

Conclusion

In summary, these findings around the themes of navigating standards, standards as tools of accountability and compliance, the intersection of standards and curriculum, collaborating for enacting the standards, and care for students and their experiences emerged as pivotal concepts underlying how mathematics teacher educators perceived and used standards for mathematics teacher preparation. In their own words, the participants elaborated on how each of these

concepts played a factor within their own work as mathematics teacher educators. In the next chapter, the goal will be to elaborate how these findings relate to the research questions previously discussed. Implications for research and for practice will also be presented.

Chapter 5: Discussion

Introduction

The themes of navigating multiple sets of standards, standards as tools of accountability and compliance, the intersection of standards and curriculum, collaboration for enacting standards, and care for students and their experiences were developed from the interviews with participants as well as the documents they provided. These themes will now be related to the two research questions used to guide this study:

1. What are mathematics teacher educators' perceptions and understandings of the mathematics teacher preparation standards?
2. How do standards for mathematics teacher preparation inform the development and maintenance of mathematics teacher preparation programs?

First, it is important to note the relevance of the framework for understanding the influence of standards provided by the National Research Council (2002). Within this framework, there were three channels of influence described: curriculum, teacher development, and assessment and accountability. This study was specifically focused on the channel of influence of teacher development. However, it is interesting to note that the channels of curriculum as well as assessment and accountability also existed within the context of teacher development. Curriculum, in this case, related to the curriculum for teacher preparation including content and pedagogical training. Assessment and accountability closely related to the ideas of accreditation and teacher certification assessments. While these are different layers of these channels than what is described in the original framework, it is relevant to consider how these channels of influence also affect teacher development, specifically initial preparation. In Figure 4, the

original framework is provided with a further description as to how teacher development is affected by the other two channels of influence.

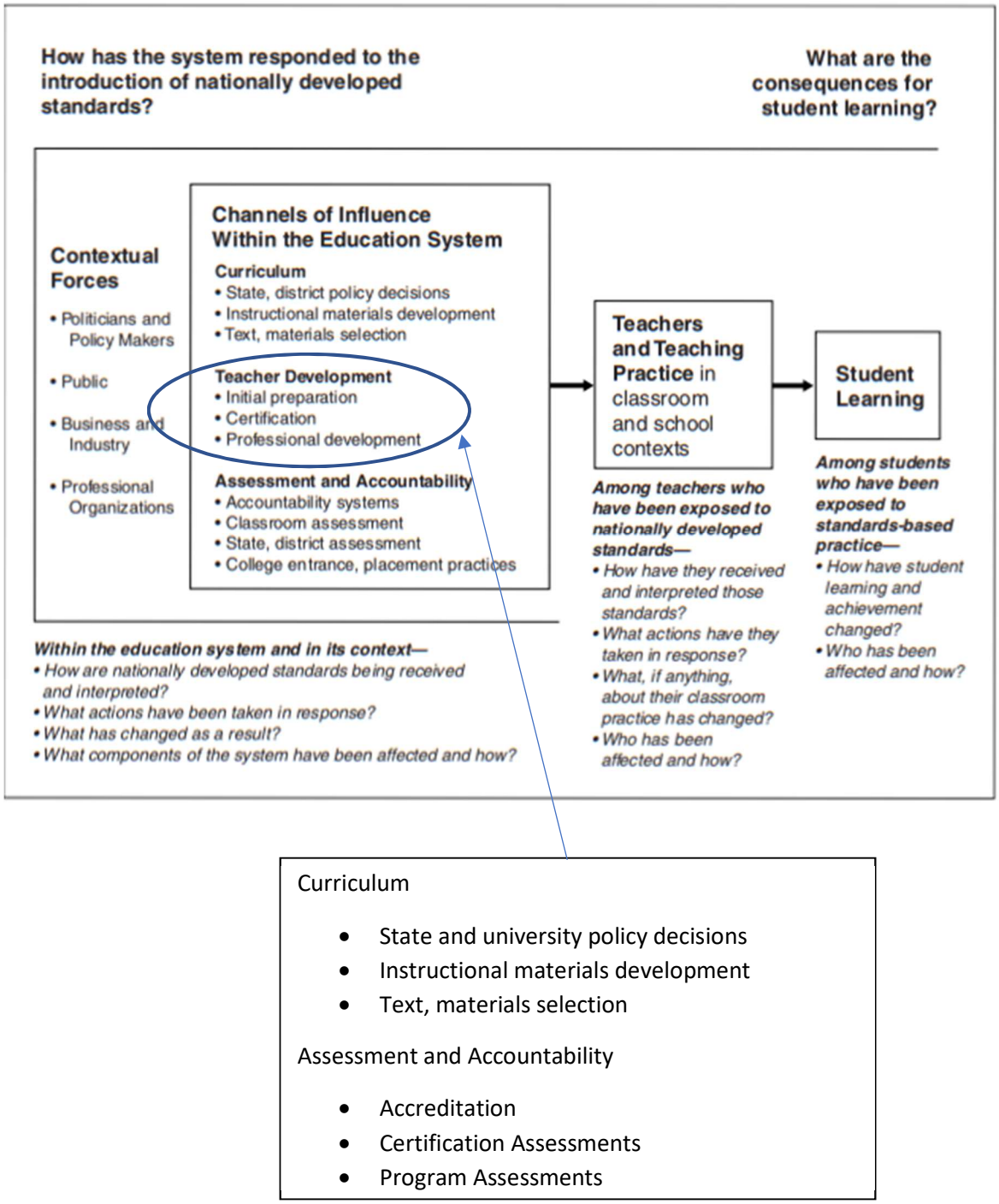

Figure 4: Framework adjustment. A possible addition to a framework for evaluating the influence of standards (National Research Council, 2002).

Elaborating on assessing the influence of standards, the National Research Council (2002) further explained,

> How are nationally developed standards being received and interpreted? The vision expressed in the standards for student learning, teaching practice, and system behavior is conveyed through broadly framed statements, and as a consequence may be interpreted differently by different people. In investigating the influence of standards, it is important to understand how these standards are viewed by particular stakeholders (p. 5).

This corresponds well with the first research question. In this study, the "particular stakeholders" viewpoints are those of the mathematics teacher educators.

Perceptions of Standards

In correlation to the first research question which was focused on the perceptions and understandings about the standards, several aspects of the themes that emerged related to this question. In particular, how participants navigated the standards such as determining what standards were instrumental in understanding how they perceived the standards. Several key phrases used by participants describing how they used standards would often point to how the standards were being perceived as well.

It should be noted that there was significant support for the standards for mathematics teacher preparation as well as appreciation for the work that had been conducted to create them. While participants expressed frustration with how standards are enforced, they overwhelmingly advocated the notion that the standards themselves were well constructed and informative for the development and implementation of mathematics teacher preparation program. Several

expressed sincere appreciation for the work of those that prepared such documents and recognized them as a significant contribution to the field.

While the participants were supportive of the work of colleagues in creating standards, adherence to these standards is not without cost. As noted previously, there are concerns within the literature that the emphasis on standards in education may result in educators taking less responsibility for decisions made (Green, 2013). This results in an emphasis on compliance to standards rather than thoughtful reflection about standards. Examples of these issues emerged from the participants as well, mostly when discussing curriculum and accreditation.

It is also noteworthy that the standards for mathematics teacher preparation as well as standards for the teaching of PK-12 mathematics were not seen as having contradictory elements but rather as working in concert with each other. For example, the AMTE standards were written specifically with the MET II being considered for questions of content knowledge. When asked how educators prioritized standards should they conflict, most had difficulty thinking of occasions in which there was conflict. However, as Bob elaborated, there was an issue of "expansive articulations." In other words, there was not necessarily a contradiction between sets of standards, but that each set of standards had its own way of stating things that needed to be interpreted to and from the language that mathematics teacher educators use within their programs. This is also supported by the repeated discussions about having to translate what was happening in each program into the language of the standards, especially in the context of accreditation. In order to relate standards with the program level, typically some sort of crosswalk was written, either formally or informally, to convey how the information contained with the standards related to what was occurring within the program.

On several occasions, participants referenced what was considered "best practice" and often this was something separate from the standards yet certainly correlated with the standards. In fact, in several occasions, it was stated that a "best practice" had already been incorporated into programs by utilizing research and experience prior to it being specifically stated within standards documents. It appears from these discussions that standards are viewed more as statements about what is to be valued about the preparation of mathematics teachers based on what is considered "best practice" rather than standards serving as the originators of these ideas. Alternatively, standards were also described as useful for advocating specific practices as "best practice." This appears to be a simultaneous process with being influence by what is considered "best practice." For example, the AMTE standards especially emphasized equitable mathematics teaching practices. These ideas were drawn from research and practices in the field that were demonstrated as being successful. However, this emphasis was also viewed as a way to encourage others in the field to also value these ideas, possibly promoting these concepts for future standards as well as encouraging implementation of these practices at institutions that may not have considered these elements as important prior to the publishing of the standards. In a way, this may be seen as communicating to the field as well as those outside the field what practices are to be valued.

Another goal of the study was to understand how mathematics teacher educators understand the space of having multiple sets of standards to inform their practice. There were essentially three approaches to this issue: choose one set of standards to primarily guide the program, incorporate pieces from each of the standards, or ignore all the standards. Nearly all the participants were aware of multiple sets of standards but most tended to focus on one set of

standards, however, there was some discrepancy on which set of standards primarily guided a program.

As might be expected, the NCTM SPA were commonly referenced as influential pieces in informing the development and growth of programs. Several participants, including Becky, Gerald, Scott, and Rose all emphasized the importance of these standards in their programs. However, Bob emphasized use of AMTE standards and his university's standards while Gloria's program was significantly impacted by the MET II document. In both cases, an individual at the institution in question was involve in writing the standards document that was prominently being referenced. It seems appropriate to hypothesize that while accreditation is often a deciding factor on what standards document is emphasized, this emphasis can be shifted by educators having a more active role in the establishment of the document itself. Not only did the emphasis change but also how the standards were referenced. There was an apparent shift in thinking from a "they" or etic perspective to a "we" or emic perspective of standards documents the closer the participant was to the writing of the documents.

Standards also were viewed as serving as a protection against outside influences that might damage the academic integrity of a program. The National Research Council (2002) referred to contextual forces that are an aspect of education and the influence of standards. Specifically, they mentioned politicians and policy makers, public, business and industry, and professional organizations. Several participants referenced issues and concerns about some of these influences and supported the use of standards as a defense against negative influences that may occur from these forces, although it should also be noted that all these influences are not necessarily negative. Scott especially emphasized using standards as a protection against policies

being made that might be financially reasonable for an institution but may not be feasible for the needs of the discipline, especially in smaller institutions that may have more financial restrictions. Similarly, Gerald highly emphasized the influence of politicians and policy makers and welcomed having professional documents that could be used to combat policies that were less than desirable for programs.

Some might also argue that this "protection" offered by standards may have some negative consequences. As stated earlier, a discourse establishes and controls knowledge (Dimitriadis & Kamerelis, 2006). It could be argued that this "protection" offered by standards is a protection of what knowledge is to be valued. While the participants overall found this supportive, this also had negative consequences when working to instigate change. For example, the strong emphasis on mathematics content standards have historically made changes such as a shift of emphasis to the mathematics content teachers will be teaching instead of upper division university mathematics difficult to achieve despite some inclusion in standards (Newton et al, 2014). Likewise, participants specifically discussed the lack of inclusion of topics such as equity in some of the more prominent standards documents and reflected on how poorly the field of mathematics education has addressed issues of equity in the past. It could be argued that since these did not receive prominent discussion in earlier standards documents, that such ideas received less focus from mathematics teacher educators.

In summary, standards are perceived from multiple standpoints. They may be perceived as minimum requirements, especially standards used for accreditation purposes. They may also be perceived as statements about what is to be valued in a field or as a communication device within the field as well as outside the field about what is to be valued. They may also be

perceived as a security feature, preventing outside sources from inhibiting program directors by giving a source to defend curriculum choices. These are not static interpretations but are dynamic depending on the needs of the mathematics teacher educator at the time the standards are being used.

Standards and Curriculum

The intersection of curriculum and standards related provided part of an answer to the second research question, giving insight into how mathematics teacher educators used or did not use standards for the development and maintenance of their programs. According to the literature discussed in chapter 2, standards, if successful, should have some sort of influence on the curriculum. As the National Research Council (2002) described in its discussion of the influence of standards,

> If standards are influencing what is taught to which students, then curriculum policy, the design and development of instructional materials, and the processes and criteria by which such materials are selected and implemented in classrooms would reflect the content described in the standards. Enacted policies and funded programs defining curriculum would align with those relating to standards-based instruction and assessment. (p. 44)

Most of the mathematics teacher educators did not see standards as something they refer to on a day by day basis. In many cases, standards were not seen as having a direct impact on decisions made at the classroom level. However, there were indirect applications of standards that affected curriculum choices made. For example, Richard described not being overly familiar with standards, however, many of the decisions and thought processes described were heavily

aligned with what is called for in standards. He described a need for a fundamental understanding of mathematics, which relates well to the repeated calls for a conceptual understanding of mathematical structures. Likewise, his program was structured with emphasis on mathematics courses designed specifically for teachers, a key feature in standards documents that other teacher educators admitted struggling to implement. Clearly there was a correlation between the ideas that were contained within the standards and the curriculum that was being enacted, even with educators who confessed to having limited knowledge of the standards themselves.

Similarly, when discussing textbook and reading choices, a direct connection with standards was not referenced. However, texts and readings that were selected certainly reflected what was valued in the standards. For example, Richard and Gloria both described using a text by Sybilla Beckman. One of her more prominently known texts and the one assumed to be referenced is *Mathematics for elementary teachers with activities*. In the foreword to this book, it is stated specifically that the book was written in response to standards for mathematics teacher educators as well as research and ideas of best practice,

> The Mathematical Education of Teachers, published by the Conference Board of the Mathematical Sciences (CBMS), was one response to Ma's work. Its first recommendation gave official voice to the dictum, "Prospective teachers need mathematics courses that develop a deep understanding of the mathematics they will teach." This report provided welcome focus on the problem, but the daunting task of creating courses to fulfill this recommendation remained. Sybilla Beckmann has risen

> admirably to that challenge…she has written a text that links mathematical principles to their day-to-day uses. (Howe, 2018, p. x)

Likewise, when discussing textbooks, Scott expressed that there was still significant variation in what texts and readings were often used in methods courses especially. However, there were texts used in his program that he suspected were commonly used in most programs such as NCTM's *Principles and Standards for School Mathematics*. Certainly, such a text should be considered aligned with the ideas promoted within standards, especially those designed by NCTM.

While many participants did not see a direct connection between standards for mathematics teacher preparation and curriculum choices such as textbooks, some did describe an indirect effect. Bob referred to this as the "ooze" of standards into curriculum and instruction. Gloria described how standards indirectly affected her choices, agreeing that it was more of a "trickle down effect" than a direct impact.

This "ooze" of the standards into the curriculum could be argued as an element of control that is enacted with an emphasis on standards. For example, Au (2007) in his metasynthesis of the impact of high stakes testing found that this emphasis on testing controlled content, pedagogy, and form. Similar to testing, it is evident that standards are a controlling feature for content choices. As stated earlier, there were clear connections in textbook choices, however, there was also a relationship between the courses in the program of study and the standards. For example, Gloria discussed how the original coursework for her program was heavily influenced by the MET documents while both Becky and Rose stated that they were "aligned" with NCTM

standards. In other words, standards exert some control over what content is chosen and included.

While text and reading selections were one way that standards were described as "oozing" into the curriculum, other connections were also depicted. One way that standards were perceived as oozing into curriculum choices was course development. Gerald referenced a course titled Connections at Rutgers as a course designed to study high school mathematics in a deeper way. After reviewing the MET II document, he acknowledged how well aligned the course was with MET II. However, this was understood as an indirect relationship given that he was unaware if MET II was referenced in the writing in the course and appeared not to serve as an informative document for him while he was an instructor for the course. Likewise, Rose emphasized an aspiration to incorporate capstone course for her secondary mathematics preparation program. Additionally, Wanda was endeavoring to expand the role of mathematics courses specifically designed for teachers in her program. Each of these cases related substantially with the recommendations from standards for mathematics teacher preparation and would then be impacting curriculum by guiding the types of courses being developed and implemented.

The indirect implications of standards were also evidenced by what was valued for grant applications. While standards in most cases were not directly referenced in grant writing, there existed again an alignment with standards. For example, several participants discussed how grantors typically desired to fund proposals that were a part of accredited institutions. While standards were often not directly tied to the grant writing, often the concepts forming the foundation of the standards were valued by grantors. Since standards could be perceived as

articulations of what is considered "best practice" or possibly suggestions of what should be considered as such, it seems logical that grantors would desire to fund proposals that support these positions. This corresponds with what the National Research Council stated in describing indicators for effective standards, "Enacted policies and funded programs defining curriculum would align with those relating to standards-based instruction and assessment" (pg. 44).

While standards may not directly impact curriculum, clearly there is a correlation between what mathematics teacher educators are including in curriculum and what is valued in the standards. To provide an analogy, one might see standards as the flag-bearer on a battle line. A flag-bearer does not necessarily participate in a battle but is a symbol of where the battle line is and how it is progressing. Similarly, standards are not so much directly involved in curriculum choices but serve to indicate the "battle line" from where those decisions emerge. This appears to stem from the idea of standards being value statements for the field. If they represent what is valued well, then the ideas and recommendations they advocate for will "ooze" into the curriculum naturally because that is what educators have already agreed is indispensable.

Standards and Accreditation

Accreditation is inextricably yoked with standards for mathematics teacher preparation. Compliance was a theme that has emerged repeatedly from research into accreditation practices (Solbrekke & Sugrue, 2014; Bourke, Ryan & Ould, 2018). While those studies were specifically focused on education department accreditation and not specifically in mathematics, it is apparent that compliance is also an issue for mathematics teacher educators in the United States. The issue of compliance is, in a way, a double-edged sword in the sense that there are positive aspects of compliance as well as negative aspects. This compliance with accreditation requirement seems to

play a major role in determining how standards were used in the development and maintenance of their programs, providing another key response to the second research question.

In multiple discussions, standards for accreditation were referred to as a "necessary evil." The necessary aspect relates to one edge of the sword of compliance, ensuring that minimum requirements are maintained. While most participants believed that their programs were designed to exceed minimum requirements and would continue such designs without accreditation, it was simultaneously recognized that this was not universally true. In fact, it was conveyed by some of the participants that colleagues from smaller, regional institutions sometimes had difficulty meeting requirements and that accreditation standards might help maintain a bar of minimum requirements for such programs to reach in order to ensure quality teachers exiting from these programs. Similarly, accreditation standards were perceived as a protection against outside constraints such as administrations and politics preventing best practices from being carried out due to financial or political concerns as mentioned earlier. Essentially, compliance is necessary to prevent sub-par programs from graduating underprepared teachers.

While this is seen as a necessary element to the education process, this is not without danger. As some may argue, this depends on who is deciding what sub-par programs are and what the gauge is to determine what this means. For example, it could be argued that less emphasis is needed on higher level mathematics content so that more emphasis could be placed on the mathematics teachers will teach. As was stated by several participants as well as some standards documents, emphasis on this type of mathematics content knowledge is valuable. Would a program that includes fewer upper division university mathematics courses to include

more of these types of courses be considered sub-par because it does not meet the standards requirements laid out for university mathematics?

Contrasting this notion of necessity, the other side of the sword of compliance relates to the "evil" aspect of the analogy. Program coordinators can become so focused on complying with mandates and accreditation requirements that valuable time is lost in mathematics teacher educators' preparation and reflection time as well as their instructional time with pre-service teachers. For example, if one were to consider the PPAT and edTPA assessments, there is the benefit of assessing to make sure that pre-service teachers are developing in necessary areas. However, there is also the danger that teacher preparation programs will feel forced to teach the test such as Gerald was concerned was occurring or be forced to discard more personalized assessments developed by university faculty in favor of the more general, standardized assessments such as described by Becky. In each of these cases, the assessments were not seen as necessarily bad, but that the effect of the assessment was a shift in viewpoints that did not necessarily align with their anticipated purpose.

Likewise, frustrations with accreditation rubrics were expressed frequently. Several participants discussed frustrations with previously acceptable rubrics being denied and extensive work needed for modifying them. For example, in Appendix I and J provided by Rose and Becky respectively, these rubrics can be incredibly long and detailed and represent a significant time investment from the mathematics teacher educators. As Rose described resorting to using the exemplars provided and adjusting the wording to fit her program, the emphasis on conformity can easily begin to overpower the ability to creatively approach curriculum and assessment choices.

It was repeatedly expressed that these requirements and mandates are not necessarily poor assessments or practices, but it was highly emphasized that the oversight of these assessments and practices is limiting the choices available to faculty, especially creative solutions to persistent issues. For example, a common issue is accreditation systems only recognize items that can be documented in certain ways. If standards are met in atypical ways, it is often not recognized and programs risk losing accreditation unless they comply with the specific methods prescribed by the accrediting body such as Rose's frustration with attempting to demonstrate how history of mathematics was being included within her program. This has the extremely unfortunate effect of making mathematics teacher educators impotent in finding creative solutions to long-standing complications in the field. In further evidence of the dampening of creative applications in the field, several participants expressed interest in reviewing and utilizing other standards and ideas but would often stop short, realizing that it didn't really matter because they had "no choice" but to follow the accreditation standards. If standards for mathematics teacher preparation are designed to represent what is seen as best practice in the field, it is unfortunate that their enforcement may prevent such practices from occurring by forcing a checklist approach to requirements instead of an integrated and thoughtful approach.

While compliance was certainly a meaningful theme in how standards affect the practice of mathematics teacher educators, another theme that was repeatedly referenced was the idea of a moving target. While it may be expected that methods and conceptualizations of best practice will change over time, a significant amount of frustration was expressed with continuous changes in how programs were being assessed. While there seemed to be no issue with expanding to include issues expressed in research such as including issues of equity in standards, most

participants were discontent with the fluctuations in how they were held accountable. For example, even when standards had not changed, what was accepted in rubrics and assessment methods did change. These changes were often seen as unnecessary since the content being assessed had not changed, just the wording of the rubrics.

Standards and Community

Another important response to the second research question was that standards are not implemented in isolation in any mathematics teacher preparation program. How standards are to be implemented in a program should be dependent on a variety of stakeholders including but not limited to education faculty, mathematics faculty, pre-service teachers, in-service teachers, local school administrations, university administration, and accrediting bodies. While some of these stakeholders clearly have a more direct relationship with the interpretation and implementation of standards, each has a role to play.

From this study, the roles of education faculty, mathematics faculty, and pre-service teachers were specifically highlighted. Education and mathematics faculty must work together in order to have a functioning program that follows the ideas supported by standards for mathematics teacher educators. Participants who believed the mathematics and education programs worked well together repeatedly confirmed that they perceived this to be a vital element to their program. As Bob suggested, the changes needed to be made in order to meet standards could not be attained without open and honest communication with the mathematics department. Participants who believed the mathematics and education programs did not work well together expressed frustration about not being able to enact changes to the curriculum that

were aligned with the standards. Clearly, there is some correlation between communication between departments and perceived successful implementation of standards.

Another stakeholder in the preparation of mathematics teachers to be considered is the pre-service mathematics teachers. Some participants expressed concern that an emphasis on standards and accreditation can be damaging to pre-service teachers if not careful. As Becky described, it is not "best practice" to only consider standards without taking into consideration how it affects the pre-service teachers. Akin to the arguments provided by Becky, Gloria discussed a need to cover content and balancing that need with the ability of the students to attain that quantity of content in the time allowed for pre-service training. In the end, she found that she needed to focus on what her students would need in teaching and even used standards such as her state's standards and the Common Core State Standards to narrow topics to a more manageable form. In these cases, not only were the standards being considered but also what pre-service teachers were able to cope with as well as what they needed most to be successful. While this may be informed by standards, this also depends on the pre-service teachers themselves.

Implications for Practice

These themes in response to the research questions have several implications for practice in the work of mathematics teacher educators. These implications include reflecting on decision-making processes, resisting unnecessary aspects of compliance, and forming partnerships with stakeholders whenever possible

Several participants expressed that the simple act of discussing how they made decisions about how they saw standards and how they implemented them was beneficial to them in their practice. In many ways, it is easy to become so focused on the day to day tasks of designing

courses, assessments, and the various other aspects of the educational process, that it may become easy to forget what to goals of these tasks are. Ultimately, the goals of accreditation processes, standards documents, and teacher educators are to help develop pre-service teachers to be the best teachers possible, however, it is often easy to forget this goal and become focused on meeting criteria instead. It is important for teacher educators to take the time to reflect why they make the decisions they do and justify to themselves that these decisions are in the best interest for the education of pre-service teachers.

To that end, if a teacher educator perceives that what is being required of them is not in the best interest of the field, there are options available. Educators can comply with requirements, even though they may disagree with them. This could be changing assessments, rubrics, or coursework for the sole purpose of meeting accreditation requirement. Educators can also creatively resist these requirements. Some interesting approaches might be Gloria's description of the unique partnership between the mathematics and education departments, even to the point of merging classes occasional to effectively teach topics. Another example might be Wanda's and Scott's descriptions of rewriting old elective mathematics courses to be specifically dedicated to a deeper understanding of secondary mathematics content. These ideas are not opposed to what is called for in accreditation and yet at the same time challenge the notion that all programs should be conducted in the exact same way. Educators can refuse to follow these requirements, dealing with the consequences that may come. An example of this might be Gerald's decision to not continue to teach to the test even if it meant not being a part of the teacher preparation program. A mixture of these responses is likely appropriate depending on the specific issue being addressed. If a program may lose its accreditation if it does not comply with accreditation requirements or state mandates, it may be more reasonable to comply than to resist.

However, it seems beneficial to the field to creatively confront issues of compliance whenever feasible and responsible.

Other implications may relate to other stakeholders in teacher education as well. It is worthwhile to note that the more involved in standards writing the teacher educators were, the more impactful those standards were on their program. Inclusion of more mathematics teacher educators could further their willingness to adopt the standards into practice. Mathematics teacher educators need to have a sense of ownership of standards in order to completely appreciate them. While this is certainly a challenging task with the quantity of such educators in the United States, it could be a worthwhile endeavor to allow more mathematics teacher educators to perceive an involvement in standards writing and conceptualization.

Implications for Research

For the purposes of this research, only large, research institutions were considered due to teacher educators at these institutions being the most likely to be aware of the different sets of standards for mathematics teacher preparation that are available. Some participants did reference smaller, regional institutions as having different issues that what was emerging at their institutions. It would be worthwhile to determine how standards for mathematics teacher preparation are perceived and utilized in these smaller institutions as well as to compare those results to the results from larger institutions such as those in this study.

It would also be worthwhile to investigate and compare different stakeholders' perceptions of standards for mathematics teacher preparation. For example, do mathematics and education faculty view standards in the same way? Do they value the same standards or different ones? Why do faculty value the standards that they do? Other stakeholders' views could also be

investigated. For example, some participants discussed pre-service teachers being frustrated with some of the systems that were being required, it could be useful to investigate whether these state mandates and accreditation requirements are effective in communicating to pre-service teachers what is valued and necessary for successful teaching.

Conclusion

Standards for the preparation of mathematics teachers have had a significant impact on the development and maintenance of mathematics teacher preparation programs. Much of such impact can be related to accreditation, however, educators being involved in constructing standards also plays a factor in determining their acceptance by faculty. Standards are highly correlated with notions of best practice in the field and are viewed as supporting these notions. Frustrations with accountability practices abound, especially regarding compliance and struggling with moving targets, yet such practices are also seen as necessary to ensure quality preparation of pre-service teachers throughout the field. Standards impact curriculum, especially in indirect and even sometimes difficult to identify ways.

In summary, standards appear to carry multiple meanings for the work of mathematics teacher educators and mathematics teacher preparation programs. They are the fruit of observations of best practice, rules that require rigid compliance, and guides that slowly pull research as well as instruction in certain directions. They subtly ooze into curriculum choices while simultaneously stand out as requirements that educators often feel they have no choice but to follow. They protect educators from outside constraints, preventing financial and administrative concerns from eliminating necessary aspects of programs while also creating constraints that teacher educators feel compelled to adhere to. It is no wonder that mathematics

teacher educators are both frustrated by the rigid requirements of accreditation based on standards but also thankful for the protection and guidance they often afford.

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Appendix A: Rutgers Connections Course Syllabus

This course attempts to answer some very sensible questions: What can a future teacher get out of advanced math courses that makes a teacher more effective? How do the ideas, methods, and procedures of advanced math provide the kinds of insight into high school content that allows a teacher to answer questions, correct misunderstandings, motivate future work, etc? How does mathematical content knowledge strengthen pedagogical content knowledge?

Course overview

Completing advanced mathematics courses, including advanced calculus, abstract algebra, and college geometry, is an important component of students' preparation to become teachers of high school mathematics. In these advanced mathematics courses, students are exposed to the importance of mathematical precision and rigor as well as new modes of mathematical reasoning. By studying topics from high school mathematics from an advanced mathematical viewpoint, students' understanding of these concepts can be enriched so that they should be better able to teach these concepts in their classrooms. For a variety of reasons, these potential benefits are not always realized and future teachers frequently question the value of completing advanced mathematics courses.

The purpose of this course is to help you build connections between your experiences in your advanced mathematics courses and the high school mathematics that you will teach. The first nine weeks of this course will focus on mathematical content with frequent mention of pedagogical issues. The rest of the course will focus on mathematical pedagogy with frequent reference to mathematical issues. In some cases the content we discuss will overlap with that content you will teach. One example is the reason "spurious roots" arise in solving certain algebraic equations. In other cases the content will be an advanced concept that you will not teach, but which provides insight into material you will teach. An example here is the interactions among algebraic ideas like "group homomorphism", linear algebra topics like matrix multiplication, geometry topics like rigid motions, and high school topics like trigonometry.

Your responsibility will be to deepen your understanding of the mathematics and to develop insights into the ways that advanced mathematical issues can inform the way you teach and the way you react to your students' developing understandings and misunderstandings.

Goals of this course

- to learn to see high school mathematics in terms of the abstract definitions and structures studied in advanced mathematics classes.
- to use links between high school and advanced mathematics to better understand both.
- to consider ways in which this understanding might affect the way your teach.
- to work on using mathematical terms precisely in speech and writing.

- to recognize some epistemological and didactical obstacles to the learning of mathematics.

Appendix B: 2016 Syllabus Information for University Alpha's Course

Learning Goals

During this course, you will further develop your capability to:

1. Work with individual students to elicit, probe, and develop their thinking about mathematics content;
2. Explain core content related to fractions;
3. Use specific methods to assess students' learning in mathematics;
4. Recognize and identify common patterns of student thinking about fraction concepts;
5. Identify and implement an instructional strategy using a model to develop understanding in response to common patterns of student thinking; and
6. Choose, appraise, and modify tasks for a specific learning goal.

In addition to these high-leverage practices, you will also begin to develop your ability to:

- Build productive relationships with students
- Develop students' sense of competence
- Provide oral and written feedback

Materials

For this course, you will need to have a video recorder and tripod. Please do not hesitate to let us know if you need assistance in procuring a video recorder and tripod. These are also available for check-out through the Brandon Center in the School of Education.

You will be reading a variety of articles and other materials (e.g., curriculum materials). Many required readings will be provided on CTools, as hard copies, or through a website. One text listed below is the one required book that will be used in this course to support learning about students' ways of thinking about fractions and to enhance understanding of the mathematics of fractions. The other is recommended, but is optional.

(*Required*)
Petit, M. M., Laird, R. E., & Marsden, E. L. (2016). *A focus on fractions: Bringing research to the classroom*. NY: Routledge. (ISBN: 978-0415801515)

(*Optional*)
Carpenter, T., Fennema, E., Fuson, K., et. Al. (1997). *Making sense: Teaching and learning mathematics with understanding*. Portsmouth, NH: Heinemann. (ISBN: 0-435-071132-7)

Appendix C: 2019 Syllabus Information for University Alpha's Course

Learning Goals
During this course, you will further develop your capability to:

1. Work with individual students to elicit, probe, and develop their thinking about mathematics content;
2. Respond to students' ideas and design instructional activities that build on their strengths;
3. Explain fractions and support children to explain mathematical ideas and reasoning;
4. Recognize and identify common patterns of student thinking about fraction concepts;
5. Choose, appraise, and modify tasks for a specific learning goal.
6. Provide oral and written feedback to children

In addition to these high-leverage practices, you will also begin to develop your ability to:

- Attend to children's identities and build productive relationships with them
- Communicate with children skillfully, sensitively, and caringly
- Attend to how children are positioned relative to each other and to mathematics (i.e., notice and intervene on status differences)
- Develop students' positive academic identities
- Publicly and strategically acknowledge children's competence as a lever to intervene on persistent patterns that reproduce racism and marginalization

Materials
For this course, you will need a video recorder and tripod. Please do not hesitate to let us know if you need assistance in procuring these items. These are also available for check-out through the Brandon Center in the School of Education.

You will be reading a variety of articles and other materials. All required readings will be provided on Canvas, except one required book, *Troublemakers: Lessons in Freedom from Young Children*, by Carla Shalaby. We are providing copies of this book to you.

Here are some books that are worth owning to enhance your professional library and your learning to teach. We will be reading excerpts from them this term and next. We are not requiring you to purchase them, but are recommending them to you. We might recommend other titles to you as we get to know you and your interests.

a) Aguirre, J., K. Mayfield-Ingram, and D, B. Martin, (Eds.) (2013). *The Impact of identity in K-8 mathematics: Rethinking equity-based practices.* Reston, VA: National Council of Teachers of M

b) Featherstone, H., Crespo, S., Jilk, L., Oslund, J., Parks, A., and Wood, M. (2011). *Smarter together! Collaboration and equity in the elementary math classroom.* Reston, VA.: National Council of Teachers of Mathematics. (ISBN #: 978-0-87353-656-1)

c) Goffney, I., and R. Gutiérrez (Eds.) (2018). *Rehumanizing mathematics for Black, Indigenous, and Latinx students: Annual Perspectives in Mathematics Education.* Reston, VA: National Council of Teachers of Mathematics.

d) Leonard, J., and Martin, D. B. (Eds.), (2013). *The brilliance of Black children in mathematics: Beyond the numbers and toward new discourse.* Information Age Publishing

e) Petit, M. M., Laird, R. E., & Marsden, E. L. (2016). *A focus on fractions: Bringing research to the classroom.* NY: Routledge. (ISBN: 978-0415801515)

Appendix D: Gloria's Habits of Mind Problem Purchasing Pens

Maria went to the store to purchase ink pens. She found three kinds of pens. The first cost $4 each; the price of the second kind was 4 for $1; and the cost for the third kind was 2 for $1 (note it is possible to buy all types of pens individually if desired). She bought 20 pens and she bought at least one of each kind. The cost was $20. When she got back to her office, Maria decided to turn this into a math problem. She asked: Given that I purchased exactly 20 pens and the cost was $20, how many of each kind of pen did I buy? Your task is to solve this problem using the following guidelines.

- Begin this problem by determining all possibilities for the number of the most expensive pens Maria may have purchased. Explain how you know these are all of the possibilities.
- In mathematics, one strategy for organizing a search for a solution or for writing an explanation is to use "cases". For your solution to the pen problem, organize your work by cases, one case for each of the possible numbers determined in the previous step.
- **Note:** On this Habits of Mind problem, we ask that you make a special effort to write a solution that is an appropriate length (long enough to communicate the major points, but not repetitive, overly detailed or excessive in length). Thus, to receive full credit on this HoM problem, solve the problem *without* creating an exhaustive list of *all* possible pen combinations and price totals. Instead, use reasoning and *some* possible pen combinations and price totals and look for patterns to help justify your answer.
- Be sure to address the question of whether there is only one combination of pens which lead to the correct result or multiple combinations of pens and explain how you know.

Appendix E: Gloria's Habits of Mind Problem Ro-Sham-Bo Robot

In Jeju Island, there is a rumor that a terrifying robot lurks on the outskirts of the island searching for unsuspecting islanders to play against in a game of Rock-paper-scissors. If the robot wins or ties in a 3 round set, then it takes away all of the islander's belongings. If the robot loses, then the robot must give the islander one thousand pieces of gold. There are at most three rounds to a game. Ties do not count as a win for either player, and if the robot and the islanders each have the same number of wins at the end of three rounds, neither player suffers a loss.

Rumor has it that the robot always uses the same pattern when deciding whether to display rock (R), paper (P), or scissors (S). The pattern that the robot uses is R R S R P P R (rock rock scissors rock paper paper rock). The catch is that you don't know where in the pattern that the robot will start! Also, if the robot reaches the end of its pattern (which ends on rock), then the robot will start over at the beginning of the pattern. For example, the robot's first three turns might be rock, rock, scissors, or they could be scissors, rock, paper, or they could be paper, rock, rock.

Your job is to determine whether or not there is a way for the islanders to beat the robot every time in a 3 round set with only the knowledge of what the robot's pattern is (and not knowing where in the pattern the robot will start). If there is a strategy that can beat the robot every time, explain the strategy in sufficient detail and explain why the strategy must always work. If there is no possible strategy, explain why there is no way to beat the robot every time

Hint: Although the islanders have no way of knowing the robot's first move, the remaining moves will be dependent on what the robot played on its previous turn.

For this week's HoM problem we ask that you make a special effort to **organize your argument according to different cases**; if there are different possibilities (or cases) for the robot's first move, you can separate these (into cases) and discuss the options for what might happen next (depending on where the robot is in the pattern). This will help determine a possible strategy. (An example of a solution using cases is below.)

(Note that you should continue to effectively use skills emphasized in previous HoM problems as needed.)

Example of a (partial) mathematical justification using cases:

HoM #1 Question: How many ways are there to make exactly 28 cents using pennies, nickels, dimes, and quarters?

Answer: To answer the question of how many ways coins can be arranged to make 28 cents we will use cases based on the largest type of coin being used in the arrangement. We note that at most one quarter can be used since the value of two is larger than 28 cents. Similarly, at most two dimes, at most five nickels, and at most 28 pennies can be used when finding a combination of coins which make 28 cents. We will find all arrangements of coins which yield 28 cents by organizing them into cases based on the coin of largest value.

Case 1: Arrangements using a quarter

If we require that one quarter be used, then, removing the value of the quarter from the 28 cents, the problem becomes "how many ways can you make 3 cents?" Since the only way to make three

cents is by using three pennies, there is only one way to make 28 cents using a quarter as one of the coins.

Case 2: Arrangements using two dimes

Requiring that two dimes be used to make 28 cents makes the problem equivalent to finding the number of ways to make 8 cents using standard coins. The two ways to make eight cents are (1) using 8 pennies, or (2) using one nickel and three pennies. Combining these with the dimes means there are two ways to make 28 cents using two dimes.

Case 3: Arrangements using one dime

Etc.

Closing paragraphs, conclusion, etc.

Appendix F: Gloria's Habits of Mind Problem: 100 and -1 Patterns with Squares

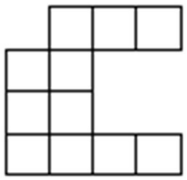

Figure 2

$(n = 2)$

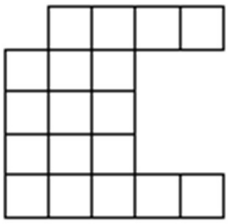

Figure 3

$(n = 3)$

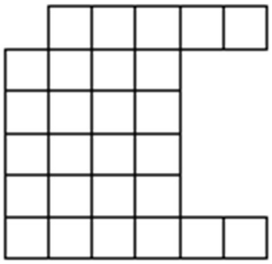

Figure 4

$(n = 4)$

Given the pattern shown above, answer the questions below.

1. What does Figure $n = 100$ look like? Describe it with text and with diagrams. How many squares will be in this figure? Explain how you know.

2. How many squares are in Figure $n = -1$? What does Figure $n = -1$ look like? Note that for this question, there is more than one possible answer so your justification needs to support your result.

Appendix G: Comparison of Required Textbooks from Syllabi

Scott:

Required Course Texts/Materials (discount available to NCTM members on website):

National Council of Teachers of Mathematics. *Catalyzing Change in High School Mathematics: Initiating Critical Conversations.* Reston, VA: Author.

NCTM (2014). *Principles to Actions: Ensuring Mathematics Success for All.* Reston, VA: Author

Stein, M.K., Smith, M.S., Henningsen, M.A., & Silver, E.A. (2009). *Implementing Standards-Based Mathematics Instruction: A Casebook for Professional Development* (2nd edition). New York, NY: Teachers College Press.

Smith, M.S. & Stein, M.K. (2011). *Five Practices for Orchestrating Productive Mathematics Discussions.* Reston, VA: NCTM

Rose:

Resources:

Smith, M. & Stein, M. (2011). 5 Practices for Orchestrating Productive Mathematics Discussions. New York: Corwin.

National Council of Teachers of Mathematics. (2014). *Principles to Actions*. Reston, VA: Author.

State standards

NCTM or state membership

Gerald:

Required Texts:

Lin, A., & Small, M. (2010). More good questions: Great ways to differentiate secondary mathematics instruction. New York, NY: Teachers College Press. (ISBN: 9780807750889)

Leinwand, S. (2009). Accessible Mathematics. Portsmouth, NH: Heinemann. (ISBN: 9780325026565)

Smith, M. S. & Stein, M. K. (2011). 5 Practices for orchestrating productive mathematics discussions. Reston, VA: The National Council of Teachers of Mathematics (NCTM). (ISBN: 978145220907)

Membership in the National Council of Teachers of Mathematics (NCTM.org) is also a course requirement.

Wanda:

NCTM and state membership

Gloria:

Required Text for [redacted]

Van de Walle, J., Karp, K., & Bay-Williams, J. (2016). *Elementary and Middle School Mathematics: Teaching Developmentally* (9th Ed.). Pearson.

National Council of Teachers of Mathematics (NCTM). (2014). *Principles to Action: Ensuring Mathematical Success for All.* Reston, VA: NCTM.

Required Tablets for [redacted]

You are required to have a tablet (e.g., iPad or Android) for use throughout the Elementary Teacher Education Program, beginning in [redacted]. You may be required to purchase applications up to a total cost of $10.00 for use in the course.

Required Text for [redacted]

NEW: Beckmann, Sybilla (5th Ed.). *Mathematics for Elementary Teachers*, Pearson, Addison-Wesley

Appendix H: Gloria's Combined Courses Syllabus

EDUCATION ____ COURSE TITLE (2 credits)

MATH ___ COURSE TITLE (3 credits)

Welcome to the Mathematics Semester. The Departments of Mathematics and Teacher Education have linked MATH ___ and EDUCATION ____/___ to offer you a richly integrated learning experience in the areas of mathematical content and pedagogy as you begin your journey to become an elementary teacher. During the Mathematics Semester, you will be able to connect the math you will study with your preparation to be a teacher. These courses will help you learn to teach children in ways that are mathematically rich while also being responsive to children's ideas. Our goal is to help you become a superb math teacher at the elementary school level—one who has a deep understanding of the math they teach and how to teach that material to their students. Give every assignment your best effort. Be an active participant. Accept the challenge to achieve at a high level but also tell us if you think we are asking too much of you. You are welcome to contact us with questions at any time.

What		**Who**	**Credit/Content**	**When**
1.	Field Experiences	**********		
2.	Pedagogy	**********		
3.	Mathematics	**********		

Course Descriptions

MATH ___ focuses on developing a deep understanding of "number and operations" which forms the core of the K-6 mathematics curriculum. At the same time, emphasis is placed on developing an appreciation for the importance of careful reasoning, problem solving and communicating mathematics both orally and in writing. Attention is given to connections with other areas of mathematics and to the need for developing the "habits of mind of a mathematical thinker."

ED_____ is a math methods course that builds on the content of MATH ___. Pedagogical issues for the mathematical topics of number and operations, fractions, geometry, and measurement are featured in ED_____. The purpose of ED_____ is to help you think hard about the mathematics you will teach from the point of view of a scholar as well as from the vantage point of the child who is learning. You will have the opportunity to explore the teaching of mathematics through investigating how children learn mathematics.

EDUCATION____ provides a bridge between your early education experiences and the methods courses and student teaching yet to come. This professional practicum is closely connected to the coursework you will do in ED_____ and MATH ___. In particular, EDUCATION ____ requires you to incorporate what you are learning in the Mathematics Semester about teaching and learning mathematics into math lessons you will teach this semester and what you are learning about classroom management into your experiences in the classroom setting—within and outside of your math lessons.

ED ____ Course Objectives

1. Establish clear goals for the mathematics that students are learning, situate goals within learning progressions, and use the goals to guide instructional decisions.
2. Select, modify, and implement tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies.
3. Make and facilitate making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving.
4. Plan for and facilitate discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments.
5. Plan for and use purposeful questions to assess and advance students' reasoning and sense making about important mathematical ideas and relationships.
6. Build fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems.
7. Engage in, plan for, and provide students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships.
8. Elicit and use evidence of student thinking to assess progress toward mathematical understanding and to adjust instruction continually in ways that support and extend learning.
9. Develop and demonstrate productive beliefs about essential elements of teaching and learning mathematics, including: access and equity, curriculum, tools and technology, assessment, and professionalism.

Assignments

Autobiography, Goal Statement, Journals (ED ____ and EDUCATION ____) You will do a variety of written reflections on your past experiences and future learning.

Math Lessons (ED ____ and EDUCATION ____) You will plan, teach, and analyze three different math lessons across the semester. Each lesson will have different elements of teaching in focus. Guidelines for planning, teaching, and reflecting on each lesson will be given as needed across the semester and lesson plans.

Teaching and Learning Project (ED ____ and MATH ___) You will solve a math problem and then work in pairs on the math problem with a child in the practicum setting. You will analyze the experience.

Curriculum Project (ED ____ and MATH ___) In groups, you will summarize curriculum standards and trajectories, analyze curriculum materials, develop and implement aligned tasks for student and teacher learning.

Professional Writings (ED ____ and MATH ___) There are many issues in mathematics teaching, in particular, and teaching, more generally, about which you need to educate yourselves and develop an informed opinion. We will read about and discuss some central issues in teaching and you will be expected to reflect on the readings and take a stand in the context of three professional writings. All Professional Writing assignments will be submitted using "Turn It In" in Canvas.

Course Objective Reflections and Competency Statements (ED ____) Twice during the semester you will have the opportunity to reflect upon the Course Objectives as well as develop Competency Statements for the Mathematics semester. The purpose of these reflections are to offer opportunities for insight into Mathematical learning throughout the semester and to provide a summary of your growth and learning at the end of the course.

Reading Quizzes (ED ____) You are responsible for completing a brief, online quiz accompanies that each assigned chapter throughout the course. Each quiz allows up to three attempts. The two lowest quiz scores are dropped at the end of the semester.

Midterm (308) This exam will assess your progress in core areas of the course during the first half of the semester. It will include an assessment of your understanding of mathematics for teaching; your ability to use that knowledge in teaching; your ability to attend to students' mathematical ideas; your knowledge and skills with respect to designing and enacting curriculum; and your ability to reason and to reflect on your own decisions about teaching.

Professional Growth Project (ED ____) The Final Project presentation will assess your progress and growth in understanding relating to course objectives. For this project, you will create and present a poster and written summary during class on the last day of regularly scheduled semester courses.

Habits of Mind Problems (MATH ___) These challenging mathematics problems help develop the habits of mind of a mathematical thinker. A total of 10 of these problems will be assigned and you will have the opportunity to revise two of them (details to be shared later). Solutions must be written up neatly with careful attention paid to explaining your reasoning. Group work is encouraged. The use of outside resources (people, books, the web, etc.) is considered academic dishonesty. These will be submitted with a partner in Canvas.

Mathematical Knowledge for Teaching (MKT) (MATH ___) Your understanding of mathematics *for teaching* will be assessed using an innovative set of problems developed at _____.

MATH ___ Exams You will have two 100 point mathematics exams during the semester and a 150 point Final Exam during Final Exam Week. The use of calculators on exams is permitted, but phones are not.

Appendix I: Rose's Assessment Rubric

Assessment #4

Rubric for _____ in Mathematics

Overall Assessment: **Target:** **____ of 28 Elements/Components of Elements**

Acceptable: **____ of 28 Elements/Components of Elements**

Unacceptable: **____ of 28 Elements/Components of Elements**

	Target	**Acceptable**	**Unacceptable**
Mathematical Practices – Problem Solving. Effective teachers solve problems. Intern can design and use a variety of' stimulating curricula that provide experiences that • Use problem solving to develop conceptual understanding, • Make sense of a wide variety of problems and persevere in solving them, • Apply and adapt a variety of strategies in solving problems confronted within the field of mathematics and other contexts. • Formulate and test conjectures in order to frame generalizations. (2a. Use problem solving to develop conceptual understanding, make sense of a wide variety of problems and persevere in solving them, apply and adapt a variety of strategies in solving problems confronted within the field of mathematics and other contexts, and formulate and test conjectures in order to frame generalizations.)			
2a.1	Consistent use of mathematical activities and investigations that provide students with opportunities to use problem solving to develop conceptual understanding.	Inconsistent use of mathematical activities and investigations using problem solving to develop conceptual understanding.	Use of problem solving to develop conceptual understanding is limited or unclear.
2a.2	Opportunities for students to be engaged in problem solving activities within the field of mathematics and making connections to real world contexts.	Opportunities for students to participate in problem solving activities within the field of mathematics. Candidate illustrates (provides) examples of connections to real world contexts.	Does not include opportunities for students to be engaged in problem solving activities or the activities only include context within the field of mathematics.

2a.3	Creates opportunities to showcase a variety of students' problem solving strategies and encourages students to make sense of problems and persevere in solving them.	Encourages a variety of problem solving strategies and encourages students to make sense of problems and persevere in solving them but does not showcase students' strategies.	Communication of problem solving strategies is limited or unclear. Does not encourage students to make sense of problems and persevere in solving them.
2a.4	Includes mathematical activities and investigations that allow for students to formulate and test conjectures in order to frame generalizations.	Includes experiences that allow for student discovery but lacks the proper foundation for students to frame generalizations.	Does not design experiences that allow for students to formulate and test conjectures in order to frame generalizations.
Mathematical Practices – Reasoning. Effective teachers reason abstractly. Intern can design and use a variety of stimulating curricula that provide experiences that require • Abstract, reflective and quantitative reasoning with attention to units, constructing viable arguments and proofs and critiquing the reasoning of others; • Representing and modeling generalizations using mathematics; recognizing structure and expressing regularity in patterns of mathematical reasoning; • Using multiple representations to model and describe mathematics; and • Utilizing appropriate mathematical vocabulary and symbols to communicate mathematical ideas to others. (2b. Reason abstractly, reflectively, and quantitatively with attention to units, constructing viable arguments and proofs, and critiquing the reasoning of others; represent and model generalizations using mathematics; recognize structure and express regularity in patterns of mathematical reasoning; use multiple representations to model and describe mathematics; and utilize appropriate mathematical vocabulary and symbols to communicate mathematical ideas to others.)			
2b.1	Reasons abstractly, reflectively and quantitatively with attention to units, constructing viable arguments and proofs.	Communicates mathematical reasoning with clarity, precision, and logical order.	Communicates mathematical reasoning using inappropriate strategies or flawed arguments that are vague or imprecise.
2b.2	Able to understand, critique, and respond coherently to the	Attempts to understand, critique, and respond coherently to the mathematical	No evidence of understanding the

	mathematical reasoning and strategies of others. Able to understand correct components of student thinking and offers guidance as needed.	reasoning and strategies of others. Inconsistently understands correct components of student thinking or guidance offered do not encourage student perseverance.	mathematical reasoning and strategies of others.
2b.3	Represents and models generalizations using mathematics while providing opportunities for students to recognize patterns of mathematical reasoning.	Represents and models generalizations using mathematics while recognizing patterns of mathematical reasoning.	Neither represents nor models generalizations using mathematics.
2b.4	Communicates mathematical ideas using a variety of representations and recognizes and clarifies the connections between the representations.	Communicates mathematical ideas using more than one type of representation but with no attempt to recognize the connections between the representations.	Communicates mathematical ideas using a single representation.
2b.5	Uses appropriate vocabulary and symbols to communicate mathematical ideas to others, and clearly communicates to students that they are expected to communicate their reasoning precisely.	Uses appropriate vocabulary and symbols to communicate mathematical ideas to others.	Does not use appropriate vocabulary and symbols to communicate mathematical ideas to others.
3e. Implement techniques related to student engagement and communication including selecting high quality tasks, guiding mathematical discussions, identifying key mathematical ideas, identifying and addressing student misconceptions, and employing a range of questioning strategies.			
3e.1	Uses techniques related to student engagement and communication including selecting high quality tasks often.	Uses techniques related to student engagement communication including selecting high quality tasks occasionally.	Does not use techniques related to student engagement and communication including selecting high quality tasks.

3e.2	Uses techniques related to student engagement and communication including guiding mathematical discussions and identifying key mathematical ideas often	Uses techniques related to student engagement and communication including guiding mathematical discussions and identifying key mathematical ideas occasionally	Does not use techniques related to student engagement and communication including selecting guiding mathematical discussions and identifying key mathematical ideas
3e.3	Uses techniques related to student engagement and communication including addressing student misconceptions often	Uses techniques related to student engagement and communication including identifying and addressing student misconceptions occasionally	Does not use techniques related to student engagement and communication including addressing student misconceptions
3e.4	Uses techniques related to student engagement and communication including employing a range of questioning strategies often (four or more strategies)	Uses techniques related to student engagement and communication including employing a range of questioning strategies occasionally (less than four strategies)	Does not implement techniques related to student engagement and communication including employing a range of questioning strategies
3g. Monitor students' progress, make instructional decisions, and measure students' mathematical understanding and ability using formative and summative assessments.			
3g.1	Uses both formative and summative assessment data in making instructional decisions. Assessment processes distinguish developmental levels of students' mathematical knowledge and skills.	Uses formative or summative assessment data in making instructional decisions.	Does not use formative or summative assessment data in making instructional decisions.
3g.2	Monitors students' progress using a variety of assessment tools that gauge advancement toward stated learning goals. Teacher candidate designs assessment processes that distinguish among developmental levels of	Monitors students' progress using a limited number of assessment tools that gauge advancement toward stated learning goals.	Does not monitors students' progress using a assessment tools that gauge advancement toward stated learning goals.

	students' mathematical knowledge and skills.		
3g.3	Uses both formative and summative assessments to measure students' mathematical understanding and ability. Teacher candidate designs assessment processes that distinguish among developmental levels of students' mathematical knowledge and skills.	Uses either formative or summative assessments, but not both to measure students' mathematical understanding and ability but not both.	Does not use formative and summative assessments to measure students' mathematical understanding and ability.
4d. Demonstrate equitable and ethical treatment of and high expectations for all students.			
4d.	Equitable and ethical treatment of and high expectations for all students is demonstrated during lesson and observed by cooperating teacher during internship.	Equitable and ethical treatment of and high expectations for all students is demonstrated during lesson or observed by cooperating teacher during internship.	No evidence of equitable and ethical treatment of and high expectations for all students.
4e. Apply mathematical content and pedagogical knowledge to select and use instructional tools such as manipulatives and physical models, drawings, virtual environments, spreadsheets, presentation tools, and mathematics-specific technologies (e.g., graphing tools, interactive geometry software, computer algebra systems, and statistical packages); and make sound decisions about when such tools enhance teaching and learning, recognizing both the insights to be gained and possible limitations of such tools.			
4e.1	Instructional tools used to enhance teaching and learning, recognizing both the insights to be gained and possible limitations of such tools.	Instructional tools used to enhance the teaching and learning but no insights to be gained and possible limitations of such tools.	No use of instructional tools

4e.2	Mathematics specific technologies used to enhance teaching and learning, recognizing both the insights to be gained and possible limitations of technologies	Mathematics specific technologies used to enhance teaching and learning, but no recognition of both the insights to be gained and possible limitations of technologies	No use of mathematics specific technologies
5b. Engage students in developmentally appropriate mathematical activities and investigations that require active engagement and include mathematics-specific technology in building new knowledge.			
5b.1	Opportunities for students to be engaged in developmentally appropriate mathematical investigations. Evidence that pacing is appropriate. Lessons capture perplexity of content. Students are given an opportunity for reflection.	Opportunities for students to be engaged in developmentally appropriate mathematical investigations. Evidence that pacing is mostly appropriate. Lessons attempt to capture perplexity of content but missing a key components. Students are given an opportunity for reflection.	No engagement of students in developmentally appropriate mathematical investigations
5b.2	Opportunities for students to use mathematics specific technologies appropriate to the learning objectives	Opportunities for students to use mathematics specific technologies but not connected to the learning objectives in a meaningful way	No opportunities for students to use mathematics specific technology
6c. Utilize resources from professional mathematics education organizations such as print, digital, and virtual resources/collections.			
6c.	Use of a variety of resources from professional mathematics education organization including print, digital, and/or virtual resources	Use of resources from professional mathematics education organization including print, digital, and/or virtual resources	No use of resources from professional mathematics education organization including print, digital, and/or virtual resources

7a. Engage in a sequence of planned field experiences and clinical practice prior to a full-time student teaching/internship experience that include observing and participating in both middle and high school mathematics classrooms and working with a diverse range of students individually, in small groups, and in large class settings under the supervision of experienced and highly qualified mathematics teachers in varied settings that reflect cultural, ethnic, linguistic, gender, and learning differences.			
7a.1	Engage in a sequence of planned field experiences and clinical practice prior to a full-time student teaching/internship experience that include observing and participating in both middle and high school mathematics classrooms under the supervision of experienced and highly qualified mathematics teachers	Engage in a sequence of planned field experiences and clinical practice prior to a full-time student teaching/internship experience that include observing and participating in only high school mathematics classrooms under the supervision of experienced and highly qualified mathematics teachers	Did not engage in a sequence of planned field experiences and clinical practice prior to a full-time student teaching/internship experience that include observing and participating in both middle and high school school mathematics classrooms under the supervision of experienced and highly qualified mathematics teachers
7a.2	Work with a diverse range of students individually, in small groups, and in large class settings under the supervision of experienced and highly qualified mathematics teachers	Work with a diverse range of students individually, in small groups, or in large class settings (but not all three) under the supervision of experienced and highly qualified mathematics teachers	Did not work with a diverse range of students individually, in small groups, and in large class settings under the supervision of experienced and highly qualified mathematics teachers
7a.3	Worked in a variety of settings that reflect cultural, ethnic, linguistic, gender, and learning differences	Worked in a variety of settings that reflect cultural, ethnic, linguistic, gender, or learning differences (but not all five)	Did not work in a variety of settings that reflect cultural, ethnic, linguistic, gender, and learning differences
7b. Experience full-time student teaching/internship in secondary mathematics that is supervised by a highly qualified mathematics teacher and a university or college supervisor with secondary mathematics teaching experience or equivalent knowledge base.			
7b.	Completed full-time student teaching/internship in secondary mathematics supervised by a highly	Completed full-time student teaching/internship in secondary mathematics supervised by a highly qualified mathematics teacher and a	Did not complete full-time student teaching/internship in secondary mathematics supervised by a highly qualified mathematics teacher

	qualified mathematics teacher and a university or college supervisor with secondary mathematics teaching experience or equivalent knowledge base.	university or college supervisor without secondary mathematics teaching experience or equivalent knowledge base.	and a university or college supervisor with secondary mathematics teaching experience or equivalent knowledge base.
7c. Develop knowledge, skills, and professional behaviors across both middle and high school settings; examine the nature of mathematics, how mathematics should be taught, and how students learn mathematics; and observe and analyze a range of approaches to mathematics teaching and learning, focusing on tasks, discourse, environment, and assessment.			
7c.1	Observations provide evidence the teacher candidate has developed the knowledge, skills and professional behaviors necessary to examine the nature of mathematics, how mathematics should be taught, and how students learn mathematics. Evidence spans both middle and high school mathematics and documents specific ways in which candidate has drawn upon research in mathematics education and professional development to inform practice.	Observations provide evidence the teacher candidate has developed the knowledge, skills and professional behaviors necessary to examine the nature of mathematics, how mathematics should be taught, and how students learn mathematics. Evidence spans only middle or high school mathematics.	Observations do not provide evidence the teacher candidate has developed the knowledge, skills and professional behaviors necessary to examine the nature of mathematics, how mathematics should be taught, and how students learn mathematics.
7c.2	Observations provide evidence the teacher candidate has developed the knowledge, skills and professional behaviors necessary to analyze a range of approaches to mathematics teaching and learning, focusing on	Observations provide evidence the teacher candidate has developed the knowledge, skills and professional behaviors necessary to analyze a range of approaches to mathematics teaching and learning, focusing on tasks,	Observations do not provide evidence that the candidate has developed the knowledge, skills or professional behaviors necessary to analyze approaches to mathematics teaching and learning, tasks,

	tasks, discourse, environment, and assessment. Candidate documents specific collaborations with cooperating teacher, peers, and university supervisors.	discourse, environment, and assessment.	discourse, environment, or assessment.

Appendix J: Becky's Assessment Rubric

Part a. ***Description of the assessment.***

Problem-based Unit of Instruction. All secondary teacher candidates in mathematics are required to the mathematics methods course, . Most candidates will take this course in the fall during the senior year the semester before student teaching. This course is designed to discuss current literature about mathematics instruction and the classroom environment in secondary classrooms, bridging the gap between theory and practice. In addition to the course, teacher candidates will have a field placement in secondary mathematics classrooms.

The assessment is a problem-based unit of instruction. The unit plan will incorporate a variety of strategies that draw upon literature for best practices for effective teaching. If teacher candidates fall below standard on this unit plan, they will be provided feedback from the instructor for revisions to assist them in meeting standard. Failure to revise the unit so it meets standard may result in the teacher candidate not passing the course.

Part b. ***Alignment of assessment to standards.***

The table below provides an overview of the NCTM Standards aligned to the problem-based unit of instruction. A scoring guide is included in Part f with additional detail.

Program Standard	**Elements Addressed**
Standard 3: Content Pedagogy	3a, 3b, 3c, 3d, 3e, & 3f
Standard 4: Mathematical Learning Environment	4b & 4e
Standard 6: Professional Knowledge and Skills	6b & 6c

Part e. ***Assessment Tool***

The problem-based unit of instruction should include all components described in the table below. The information should be displayed in a clear and logical manner with enough detail to allow anyone to teach the unit when provided with your binder.

COMPONENT	DESCRIPTION
1. INTRODUCTION (3a) a. Title/Authors b. Table of Contents c. Target Audience d. Project Description e. Driving Question/Grand Challenge f. Goals of Unit g. Objectives of Unit h. Standards	a. include group member names b. may be page-numbered or organized into sections c. grade level(s) and course(s) for which unit is designed d. brief discussion of central theme or concepts, scope and sequence of lessons, and description of final product; provides overview of content covered in until including how the unit connects to previous and future mathematics content. e. engaging, concise question that drives the unit f. describes the larger context of the project's objectives; gives the 'big ideas' the individual lessons develop g. lists specific skills, knowledge, or products that "students will be able to…" do or complete by the end of the project h. lists the national and/or state standards that will be introduced, developed, or demonstrated in the unit
2. ANCHOR VIDEO (3d & 4e)	The anchor video should engage students directly with the grand challenge to be explored. It should be situated in real-world events or experiences that are relevant and help students identify the math or science concepts that may be applied in the unit.
3. GENERATE IDEAS (3e)	An activity on the first day of a problem-based unit that allows students to explore their initial thoughts and ideas related to the Grand Challenge. This group activity allows students to explore to problem posed using data or resources.
4. PBI UNIT CONCEPT MAP (3d)	The concept map should provide a visual representation of all the concepts addressed within the unit plan including detailed connections between concepts covered during the unit as well as connections to content that would proceed and follow the unit.

5. PROBLEM CALENDAR (3e & 4b)	Detailed list of activities, sequenced daily over the course of the PBI unit along with aligned objectives and activities.
6. LESSON PLANS (3a, 3b, 3c, 3d, 3f, 4b, & 4e)	At least five lesson plans should be include for the unit. These lesson plans should draw from appropriate literature on effective mathematics instruction in secondary classrooms and make use of varied strategies (e.i., group work, meaningful discourse, manipulatives). Instruction should also apply differentiated instruction techniques and consider modifications as needed to support learning for all students. At least one lesson will need to be integrated.
7. PRE-ASSESSMENT (3f)	Provide an appropriate pre-assessment aligned to unit objectives.
8. 'GO PUBLIC' PLAN (3f)	Description of the final student product in detail, how the product will be presented and the rubric to assess the quality of final product. The assessment must include a public dissemination component.
9. LETTER TO PARENT (6b)	Correspondence that would be sent home to the students that: a. Explains purpose of problem b. Describes final student product c. Requests any materials they may need to be provided by student d. May invite parents to a final 'presentation' or culminating event for PBI unit Letter should be professionally written in business letter format and on letterhead.
10. RESOURCES (4e)	List all resources needed to complete the PBI Unit including equipment or supplies for each lesson, web sites that students may use, technology used, experts or guest presenters, etc.

Part f. ***Assessment Scoring Guide***

NCTM CAEP Element Alignment	Unacceptable	Acceptable	Target
Unit Overview: Narrative focuses on educational value of the unit plan within the context of curriculum standards for secondary mathematics and their relationship to student learning by the following: • What the unit will enable students to do. • How it connects to real-life and relevant contexts. • How content prepares students to be more successful in other areas or topics in mathematics.			
3a.1	*Overview does not clearly communicate the value of the unit*	*Overview communicates the value of the unit within the context of curriculum standards, but some explanations may not be thoroughly developed across mathematical domains.*	*Overview thoroughly communicates the value of the unit within the context of curriculum standards and across mathematical domains.*
Content Pedagogy – Curriculum Standards: Effective teachers apply knowledge of curriculum standards for secondary mathematics and their relationship to student learning within and across mathematical domains.			
3a.2	*Goals of instruction vague, unclear or not quite appropriate.*	*Instruction is developmentally appropriate and clearly communicates student learning outcomes based on content standards.*	*Instruction engages students in developmentally appropriate mathematical investigations and clearly communicates student learning outcomes based on content standards.*
Content Pedagogy – Research in Planning. Effective teachers analyze and consider research in planning for and leading students in rich mathematical learning experiences.			
3b, 6c	*Unit does not include research citations to appropriate research or research cited does not clearly relate to the unit's student learning.*	*Unit includes research citations and brief description identifying how the research was used to fit instructional needs.*	*Unit includes numerous research citations and identifies how the research was used to fit instructional needs.*
Content Pedagogy –Lesson Planning. Effective teachers plan lessons and units that incorporate a variety of strategies, differentiated for diverse populations, and mathematics specific and instructional technologies in building all students' conceptual understanding and procedural proficiency.			

3c.1	*Lesson plans does not include a variety of instructional strategies.*	*Lesson plans include more than one instructional strategy that could be differentiated for diverse populations.*	*Lesson plans include variety of instructional strategies differentiated for diverse populations.*
3c.2	*Lesson plans inappropriately incorporate mathematics specific technology or fails to build students' conceptual understanding and procedural proficiency.*	*Lesson plans appropriately incorporate mathematics specific technology in an attempt to build students' conceptual understanding and procedural proficiency.*	*Lesson plans appropriately incorporate mathematics specific technologies to effectively build all students' conceptual understanding and procedural proficiency.*
NCTM CAEP Element Alignment	**Unacceptable**	**Acceptable**	**Target**
Content Pedagogy –Connections. Effective teachers incorporate strategies that provide students with opportunities to make connections to real-life and relevant contexts.			
3d	*Planning does not include opportunities for students to communicate about mathematics and/or make connections among mathematics.*	*Planning includes an opportunity for students to communicate about mathematics and/or make connections among mathematics.*	*Planning includes provisions for students to have several opportunities to communicate about mathematics and make connections among mathematics, other content areas, everyday life, and the workplace.*
Content Pedagogy –Engagement and Communication. Effective teachers incorporate strategies that provide opportunities for student engagement and communication, including facilitating meaningful discussions, the selection of high quality, worthwhile tasks, identifying and addressing student misconceptions, and using various questioning methods.			
3e	*Planning does not include techniques to engage students at the beginning of the unit.*	*Planning includes at least one technique to engage students at the beginning of the unit.*	*Planning includes the use of techniques to foster student engagement and communication (i.e., selecting high quality tasks, guiding mathematical discussions,*

			identifying key mathematical ideas, identifying and addressing student misconceptions, and employing a range of questioning strategies).
Content Pedagogy – Assessment Plan. Effective teachers plan select, implement, interpret, and use formative and summative assessments to inform instruction by reflecting on mathematical proficiencies for all students.			
3f	*Assessments do not measure student proficiencies associated to the student learning outcomes.* *OR* *Assessments focus on student recall of facts and algorithms with no evidence of interest in understanding the ways students think about mathematics and skewed with regard to level of thinking and difficulty.*	*Candidate designs both formative and summative assessments to effectively measure student proficiencies associated to all student learning outcomes.* *Assessments focus on understanding the ways student think about mathematics but with limited strategies or skewed with regard to level of thinking or difficulty.*	*Candidate designs both formative and summative assessments to effectively measure student proficiencies associated to all student learning outcomes.* *Assessments include a variety of strategies focusing on understanding the ways students think about mathematics as well as varying levels of thinking and difficulty.*
NCTM CAEP Element Alignment	**Unacceptable**	**Acceptable**	**Target**
Mathematical Learning Environment – Lesson Planning. Effective teachers plan and create developmentally appropriate sequential, and challenging learning opportunities grounded in mathematics education research in which students are actively engage in building new knowledge for prior knowledge experiences.			
4b.1	*Lesson plans do not create challenging learning opportunities or are not developmentally appropriate.*	*Lesson plans create learning opportunities that are developmentally appropriate but either too challenging or not challenging enough.*	*Lesson plans are sequenced to create challenging learning opportunities that are developmentally appropriate.*
4b.2, 6c	*Lesson plans are not grounded in*	*Instructional strategies are grounded in mathematics*	*Instructional strategies are*

	mathematics education research.	*education research. (5E instruction model, Marzano's Best Practices, etc.)*	*grounded in mathematics education research in which students are actively engaged.*
4b.3	*Lesson plans do not build new knowledge from prior knowledge and experiences.*	*Lesson plans build new knowledge from prior knowledge and experiences.*	*Lesson plans actively engage students in building new knowledge from prior knowledge and experiences.*
Mathematical Learning Environment – Instructional Tools and Mathematics Specific Technologies. Effective teachers apply mathematical content and pedagogical knowledge to select and use instructional tools such as manipulatives and physical models, drawings, virtual environments, spreadsheets, presentation tools, and mathematics specific technologies (e.g., graphing tools, interactive geometry software, computer algebra systems, and statistical packages); and make sound decisions about when such tools enhance teaching and learning, recognizing both the insights to be gained and possible limitations of such tools.			
4e.1	*No attempt to use* ***instructional tools*** *and no reasonable explanation why the limitations of the tools do not enhance learning.*	*Unit clearly describes how the* ***instructional tools*** *will be used to enhance the teaching and learning.*	*Unit clearly describes how the* ***instructional tools*** *will be used to enhance teaching and learning, recognizing both the insights to be gained and possible limitations of such tools.*
4e.2	*No attempt to use* ***mathematics*** *specific* ***technologies*** *and no reasonable explanation regarding the possible limitations of technologies.*	*Unit clearly describes how the* ***mathematics specific technologies*** *will be used to enhance teaching and learning, recognizing either the insights to be gained OR possible limitations of technologies.*	*Unit clearly describes how the* ***mathematics specific technologies*** *will be used to enhance teaching and learning, recognizing both the insights to be gained and possible limitations of technologies.*

NCTM CAEP Element Alignment	Unacceptable	Acceptable	Target
Professional Knowledge and Skills: Effective teachers of secondary mathematics are lifelong learners and recognize that learning is often collaborative. They participate in professional development experiences specific to mathematics and mathematics education, draw upon mathematics education research to inform practice, continuously reflect on their practice, and utilize resources from professional mathematics organizations.			
6b	*No attempt is made to communicate project goals or expectations to students' families.*	*Involves families by writing a parent/guardian letter but does not clearly communicate project goals and expectations.*	*Involves families by writing a parent/guardian letter communicating project goals and expectations as well as inviting them to culminating student project presentations.*