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Relations of Mathematics Teacher Education Research Categories with Pre-Service Teacher Education Syllabi

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RELATIONS OF MATHEMATICS TEACHER EDUCATION RESEARCH CATEGORIES WITH PRE-SERVICE TEACHER EDUCATION SYLLABI

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Abstract

Using an evaluative tool, the Mathematics Teacher Educator (MTEd) Instrument, mathematics teacher education syllabi were analyzed to determine the extent to which practice lines up with research at the mathematics teacher educator level. Analysis revealed that only moderate evidence of research-to-practice was found. Technology and assessment were the only categories that were correlated across all combinations of the data set (elementary, secondary, full) to overall score. Consequently, technology and assessment may be overall indicators of the level of research-to-practice contained in mathematics teacher education courses. The elementary and secondary course syllabi only differed in the area of content knowledge (elementary evidenced higher levels). This is consistent with literature, where more content knowledge may be necessary for pre-service elementary teachers. Finally, course hours were not related to overall score. Therefore, more course hours may not be the panacea for ensuring a research-to-practice connection is forged during pre-service mathematics teacher education courses.

Keywords: mathematics teacher educator, pre-service teacher education, research-to-practice, course syllabi, MTEd Instrument

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Chapter 1: Introduction

Of great interest over the last century has been the relationship, and often the gap, between research and practice in education (NCTM Research Committee, 2007). The relationship between research and practice can be viewed as a relationship between a theoretical body of knowledge in the hands of researchers and the practices carried out by teachers (Malara & Zan, 2008). They discuss how theory modifies the teacher and then the teacher modifies their practice accordingly. For this flow of change to occur, it is outlined by Malara and Zan that two conditions must be met: “the teacher must be able to absorb this research, in particular, they must be aware of their role as decision makers; and the research itself must be conveyed in forms which are accessible also to practitioners” (p. 546).

Figure 1

Malara and Zan’s (2008) Theory-to-Practice Relationship

Theory	→ *Modifies*	**Teacher**	→ *Modifies*	**Practice**

It is important to note that there can also be a backwards flow of modification from practice-to-theory. Craft knowledge is one such concept that attempts to describe this backwards flow of modification. Craft knowledge is developed during the teaching practice through the process of reflection and practical problem-solving. Craft knowledge is not theoretical, rather practical and it can be informed by theoretical understandings, ideological concepts, or scholarly knowledge (Cooper & McIntyre, 1996). As such, reflection and practical problem-solving during the act of teaching (practice) can help modify how teachers understand research and also how teachers (re)produce research.

From a policy perspective, the interest in linking research-to-practice has resulted in numerous policy initiatives in all regions of the world. Many jurisdictions are increasingly using research-based discourse to frame their initiatives (NCTM Research Committee, 2007). At the same time, robust research studies continue to emerge within the field of mathematics teacher education and mathematics education. As proposed in this current research, dominant research themes in mathematics teacher education and mathematics education include: reflective practice, mathematical tasks, lesson study, assessment and evaluation, theory and practice connections, policy and politics of mathematics education, equity and diversity, affect (beliefs and attitudes), content knowledge, pedagogical knowledge, and technology.

With the increased interest in linking research-to-practice and the existence of numerous and robust research studies in the field of mathematics teacher education, a question arises about how research is informing the practices of mathematics teacher educators. As such, the primary research problem of this current research is understanding the extent to which research is informing the practices of mathematics teacher educators, and thus the way in which pre-service teachers learn to teach mathematics.

This current research is an extension of a pilot study entitled *The Impact of Mathematics Teacher Education Research on Pre-Service Teacher Education* (Clark, Kotsopoulos, Morselli, & Purdy, 2011). The pilot study was conducted by a group of mathematics education researchers (Clark, Kotsopoulos, & Morselli) and one research assistant (Purdy).

1.1 Pilot Study Overview

As a way to begin to examine this potential research-to-practice gap, the pilot study chose to examine mathematics education course syllabi from around the world. As a first step, the researchers conducted a pilot study on a small sample of course syllabi using an evaluative instrument developed to assess the syllabi. The evaluative instrument was developed by the research group and took the form of a rubric. It was developed out of the dominant research themes in mathematics education and later took the name Mathematics Teacher Educator (MTEd) Instrument (see Appendix A, for the MTEd Instrument). The dominant research themes identified in the MTEd Instrument were: reflection, mathematical tasks, lesson study, assessment, theory and practice connections, policy and politics of mathematics education, equity and diversity, affect, content knowledge, pedagogical content knowledge, and technology.

The purpose of the pilot study was to determine whether the MTEd Instrument could be used to answer the overriding research question; *How is research reflected in mathematics teacher educators' practices, as evidenced in course syllabi?* Additionally, the pilot study sought to allow for the refinement of the MTEd Instrument (see Appendix A, for the MTEd Instrument) before extensive analysis took place.

1.2 Extension of Pilot Study into Current Research

The purpose of the current research is to build off of the pilot study and continue to examine the extent to which research is informing the practices of mathematics teacher educators, and thus the way in which pre-service teachers learn to teach mathematics. In this respect, the current research examines the same research question as the pilot study; *How is research reflected in mathematics teacher educators' practices, as evidenced in course syllabi?* While the two research studies have the same research questions, the intent of the current research is to be able to answer the research question in a more comprehensive manner than in the pilot study.

Essentially, the aim of the current research is to take a sample from the full syllabi data set in order to raise the issue of research-to-practice take-up at the mathematics teacher educator level and to critique potential implications of gaps that may or may not exist.

Additionally, there are several important variations between the pilot study and the current research. First, the pilot study only analyzed one or two syllabi from each of the following geographical regions: Australia, Canada, Europe, Asia, and the United States of America, whereas, the current research analyzes 31 syllabi from various geographical regions. The goal of the current research is to analyze a larger sample size in order to potentially reduce uncertainty in results and allow broader conclusions to be drawn. Second, the current research will examine possible answers to the research question using quantitative measure as opposed to just descriptive statistics, as was done in the pilot study.

Aside from the fact that this current research has grown out of a pilot study, there is a lack of relevant research on this topic in academia. Although there are a lot of research-to-practice studies, there is not many that look at syllabi to find out the extent to which research is informing the practices of mathematics teacher educators. Through the use of a systematic review of literature, it was found that the studies that do exist largely focus on common elements of syllabi (Taylor & Ronau, 2006) or programmatic goals reflected in syllabi (Harrington & Enochs, 2009). The review of literature revealed that no studies were found that explored the relationship between research and practice from the mathematics teacher educator's perspective.

Some of the databases included in the systematic review were: Journal Storage (JSTOR), Sage Full Text Collection (Education), and Google Scholar. The original search terms were: *mathematics (all text), education (all text), research (all text), practice (all text), university (all text),* and *courses (all text)*. From this search, 20 874 articles were found and 100 of them were reviewed for relevancy. The original search terms were then adjusted four more times to refine the search and to account for alternative terms that other countries might use. The first iteration of the search terms was the same as the original expect that *pre-service (all text)* was added. This search returned 624 articles and 100 of them were reviewed for relevancy. Following this, a second iteration of the search terms took place that was the same as the first iteration except that the terms *mathematics*, *education*, and *research* were required to be in the title of the article. From this search 13 articles were found and all were reviewed for relevancy. The next iteration of the search terms was the same at the first iteration except that *survey (all text)* was substituted in for *pre-service (all text)*. This search returned 11 211 articles and 100 articles were reviewed for relevancy. Finally, the last iteration of the search terms was the same as the second iteration except that *survey (all text)* was substituted in for *pre-service (all text)*. From this last search 33 articles were returned and all were reviewed for relevancy. Remarkably, through the systematic review of literature, little research was found to exist that examines the research-to-practice practices of mathematics teacher educators. This current research aims to fill this gap.

Chapter 2: Literature Review

The goal of this research is to reveal insight into the extent to which course syllabi reflect research findings. As a result, it is vital to explore current mathematics teacher education research in order to define dominant research areas that should be visible in mathematics teacher educator's practice, as evidenced through their course syllabi. In addition to gaining knowledge about the dominant research areas, it is also important to understand the opportunities that pre-service teachers need to be given during their teacher preparation program in order to become effective mathematics teachers.

Since many research areas are the focus of the MTEd Instrument, only a brief overview can be provided for each of the dominant areas of research. Additionally, the order in which the dominant research areas are mentioned in the literature review is random and there is no weighting system associated with these research areas.

2.1 Reflection

Prospective teachers need opportunities to learn how to engage in thinking about their teaching. Artzt and Armour-Thomas (2002) contended that for teachers to develop their teaching practice, they must engage in reflection before, during, and after implementing a lesson. In the same way, prospective teachers must participate in those same forms of reflection throughout their teacher preparation program (Chapman, 2009).

It has been proposed that reflection, for the purposes of pre-service teacher education, can be divided into two broad categories, incident reflection and process reflection (Ricks, 2010). According to Ricks (2010), incident reflection would occur when a pre-service teacher encounters an unplanned incident or episode and process reflection would occur when a pre-service teacher engages in planned reflection that allows for the progression and refinement of an idea.

Similar to Ricks' (2010), Clark, Kotsopoulos, and Morselli (2009) define three different types of reflection: a priori reflection, where a pre-service teacher thinks in advance about a topic: an initeri reflection, where a pre-service teacher engages in reflection in the moment of a task or teaching: and a posteri reflection, where reflection upon an action, lesson, or task occurs after the fact. These authors propose that pre-service teachers need to be given opportunities to engage in all three types of reflection during their teacher preparation program.

2.2 Mathematical Tasks

Mathematical tasks are proposed to have an important role in mathematics teacher education, as evidenced by a special issue article in the Journal of Mathematics Teacher Education (Watson & Mason, 2007; Zaslavsky, 2007) devoted to the analysis and discussion of different ways teacher educators use mathematics-related tasks in mathematics teacher education.

Watson and Sullivan (2008) distinguish between *classroom tasks*, that is "questions, situations and instructions teachers might use when teaching students" (p. 109) and *tasks for teachers*, that is "the mathematical prompts, many of which are classroom tasks, that are used as part of teacher learning" (p. 109). The authors suggest that tasks for teachers may have different purposes including: informing teachers about a wide range of possible classroom tasks, leading teachers to learn more mathematics, and leading teachers to reflect on the nature of mathematical activities and the student learning processes.

Consequently, the understanding promoted by mathematical "tasks can provide an effective and meaningful basis to help pre-service teachers to develop deeper understandings" (Chapman, 2007, abstract). In turn, it is likely that when pre-service teachers are given opportunities to engage in pupil level and pre-service teacher-level mathematical tasks, they will gain a blend of mathematical and pedagogical knowledge (noting that depending on the way the teacher educator uses or presents the mathematical tasks, one of the two can be highlighted to a greater extent).

2.3 Lesson Study

Adopted from practices of Japanese teachers, lesson study in pre-service teacher education has been widely embraced internationally (Fernandez, 2005; Fernandez & Yoshida, 2004; Lewis, Perry, & Hurd, 2009). As stated by Stigler and Hiebert (1999), lesson study is a process that is aimed at improving teaching practices by allowing groups of teachers to collaborate and reflect upon lesson plans developed jointly, and then taught by one or more teachers while the other teachers observe.

In mathematics education, there has been an increase in the use of lesson study as action research, in which both teachers and researchers participate. This increase has allowed for the possibility of research informing practice, as well as practice generating both research problems and knowledge. As such, it is important for pre-service teachers to engage in lesson study in order to learn how to be a part of a collaborative team and gain the tools needed to participate as a professional in a larger teaching community (Lewis, Perry, Foster, Hurd, & Fisher, 2011). Furthermore, studies have shown that lesson study enhances pre-service teachers' collaboration skills, strengthens their reflective tendencies, helps them build an understanding of how children develop mathematical knowledge, advances their pedagogical practices, and most importantly, gives them the opportunity to improve student outcomes (Corcoran, 2011; Post & Varoz, 2008). Thus, it appears that pre-service teachers need opportunities to engage in collaborative planning of lessons, enacting lessons, and reflecting upon lessons, in the form of lesson study, during their teacher preparation program.

2.4 Assessment

Generally accepted in mathematics education is the need for pre-service teachers to engage in assessment practices through the act of analyzing pupil level mathematization. Additionally, it is important for teachers to engage in diagnostic, formative, and summative assessment tasks (Cunningham & Bennett, 2009; Ketterlin-Geller & Yovanoff, 2009; Xu & Liu, 2009).

Studies in the area of assessment practices for pre-service teachers have addressed various issues including: the preconceived notions that affect pre-service teachers evaluative skills (Morris, 2007; Simon, Chitpin, & Yahya, 2010), the concern with assessment for classroom management purposes (Simon et al., 2010), pre-service teacher struggle with the social justice aspects of assessment (Simon et al., 2010), and the effects of pre-service teachers traditional conceptions of standards-based assessment opposed to newer measurement-based assessment reform ideas (Frykholm, 1999; Simon et al., 2010). Research regarding assessment suggests that opportunities to analyze pupil level mathematization gives pre-service teachers the chance to experience authentic assessment practices that encourage and support further learning, and their own understanding of student thinking.

2.5 Theory and Practice

Numerous scholars have identified the great necessity, despite extreme challenges, in connecting theory and practice for pre-service teachers and practicing teachers (Breen, 2003; Jaworski, 1998, 2006). In some cases, teacher practices are not supported by research and teachers are increasingly required to engage in evidenced-based discourses in their practice. From these concerns, it becomes evident that pre-service teachers need to engage in learning opportunities that allow them to make connections between theory and practice.

It was put forward by Tsafos (2010) that, “theory does not guide, confirm and legitimize practice; instead theory and practice complement each other” (p. 157). From this perspective, it can be conceived that the connections pre-service teachers must make between theory and practice are complex and not limited to the passive act of transferring theoretical knowledge from the mathematics teacher educator to the pre-service teacher.

Research in the area of educational theory-to-practice has considered: the ways in which pre-service teachers make connections between research and practice when learning to teach (McDonnough & Matkins, 2010; Tsafos, 2010), the take-up of research in the pedagogical approaches of practicing teachers (Mathern & Hansen, 2007), and the understanding of theoretical perspectives (i.e., challenges with making connections, ways to occasion connections, etc.) (English, 2003; Heid et al., 2006).

An understanding of theory-to-practice research, in the realm of mathematics teacher education, suggests that pre-service teachers need to be given opportunities to engage in and with research that allows them to make practical connections between educational theory and practice. It is likely that forging these connections at the pre-service teacher education stage will allow future teachers to take their knowledge of theory into the classroom so that it can complement their teaching practice.

2.6 Policy and Politics

Policy documents (e.g., No Child Left Behind) and educational reforms (e.g., Post-Sputnik educational reforms) pervade mathematics education ("An act to close the achievement gap with accountability, flexibility, and choice, so that no child is left behind ", 2002; Hunt, 2005). Included in this plethora of policy documents are documents concerned with pre-service teacher education. These documents typically take the form of curriculum and teaching standards and guidelines for teacher preparation programs (NCATE, 2008; NCTM, 2000). Although these documents are published by organizations in the United States of America, parallel documents, several of which draw from the National Council of Teachers of Mathematics (NCTM), drive what is taught and by whom throughout the world. In this light, mathematics education is considered a highly political act, to the point that the dominant population holds the power and "policy and most research about diversity, cultural pluralism and a Eurocentric curriculum evolve around this conception of power" (Popkewitz, 2004, p. 254).

From the understanding that policy and politics permeate mathematics education, it is likely that pre-service teachers need to engage with, become familiar with, and teach to the standards and guidelines endorsed by the political party in power in their region. Studies, such as that done by Apple (1992) and Johnston (2007) have verified the importance of pre-service teachers exploring and engaging with policy documents as a means of becoming familiar with regional, educational standards.

2.7 Equity and Diversity

Widely documented in mathematics education, and education as a whole, is the under achievement and marginalization of ethnically, racially, linguistically, socio economically, geographically, academically, or sexually diverse students (Bartolo, Smyth, Swennen, & Klink, 2008; Gutiérrez, 2008; Lee, 2002; Richardson, 2009). Bartolo, Smyth, Swennen, and Klink (2008) note:

> It is important to recognise that these categories frequently overlap and when added together, it is clear that this is not a minority issue but is the reality of

> experience for all teachers and all potential teachers who will teach pupils from across this diverse spectrum (p. 117).

There have been numerous factors identified as contributing to the underachievement and marginalization of certain populations of students which include: pedagogical factors (Esmonde, 2009), Eurocentric mathematics (Bishop, 1997; D'Ambrosio, 1985; Namukasa, 2005; Skovsmose, 1990), and teacher preparation (Sleeter, 2001). This research points to the fact that there may be serious deficiencies in the ways in which some students are permitted to learn. Consequently, as Bartolo et al. (2008) state, the way in which teachers are prepared during pre-service teacher education is a central concern. As a result, prospective teachers need to explore the concepts of equity and diversity during their teacher preparation program so that they can gain knowledge about how to meet the needs of diverse learners.

2.8 Affect

Goldin (2002) stresses that the role of affect is crucial when individuals are engaged in a mathematical task because the affective system is not merely auxiliary to cognition, it is central. Traditionally, four key components of affect are studied: emotions, beliefs, conceptions, and attitudes. For the purposes of this research, a specific sub-theme is worthy of consideration that of teachers' beliefs. In particular, beliefs about teaching and learning mathematics deeply influence teachers' instructional practice (Philipp, 2007; Thompson, 1992). It is even contested that affect influences teaching practice as much as the social context and the teachers' level of thought and reflection (Ernest, 1989). Furthermore, Thompson (1992) notes that it is impossible to distinguish beliefs from knowledge because "teachers treat their beliefs as knowledge" (p. 127) and that it is important to take into account the two kinds of beliefs: beliefs about mathematics and beliefs about mathematical teaching and learning. These two kinds of beliefs are linked to content knowledge and pedagogical content knowledge (Shulman, 1986) and, as Thompson (1992) explains, may have a crucial role in influencing the teachers' instructional practice. An understanding of the research about affect suggests that pre-service teachers need to address their beliefs by becoming aware of them, challenge their unhelpful beliefs, and potentially changing those unhelpful beliefs through discussion in their teacher preparation programs (beliefs about mathematics, mathematics teaching, and mathematical learning).

2.9 Content Knowledge

The content knowledge required for pre-service teachers to teach mathematics is often driven by the content outlined in curriculum documents, and is typically based on multiple strands of mathematics. Over the last decade, numerous scholars have attempted to articulate the sorts of content knowledge required by future mathematics teachers. The outgrowth of this research has become known as *mathematics for teaching* (M*f*T) (Adler & Davis, 2006; Ball, 2000; Ball, Bass, Sleep, & Thames, 2005; Ball & Grevholm, 2008; Kotsopoulos & Lavigne, 2008). Stylianides and Stylianides (2009) define M*f*T as the "mathematical content that is important for teachers to know and be able to use in order to manage successfully the mathematical issues that come up in their practice" (p. 161). Furthermore, Ball and Bass (2000) refer to the knowledge of M*f*T as Mathematical Knowledge for Teaching (MK*f*T) which is also important for teachers to be able to know and implement. Stylianides and Stylianides (2009) build on Ball and Bass's (2000) contributions and explain that "this specialised kind of mathematical knowledge [MK*f*T] is important for solving the barrage of 'mathematical problems of teaching' that teachers face as they teach mathematics" (p. 161).

Research in this area has sought to explore how pre-service teachers develop this sort of content knowledge. One such idea is put forward by Ball and Bass (2000) regarding how crucial it is to provide pre-service teachers with "opportunities for learning subject matter that would enable teachers not only to know, but to learn to use what they know in the varied contexts of practice" (p. 99) during their teacher preparation program.

2.10 Pedagogical Content Knowledge

Shulman (1986) defined two different components of teachers' knowledge: content knowledge, also known as M*f*T as stated earlier, and pedagogical content knowledge (PCK). M*f*T and PCK are complementary pieces of the knowledge puzzle necessary for teaching mathematics. Research in the area of PCK is vast and includes many interpretations and various definitions of the components involved (Abell, 2008; Grossman, 1990; Loughran, Berry, & Mullhall, 2006; Loughran, Mulhall, & Berry, 2008; Magnusson, Krajcik, & Borko, 1999). To refer back to Shulman (1986), his definition of PCK consists of two components: first, knowledge of representations (i.e., explanations or analogies of subject matter that make it comprehendible, illustrations of instructional strategies) and second, knowledge of students' learning difficulties (i.e., naive prior knowledge, misconceived ideas, missing links to inter-related ideas, lack of problem solving skills). Using this definition of PCK, it appears that prospective teachers need opportunities to examine, develop, and analyze various pedagogical strategies in order to gain knowledge about instructionally sound representations and how to approach students' learning difficulties.

2.11 Technology

According to Niess (2005), research regarding technology integration in mathematics teacher education has focused primarily on the ways to use technology to enhance teaching and learning. Recently, educational reforms around technology have promoted the advantages of integrating Information and Communication Technologies (ICT) into all classrooms (Fox &

Henri, 2005; Greenhow, Robelia, & Hughes, 2009; Jonassen, Howland, Marra, & Crismond, 2008; Tan, Hung, Scardamalia, & Khine, 2006; Xiao & Carroll, 2007). Chai, Koh, and Tsai (2010) describe ICT as the integration of technology into the classroom and within various facets of teaching and learning.

Some of the issues and implications addressed through technology research include: professor demonstrated or modeled use of mathematics technology (Sturdivant, Dunham, & Jardine, 2009), opportunities for pre-service teachers to engage in investigation of mathematics technology (da Ponte, Oliveira, & Varandas, 2002), and authentic implementation of mathematics technology by pre-service teachers (Lin, 2008).

Studies have shown that when pre-service teachers are provided with the opportunity to investigate and implement technology using the above three teaching strategies, the result is a pre-service teacher with maximized and current knowledge and understanding of technology integration in a mathematics classroom (Blubaugh, 2009; Niess, 2001).

2.12 Literature Review Summary

As the previous discussion has shown, mathematics teacher education literature can be grouped into eleven dominant areas of research. However, due to the scope of this research, only a limited amount of information was presented on each of the eleven dominant areas of research. For more extensive reviews of each of the these categories, please refer to the following literature: reflection (Chapman, 2009), mathematical task (Watson & Mason, 2007), lesson study (Hart, Alston, & Murata, 2011), assessment (Popham, 2009), theory and practice (Jaworski, 2006), policy and politics (Apple, 1992), equity and diversity (Bartolo et al., 2008), affect (Namukasa, Gadanidis, & Cordy, 2009), content knowledge (Ball & Bass, 2000), pedagogical content knowledge (Ponte, 2006; Ponte & Chapman, 2008), and technology (Boggan, Harper, &

Bifuh-Ambe, 2009). An examination of the literature associated with these eleven dominant research areas allows for a potentially clearer understanding of the opportunities necessary for pre-service teachers to engage in during their teacher preparation program in order to become effective mathematics teachers.

Chapter 3: Theoretical Framework

The necessity of forging a research-to-practice relationship has been extensively researched and many reasons for building a strong relationship have been realized. According to researchers such as, Lester and William (2002) and Barnett and Kitto (2004), there is a concern that mathematics education research is not being appropriately communicated to teachers. One researcher who discusses this relationship at length is Silver (2003). Silver states that, “the two groups [researcher and teacher] have much to gain from collaboration in the borderlands between research and practice” (p. 183). He then goes on to define exactly what each of the two groups has to offer each other;

> Researchers have much to offer, including theoretical perspectives that might be useful in framing and describing practical issues and problems, research methods that might illustrate data-collection practices with practical utility, and findings that possess sufficient generalizability to support appropriate use in applied settings. Practitioners also have much to offer, including a set of important issues and concerns that could and should be addressed in research, a collection of insights gained in and through practice, and a passionate concern for the improvement of education. (Silver, 2003, p. 183)

Finally, Silver (2003) ends his discussion about the necessity of a research-to-practice connection by concluding that, “unless our effort to transverse the border between research and practice reflect a genuine appreciation for and understanding of the culture and customs of those across the border, they may be doomed to failure” (p. 183). Silver clearly makes a strong argument for the necessity of a research-to-practice connection and when applied to this current research, it becomes evident that this research is investigating a relevant research problem since the goal is to define the extent to which research is informing the practices of mathematics teacher educators.

3.1 Role of the Mathematics Teacher Educator

To further the discussion about forging a research-to-practice connection, the practices of the mathematics teacher educator must now be explored since they are the individuals that forging this connection. The goal here is to determine that a mathematics teacher educators' job is to use current research in the field of mathematics teacher education to improve their own practice and provide their pre-service students with opportunities to engage in, and learn theory informed teaching practices. This idea is articulated well by Adler, Ball, Krainer, Lin, and Novotna (2005) when they say that it is a mathematics teacher educator's job to improve "teachers' opportunities to learn" (p. 363). Additionally, a mathematics teacher educator is able to provide these opportunities when they are aware of "how teachers learn, and from what opportunities and under what conditions" (Adler et al., 2005, p. 363) they learn.

To become aware of how pre-service teachers learn and from what opportunities and conditions, it is necessary for mathematics teacher educators to review mathematics teacher education research that provides answers to these critical questions. As such, if mathematics teacher educators are to fill the requirements of their job as set out by Adler et al. (2005), then they will need to use current research to improve their practice and thus, provide their pre-service teachers with opportunities to engage in, and learn research informed teaching practices.

3.2 Role of the Syllabus

As stated in the introduction, this current research takes the approach of analyzing pre-service mathematics teacher education course syllabi to learn more about the research-to-practice connection made at the mathematics teacher educator level. This approach was selected during the pilot study and is thought to be a convenient starting point for examining the primary research question in this current research. The syllabus is an appropriate data source because it is a communication device that contains relevant information pertaining to what is being taught in pre-service teacher education courses.

The role of a syllabus in a university setting is explored to determine how this document may support an exploration of the degree to which current mathematics teacher education research is evidenced in pre-service teacher education programs. According to the Merriam-Webster's dictionary, *syllabus* is defined as a summary, a course of study, or an outline. Matejka and Kurke (1994) propose that there are four key functions of a syllabus. The syllabus represents a legal agreement between the instructor and the student, the student and the university, and the instructor and the university; it is a communication device regarding the learning outcomes and goals of a program of study; it is a plan or description of the events to occur within the course; and it is a cognitive map, outlining the way in which knowledge will be shaped by the content of the course.

Additionally, Baker (2001) suggests that "the syllabus may have begun as a modern administrative overlay, but it has become a powerful teaching tool…used to communicate important aspects of the course to students" (p. 391). Following Matejka and Kurke's (1994) and Baker (2001) descriptions of a syllabus, it seems appropriate to say that a study of course syllabi should produce an adequate understanding of the extent to which mathematics teacher educators apply research-to-practice in their courses. On the contrary, it would appear obvious that what is written in a syllabus is not always enacted in the classroom and vice versa.

Furthermore, Burkhardt, Fraser, & Ridgway (1990) provide comprehensible definitions for various kinds of *curriculum*, where the term *curriculum* has common ground with the term syllabus, that may add to the understanding of the role of a syllabus.

> The *ideal curriculum* is what experts propound; because it is not firmly grounded in relevant experience, it is fundamentally speculative but important in defining directions for change that should be pursed. The *available curriculum* is the one for which teaching materials exist, though these will not always be matched to the capabilities of all teachers. The *adopted curriculum* is the one which some state or local authority says must be taught. The *implemented curriculum* is what teachers actually teach in the classroom; because teachers vary enormously in their capabilities, there is a wide distribution of implemented curricula. The *achieved curriculum* is what the students actually learn; its distribution is even wider across many variables. The *tested curriculum* is determined by the spectrum of tests which vary public credibility, and through that, influence what happens in classrooms. (Burkhardt et al., 1990, pp. 5-6)

Following Burkhardt et al. (1990) curriculum definitions, it can be concluded that the syllabi being examined in this current research are assumed to be *ideal curriculum*. Although the *ideal curriculum* is not grounded in relevant experience, thus not making it fully realistic, it is important to consider because it defines directions for change that should be pursued and according to Matejka and Kurke's (1994) a curriculum, no matter its' type, should be written as if it were a legal document.

Chapter 4: Methods

4.1 Participants

Syllabus submissions for this research were solicited from professors of mathematics teacher education around the world by email invitation (see Appendix B, for transcripts of email invitations) on three occasions or were located via web searches. The two listserv mailing lists that were used in this process were the Psychology of Mathematics Education (PME) Listserv and the Canadian Mathematics Education Study Group (CMESG) Listserv.

It was found in the initial solicitation of mathematics education professors that, in some countries, different words were used to capture the same essence as syllabus as used in this research. These words included: course outline, curriculum, course booklet, program outline, course pack, course documents, and so forth. Therefore, subsequent solicitations following the first included additional clarification.

Submissions were deemed to be part of the public domain and thus, no ethics review was required as per the University of Western Ontario's (UWO) Research Ethics Board (REB) policies. In total, 147 syllabi were submitted (see Table 1, for submitted syllabus totals, sorted by country). Syllabi varied in instructional ranged for Kindergarten to Grade 12 and at the graduate level. Despite numerous invitations, we were unable to obtain representation from every continent.

Table 1

Submitted Syllabus Documents by Country

Country	Number
Malaysia	2
Taiwan	6
Australia	12
Canada	18
Italy	3
England	3
Norway	4
Portugal	1
Ireland	1
Austria	1
Jerusalem	1
Turkey	1
New Zealand	9
United States of America	85
Total	147

The full syllabus set (n = 147) underwent a preliminary filtering. The primary reason for the exclusion of syllabus documents was that they were not consistent with the methods courses under investigation in this research (e.g., syllabi based upon practicum/field experience, syllabi based on enrichment mathematics, syllabi based on mathematic content exclusive of pedagogy, syllabi from graduate courses that had a narrow/conceptual focus). Additionally, some syllabus documents were excluded from the sample for extenuating circumstances because translation of the syllabus document was not possible and the document could not be categorized as a syllabus which is course specific (e.g., program progression documents that outlined the number of courses required to complete a degree). However, multiple syllabi from one institution were not excluded, given that obvious differences existed between the syllabi when examined (see Table 2, for syllabus totals after first filter, sorted by country).

Table 2

Syllabus Totals by Country after First Filter

Country	Initial Sample	Sample After First Filter
Canada	18	16
United States of America	85	71
Italy	3	3
England	3	2
Norway	4	0
Portugal	1	0
Ireland	1	1
Austria	1	0
Jerusalem	1	0
Turkey	1	0
Australia	12	12
New Zealand	9	9
Malaysia	2	2
Taiwan	6	0
Total	147	116

For the purposes of this research, the filtered syllabus sample (n = 116) was filtered again based upon feedback obtained following the presentation of the pilot study, which is discussed shortly, given at the Psychology of Mathematics Education - North America (PME-NA) 2011 Conference in Reno, Nevada. Feedback from the presentation on the pilot study from experts in the field of mathematics teacher education recommended that the syllabi be filtered to reflect those syllabi with a similar number of course hours and across similar levels of teacher education (i.e., elementary or secondary).

As a result, the syllabus data set was further filtered to exclude mathematics education courses that did not evidence, through the syllabus, a one term course with 30 to 49 hours of instructional time. Where, a one term course is assumed to be approximately 12 to 13 weeks in length. This filter then reduced the syllabus sample size down from 116 syllabi to 31 syllabi (see Table 3, for syllabus totals after course hours filter, sorted by country).

Table 3

Syllabus Totals by Country after Course Hours Filter

Country	Initial Sample	Sample After First Filter	Sample After Course Hour's Filter
Canada	18	16	6
United States of America	85	71	14
Italy	3	3	2
England	3	2	0
Norway	4	0	0
Portugal	1	0	0
Ireland	1	1	0
Austria	1	0	0
Jerusalem	1	0	0
Turkey	1	0	0
Australia	12	12	5
New Zealand	9	9	3
Malaysia	2	2	1
Taiwan	6	0	0
Total	147	116	31

4.2 Data Sources

In total 31 syllabi formulated the final sample analyzed (see Table 3, for syllabus totals after course hours filter, sorted by country). The mean length of the syllabi in the final sample was 9.3 pages and the mean number of course hours was 37.9 hours (see Table 4, for length and instructional time of syllabi in final sample and mean). While the range in hours varies by almost 20 hours, each of these courses spanned one academic term (approximately 12 to 13 weeks), and was deemed to be as close of an approximation of similar hours as possible.

For the purpose of this research, and to protect the identity of the course instructors, syllabi will be referred to by country and where two or more are from one country, then these shall be referred to in sequence numerically after the country (e.g., Canada 1, Canada 2, etc.).

Table 4

Final Syllabus Data Set (mean length and instructional time)

University	Length of Syllabi (Pages)	Instructional Time (Hours)
Canada 1	7	42
Canada 2	13	36
Canada 3	19	36
Canada 4	2	44
Canada 5	2	44
Canada 6	4	36
United States of America 1	5	36
United States of America 2	9	48
United States of America 3	12	40
United States of America 4	8	32
United States of America 5	18	38
United States of America 5	10	32
United States of America 7	7	40
United States of America 8	16	40
United States of America 9	4	35
United States of America 10	7	40
United States of America 11	6	30
United States of America 12	7	40
United States of America 13	3	48
United States of America 14	3	32
Italy 1	2	30
Italy 2	3	49
Australia 1	15	36
Australia 2	8	36
Australia 3	12	40
Australia 4	9	30
Australia 5	25	36
New Zealand 1	16	40
New Zealand 2	16	40
New Zealand 3	14	40
Malaysia 1	6	30
Mean	9.3	37.9

As a means to further the discussion and extend the comparison between syllabi, the final syllabus data set was then broken down into two categories, elementary and secondary. Elementary refers to syllabi used in courses that prepare teachers to teach kindergarten to grade eight. Secondary refers to syllabi used in courses that prepare teachers to teach grade nine to grade twelve. The final sample of 31 syllabi included 19 elementary syllabi and 12 secondary syllabi (see Table 5, for elementary and secondary syllabus totals, sorted by country).

Table 5

Final Syllabus Data Set Sorted by Country (elementary vs. secondary)

		Level	
Country	Syllabi	Elementary	Secondary
Canada	6	6	0
United States of America	14	5	9
Italy	2	1	1
Australia	5	5	0
New Zealand	3	2	1
Malaysia	1	0	1
Total	31	19	12

4.3 Materials

4.3.1 MTEd Instrument

The MTEd Instrument was developed by Clark, Kotsopoulos, Morselli, and Purdy (2011) to analyze the syllabi (see Appendix A, for the MTEd Instrument). The MTEd Instrument is a rubric which evaluates, using levels, the extent to which the research emphasized in the mathematics education literature and outlined in the literature review are evidenced in a syllabus. That is, the MTEd Instrument was an outgrowth of the existing research (outlined in the literature review) on optimal recommended learning opportunities for pre-service teachers learning how to teach mathematics (Arbaugh & Taylor, 2008).

The initial exploration of current mathematics teacher education research took place during the pilot study in order to begin to develop the MTEd Instrument. This exploration took the form of a rapid review of the dominant research areas in mathematics teacher education research in order to begin developing the MTEd Instrument. As the scope of the pilot study expanded into this current research, so did the scope of the literature review that contributed to the refinement of the MTEd Instrument. As such, there has been an evolution of the MTEd Instrument from the beginning of the pilot study to the current research.

The first version of the MTEd Instrument was developed at the beginning of the pilot study when the primary researchers reviewed literature and discussed the possible domains of dominant mathematics teacher education research. The second version of the MTEd Instrument was developed as a product of reviewing some of the collected syllabi and realizing that two dominant research themes (i.e., equity and diversity and technology) were missing in version one of the MTEd Instrument. Version two of the MTEd Instrument was used to analyze a small sample of mathematics education course syllabi. During the pilot study analysis of syllabi, version three of the MTEd Instrument was developed as the researchers began adding detailed examples of evidence to some of the categories and levels in order to make the evaluation and coding process more streamlined. Version three of the MTEd Instrument was ultimately tested during the pilot study to examine the robustness and the appropriateness of the categories. The results of the pilot study were presented at an international conference (Clark et al., 2011), at which time feedback on the MTEd Instrument was also solicited.

Following this, version four of the MTEd Instrument was defined at the beginning of this current research. In conjunction with the feedback from the international conference, the MTEd Instrument was refined through a systematic review using the past ten years of the Journal of Mathematics Teacher Education as a guide. The "Introductory" article that outlines the content of the four proceeding articles was read for each issue of the Journal of Mathematics Teacher Education (2001 to 2011). While reading, each article was categorized under one or more of the eleven categories listed on the MTEd Instrument. If the article did not fit into one of the eleven categorizes then it was put aside to review later and decide if it required its own category on the MTEd Instrument. As such, two additional categories were considered: students' mathematical reasoning and developmentally appropriate practice. After discussion with one of the researchers involved in the pilot study, it was realized that these two categories did not need to be added because students' mathematical reasoning fit under the category of mathematical tasks and developmentally appropriate practice fit under the category of pedagogical content knowledge.

Finally, version four of the MTEd Instrument was developed just prior to analyzing the full data set of syllabi in this current research. The final refinement of the MTEd Instrument was minor and only wording and examples were added to further streamline the coding and evaluation process (see Appendix A, for the MTEd Instrument).

4.4 Data Analysis

The data analysis portion of this research followed in line with the qualitative grounded theory approach by Glaser and Straus (1967), as well as Straus and Corbin (1990). This approach takes a case-oriented perspective that has a comparative orientation in which "cases similar on many variables but with different outcomes are compared to see where the key . . . differences may lie." (Borgatti, 2006). Using this approach, the syllabi in this research were viewed as the *cases* and they were analyzed to find the key causal differences.

For the purposes of this research, each of the 31 syllabi contained in the final syllabus data set were analyzed using open coding which was the grounded theory analysis piece concerned with "…identifying, naming, categorizing and describing phenomena found in the text." (Borgatti, 2006). At this point, it should be noted that the initial phase of open coding was not conducted in this research due to redundancy. As stated in the grounded theory approach, the starting point is reading and re-reading the textual databases in order to discover the categories that will be examined and compared. In this research, this step was not taken since a rubric (the MTEd Instrument) was already developed in the pilot study.

Thus, the initial phase of analysis that took place in this research was the highlighting of any information that evidenced one or more of the eleven categorizes found in the MTEd Instrument (reflection, mathematical task, lesson study, assessment, theory-to-practice connections, policy and politics of mathematics teaching, equity and diversity, affect, content knowledge, pedagogical content knowledge, technology). The highlighting process took the form of track-changes in Microsoft Word® or physical highlighting of a printed syllabus document.

Once a piece of evidence was found and highlighted in the syllabus document, two additional pieces of information were written as memo notes beside the highlighted word or phrase. These memo notes, "…short documents that one writes to oneself as one proceeds through the analysis of a corpus of data" (Borgatti, 2006), contained two elements: first, the category that it pertained to (e.g., 1 – Reflection, 5 – Theory and Practice Connections, 11 – Technology, etc.) and second, what level of research it evidenced (levels one to four).

Once the syllabus documents were coded from beginning to end, the information gathered from the highlighted evidence (category and level) was transferred in to a spread sheet. If multiple pieces of evidence were highlighted for one category, within one syllabus, then the highest level recorded for that category was noted in the spread sheet. If no pieces of evidence were highlighted for a particular category, within one syllabus, then the category was given a level one. The validity of the open coding process stated above was confirmed through a ten percent reliability test done by one of the thesis committee members and original authors of the MTEd Instrument, Dr. Donna Kotsopoulos. Inter-rater reliability was 90%.

Low, *moderate,* and *high* tags were assigned to each syllabus based upon the cumulative level the syllabus obtained. The cumulative level was determined by adding up the levels from each of the individual categories. A syllabus was tagged as showing: *low* evidence of research if it scored below 22, *moderate* evidence of research if it scored between 22 and 32, and *high* evidence of research if it scored higher than 32.

The final data set was evaluated quantitatively using the following tests: descriptive statistics, correlation analysis, and Mann-Whitney *U*. SPSS (Version 19) statistical package for Windows was used for the statistical analysis. Descriptive statistics were computed to summarize overall levels across the eleven research areas analyzed. Correlation analysis was conducted to examine the relationship between category levels and overall levels assigned to each syllabus in elementary-only, secondary-only, and then across both secondary and elementary combined. Finally, the Mann-Whitney *U* test was conducted between two groups found in the final data set, elementary and secondary, to see if the distribution of levels varied in a statistically significant way. The Mann-Whitney *U* test was chosen as a method of statistical analysis for this research because it is a non-parametric statistical analysis test that compares two samples to determine if differences across categories are statistical significance.

Chapter 5: Results

This research examined the degree to which current research was evidenced in mathematics teacher education course syllabi. Through the process of open coding and memo notes, all 31 syllabi from the final data set were coded using the MTEd Instrument (see Table 6, for data from coded syllabi). Individual scores for all eleven categories found on the MTEd Instrument and the overall scores for each syllabus are shown in the Table 6.

5.1 Descriptive Statistics

The coded information contained in Table 6 was inputted into SPSS (Version 19). The resulting descriptive statistics, including mean, standard deviation, and minimum/maximum ranges are reported in Table 7.

Table 6

Descriptive Statistics of Syllabi (n = 31)

				Range	
	N	*M*	*SD*	*Min.*	*Max.*
Course Hours	31	37.9355	5.30996	30.00	49.00
MTEd Categories					
Reflection	31	2.5161	1.02862	1.00	4.00
Tasks	31	1.7742	.80456	1.00	4.00
Lesson Study	31	2.7097	1.07062	1.00	4.00
Assessment	31	2.1613	.89803	1.00	4.00
Theory	31	2.6129	.66720	2.00	4.00
Policy	31	3.0323	.75206	1.00	4.00
Equity	31	2.9355	1.41269	1.00	4.00
Affect	31	1.6774	.87129	1.00	4.00
Content	31	2.7097	.64258	1.00	3.00
Pedagogy	31	3.0323	1.01600	1.00	4.00
Technology	31	3.8387	1.43983	1.00	4.00
Overall Score	31	28.0000	5.28520	17.00	38.00

Table 7

Data from Coded Syllabi (n = 31)

		MTEd Instrument Categories											
Syllabus	Level	Reflection	Tasks	Lesson Study	Assessment	Theory	Policy	Equity	Affect	Content	Pedagogy	Technology	Score
Canada 1	Elementary	4	1	2	2	2	2	4	2	3	1	3	26
Canada 2	Elementary	4	2	4	3	3	3	4	4	3	4	4	38
Canada 3	Elementary	3	2	4	3	4	4	4	1	3	4	4	36
Canada 4	Elementary	4	4	1	1	3	2	1	1	1	4	1	23
Canada 5	Elementary	2	2	1	2	2	2	1	2	3	2	2	21
Canada 6	Elementary	2	2	2	3	3	3	4	3	3	2	4	31
USA 1	Elementary	3	1	4	2	3	3	4	2	3	4	4	33
USA 2	Elementary	2	1	3	2	3	3	4	4	3	2	4	31
USA 3	Elementary	2	2	4	2	3	4	4	1	3	2	4	31
USA 4	Elementary	4	4	4	3	2	3	1	1	3	4	4	33
USA 5	Elementary	2	2	2	2	2	3	4	2	3	2	4	28
USA 6	Secondary	4	2	3	2	2	4	4	2	2	3	4	32
USA 7	Secondary	2	1	3	3	3	4	4	2	3	4	4	33
USA 8	Secondary	1	2	1	1	2	3	1	1	2	2	1	17
USA 9	Secondary	2	2	2	2	2	4	4	1	3	4	1	27
USA 10	Secondary	4	1	3	4	3	4	1	2	2	4	4	32
USA 11	Secondary	2	2	2	1	2	3	4	1	3	4	4	28
USA 12	Secondary	4	1	4	4	4	3	4	1	1	3	4	33
USA 13	Secondary	3	1	3	1	2	3	3	2	3	4	4	29
USA 14	Secondary	1	1	3	2	2	2	4	1	1	4	4	25
Italy 1	Elementary	1	3	1	1	2	3	1	2	3	2	1	20
Italy 2	Secondary	2	1	1	1	3	1	1	2	3	2	1	18
Australia 1	Elementary	2	2	3	4	4	3	1	1	3	3	1	27
Australia 2	Elementary	2	1	3	2	2	2	4	1	3	2	1	23
Australia 3	Elementary	2	1	3	2	3	3	1	2	3	2	1	23
Australia 4	Elementary	2	2	4	3	2	3	4	3	3	4	4	34
Australia 5	Elementary	2	2	4	2	3	3	2	1	3	2	1	25
New Zealand 1	Elementary	4	2	2	2	3	4	4	1	3	4	4	33
New Zealand 2	Elementary	2	1	2	1	3	4	4	1	3	4	1	26
New Zealand 3	Secondary	1	2	2	2	2	3	4	1	3	4	4	28
Malaysia 1	Secondary	3	2	4	2	2	3	1	1	3	2	1	24

There were three possible levels that could be obtained by each syllabus based upon the overall score the syllabus obtained (*low*, *moderate*, or *high*). An overall level of *high* was achieved by eight syllabi since their overall score was 33 or higher. An overall level of *moderate* was achieved by nineteen syllabi since their overall score was between 22 and 32. An overall level of *low* was achieved by four syllabi since their overall score was 21 or lower. The overall score assigned to the syllabi ranged from 17.0 to 38.0. Most syllabi achieved a level of *moderate* in terms of representation of the research areas. Of the eight syllabi that scored *high*, six of them were elementary and two of them were secondary. Of the four syllabi that scored *low*, one of them was elementary and three of them were secondary. Consequently, the evidence of research in the course syllabi was *moderate* overall.

Descriptive analysis of the 31 course syllabi revealed variation across the research areas identified on the MTEd Instrument. Mathematical tasks (M = 1.77, SD = 0.80) and affect (M = 1.68, SD = 0.87) were the lowest represented on the syllabi. Additionally, equity (M = 2.94, SD = 1.41) and technology (M = 3.84, SD = 1.44) had the greatest amount of variance. Conversely, the three categories that showed low variance were: theory (M = 2.61, SD = 0.67), policy (M = 3.03, SD = 0.75), and content (M = 2.71, SD = 0.64).

Qualitative examples of the cells of the MTEd Instrument are provided in Table 8. The table does not distinguish between elementary and secondary examples. As reported shortly, differences in means across cells between elementary and secondary syllabi was not significant except for content. Therefore, only one table of examples is provided.

Table 8

Qualitative Examples of MTEd Instrument Cells

Categories	Level 1	Level 2	Level 3	Level 4
Reflection	*(no reference to reflection)*	"[teaching assignment] Comments will focus on how successful the sequence of lessons was - including areas for improvement, and possible directions of future lessons." (Australia 4) *(only one type of reflection – posteri)*	"[teaching assignment] Following your peer teaching session you will view your lesson on tape and write a 2-3 page self-analysis/reflection paper using feedback from the instructor and students in the class." (USA 13) *(two types of reflection – initeri while watching tape and posteri after viewing)*	"[assignment] …weekly reflective journal" (Canada 1) *(a weekly journal is ongoing and thus requires all 3 types of reflection – priori, initeri, and posteri)*
Mathematical Tasks	*(no reference to mathematical tasks)*	"[lesson planning assignment] At least two examples of how to solve the problem you have chosen for the main part of the lesson. Solutions (showing various approaches) to the questions you are assigning for work-time and/or homework." (Canada 6) *(opportunity to engage in only pupil level tasks)*	"[assignment] Activity of problem solving: find an operation that is commutative and not associative. Activity of problem solving: the sum of the first 100 numbers. Activity of problem solving: the magic square." (Italy 1 - translated) *(some opportunity to engage in mathematical tasks)*	"[assignment] Three problem-solving assignments will be given to you to complete. The main goals of these assignments are for you to become a better problem solver yourself, to identify and develop strategies for solving problems…to reflect on your own approach and style in problem solving." (USA 4) *(extensive opportunity to engage in mathematical tasks)*
Lesson Study	*(no reference to lesson planning)*	"[assignment] …developing a unit of mathematics study (individually)… include…lesson plans (minimum of five)" (Canada 1) *(individual planning lessons but they are not enacted or reflected upon)*	"[course objectives] Design and implement a mathematics lesson in collaboration with practicum teacher." (USA 7) *(collaborative lesson planning and implementing those lessons but no reflection piece)*	"[assignment] Plan and teach a mathematics lesson…collaborate with your mentor teacher on a lesson that you will be responsible to teach. After conducting your lesson you need to write a reflection on your assessment of the lesson" (USA 4) *(planned collaboratively, presented, and reflected upon)*
Assessment	*(no reference to engaging in assessment)*	"[student outcomes] …by the end of this course, students should be able to describe a variety of formative and summative assessment techniques" (Canada 1) *(limited opportunity to analyze student level work*	"[course content] Assessment of children's mathematical understanding, performance, and disposition." (USA 4) *(some opportunity to analyze the different*	"[student outcomes] Developing understanding of curriculum in context through assessing students' work, mathematic problems and/or texts." (USA 10) *(extensive opportunity to*

		because the candidate is only required to describe assessment techniques)	*aspects of student level work)*	*analyze student level work and other aspects of the mathematics program)*
Theory and Practice Connections	*(reference only to textbook and no other research)*	"[assignment] …article and reading summary paragraph." (Canada 1) *(limited opportunity to engage with research since highly structured introduction to research literature)*	"[assignment] …assume responsibility for reading, reporting on, and presenting three practitioners' articles…presentation should include an overview of the concepts…along with the group's critique or reflections." (USA 7) *(some opportunity to engage with research through course being grounded in research but no chance to engage in their own inquiry/research)*	"[section under each class schedule with research links] Linking Theory and Practice" (Canada 3) "[inquiry project assignment] … engage in teacher/action research...actively involved in asking questions aimed at understanding or improving teaching." (Canada 3) *(extensive and authentic engagement in research with links to current research and engagement in their own inquiry/research)*
Policy and Politics of Mathematics Teaching	*(no reference to curriculum documents or political aspect of education)*	"[course description] The course provides participants the opportunity to be familiar with the organisation of mathematics through the BC' s math curriculum" (Canada 1) *(limited evidence of policy exploration since curriculum document stated but no extra journal readings required)*	"[lesson topic] …familiarization with the content standards of NCTM, the Ontario Curriculum, and additional Ministry documents (e.g., Expert Panel reports and support documents)." and a list of supplementary journal readings (Canada 6) *(some evidence of policy exploration due to additional readings and one class discussion)*	"[course objective] Critique national assessment practices and tasks for mathematics." and a list of supplementary journal readings (Australia 1) *(extensive evidence of policy exploration due to additional readings and critique of national standards)*
Equity and Diversity	*(no reference to the exploration of equity and diversity issues)*	"[learning objectives] …developed an understanding of…suitable teaching approaches for addressing anxiety and other mathematical phobias." (Australia 5) *(limited evidence of equity exploration due to narrow focus on mathematics specific phobias and not the diverse needs of contemporary students)*	"[lesson topic] Multicultural Mathematics" (Canada 1) *(a topic for a class but not an overriding concept for the entire course)*	"[course objectives] …apply their understanding of student differences and needs in the classroom to promote quality mathematics for all student." (USA 9) *(equity statement and an overriding concept for the entire course)*
Affect	*(no reference to addressing affect issues)*	"[course assignment] Mathematics Autobiography… write your ideas, attitudes and beliefs about mathematics…"	"[generic skill] Students will develop… confidence in addressing personal conceptual and skill based knowledge of mathematics during class activities."	"[course framework] Reflecting Professionally - How does my relationship to math, my math thinking, and my teaching change over time?"

		(USA 13) *(addresses affect but does not try to challenge or potentially change affect)*	(Australia 4) *(addresses affect and challenges students' confidence but it does not try to potentially change affect)*	(Canada 2) *(addresses, challenges, and potentially changes affect)*
Content Knowledge	*(no reference to content knowledge exploration)*	"[course schedule] Algebraic Thinking [and] Geometry" (USA 10) *(engaged in only two selective components of content knowledge)*	"[course schedule] Geometry and Measurement [and] Number Concepts and Operations [and] Patterns and Place Value, Fractions [and] Percents, and Decimals, Statistics and Probability Data Analysis." (Canada 1) *(engaged in content knowledge at student grade level but not taken beyond)*	*(no syllabi received this level since none evidenced engagement in broader ranges of content knowledge beyond the level of instruction of the students)*
Pedagogical Content Knowledge	*(no reference to pedagogical discussion)*	"[learning outcomes] …on successful completion of this course, students should be able to access strategies to implement…relevant pedagogy." (Australia 2) *(examine pedagogical strategies but no development or analysis of pedagogical strategies)*	"[course description] …pragmatic activities involving the development and implementation of effective teaching and learning strategies." (USA 12) *(examine and develop pedagogical strategies but no analysis of pedagogical strategies)*	"[course objectives] Be immersed in, discuss when and how, and implement the use of different instructional strategies appropriate for teaching mathematics including whole class, small group, cooperative learning, and individual instruction." (USA 7) *(examine, develop, and analyze pedagogical strategies)*
Technology	*(no reference to the use of technology)*	"[course topic] Technology" (Canada 5) *(didactic method of technology investigation since technology is limited to a course topic to be covered by the professor)*	"[assignment] …lesson plans…one based with the use of technology" (Canada 1) *(some evidence of investigation into technology but limited to one lesson plan opposed to integrating technology into an entire unit)*	"[technology use statement] Utilize technology as a resource for your own learning and the learning of children." (USA 4) *(extensive evidence of investigation into technology since it is an overriding concept for the entire course)*

5.2 Mann-Whitney

A Mann-Whitney test was conducted between the elementary data set and the secondary data set and the results indicated that evidence of content was greater in the elementary syllabi (Mean Rank = 18.11) than in the secondary syllabi (Mean Rank = 12.67), $U = 74.000$, $p = 0.18$, r

= .42 and this was statistically significant (see Table 9, for Mann-Whitney statistics for elementary and secondary syllabi).

Table 9

Mann-Whitney Statistics for Elementary and Secondary Syllabi

	Mann-Whitney *U*	*p-value*
Course Hours	112.5	.951
MTEd Categories		
Reflection	103.0	.632
Tasks	84.0	.175
Lesson Study	100.5	.570
Assessment	98.5	.500
Theory	82.0	.150
Policy	101.0	.559
Equity	110.0	.850
Affect	91.5	.313
Content	74.0	.018*
Pedagogy	85.5	.204
Technology	102.0	.577
Overall Score	103.0	.654

* Statistically significant at $p \leq 0.05$ (2-tailed).

There were no other statistically significant differences found across any of the other MTEd Instrument categories. Therefore, other than in the area of content, evidence of research representing the MTEd Instrument categories across both the elementary and secondary syllabi was consistent.

5.3 Correlations in the Elementary Syllabus Data Set

Correlation analysis of elementary syllabi (see Table 10, for elementary correlations – instrument categories and overall score) revealed a statistically significant very strong positive relationship between technology and overall score (r = .841, p = .000). Additionally, numerous statistically significant strong positive relationships were found including: reflection and pedagogy (r = .492, p = .016), reflection and overall score (r = .484, p = .018), lesson study and assessment (r = .571, p = .005), lesson study and technology (r = .418, p = .038), lesson study and overall score (r = .666, p = .001), assessment and technology (r = .477, p = .020), assessment and overall score (r = .649, p = .001), theory and policy (r = .520, p = .011), policy and overall score (r = .521, p = .011), equity and technology (r = .586, p = .004), equity and overall score (r = .575, p = .005), and pedagogy and overall score (r = .579, p = .005). Finally, a statistically significant moderate positive relationship was found between policy and pedagogy (r = .392, p = .048)

Correlation analysis of elementary syllabi also revealed statistically significant strong negative relationships including: course hours and lesson study (r = -.446, p = .028), course hours and assessment (r = -.459, p = .024), mathematical tasks and equity (r = -.490, p = .017), and mathematical tasks and content (r = -.403, p = .044). Therefore, mathematical tasks were negatively related to equity and content and more course hours did not suggest more lesson study or more evidence of assessment. Important to note, course hours and overall score were negatively related and not statistically significant.

Table 10

Correlation of Instrument Categories and Overall Score, Elementary (n = 19)

	MTEd Instrument Categories											
	Reflection	Tasks	Lesson Study	Assessment	Theory	Policy	Equity	Affect	Content	Pedagogy	Technology	Score
Course Hours	.167	-.341	-.446*	-.459*	.142	-.160	.042	-.005	-.333	-.280	-.101	-.299
Reflection	--	.132	.177	.189	.138	-.058	.139	-.152	-.339	.492*	.351	.484*
Tasks		--	-.109	.140	-.089	.016	-.490*	-.217	-.403*	.288	.079	.046
Lesson Study			--	.571**	.279	.363	.283	-.040	.359	.314	.418*	.666**
Assessment				--	.229	.122	.113	.171	.377	.212	.477*	.649**
Theory					--	.520*	.066	-.243	-.120	.341	.008	.308
Policy						--	.349	-.239	.363	.392*	.371	.521*
Equity							--	.240	.330	.059	.586**	.575**
Affect								--	.232	-.227	.379	.187
Content									--	-.261	.288	.260
Pedagogy										--	.253	.579**
Technology											--	.841**

** Correlation is significant at the 0.01 level (1-tailed).
* Correlation is significant at the 0.05 level (1-tailed).

5.4 Correlations in the Secondary Syllabus Data Set

Correlation analysis of secondary syllabi (see Table 11, for secondary correlations – instrument categories and overall score) revealed a statistically significant very strong positive relationship between technology and overall score (r = .772, p = .002). Additionally, numerous statistically significant strong positive relationships were found including: course hours and theory (r = .507, p = .046), course hours and affect (r = .510, p = .045), reflection and lesson study (r = .641, p = .012), reflection and overall score (r = .600, p = .020), lesson study and assessment (r = .647, p = .012), lesson study and overall score (r = .562, p = .029), assessment and theory (r = .554, p = .031), assessment and policy (r = .514, p = .044), assessment and overall score (r = .664, p = .009), policy and overall score (r = .586, p = .023), equity and pedagogy (*r* = .553, *p* = .031), equity and technology (*r* = .555, *p* = .031), equity and overall score (*r* = .499, *p* = .049), and pedagogy and technology (*r* = .635, *p* = .013).

Correlation analysis of secondary syllabi also revealed statistically significant strong negative relationships between: mathematical tasks and theory (*r* = -.696, *p* = .046) and mathematical tasks and affect (*r* = -.507, *p* = .046). It would appear that more evidence of mathematical tasks was negatively related to evidence of theory or affect components to the syllabi. Important to note, course hours and overall score were not related and not statistically significant for secondary syllabi as well.

Table 11

Correlation of Instrument Categories and Overall Score, Secondary (n = 12)

	MTEd Instrument Categories											
	Reflection	Tasks	Lesson Study	Assessment	Theory	Policy	Equity	Affect	Content	Pedagogy	Technology	Score
Course Hours	-.011	-.578*	-.288	-.087	.507*	-.172	-.338	.510*	.092	-.059	-.027	.084
Reflection	--	-.225	.641*	.443	.413	.436	-.120	.456	-.184	-.131	.238	.600*
Tasks		--	-.304	-.307	-.696**	.210	.110	-.507*	.272	-.191	-.354	-.364
Lesson Study			--	.647*	.234	.218	.140	.051	-.320	.048	.403	.562*
Assessment				--	.554*	.514*	.272	.052	-.407	.232	.380	.664**
Theory					--	.057	-.110	.383	-.225	-.116	.154	.479
Policy						--	.232	.293	.054	.335	.195	.586*
Equity							--	-.251	-.090	.553*	.555*	.499*
Affect								--	.138	.055	.239	.394
Content									--	.144	-.289	-.168
Pedagogy										--	.635*	.464
Technology											--	.772**

** Correlation is significant at the 0.01 level (1-tailed).
* Correlation is significant at the 0.05 level (1-tailed).

5.5 Correlations in the Full Syllabus Data Set (Elementary and Secondary)

Correlation analysis of the full syllabus data set (see Table 12, for full data set correlations – instrument categories and overall score) revealed a statistically significant very strong positive relationship between technology and overall score (r = .814, p = .000). Additionally, numerous statistically significant strong positive relationships were found including: reflection and overall score (r = .510, p = .002), lesson study and assessment (r = .598, p = .000), lesson study and overall score (r = .626, p = .000), assessment and technology (r = .428, p = .008), assessment and overall score (r = .653, p = .000), policy and overall score (r = .547, p = .001), equity and technology (r = .566, p = .000), equity and overall score (r = .553, p = .001), pedagogy and technology (r = .424, p = .009), and pedagogy and overall score (r = .551, p = .001). Finally, many statistically significant moderate positive relationship were found including: course hours and theory (r = .315, p = .042), reflection and lesson study (r = .356, p = .025), reflection and assessment (r = .326, p = .037), lesson study and technology (r = .388, p = .016), assessment and theory (r = .399, p = .013), theory and overall score (r = .329, p = .036), policy and pedagogy (r = .381, p = .017), and policy and technology (r = .309, p = .045) (see Table 8, for qualitative examples of MTEd Instrument cells).

The correlation analysis of the full data set of syllabi also revealed a statistically significant strong negative relationship between course hours and tasks (r = -.424, p = .009) and a statistically significant negative moderate relationship between course hours and lesson study (r = -.352, p = .026). Consequently, more course hours did not result in either more evidence of mathematical tasks or lesson study. Important to note, course hours and overall score were negatively related and not statistically significant.

Table 12

Correlation of Instrument Categories and Overall Score, Full Data Set (n = 31)

	MTEd Instrument Categories											
	Reflection	Tasks	Lesson Study	Assessment	Theory	Policy	Equity	Affect	Content	Pedagogy	Technology	Score
Course Hours	.109	-.424**	-.352*	-.213	.315*	-.174	-.138	.166	-.066	-.187	-.059	-.182
Reflection	--	.002	.356*	.326*	.269	.163	.019	.080	-.185	.244	.278	.510**
Tasks		--	-.126	-.031	-.211	.081	-.248	-.234	.054	.057	-.080	-.006
Lesson Study			--	.598**	.287	.279	.229	-.020	.076	.204	.388*	.626**
Assessment				--	.399*	.267	.178	.152	-.019	.166	.428**	.653**
Theory					--	.274	.024	-.009	-.042	.099	.048	.329*
Policy						--	.299	-.105	.076	.381*	.309*	.547**
Equity							--	.076	.126	.245	.566**	.553**
Affect								--	.207	-.185	.293	.227
Content									--	-.151	-.062	.081
Pedagogy										--	.424**	.551**
Technology											--	.814**

** Correlation is significant at the 0.01 level (1-tailed).
* Correlation is significant at the 0.05 level (1-tailed).

5.6 Cross-Sectional Analysis of Correlations (aside from Course Hours)

There were some correlations that were particularly significant with a *p-value* at 0.01 or below and presented themselves across two or more data sets (see Table 13, for cross-sectional correlation groupings). These correlations were found between (a) the elementary data set and the full syllabus data set, and (b) the elementary data set, the secondary data set, and the full syllabus data set. There were no statistically significant (at or below $p = .01$) correlations found across the elementary data set and the secondary data set or the secondary data set and the full syllabus data set.

Table 13

Cross-Sectional Correlation Groupings

	Full Data Set & Elementary Data Set	Elementary Data Set, Secondary Data Set, & Full Data Set
Correlation Pairs	Assessment & Lesson Study	Technology & Overall Score
	Equity & Technology	Assessment & Overall Score
	Pedagogy & Overall Score	
	Lesson Study & Overall Score	
	Equity & Overall Score	

5.7 Correlations Related to Overall Score (aside from Course Hours)

Correlation analysis revealed various types of correlations between MTEd Instrument categories and overall score. These correlations ranged from statistically significant very strong correlations to no relationship at all. Additionally, correlations were found to be consistent across various groupings of data sets (see Table 14, for correlations between overall score and MTEd Instrument categories).

Table 14

Correlations between Overall Score and MTEd Instrument Categories

Overall Score &	Statistical Relationship (at p = .01 or below) Positive	Negative	No	Consistent Across
Technology	√ (statistically significant very strong)			All 3 Data Sets
Assessment	√ (statistically significant very strong)			All 3 Data Sets
Pedagogy	√			2 Data Sets (elementary and full data set)
Equity	√			2 Data Sets (elementary and full data set)
Lesson Study	√			2 Data Sets (elementary and full data set)
Policy	√			1 Data Set (full data set only)
Reflection	√			1 Data Set (full data set only)
Theory	√			1 Data Set (full data set only)
Mathematical Tasks			√	All 3 Data Sets
Affect			√	All 3 Data Sets
Content			√	All 3 Data Sets

Correlation analysis revealed two statistically significant very strong positive relationships consistent across all three data sets: technology and overall score (see Figure 2, for technology versus overall score) and assessment and overall score (see Figure 3, for assessment vs. overall score).

The distribution of data reveals that most syllabi scored either very poorly (score of one) or very well (score of four), with only a couple exceptions in between. Figure 2 demonstrates a strong positive relationship between technology and overall score.

Figure 2

Technology vs. Overall Score on MTEd Instrument for Full Data Set

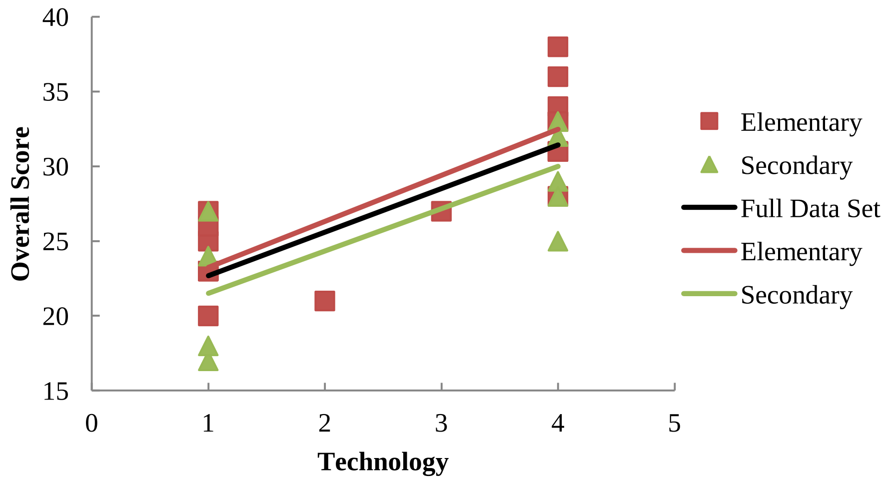

Figure 2. Scatter plot of all collected data (elementary, secondary, and full data) for overall score evaluated against the category of technology on the MTEd Instrument. A line of best fit is displayed for each data set (elementary, secondary, and full data set) to show a strong, positive relationship between technology level and overall score.

Figure 3

Assessment vs. Overall Score on MTEd Instrument for Full Data Set

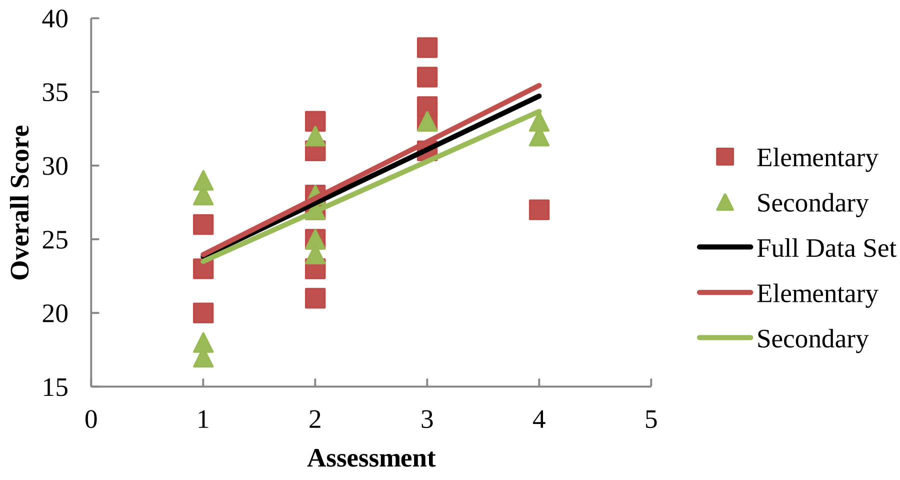

Figure 3. Scatter plot of all collected data (elementary, secondary, and full data) for overall score evaluated against the category of assessment on the MTEd Instrument. A line of best fit is displayed for each data set (elementary, secondary, and full data set) to show a strong, positive relationship between assessment level and overall score.

With regard to the six categories on the MTEd Instrument that showed statistically significant strong positive relationships with the overall score, these correlations were not consistent across all three data sets which suggested that their correlations were in fact weaker than suggested by their *p-values* (see Figures 4-9, for graphs on: policy vs. overall score, reflection vs. overall score, pedagogy vs. overall score, lesson study vs. overall score, equity vs. overall score, theory vs. overall score, respectively).

Figure 4

Policy vs. Overall Score on MTEd Instrument for Full Data Set

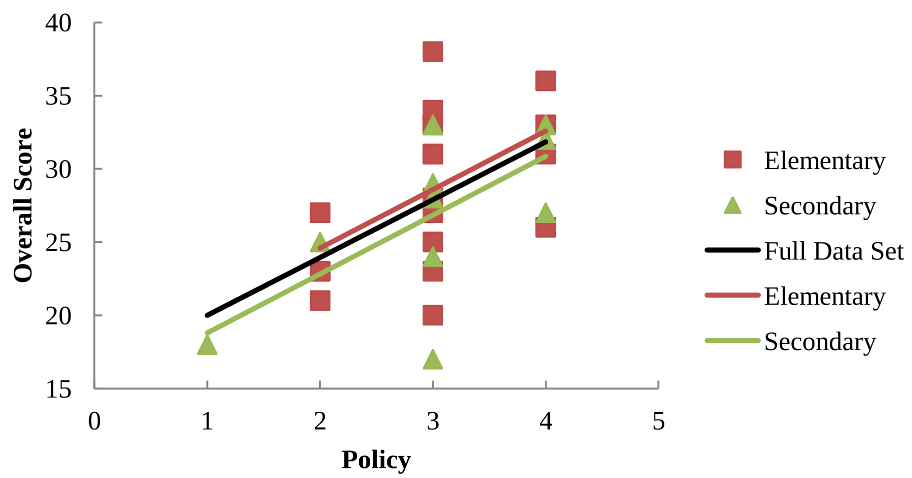

Figure 4. Scatter plot of all collected data (elementary, secondary, and full data) for overall score evaluated against the category of policy on the MTEd Instrument. A line of best fit is displayed for each data set (elementary, secondary, and full data set) to show a positive relationship between policy level and overall score.

Figure 5

Reflection vs. Overall Score on MTEd Instrument for Full Data Set

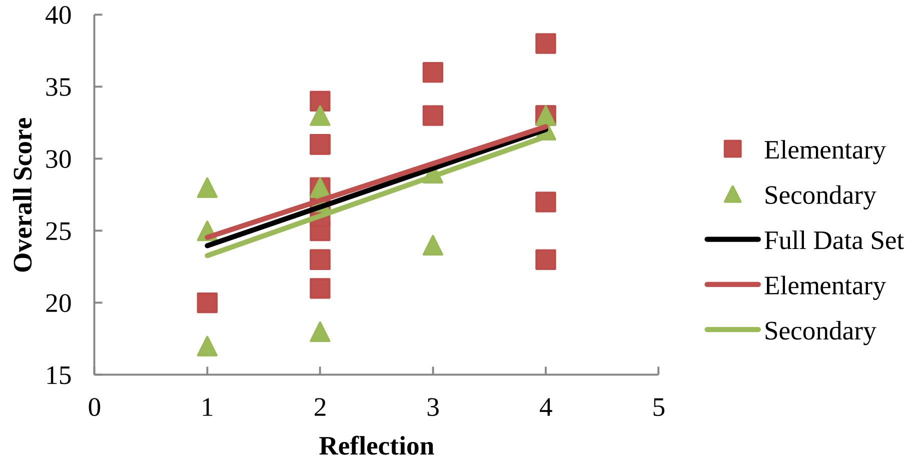

Figure 5. Scatter plot of all collected data (elementary, secondary, and full data) for overall score evaluated against the category of reflection on the MTEd Instrument. A line of best fit is displayed for each data set (elementary, secondary, and full data set) to show a positive relationship between reflection level and overall score.

Figure 6

Pedagogy vs. Overall Score on MTEd Instrument for Full Data Set

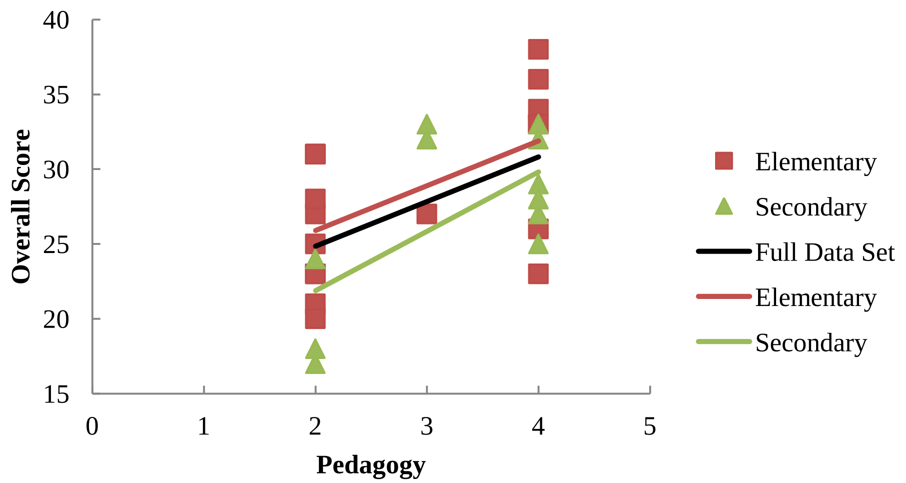

Figure 6. Scatter plot of all collected data (elementary, secondary, and full data) for overall score evaluated against the category of pedagogy on the MTEd Instrument. A line of best fit is displayed for each data set (elementary, secondary, and full data set) to show a positive relationship between pedagogy level and overall score.

Figure 7

Lesson Study vs. Overall Score on MTEd Instrument for Full Data Set

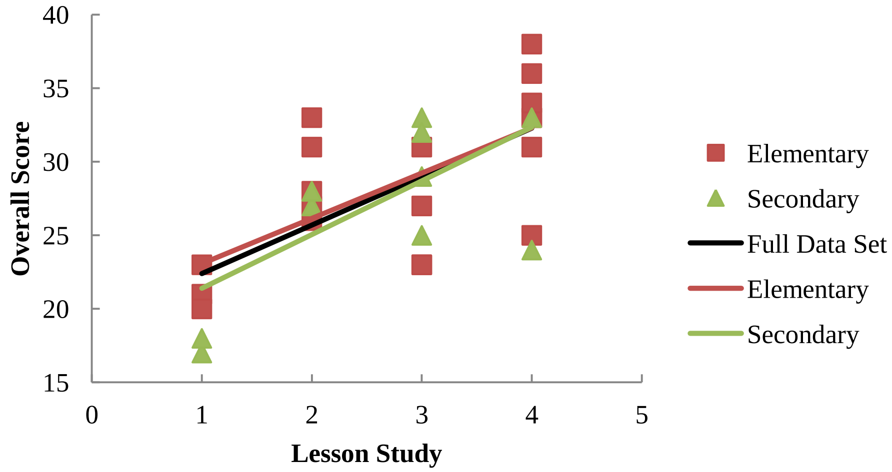

Figure 7. Scatter plot of all collected data (elementary, secondary, and full data) for overall score evaluated against the category of lesson study on the MTEd Instrument. A line of best fit is displayed for each data set (elementary, secondary, and full data set) to show a positive relationship between lesson study level and overall score.

Figure 8

Equity vs. Overall Score on MTEd Instrument for Full Data Set

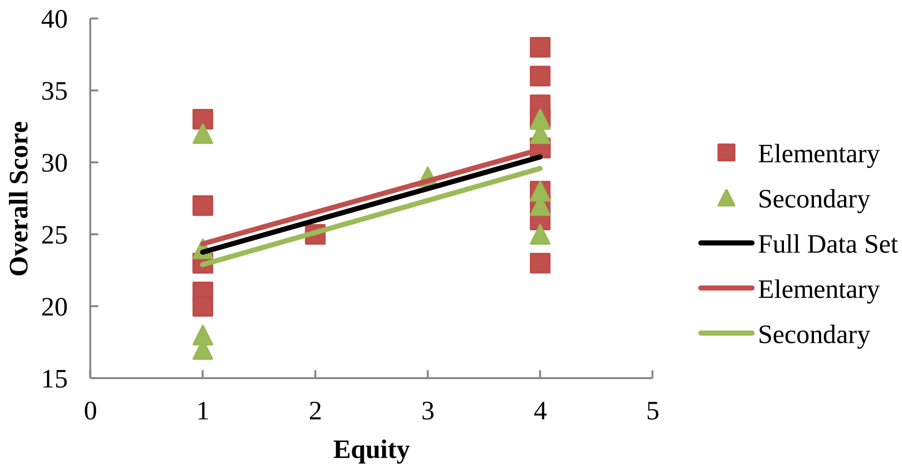

Figure 8. Scatter plot of all collected data (elementary, secondary, and full data) for overall score evaluated against the category of equity on the MTEd Instrument. A line of best fit is displayed for each data set (elementary, secondary, and full data set) to show a positive relationship between equity level and overall score.

Figure 9

Theory vs. Overall Score on MTEd Instrument for Full Data Set

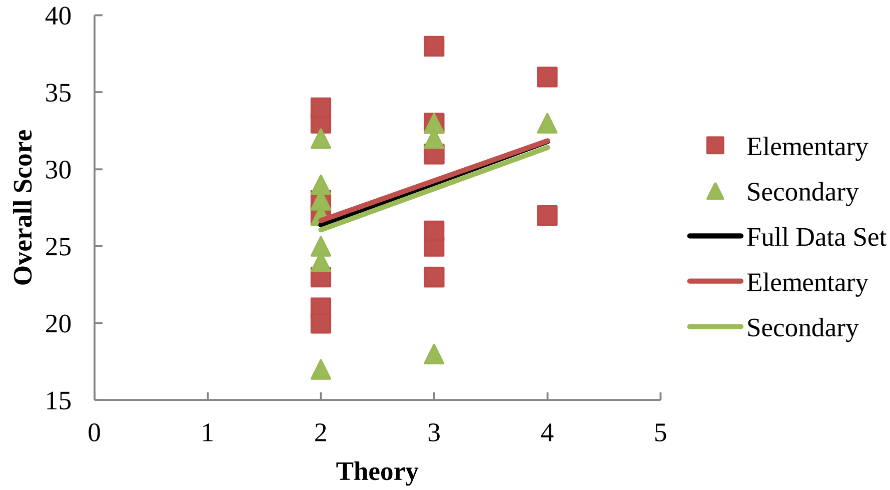

Figure 9. Scatter plot of all collected data (elementary, secondary, and full data) for overall score evaluated against the category of theory on the MTEd Instrument. A line of best fit is displayed for each data set (elementary, secondary, and full data set) to show a positive relationship between theory level and overall score.

5.8 Correlations Unrelated to Overall Score (aside from Course Hours)

Correlation statistics showed that three categories on the MTEd Instrument did not have any correlation with the overall score of the syllabi. These three categories were: mathematical tasks, affect, and content knowledge. The commonality between these three categories is that they all revealed results that were closely grouped around a central level. As a result, most syllabi received the same score in each of these categories which means they are independent of the overall score.

Most syllabi scored level one or two in the mathematical tasks category and the affect category (see Figure 10 and Figure 11, for mathematical tasks vs. overall score graph and affect vs. overall score graph, respectively). These graphs show many different combinations of category scores and overall scores. In some cases, it was possible for a syllabus to receive a high overall score but at the same time a low score in the individual category (e.g., level two in mathematical tasks and an overall score between 35 and 40). In other cases, it was possible for a syllabus to receive a low overall score but at the same time a high score in the individual category (e.g., level four in mathematical tasks and an overall score between 20 and 25). Therefore, the range in overall scores at a specific level is large.

Most syllabi scored a level three in the content category (see Figure 12, for content vs. overall score graph). This graph shows many different combinations of category scores and overall scores. In some cases, it was possible for a syllabus to receive a high overall score but at the same time a low score in the individual category (e.g., level one in content and an overall score between 30 and 35). In other cases, it was possible for a syllabus to receive a low overall score but a high score in the individual category (e.g., level three in content and an overall score between 15 and 20). Therefore, the range in overall scores at a specific level is large.

Figure 10

Mathematical Tasks vs. Overall Score on MTEd Instrument for Full Data Set

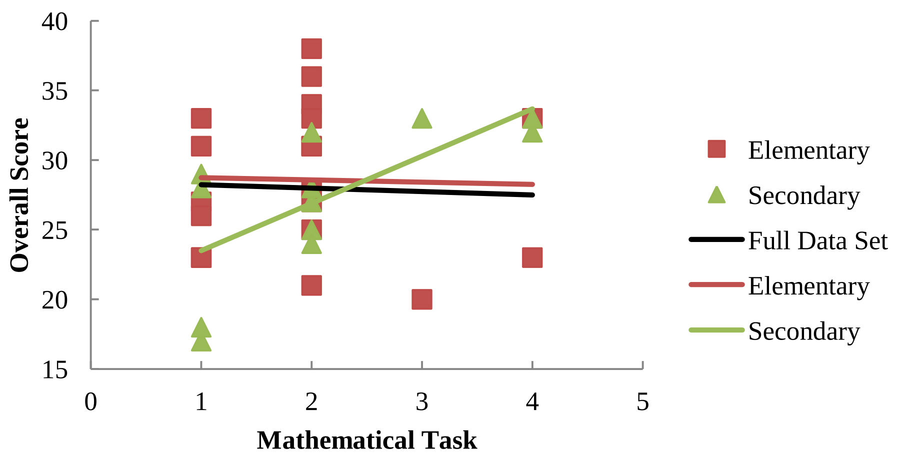

Figure 10. Scatter plot of all collected data (elementary, secondary, and full data) for overall score evaluated against the category of mathematical tasks on the MTEd Instrument. A line of best fit is displayed for each data set (elementary, secondary, and full data set) to show a weak relationship between mathematical tasks level and overall score.

Figure 11

Affect vs. Overall Score on MTEd Instrument for Full Data Set

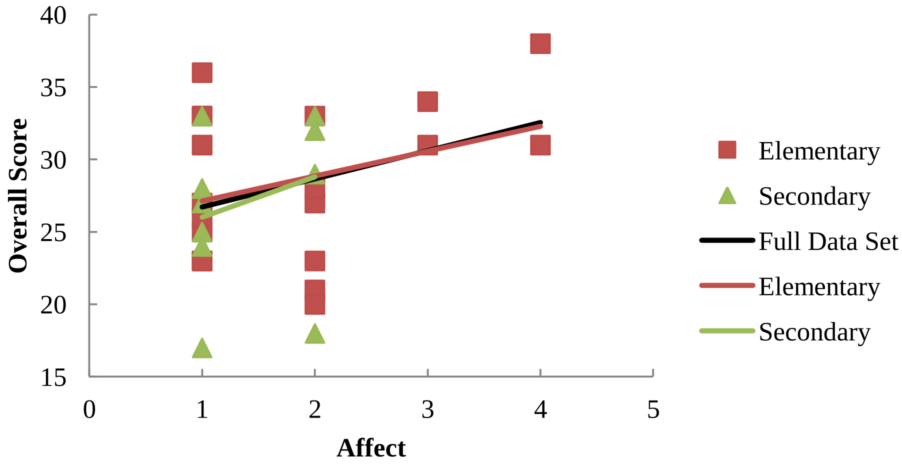

Figure 11. Scatter plot of all collected data (elementary, secondary, and full data) for overall score evaluated against the category of affect on the MTEd Instrument. A line of best fit is displayed for each data set (elementary, secondary, and full data set) to show a weak relationship between affect level and overall score.

Figure 12

Content vs. Overall Score on MTEd Instrument for Full Data Set

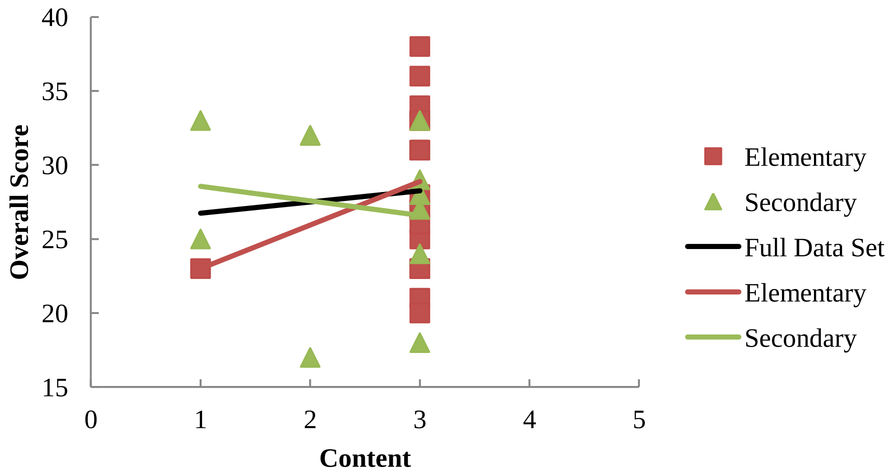

Figure 12. Scatter plot of all collected data (elementary, secondary, and full data) for overall score evaluated against the category of content on the MTEd Instrument. A line of best fit is displayed for each data set (elementary, secondary, and full data set) to show a weak relationship between content level and overall score.

5.9 Results Summary

The MTEd Instrument suggests that only *moderate* levels of dominant areas of research in mathematics teacher education were found in the syllabi. Technology and assessment were the only categories that were correlated across all combinations of the data set to overall score. The elementary and secondary course syllabi only differed in the area of content, where elementary syllabi were shown to have a higher overall level. Finally, course hours were not related to overall score.

Chapter 6: Discussion

The goal of the current research was to examine the degree to which research in the field of mathematics teacher education is informing the practices of mathematics teacher educators, and thus the way in which pre-service teachers are learning to teach mathematics through the analysis of mathematics teacher education syllabi. The results demonstrate that the research-to-practice take-up at the mathematics teacher educator level may be predominately *moderate* (according to the MTEd Instrument) at best, based upon the assessment of the syllabi submitted. This is demonstrated through the overall score results that show only eight syllabi achieved a *high* rating, nineteen achieved a *moderate* rating, and four achieved a *low* rating. In particular, the findings reveal that the representation of some of the areas of mathematics teacher education research are especially lacking or non-existent in 23 out of the 31 syllabi analyzed. Despite calls to minimize the gap in research-to-practice connections, some gaps seem to nevertheless be evident.

It is important to note again, that while the analysis of course syllabi for this research showed *moderate* evidence of research-to-practice connections for mathematics teacher educators, connections may still emerge in classroom practices. However, the absence of evidence has led to questions about the importance of transparency of course content for students. Numerous scholars have argued that this sort of transparency is essential and indeed may be why some institutions have policy statements regarding course syllabi (Adler, 1999; Baker, 2001; Matejka & Kurke, 1994). Conversely, as stated in the theoretical framework, it is important to note that items may be stated on a syllabus and not enacted in the classroom.

In addition to the main findings related to the gap between research and practice, the more broad research question that framed this current research, *How is research reflected in* *mathematics teacher educators' practices, as evidenced in course syllabi,* can begin to be answered using the reported results.

6.1 Descriptive Statistics

The categories of mathematical tasks and affect have the lowest mean levels and thus, are the two categories represented the least on mathematics teacher educators' syllabi. One possible reason for the lack of representation of mathematical tasks on mathematics teacher education syllabi might be that pre-service research in this area is rather current (Chapman, 2007; Watson & Sullivan, 2008; Zaslavsky, 2007). This is not to say that there is no historical research on the importance of mathematical tasks but that current research is now focusing more on pre-service mathematical tasks and giving consideration to the importance of providing pre-service teachers with opportunities to engage in both pupil- and teacher-level mathematical tasks (Watson & Sullivan, 2008).

The possible explanations for the lack of representation of affect on mathematics teacher education syllabi are much more complex. Research in this area of affect is robust and stretches across many years, making it unusual that so few syllabi make reference to it. Interestingly, affect is proposed to influence teaching practice as much as the social context and the teachers' level of thought and reflection (Ernest, 1989). Perhaps the only justification for the lack of representation of affect on mathematics teacher education syllabi relates to an idea put forward by Thompson (1992) when he notes that it is impossible to distinguish beliefs from knowledge because "teachers treat their beliefs as knowledge" (p. 127). This quote reveals the close tie that affect has to knowledge. As a result, it could be inferred that mathematics teacher educators overlook affect when planning their pre-service teacher preparation programs because the syllabi already represents, at least implicitly, their orientation towards affect.

Equity and technology have the greatest amount of variance with regard to the levels received from syllabus to syllabus, and this is not surprising. As coding of the syllabi took place, it appeared that most syllabi were receiving either level one or four. Most syllabi either mentioned equity and/or technology once in their overriding course goals section or not at all. Unlike other categories on the MTEd Instrument, both equity and technology had similar requirements for levels one to four. These requirements ranged from: no evidence for level one, limited or didactic methods of topic exploration for level two, some evidence of topic exploration for level three (e.g., incorporated into one lesson), extensive evidence of topic exploration for level four (e.g., unit of study or overriding course goal statement). The MTEd Instruments allowance of an overriding course goal statement to be justification for a level four caused many syllabi to receive a level four quite easily and the rest of the syllabi to receive a level one. It should be noted that these were the only two categories that allowed an overriding course goal statement to be justification for level four. Therefore, this may be a limitation of the MTEd Instrument.

Conversely, the three categories that showed the least amount of variance with regard to the levels received from syllabus to syllabus were theory, policy, and content. One potential explanation for this is the fact that these research areas have either been around for a long period of time or have been the focus of extensive research over an extended period of time. As a result, these predominant research areas are likely known to mathematics teacher educators and they understand that it is necessary to include them in their mathematics teacher education programs, and thus their syllabi.

The low variance of levels received in the category of policy from syllabus to syllabus suggests that mathematics education is a political endeavor that is closely prescribed by policy and needs to be followed by teachers and taught to pre-service teachers (Popkewitz, 2004). Thus, mathematics teacher educators appear aware of the necessity of exploring policy within their pre-service teacher education programs. Another explanation is that policy informs practice in education. Therefore, policy also informs teacher education.

Mathematics teacher education research in the areas of theory and practice connections and content knowledge show low variance, with regard to the level received from syllabus to syllabus. As mentioned in the literature review, numerous scholars and policy initiatives (NCATE, 2008; NCTM, 2000) have identified the challenges and necessity in connecting theory and practice for pre-service teachers (Breen, 2003; Jaworski, 1998, 2006) and as a result, a good deal of research has gone into this field and has found its way into course syllabi. Conceptual ideas pervade the field of theory-to-practice ranging from: concerns about teaching practices that do not line up with research (Mathern & Hansen, 2007; McDonnough & Matkins, 2010; Tsafos, 2010), theory and practice complimenting each other opposed to guiding each other (Tsafos, 2010), and theoretical perspectives (English, 2003; Heid et al., 2006).

Mathematics teacher education research in the area of content knowledge is extensive and robust, particularly over the past decade (Adler & Davis, 2006; Ball, 2000; Ball et al., 2005; Ball & Grevholm, 2008; Kotsopoulos & Lavigne, 2008; Stylianides & Stylianides, 2009). As stated in the literature review, numerous scholars have attempted to articulate the sorts of content knowledge required by future mathematics teachers. Many outgrowths of this have occurred, with the work of Ball and her colleagues being of substantial importance (Ball, 2000; Ball et al., 2005; Ball & Grevholm, 2008). Overall, the extensive research available on theory-to-practice connections and content knowledge may explain why pre-service teacher educators include these areas of research in their program and thus, why these two categories showed the least amount of variance with regard to the levels received from syllabus to syllabus.

6.2 Mann-Whitney

Content knowledge was observed more on elementary syllabi than on secondary syllabi and this is not surprising. Secondary teachers likely have more background disciplinary education in mathematics and thus, mathematics teacher educators may make the assumption that content knowledge is not necessarily a crucial aspect of their teacher education program. Elementary teachers, on the other hand, tend to "have had little or no mathematics since high school, and have found their high school mathematics difficult" (Jonker, 2008, p. 328). In addition, "there is specialized content knowledge needed for teaching elementary mathematics that is unique from the common mathematical content knowledge" (Swars, Hart, Smith, Smith, & Tolar, 2007, p. 325). Content knowledge was the only category on the MTEd Instrument that displayed a statistically significant difference between elementary and secondary syllabi.

6.3 Correlation Analysis

Correlation analysis was conducted for three data sets: elementary-only, secondary-only, and the full data set and a number of statistically significant relationships were revealed (*p-value at 0*.5 or below). Due to the large number of statistically significant relationships found in this current research, only the strongest relationships will be discussed (*p-value* at 0.01 or below). Limiting discussion to only the strongest relationships is appropriate for this research because having only four levels for each category causes correlations to appear more readily. The results have been organized into two groups, unique correlations and cross-sectional correlations. As such, unique statistically significant relationships will be discussed first, followed by a discussion of correlations that have presented themselves across various data sets (cross-sectional analysis).

6.4 Correlations within Individual Data Sets (aside from Course Hours)

Unique, statistically significant (at or below $p = .01$) correlations were found in the secondary data set exclusively and the full data set exclusively. It should be noted that there were no statistically significant correlations found in the elementary data set exclusively (see Table 15, for correlations within individual data sets exclusively).

Table 15

Correlations within Individual Data Sets Exclusively

	Secondary Data Set	Full Data Set
Correlations	Mathematical Tasks & Theory	Assessment & Technology
		Pedagogy & Technology
		Policy & Overall Score
		Reflection & Overall Score

6.4.1 Secondary Data Set Exclusively

Correlation analysis reveals a statistically significant strong positive relationship between the categories of mathematical tasks and theory. Upon reflection of the literature, mathematical tasks that prompt pre-service teachers to engage in tasks that allow them to develop a deeper understanding of mathematical content and student learning processes (Chapman, 2007; Watson & Sullivan, 2008) do not relate to theory-to-practice connections that prompt pre-service teachers to actively engage in and with research articles (McDonnough &

Matkins, 2010; Tsafos, 2010). Therefore, despite their statistically significant strong positive correlation, there is no clear justification for why this relationship exists.

6.4.2 Full Data Set Exclusively

Correlation analysis reveals a statistically significant strong positive relationship between the categories of pedagogy and technology. This relationship is not surprising because for many years, technology has been considered a pedagogical teaching strategy that encourages and supports student learning (Hennessy et al., 2007; Jaffee, 1997; Juniu, 2011). Technology has become an integral part of everyday life which means a switch from *optional tool* to *necessary tool* has taken place and this switch has been recognized in the field of education.

Viewing technology as a pedagogical tool fits well with the current reforms that promote the integration of technology throughout the classroom and within various facets of the teaching and learning process (Chai et al., 2010). As a result, a potential explanation for the correlation between pedagogical content knowledge and technology is that it is possible that pre-service teachers are engaging in technology investigation at the same time that they are being exposed to pedagogical content knowledge. This is due to the fact that technology can be embedded into the area of pedagogy since technology is sometimes viewed as a pedagogical teaching strategy.

Correlation analysis reveals a statistically significant strong positive relationship between the categories of assessment and technology. The literature suggests that opportunities for pre-service teachers to engage in the analysis of pupil level diagnostic, formative, and summative assessment tasks (Cunningham & Bennett, 2009; Ketterlin-Geller & Yovanoff, 2009; Xu & Liu, 2009) does not relate to opportunities for pre-service teachers to engage in investigation and implementation of technology into all facets of the classroom (Chai et al., 2010). Therefore, despite their statistically significant strong positive correlation, there is no clear justification for why this relationship exists.

6.5 Cross-Sectional Correlation Analysis (aside from Course Hours)

Statistically significant correlations (at or below p = .01) were found across various groupings of data sets which included: the elementary data set and the full data set; and the elementary data set, the secondary data set, and the full data set. It should be noted that there were no statistically significant (at or below p = .01) correlations found across: the elementary data set and the secondary data set; or the secondary data set and the full data set (see Table 13, for cross-sectional correlation groupings table).

6.5.1 Elementary and Full Data Set

Correlation analysis reveals a statistically significant strong positive relationship between the categories of lesson study and assessment, in both the elementary data set and the full data set. A key aspect of lesson study is the process of pre-service teachers reflecting on enacted lesson plans to build their understanding of how students develop mathematical knowledge (Corcoran, 2011; Post & Varoz, 2008). If we use this knowledge of lesson study as a starting point and take into account the various aspects of assessment, for example diagnostic assessment where the teacher tries to build an understanding of how each student develops their mathematical knowledge (Ketterlin-Geller & Yovanoff, 2009), it can be argued that lesson study is also about assessment. As a result, a potential explanation for the correlation between lesson study and assessment is that pre-service teachers engage in assessment during lesson study due to the fact that assessment is embedded into lesson study.

Correlation analysis reveals a statistically significant strong positive relationship between the categories of equity and technology, in both the elementary data set and the full data set. As stated previously, another relationship between equity and technology exists with regard to having the greatest amount of level variance, from syllabus to syllabus. Interestingly, the earlier relationship can play a role in the explanation of the correlation between these two categories. As affirmed earlier, the categories of equity and technology were the only two categories on the MTEd Instrument that allowed an overriding course goal statement to be justification for level four. As a result, most syllabi received a level one or level four because they either mentioned equity and/or technology once in their overriding course goals section or not at all. Through additional anecdotal observation during the coding process, it became apparent that if a syllabus had an overriding course goal statement regarding equity, then that same syllabus would have an overriding course goal statement regarding technology, and vice versa.

The overriding goal statements often contained a reference to the National Council of Teachers of Mathematics (NCTM) standards and/or the National Council for Accreditation of Teacher Education (NCATE) themes in most United States of America syllabi. Furthermore, when NTCM standards and/or NCATE themes were referenced, there was a high likelihood that equity and technology statements would also be noted within the overriding course goals section. This allowed the syllabus to score level four in both categories (e.g., USA 3, USA 5, USA 6, USA 7, USA 11, and USA 14). Therefore, one explanation for the correlation between the categories of equity and technology is that USA syllabi that emphasized NTCM standards and/or NCATE themes likely cited equity and technology as overriding course goals because those standards/themes also emphasized those goals. According to NCTM, the equity principle states, “equity requires accommodating differences to help everyone learn mathematics” (NCTM, 2000, p. 13). Also according to NCTM, the technology principle states, “technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students’ learning” (NCTM, 2000, p. 24). Similarly, NCATE identifies equity and diversity as one of their unit standards (standard four) and states that “assessment indicates that candidates can demonstrate and apply proficiencies related to diversity” (NCATE, 2008). Additionally, the conceptual framework piece of NCATE’s unit standards states that “candidate proficiencies related to expected knowledge, skills, and professional dispositions, including proficiencies associated with diversity and technology”(NCATE, 2008).

6.5.2 Elementary, Secondary, and Full Data Set

Correlation analysis reveals a statistically significant strong positive relationship between assessment and overall score. This relationship reveals that when a level in the category of assessment fluctuates, the overall score for that syllabus fluctuates in the same direction, noting that the overall score defines the degree to which current research is informing the practice of the mathematics teacher educator that is providing the course. In other words, the category of assessment has a strong positive relationship with the degree to which current research is informing the practices of mathematics teacher educator’s across their entire program.

The literature on assessment states that opportunities for pre-service teachers to engage in the analysis of pupil level diagnostic, formative, and summative assessment tasks allows them to gain the necessary knowledge and understanding needed to teach mathematics (Cunningham & Bennett, 2009; Ketterlin-Geller & Yovanoff, 2009; Xu & Liu, 2009). Using the knowledge that assessment weaves through many stages of the teaching and learning process (diagnostic, formative, and summative assessment), an explanation for the relationship between assessment and overall score can begin with the realization that assessment is embedded into some of the eleven categories on the MTEd Instrument (e.g., lesson study, pedagogy, equity). Moreover, the incorporation of assessment into these three categories on the MTEd Instrument only happens within the definition for level four in that category.,

Firstly, assessment is embedded into level four of the lesson study category. A key aspect of lesson study is the process of pre-service teachers reflecting on enacted lesson plans to build their understanding of how students develop mathematical knowledge (Corcoran, 2011; Post & Varoz, 2008). The process of building an understanding of how students develop mathematical knowledge is essentially an act of assessing student's mathematization. Furthermore, assessing students' mathematization is a large piece of how pre-service teachers learn to assess students and their knowledge. As such, it becomes evident that assessment is embedded into well executed lesson study that incorporates pre-service teacher reflection on student learning and their mathematical knowledge development. Furthermore, level four for the category of lesson study in the MTEd Instrument states that pre-service teachers must be given opportunities to develop lesson plans collaboratively that are presented to the class and reflected upon, where the reflection piece is critical to evidencing assessment.

Secondly, assessment is embedded into level four of the pedagogy category. When we refer back to the literature on pedagogical content knowledge we see that one of the two key components of pedagogical content knowledge, according to Shulman (1986), is knowledge of students' learning difficulties (e.g., naive prior knowledge, misconceived ideas, missing links to inter-related ideas, lack of problem solving skills). The way in which knowledge of students' learning difficulties comes about is through assessment of student abilities. For example, Ketterlin-Geller and Yovanoff (2009) state that diagnostic "assessment results provide information about students' mastery of relevant prior knowledge and skills…as well as preconceptions or misconceptions about the material" (p. 1). Therefore, for teachers to have strong pedagogical content knowledge, they must become aware of their students' abilities through diagnostic assessment. As such, level four for the category of pedagogy in the MTEd Instrument states that pre-service teachers must be given opportunities to examine, develop, and analyze pedagogical teaching strategies, where the analysis piece is critical to evidencing assessment because it requires pre-service teachers to engage in diagnostic assessment of students in order to analyze if a certain pedagogical teaching strategy is appropriate for those students.

Thirdly, assessment is embedded into level four of the equity category. A review of the literature reveals that one factor that contributes to the underachievement and marginalization of certain populations of students is teacher pedagogy (Esmonde, 2009). Thus, in order to make teaching and learning more equitable for all students it is important for teachers to have strong pedagogical content knowledge, and as stated earlier, the way in which teachers gain parts of this knowledge is through diagnostic assessment of their students' abilities. As such, level four for the category of equity and diversity in the MTEd Instrument states that pre-service teachers must be given extensive opportunities to explore equity and diversity considerations in mathematics education, where the extensive opportunities piece is critical to evidencing assessment because it requires pre-service teachers to assess student's diverse needs and teach equitably to those needs.

Therefore, assessment is embedded into the categories of lesson study, pedagogy, and equity. When any one of these categories, or a combination of these categories, receives a level four, assessment is implicitly linked and emphasized. Additionally, the overall score fluctuates in the same direction as assessment because level four is beginning received by one or all of the three identified categories (lesson study, pedagogy, and equity).

Correlation analysis also reveals a statistically significant very strong positive relationship between technology and overall score. The data suggests that when a level in the category of technology fluctuates, the overall score for that syllabus fluctuates in the same direction, noting that the overall score defines the potential degree to which current research is evident in mathematics teacher education syllabi. In other words, the category of technology may indicate the degree to which current research is informing the practices of mathematics teacher educator's across their entire program.

Educational reforms around technology have endorsed the advantages of integrating information and communication technologies (ICT) into all classrooms (Chai et al., 2010; Fox & Henri, 2005; Greenhow et al., 2009; Jonassen et al., 2008; Tan et al., 2006; Xiao & Carroll, 2007). This type of mass adoption of technology into all facets of teaching and learning is a relatively new and evolving concept as it is still in its' reform stages as stated by Chai et al. (2010). As such, it can be alleged that a mathematics teacher education course that integrates technology into their program demonstrates an approach to pre-service teacher education that is grounded in current research. Moreover, pre-service mathematics teacher education courses that incorporate technology into the classroom may also incorporate other educational reforms into their program and thus, a high degree of current research in their pre-service teacher education course syllabi may also be evident.

Because of the strong evidence of technology relation across the data set, technology may be an excellent indicator of overall score on the MTEd Instrument. This measure could be used, in place of an elaborate rubric to quickly evaluate a pre-service teacher education program in terms of evidence of current research. For example, the time it took to evaluate a single syllabus limited the amount of data that could be analyzed in this research. A method of evaluating a much larger sample size could be to evaluate syllabi based only on technology which will give a good indication of overall MTEd Instrument score. To further increase the rate at which data could be analyzed, a computer algorithm could be generated to search each syllabus for key words relating to technology and technology applications.

The distribution of data for technology on the MTEd Instrument reveals that most syllabi scored either very poorly (score of one) or very well (score of four), with only a couple exceptions in between. The reason for this distribution is twofold. Firstly, the MTEd Instruments' structure gives a score of four to any syllabus that has only a couple instances of technology in the program mentioned (e.g., technology mentioned in the overriding course goals section of the syllabus). Secondly, syllabi that did mention technology generally did an excellent job of incorporating it into the program. In summary, this distribution may be an indication of a break between pre-service teacher education programs grounded in current research and programs that are unaffected by research despite what research shows is important for pre-service teachers to be learning.

6.6 Correlations Unrelated to Overall Score (aside from Course Hours)

Correlation statistics showed that three categories on the MTEd Instrument did not have any correlation with the overall score of the syllabi: mathematical tasks, affect, and content knowledge. The only surprising correlation result is content knowledge. There is extensive research available on content knowledge and the importance of this for teacher development

(Ball, 2000; Ball et al., 2005; Ball & Grevholm, 2008; Breen, 2003; Jaworski, 1998, 2006) so it is surprising that there is no correlation between content knowledge and overall score.

Since research in the area of mathematical tasks for pre-service teacher education is quite current and new (Chapman, 2007; Watson & Sullivan, 2008; Zaslavsky, 2007), that might be the reason why there is no relationship between mathematical tasks and overall score. The newness of this research area is displaying itself in this current research as low scores which could mean that the lack of representation of mathematics tasks on syllabi is why there is no correlation between mathematical tasks and overall score.

The explanation for affect not being correlated with overall score may be similar to the earlier discussion around affect. As stated previously, affect has close ties to knowledge (Thompson, 1992) which could mean that pre-service teacher educators are intuitively lumping affect into the category of content knowledge and thus, not evidencing affect on their syllabi. It can be inferred that the lack of representation of affect on syllabi is why there is no correlation between affect and overall score.

6.7 Course Hours

Correlation statistics showed no statistically significant positive correlations (at p = .01 or below) between course hours and overall score. This means that an increase to course hours did not potentially result in pre-service teachers gaining more knowledge and understanding about research informed practice.

When considering statistically significant correlations (at p = .01 or below) between course hours and individual MTEd Instrument categories, we see that one statistically significant strong negative relationship appears between mathematical tasks and course hours within the full data set. This relationship reveals that when course hours increase, the level for mathematical tasks decreases, and vice versa. This relationship is counterintuitive considering the literature on mathematical tasks states that mathematical tasks prompt pre-service teachers to engage in tasks that allow them to develop a deeper understanding of mathematical content and student learning processes (Chapman, 2007; Watson & Sullivan, 2008). Therefore, despite their statistically significant strong negative correlation, there is no clear justification for why this relationship exists.

6.8 Discussion Summary

The results of this current research suggest that the research-to-practice take-up at the mathematics teacher educator level may be predominately *moderate* (according to the MTEd Instrument). Additionally, technology and assessment are the only two categories that are correlated across all combinations of the data set to overall score. This suggests that technology and assessment may be overall indicators of the level of research-to-practice contained in mathematics teacher education course syllabi. Also, elementary syllabi differ from secondary syllabi in the area of content, where elementary syllabi are shown to have a higher overall level. This is consistent with what might be expected based upon the literature that more content knowledge may be necessary for those preparing to become elementary teachers. Lastly, course hours are not related to overall score which suggests that more course hours may not results in pre-service teachers gaining more knowledge and understanding about research informed practice.

Chapter 7: Conclusions

The question that framed this current research was; *How is research reflected in mathematics teacher educators' practices, as evidenced in course syllabi?* More specifically, the goal of the current research is to examine the degree to which current research in the field of mathematics teacher education is informing the practices of mathematics teacher educators, and thus the way in which pre-service teachers are learning to teach mathematics.

There were four major findings that resulted from this current research. First, despite the push to link research-to-practice, the MTEd Instrument suggested that only *moderate* levels of dominant areas of research discourse in mathematics teacher education were found in the syllabi. Second, technology and assessment were the only categories that were correlated to the overall score across all combinations of the data set. Third, the elementary and secondary course syllabi only differed in the area of content, where elementary syllabi were shown to have a higher overall level. Finally, course hours were not related to overall score.

7.1 Limitations

There were a few limitations of this research. First, a language barrier may have caused some mathematics teacher educators' who wanted to participate in the research to be unable to. This may have been because they could not translate their documents or they could not understand which document this research was interested in analyzing.

The second limitation was the sample size of the final data set. Due to various reasons, the full data set (n = 147) needed to be filtered down many times which caused the final data set to be small (n = 31). Noting, this filtering process was an unavoidable step that had to be taken in order to achieve a homogenous data set. Syllabi were filtered out of the full data set (n = 147) for the following reasons: not consistent with a methods course, translation of the syllabus document was not possible, the document could not be categorized as a syllabus, and the course was not a one term course (approximately 12 to 13 weeks), with course hours between 30 and 49.

Despite restricting syllabi in the sample to those with total hours between 30 and 49, the variance of course hours from syllabus to syllabus within the final data set (n = 31) was nevertheless a limitation. This limitation was two-dimensional. First, this limitation was unavoidable because the final data set (n = 31) would have been far too small if it was required that all syllabi have the exact same number of course hours as evidenced on their syllabus. Second, not all course syllabi in the full data set (n = 147) stated their number of course hours on their syllabus. As such, syllabi that did not state their course hours on their syllabus had to be excluded from the final data set (n = 31) even if they did fit into the category of one term, 30 to 49 hours.

Another potential limitation of the current research was the use of syllabi as the primary data source. As stated earlier, this research built off the idea put forward by Matejka and Kurke (1994) that the syllabus represents a legal agreement between the instructor and the student, the student and the university, and the instructor and the university and thus, represented what supposedly happened in the classroom during the course. However what was included in the syllabus may not necessarily be enacted in the classroom. Conversely, just because an area of research was not identified on the syllabus does not mean it was not enacted in the classroom.

Other potential limitations of the current research related to the MTEd Instrument. The MTEd Instrument used a scale that was limited to level one through level four which may have caused a compression of trends due to its small range. A larger ranged grading scale may be appropriate.

Additionally, another potential limitation to the current research was human error in quantifying syllabus scores (despite high inter-coder reliability). During the process of coding and writing memo notes, it could be conceived that the coder misread a section of the syllabus or inaccurately noted a level in their memo notes which would cause human error to affect the results of this research.

The MTEd Instrument weighted all the categories equally when it could be argued that some of the eleven categories are more differentially important to mathematics teacher education in different contexts. The MTEd Instrument could be potentially modified to accommodate various category weightings in order to illustrate a more holistic or context relevant picture of mathematics teacher education research. As such, a holistic picture would be demonstrated through varied category weights where the most important to least important elements of a mathematics teacher education course would be evidence on the MTEd Instrument.

Another potential rubric modification is building on the detail and examples found in each box of the MTEd Instrument. As it stands currently, the MTEd Instrument has gone through four modifications and in each modification the rubric was further developed by adding detail and more examples of evidence in each category. Following this trend, a potential rubric modification would be further developing each box by adding more detail and examples. Examples of this kind of extension include: the category of reflection may be potentially modified to explicitly include an incident reflection and process reflection piece (Ricks, 2010), the category of assessment may be potentially modified to explicitly include a diagnostic, formative, and summative assessment piece (Cunningham & Bennett, 2009; Ketterlin-Geller & Yovanoff, 2009; Xu & Liu, 2009), the category of theory may be potentially modified to emphasize the importance of theory becoming present in practice only when a practical application is possible Tsafos (2010), and the category of technology may be potentially modified to explicitly include a Technological, Pedagogical, and Content Knowledge (TPACK) piece (Chai et al., 2010).

The last potential rubric modification that will be put forward is that the rubric needs to be updated on a regular basis in order to keep it up-to-date with current mathematics teacher education research. Without continual updating of the MTEd Instrument based on current mathematics teacher education research the evaluative tool will become stagnant, out-of-date, and ineffective.

Finally, it is recognized that a wide range of culturally-relevant pedagogies exist and may be unique to a particular mathematics teacher education program, given that teaching is a cultural activity as stated by Hiebert and Stigler (1999). The MTEd Instrument is intentionally not designed to address culturally-relevant pedagogies but could benefit from such elaborations in certain settings.

7.2 Recommendations

The next step in research regarding the up-take of mathematics teacher education research into the practices of mathematics teacher educators would be to analyze other subsets of the full data set collected in this research (n = 147) using the MTEd Instrument to find out if the same or new trends appear. Analysis of the full data set is also an option. However, considerations and limitations would need to be discussed for this type of future research regarding the fact that the new group of syllabi to be analyzed will not evidence similar course hours.

Alternatively, a different approach to researching the up-take of mathematics teacher education research into the practices of mathematics teacher educators could be taken by examining the research-to-practice connection using a data source other than syllabi to see if the results are idiosyncratic. Two potential, alternative data sources might be: transcripts from mathematics teacher education classes or questionnaires designed for pre-service teachers who have recently taken a mathematics teacher education course. The transcripts would need to be coded using some type of content analysis (e.g., memo notes) to determine the degree to which mathematics teacher educators are evidencing current research in their practice. The questionnaires on the other hand, would be need to designed to ask pre-service teachers about what types of learning opportunities they were given during their mathematics teacher education course. In both cases, the MTEd Instrument could be used as an evaluative tool to analyze the data sources.

Additional future research could extend further than the research-to-practice take-up by mathematics teacher educators, as explored in this research, and into the subsequent practices of pre-service teachers. It would be of great interest to explore the way in which pre-service teachers incorporate (or not) research into their successive practice, distinguishing between pre-service teachers who participated in courses that exhibited *low*, *moderate*, and *high* research-to-practice evidence within their course syllabi.

Finally, future research needs to further examine the relationship between; the number of course hours a mathematics teacher education course offers and the quantity and quality of the knowledge and understanding that pre-service teachers receive from that course. It is recommended that an analysis of courses with more course hours take place to see if the results are also idiosyncratic.

Appendices

Appendix A: MTEd. Instrument

Low evidence of research (overall score less than 22)	**Moderate** evidence of research (overall score from 22 to 32)	**High** evidence of research (overall score more than 32)

Categories	Level 1	Level 2	Level 3	Level 4
1. Reflection	**No** opportunities to engage in reflection.	Opportunities to engage in only **one** type of reflection.	Opportunities to engage in only **two** types of reflection.	Opportunities to engage in all **three** types of reflection (priori, initeri, a posteri).
2. Mathematical Tasks	**No** direct engagement with mathematical tasks.	Opportunities to engage only in **either** pupil or pre-service level tasks.	Some opportunities to engage in **both** types of tasks.	**Extensive** opportunities to engage in **both** types of tasks.
3. Lesson Study	**No** lesson planning.	Developing lesson plans **individually or collaboratively** that are **not** enacted. [No reflection piece]	Developing lesson plans **individually or collaboratively** that are **presented** to the class. [No reflection piece]	Developing lesson plans **collaboratively** that are **presented** to the class and **reflected** upon.
4. Assessment	**No** opportunities to engage in assessment.	**Limited** opportunities to engage in assessment and analyze pupil level mathematization.	**Some** opportunities to engage in assessment and analyze pupil level mathematization.	**Extensive** opportunities engage in assessment and to analyze pupil level mathematization.
5. Theory and Practice Connections	**No** opportunities to engage with research. [e.g., only the textbook – no references to other research]	**Limited** opportunities to engage with research through course readings and discussions. [e.g., attempt made to introduce students to research literature – highly structured or select]	**Some** opportunities to engage with research through course readings and discussions (course is **somewha**t grounded in research and research is evident in the course content). [e.g., when a new topic is introduced the students are provided with links to current research]	**Extensive and authentic** opportunities to engage in and with research (course **is** grounded in research and research is evident in the course content). [e.g., when a new topic is introduced the students are provided with links to current research and in addition, the student has the opportunity to engage in their own inquiry or research]
6. Policy and Politics of Mathematics Teaching	**No** evidence of any exploration of the political aspects of mathematics education.	**Limited** evidence of exploration of the political aspects of mathematics education. [e.g., Regional Curriculum Documents]	**Some** evidence of exploration of the political aspects of mathematics education. [e.g., Region Curriculum Documents - with **some** journal-type readings which further the discussion about the role of those documents]	**Extensive** evidence of exploration of the political aspects of mathematics education. [e.g., Region Curriculum Documents - with **lots** of journal-type readings which further the discussion about the role of those documents, and the issues (i.e., high stakes

				testing)]
7. Equity and Diversity	**No** evidence of any exploration of the equity and diversity considerations in mathematics education.	**Limited** evidence of exploration of the equity and diversity considerations in mathematics education.	**Some** evidence of exploration of the equity and diversity considerations in mathematics education. [e.g., one lesson]	**Extensive** evidence of exploration of the equity and diversity considerations in mathematics education. [e.g., a diversity statement on the syllabi]
8. Affect	**No** evidence of addressing the implications of affect on the teaching of mathematics.	Evidence of **addressing** the implications of affect on the teaching of mathematics.	Evidence of **addressing and challenging** the implications of affect on the teaching of mathematics.	Evidence of **addressing, challenging, and potentially changing** the implications of affect on the teaching of mathematics.
9. Content Knowledge	**No** evidence of exploration of content knowledge at any level.	Engaging in a **selective component** of content knowledge **at the level of** instructional of the students.	Engaging in content knowledge **at the level of** instruction of the students.	Engaging in broader ranges of content knowledge **beyond the level** of instruction of the students.
10. Pedagogical Content Knowledge	**No** evidence of pedagogical discussion.	**Examine** pedagogical strategies. [e.g., limited opportunity for critical analysis]	**Examine** and **develop** pedagogical strategies. [e.g., some opportunity for critical analysis]	**Examine, develop,** and **analyze** pedagogical strategies. [e.g., extensive opportunity for critical analysis]
11. Technology	**No** evidence of technology integration.	**Didactic methods** of technology investigation and implementation. [e.g., teacher led only]	**Some** evidence of pre-service teacher investigation and implementation of technology. [e.g., one lesson]	**Extensive** evidence of pre-service teacher investigation and implementation of technology. [e.g., a unit of study or a technology use statement in the syllabi]

Appendix B: Email Invitation Used to Solicit Data

Used during Pilot Study and Data is in the Form of Course Syllabi

----- 1st Solicitation Email Message (sent to mathematics teacher educators around the world) ----

The 1st solicitation email message is no longer available due to the age of the email and the email program deleting older messages. The original solicitation email message was extremely similar to the following 2nd solicitation email message except that it was made clear in the 2nd message that we no longer needed syllabi from North America. As I recall, the 2nd solicitation email was essentially copied and pasted from the 1st solicitation email with the inclusion of the comment about North American syllabi.

----- 2nd Solicitation Email Message (sent to mathematics teacher educators around the world) ----

From "Donna Kotsopoulos"
Date Wed, 23 Jun 2010 08:55:57 -0400
To <pme-mail@lists.nottingham.ac.uk>
Subject Syllabi still needed from some continents

Dear Colleagues,

Myself, Francesca Morselli (University of Genoa), and Kathy Clark (Florida State University) are conducting a comparative analysis of mathematics education (didactical/pedagogical) course syllabi (elementary and secondary levels). By course syllabi, we mean those documents provided to students in your teacher education program that outlines course assignments, readings, overviews, goals, and so forth. We are writing at this time to ask if you would be willing to share your course syllabi with us to analyze as part of the study. All information about you and your institution will remain confidential, only the country of the program will be identified.

We are interested in syllabi from all continents but EXCLUDING North America from whom we have had already a tremendous response.

If you are willing to participate, please reply with your attachment. We may be able to have your syllabi transcribed, if necessary.

With thanks in advance.

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