AN EXPLORATION OF MATHEMATICS TEACHER LEADERS IN PME-NA PROCEEDINGS FROM 1984-2019

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School districts across the United States are turning to mathematics teacher leaders (MTLs) to support the teaching and learning of mathematics. And yet, what does research seem to say about MTLs? In this paper, we report findings from an exploration of PME-NA proceedings between 1984 and 2019 to examine the role of MTLs. In particular, we examine the following: historical MTL submission trends and the extent to which these trends are coupled with the implementation of national MTL events; broad methodological trends; as well as the ways in which MTLS are positioned. Our findings indicate that future research requires explicitly describing MTLs' roles within systems of professional development to better understand their impact on practice and learning.

Keywords: Teacher Education – Inservice/Professional Development, Instructional Leadership

Introduction

Mathematics reformers have long called for improved learning opportunities for all students across preK-12 classrooms in the United States. Although instruction that promotes mathematics as sensemaking and problem solving has been recommended (Cobb et al., 2018), this shift dramatically differs from the way many classroom teachers once learned and taught math (Hiebert, 1999). Thus, local school systems are left to determine how to create conditions that support changes in teachers' instruction (Hopkins et al., 2013). To address this challenge, many schools are hiring mathematics coaches, or as we will refer to in this paper – *mathematics teacher leaders (MTLs)* – as they embody key features of effective professional development (Gibbons & Cobb, 2017). Indeed, MTLs have become a popular professional development fixture in United States schools (Fennell, 2017).

Given the rapidity with which MTL positions have spread, there is an urgency which requires the field of mathematics education to better understand the research surrounding effective MTL implementation. The overarching aim of this paper, then, is to explore and examine the research related to MTLs in the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA) proceedings between 1984 and 2019. In doing so, our purpose is to discover patterns, commonalities, and trends across the PME-NA proceedings that will inform future research directions, while simultaneously deepening our own understanding of how MTLs are positioned across varied contexts. We hope to illuminate this important work so that other mathematics education researchers can build upon and advance policy and practice surrounding MTLs as there are many schools without a formalized position. We note that the research presented within this paper is only a small slice of the work our team has initiated in which we are examining MTLs' positionality within educational research studies as a whole.

Guiding Literature

Roles and Responsibilities of MTLs

Using knowledge of best practice regarding professional development, many school districts have created MTL positions to meet the demands of high stakes accountability and to support teachers in their work to provide quality mathematics instruction for each and every student (McGatha & Rogelman, 2017). MTLs are expected to provide professional development within the context of teaching and learning versus the traditional "sit and get" approach to professional development. AMTE provides a broad working definition of a MTL which identifies these individuals as "…teachers, teacher leaders, or coaches who are responsible for supporting effective mathematics instruction and student learning at the classroom, school, district, or state levels" (2013, p.1). To narrow the definition further, we define MTLs as a district- or school-based support person whose knowledge and expertise in mathematics content, pedagogy, and children's learning trajectories assists teachers with their content, pedagogy, and understanding of children's learning trajectories (Campbell & Malkus, 2013).

Even with the definition, the roles and responsibilities of MTLs are complex and ever evolving. Because the term MTL has different and distinct interpretations depending on location, the work of a MTL is diverse and spans across contexts to include administrative tasks, instructional tasks, professional development tasks, and data analysis. To align with our definition, we focus on the type of support MTLs provide. Depending on location and need, there are different models of support that MTLs provide: individual or teacher pair (Barlow et al., 2014), working with teacher groups (Elliott et al., 2009; Lesseig et al., 2016), whole school-level (Campbell et al., 2013; Felux & Snowdy, 2006; McGatha & Rigelman, 2017). Individual and pair support activities could include observations with coaching cycles and modeling lessons. Small group support could include assisting with professional learning communities or team meetings. Whole school support could include trainings and professional development sessions. Additionally, some MTLs are expected to provide support in the form of student intervention; this type of support could model intervention instruction for teachers as a form of professional development. In order to provide this support, MTLs need the necessary expertise in mathematics content and pedagogy and must exhibit key leadership skills in working with adult learners (AMTE, 2013; NCTM, 2012).

Key Historical Events

The use of MTLs to support the teaching and learning of mathematics is not a new call to action. Drawing upon Fennell's (2017) work discussing MTL policy recommendations from a historical perspective, we note key events that have influenced the development and use of MTLs across the United States.

The 1970s saw the emergence of projects that focused on creating positions for MTLs (e.g., *Developing Mathematics Enthusiasts* project, Fennell, 1978). Across these projects, school-level MTLs were identified and employed as mentors to provide content-specific support to other teachers and school stakeholders. In the decade that followed, Fennell notes three key events which underscored the importance of these newly created school-based MTL positions: (1) the National Council of Teachers of Mathematics (NCTM) recommended state certification endorsement for elementary mathematics specialists, (2) John Dossey, the acting president of NCTM during this time frame, published a call for mathematics specialists (Dossey, 1984), and (3) the National Research Council's (NRC) *Everybody Counts* (1989) report expressed the need for elementary mathematics specialists. The combination of these three national events within such a short timeframe highlights the urgency and significance of implementing highly competent and prepared MTLs within schools.

The 1990s were marked by a lull in policy and events related to MTLs. However, this trend came to a halt in the early 2000s with a resurgence of MTL policies and events. Fennell (2017) highlights nine key milestones (p. 6) during this time, including the NCTM's *Principles and Standards for School Mathematics* (2000), the NRCs *Adding it Up* (2001), and the National Mathematics Advisory Panel (2008) documents all making recommendations related to the use of MTLs to support the teaching and learning of mathematics. Additionally, during this time, national legislation centering on No Child Left Behind (2001) and followed by the Every Student Succeeds Act (2015) prompted schools and districts to create MTL positions as a way to address the push for assessment and accountability in mathematics.

Moving into the 2010s, the call for MTLs continued to advance. A major event in 2010 was the release of the *Standards for Elementary Mathematics Specialists: A Reference for Teacher Credentials and Degree Programs* from the Association of Mathematics Teacher Educators (AMTE; revised in 2013). In that same year, a joint position statement calling for all elementary schools to have access to mathematics specialists was released by AMTE, the Association of State Supervisors of Mathematics (ASSM), the National Council of Supervisors of Mathematics (NCSM), and NCTM. Building upon AMTE's standards, NCTM/CAEP released the Elementary Mathematics Specialist Standards (NCTM, 2012), with both sets of standards used by many programs across the country.

Policy recommendations and key events do not stop here. As we progress through the 2010s, we see MTLs referenced in Linda Gojak's NCTM president message (2013), as well as an AMTE research conference focused on elementary mathematics specialists in 2015. When looked at as a whole, this timeline overview shows the call for MTLs has persisted for decades and continues to be at the forefront of research, policy, and organizational recommendations.

Research Questions

The overarching purpose of this paper is to explore PME-NA submissions[1] that center on mathematics teacher leaders (MTLs) during the years 1984-2019. Specifically, we ask the following three research questions:

1. What are the historical trends for PME-NA MTL submissions between the years of 1984 and 2019 and to what extent do these trends align with the implementation of key MTL events and/or policies?
2. What methodological trends are observed across PME-NA submissions between 1984 and 2019?
3. How are MTLs positioned across PME-NA submissions between 1984 and 2019?

Method

Below, we outline the procedure that was systematically used to integrate the research related to MTLs across PME-NA proceedings in years 1984-2019. Additionally, we describe the methodological parameters of our data identification and analysis.

Data Identification

We initiated our exploration by conducting a comprehensive search of PME-NA proceedings between 1984 and 2019. In targeting this date range, we drew upon the key MTL events as identified by Fennell (2017). The lower date range was identified due to the published call for elementary mathematics specialists (Dossey, 1984) mentioned in Fennell's (2017) MTL milestones. The upper date range was identified as 2019 as this was the last year for which PME-NA proceedings were available. We note that the PME-NA proceedings provided us with a data source that was both entirely focused on mathematics and peer-reviewed.

[1] When we use the word submission, we are referring to submissions that appear in published PME-NA proceedings, and may include any of the following: research reports, brief research reports, posters, working groups, and/or plenaries.

To ensure our search maintained high recall and precision (Sadelowski & Barroso, 2007), we used search terms beyond mathematics specialist, mathematics coach and mathematics teacher leader to capture the nuanced ways in which MTLs might be positioned in the proceedings. These terms included: interventionist, response to intervention specialist, resource teacher, instructional coach, Title I Step-Up Mathematics, mathematics lead, and mentor. Initially, we used the search function to apply each of these terms to each published PME-NA proceeding between 1984-2019[2]. In doing so, we noticed that our search brought up many submissions that were not directly related to our central research questions. Thus, we made the decision to only include submissions in which the search terms appeared in the title, abstract, and/or keywords[3]. If the search terms appeared in the body of the submission, but did not appear in the title, abstract, and/or keywords, then that submission was excluded. To examine relevancy across all paper modalities, our collection included papers, research briefs, posters, working groups and plenaries. We also included all methodologies. Last, due to our interest in preK-12 education, we eliminated those entries that emphasized undergraduate mathematics education or faculty studies. Ultimately, our search resulted in 109 unique submissions.

Data Analysis

The submissions in this analysis were coded in several distinct ways. We first completed counts to determine the frequency of submissions for each year, and also looked at spikes and declines in year-to-year submissions (Research Question 1). Next, during our analysis of the methods sections, we applied the following coding scheme for methodology (Research Question 2): qualitative (QUAL), quantitative (QUANT), mixed methods (MIXED), and other (OTHER[4]). Our last coding scheme was also applied while reading the methods section and centered on how the MTL was positioned within the submission (Research Question 3): School-Based Coach, Researcher, Pre-Service Teacher, Pre-Service Teacher Mentor Teacher, Teacher Leader, Mentor Teacher, or Mentor of Students. All codes were mutually exclusive.

Findings

We now present the findings for each of our three research questions in the space that follows.

Research Question 1: Overall Trends

We first explore overall PME-NA MTL submission trends between the years of 1984-2019. As illustrated in Figure 1 below, there are several trends we wish to highlight.

[2] We were unable to include the years 1994, 1993, 1992, 1988, 1986, and 1984 because the search function on those proceedings did not work.
[3] For posters, we only searched for our terms in the titles and/or keywords because those submissions did not have abstracts.
[4] Submissions coded as Other included Plenaries and Working Groups as these submissions did not have a methodology.

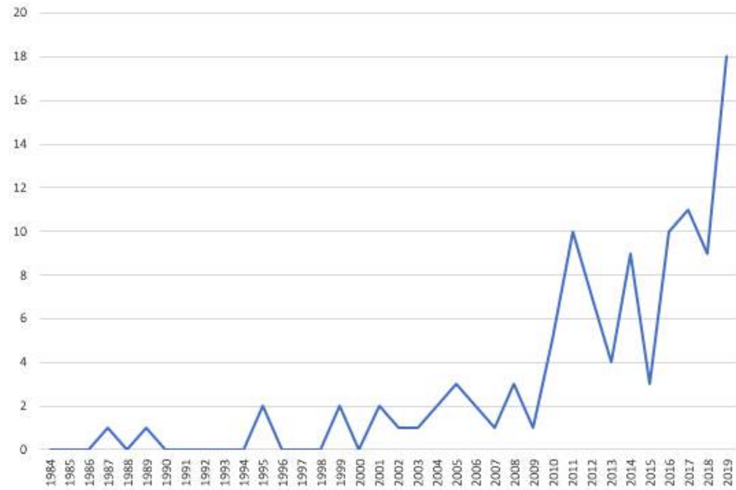

Figure 1: Overall PME-NA MTL Submission Trends from 1984-2019

Overall, there has been an increasing trend in PME-NA MTL submissions between 1984-2019. Starting in 1984, when Dossey published the call for elementary mathematics specialists, there were zero MTL submissions. In 2019, after the implementation of 22 different events for elementary mathematics specialists (Fennell, 2017), there were 18 MTL submissions. This finding indicates the, overall, increased focus on research involving MTLs.

An interesting trend is also noted when comparing year-to-year submission patterns with the key events identified by Fennell (2017). That is, we see the largest spikes in MTL submissions between the years 2010-2011 (increase of 5 MTL submissions), 2013-2014 (increase of 5 MTL submissions), 2015-2016 (increase of 7 MTL submissions), and 2018-2019 (increase of 9 MTL submissions), and these trends are tightly coupled with key MTL events outlined in Table 1. In other words, the largest MTL submission spikes appear to follow the implementation of key MTL national events. Furthermore, we see somewhat pronounced decreasing trends in MTL submissions between the years of 2011-2012 (decrease of 3 submissions), 2012-2013 (decrease of 3 submissions), and 2014-2015 (decrease of 6 submissions). For the most part, these trends are coupled with the absence of key MTL national events. For example, the absence of key MTL events in 2011 and 2014 might help explain the decrease in MTL PME-NA submissions between the years 2011-2012 and 2014-2015.

Table 1: Select MTL Events from Fennell (2017)

Year	Events
2010	AMTE released *Standards for Elementary Mathematics Specialists*
2013	NCTM President's Message from Linda M. Gojak: *It's Elementary! Rethinking the Role of the Elementary Classroom Teacher*
2015	NCTM Research Brief *The Impact of Mathematics Coaching on Teachers and Students* (McGatha, Davis, Stokes) AMTE EMSs Research Conference Every Student Succeeds Act

Research Question 2: Methodological Trends

As previously mentioned, we read the methods section for each of the 109 MTL submissions to better understand broad methodological trends for PME-NA MTL submissions between 1984-2019. Overall, 68% (n = 67) of the MTL submissions were coded as QUAL, 23% (n = 22) were coded as MIXED, and 9% (n = 9) were coded as QUANT. Hence, most submissions involved qualitative investigations, while quantitative investigations surfaced less frequently. Furthermore, preliminary analysis indicates variability in the quality and types of research questions posed, and further analysis is required within each methodological approach.

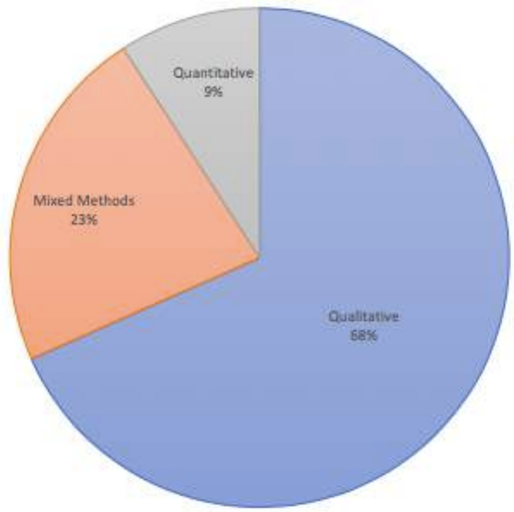

Figure 2: Methodological PME-NA MTL Submission Trends from 1984-2019

Research Question 3: Positioning of MTL

We also analyzed the nuanced ways in which MTLs were positioned in PME-NA submissions from 1984-2019. Across our data set of 109 submissions, MTLs were positioned in seven different ways. In Table 2 below, we provide a description of each of the ways in which MTLs were positioned, as well as a count for each. We note that, overall, MTLs were most frequently positioned as a School-Based Coach (n=44), followed by Researcher (n=22), and then Pre-Service Teacher Mentor Teacher (n=16). Other roles, such as Pre-Service Teacher (n=3) and Mentor of Students (n=2) less frequently emerged.

Table 2: MTL Positioning in PME-NA Submissions from 1984-2019

Positioning	Count	Description
School-Based Coach	44	The MTL is released from their classroom teaching position and is charged with supporting teaching and learning across one or more schools.
Researcher	22	The MTL is a university researcher, faculty member, and/or staff member who serves as a coach/mentor to others in various contexts.
Pre-Service Mentor Teacher	16	The MTL is a classroom teacher that mentors or supervises pre-service teachers at a preK-12 school.
Teacher Leader	12	The MTL is a classroom teacher who receives professional development to become a teacher leader without mention of any supervisory role(s).

Mentor Teacher	5	The MTL is a classroom teacher who mentors their peers/colleagues/in-service teachers, and serves in a supervisory/mentoring role.
Pre-Service Teacher	3	The MTL is a pre-service teacher who provides peer-feedback to other pre-service teachers in the context of a methods course (e.g., rehearsals, reform-based lessons, etc.).
Mentor of Students	2	The MTL is a classroom teacher who mentors preK-12 students.

Discussion and Implications

The overarching purpose of this paper was to initiate the integration of research on MTLs across PME-NA proceedings in years 1984-2019. In the space that follows, we summarize the main findings for each of our three research questions, and also discuss implications.

Overall, we observed an increasing trend in the number of PME-NA MTL submissions during our identified time frame. Furthermore, we observed coupling between year-to-year MTL submission spikes or declines and the presence or absence of national MTL events. That is, large spikes in year-to-year MTL submissions were coupled with the implementation of a national MTL event, while declines in year-to-year MTL submissions were coupled with the lack of national MTL event. This seems to indicate that MTL policies and events at the national level are actively shaping MTL research agendas and publication. That is, in the presence of national MTL policies and events, MTL research is occurring. Conversely, in the absence of national MTL policies and events, there is less attention to MTL research. Whether related to national events or not, there is a general upward trend in MTL research and interest in the mathematics education community in this research.

Regarding methodological trends, our analysis indicated that most of the MTL PME-NA submissions involved qualitative methods, while mixed and quantitative methods were less prevalent. We have several hypotheses to help explain this trend. First, it is possible that researchers seem to be most interested in asking research questions about MTLs that can best be answered using qualitative methods. For example, early stage, qualitative studies are needed to understand MTLs' work before implementation/impact studies at a large scale can evaluate roles related to variables like student achievement. However, this is – perhaps – too easy of an explanation, and there is likely more going on here. Second, it is possible that the research community lacks quantitative measures and instruments that can validly and reliably be used to document the nuanced work of MTLs. While there is some research that has begun to explore this hypothesis (Harbour, Livers, & Hjalmarson, 2019), more is needed. Third, and relatedly, impact and/or influence is so difficult to measure because there are many confounding variables and multiple levels to MTLs' work. Ultimately, this makes it rather challenging to tease apart MTLs' unique impact. Thus, future research should focus on MTLs as part of the system of professional development in the school/district to understand their impact on both teachers' practice and students' learning.

Last, in exploring the ways in which MTLs are positioned across PME-NA proceedings, we identified seven different categories that ranged from MTL as School-Based Coach to MTL as Pre-Service Teacher. This speaks to the wide-spread variation in the ways in which researchers refer to individuals in this position. Although prior research has already suggested that the field lacks a common definition for MTLs (Baker et al., 2017; National Mathematics Advisory Panel [NMAP], 2008), our study adds further evidence in support of this trend. Hence, future research should be developed to explore the characterization of MTL work and practice in order to compare different implementation models, better describe MTL roles within schools/districts and their work with both teachers and students, and further develop MTL knowledge and skills to better support preparation programs and other ongoing professional learning experiences.

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