

PREPARING SECONDARY MATHEMATICS AND SCIENCE TEACHER LEADERS IN RURAL DISTRICTS

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This study examines secondary mathematics and science teacher perceptions of teacher leadership during the first year of a professional development program focused on preparing teacher leaders in rural schools. It also begins to offer details as to what content-focused teacher leadership looks like and how teachers in rural schools enact teacher leadership. Data collection includes interview and survey analysis. Findings indicate four areas of growth for participants and project staff: participants began to expand their thinking and influence beyond the classroom, advocate more for students, develop a richer understanding of what content specific teacher leadership looks like, and gain a deeper understanding that teacher leadership in rural districts may be easier given the context of smaller settings but may also be more challenging in terms of teacher burnout.

Keywords: High School Education, Middle School Education, Teacher Knowledge, Teacher Education – Inservice/ Professional

Introduction

Teacher leadership has been in the literature for over 40 years and more recently, calls have been made to focus on content-focused teacher leadership (Wenner & Campbell, 2016). In 2014, the National Research Council (NRC) held a day and a half convocation to discuss the current and possible ways to better develop and utilize STEM teacher leadership. One result of the convocation was a publication that summarized convocation outcomes such as what STEM teacher leaders can do to effect policy, current models for empowering teacher voices, professional development for STEM teacher leaders, and research in the field of STEM teacher leadership (NRC, 2014). One finding from the report was the impact professional development “can make toward creating a robust corps of STEM teacher leaders” (NRC, 2014, p. 44). Mohan, Galosy, Miller, & Bintz (2017) completed a study to review and synthesize existing research on science and mathematics teacher leadership development programs. In their initial review of 89 research abstracts and 70 programs, their final study included 18 research articles and 15 programs. The review of these articles and programs, in addition to discussions with science and mathematics teacher leadership development leaders, resulted in four “focal areas” or recommendations for science and mathematics teacher leadership programs: programs and the teacher leadership development landscape, purposes of teacher leadership development programs, attributes of teacher leadership development programs, and research on teacher leadership development programs. Two key recommendations within these focal areas were the need to ensure teachers from underserved and underrepresented areas have leadership development opportunities and the importance of sharing findings of science and mathematics leadership development programs (Mohan et al., 2017).

Rural districts represent an underserved and underrepresented area where a focus on teacher leadership development is needed (Anderson, 2008). Rural areas also demonstrate a need for strong teacher professional development to address challenges such as fewer resources for instruction, lower teacher salaries, and less opportunities for professional development for teachers (Bush, 2005; Goodpaster, Adedokun, & Weaver, 2012; Showalter, Klein, Johnson,

Hartman, 2017). Specifically, professional development in mathematics and science is needed as already existing teacher shortages in STEM areas are even greater and student performance in and access to higher level mathematics and science coursework is low in rural communities (Irvin, Byun, Smiley, & Hutchins, 2017; Showalter, Klein, Johnson, Hartman, 2017).

In response to this need for content-focused rural teacher leadership development, the Rural Secondary Science and Mathematics Teacher Leader Project (RSSMTL), in collaboration with 10 schools in 15 districts, was developed to prepare secondary mathematics and science teachers in rural districts. This study analyzes data from the first year of the program to determine how science and mathematics teacher perceptions of teacher leadership change through a teacher leader professional development program and what it looks like to become a mathematics or science teacher leader in a rural school.

RSSMTL focuses on Wenner & Campbell's (2016) definition of teacher leadership as "teachers who maintain K-12 classroom-based teaching responsibilities, while also taking on leadership responsibilities outside of the classroom" (p. 7). Given that change takes long time support, we are in the midst of a five-year grant funded program to develop strong secondary mathematics and science teachers in rural areas.

RSSMTL Conceptual Framework

Based on research literature in rural content specific teacher development and leadership as well as the needs articulated by our school partners, the below conceptual framework guided the development of the RSSMTL.

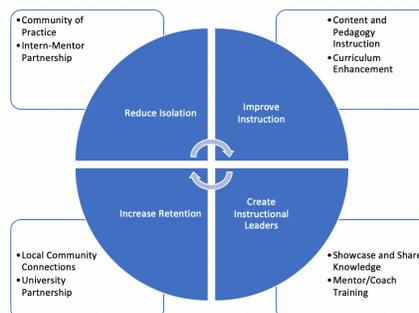


Figure 1. The Conceptual Framework for RSSMTL

Project Components

The RSSMTL conceptual framework four components are explained below and program elements that teachers complete to address each of the four components are described. Table 1 also presents the program components and elements.

Component 1: Reduce Isolation. Teachers in rural schools struggle with isolation given the sometimes smaller size of their schools. A science teacher, for example, may be the only person teaching physics at her school. Component 1 and the affiliated project elements are designed to reduce teacher isolation (Baird, Prather, Finson, & Oliver, 2006). The participating teachers and project team are creating a *community of practice* where we are able to learn together as teacher leaders in rural districts. As part of the project, teachers work with our preservice teachers who typically would not be placed in their schools due to the longer commutes but is now more possible with funding to supplement travel costs. Teachers speak to the value of having content partners with whom they can now talk about their teaching – both in terms of their student teachers (*intern-teacher relationships*) as well as fellow teachers in the program. For example,

as the only science teacher teaching physics at her school, Brianna can now talk with her RSSMTL colleague who also is the only physics teacher at her rural school. As the RSSMTL participants increase their spheres of influence and connection as teacher leaders, they have been able to share those connections with teachers in their communities.

Component 2: Improve Instruction. Teachers in rural districts often lack access to high quality professional development or to content-specific specialists to aid in continuous improvement of their instruction (Hickey & Harris, 2005; Howley & Howley, 2005). If rural teachers do receive professional development, it is often not well aligned to their specific needs (Jimerson, 2004). Therefore, this component and aligned program elements are designed to improve teacher participant instruction. *Content and pedagogical instruction* emphasizing inquiry based teaching practices (Anderson, 2007; Silver, Kilpatrick, & Schlesinger, 1990) coupled with both Project Based Learning (Krajcik, Czerniak, & Berger, 2002) as well as Place Based Learning (Sobel, 2004) are foundational to the program. We meet for a two-week Summer Instructional Leadership Academy (ILA) each summer and spend time learning about these three pedagogical approaches. For example, in terms of *curriculum enhancement*, each teacher has developed a Project Based Learning unit. Teachers implement and record at least four lessons during the academic year focused on these curricular and instructional changes. They also take three online content specific graduate courses to enhance their content knowledge. These courses are offered online so that teachers do not have to leave their communities to participate in the course yet are able to virtually connect with the instructor and their RSSMTL colleagues throughout the course. Teachers complete projects that are integrated into their daily work of teaching so they can immediately apply their learnings with their students. Teachers have been able to, in turn, as teacher leaders share the content and pedagogical content knowledge they are learning with teachers in their districts. Hence, the initial void of content specific curriculum specialists in some of our smaller, more rural districts that was part of the initial impetus for this work, is beginning to be filled by RSSMTL participants.

Component 3: Increase Retention. Teachers in rural districts tend to have higher rates of retention than in urban or suburban schools (Provasnik et al., 2007) though rural districts do report difficulties in recruiting and retaining high quality mathematics and science teachers (Friedrichsen, Chval, & Tiescher, 2007; Monk, 2007). Strong professional development, community involvement and local school support improves the retention of high quality teachers in rural districts (Goodpaster, Adedokun, & Weaver, 2012). Hence, Component 3 and the accompanying program elements are designed to increase retention among participants. As part of RSSMTL, teachers develop *local community connections*. As part of the Project Based and Placed Based Learning, teachers connect with resources in their areas to both bring into their classrooms as well as take their students into the community. For example, Tammy connected with a local restaurant to have her geometry students re-design one of their take-out boxes. As part of the project, the restaurant management came to the school to view student presentations on their designs and then selected the best designs to visit their local restaurant. In addition, teachers plan local STEM community nights at their schools to engage parents and the local community in the work of their students. For example, several teachers focused their STEM nights on the eclipse that occurred on August 21, 2017. Furthermore, *university partnerships* continue to develop as student teaching interns and their supervisors connect with the teachers as they work in their classrooms. Teachers also co-teach methods courses alongside project team members. For example, as part of the content-focused methods course, teachers come to campus

to share with student teachers as well as the methods courses travel to the teachers' schools to view lessons taught to their students.

Component 4. Create Instructional Leaders. Empowering teachers to develop their own instructional practices as well as supporting their ability to support the development of colleague's instructional practices offers teacher ways to become instructional leaders. It also addresses the lack of content-specific specialists in smaller rural districts by equipping classroom teachers with these skills (Hickey & Harris, 2005). Therefore, Component 4 and its accompanying program elements address this need. Teachers in the RSSMTL program *showcase and share knowledge* through multiple avenues. First, they complete the National Board Certification process for their specific content area. This process allows them to systematically and deeply reflect on their practice while simultaneously encouraging them to improve and strengthen that practice (Lustick & Sykes, 2006). As National Board Certified teachers, participants are more effective teachers (Cowen & Goldhaber, 2016) and better prepared to take on leadership roles (Sato, Hyler, & Monte-Sano, 2014). In addition, teachers write articles for professional journals as well as present their Project-Based Learning units at state and national conferences. Finally, at the close of the RSSMTL program, teachers will plan and host a professional development conference for their colleagues that focuses on lessons they have learned as part of the RSSMTL program. They also complete *Mentor Teacher and Coach Training* to enhance their work with student teachers and induction teachers as well as strengthen their skills to work alongside their colleagues to improve collective practices (Lotter, Yow, & Peters, 2014; Yow & Lotter, 2016).

Table 1. RSSMTL Program Components & Elements

Component	Focus	Aspects	Program Element
1	Reduce Isolation	Community of Practice	Relationships developed among teachers with RSSMTL colleagues and project staff
		Intern-Mentor Relationships	Teachers hosting student teacher interns
2	Improve Instruction	Content and Pedagogy Instruction	Inquiry Based teaching practices coupled with Project Based and Place Based Online pedagogical and content graduate coursework
		Curriculum Enhancement	Project Based Unit Development
3	Increase Retention	Local Community Connections	Project Based and Place Based Learning Units that involve local community resources STEM Community Nights
		University Partnerships	Teachers hosting student teaching interns Co-teach methods courses
4	Create Instructional Leaders	Showcase and Share Knowledge	National Board Certification Articles and Professional Presentations Professional Development Conference for Colleagues
		Mentor and Coach Training	Complete Mentor Teacher and Coach Training

Methods

Participants

Twenty teachers participate in the RSSMTL program. They were selected from a pool of applicants based on a principal reference, a written essay, transcript and licensure test review, and an interview. All 20 teachers have master's degrees and include ten mathematics teachers (six middle school and four high school) and ten science teachers (four middle school and six

high school). Twelve are Caucasian and eight are African-American. Three are male and seventeen are female.

Data Collection

Data collection included a pre-and post-interview and a pre-and post-survey.

Interview. Prior to beginning the program, teachers were interviewed using a semi-structured interview protocol. The interviews lasted between 45 to 60 minutes and were audio recorded. The interview protocol asked about their beliefs about instruction and teacher leadership. In terms of instructional beliefs, teachers were asked questions such as how they thought students learned best, how they structured their lessons, and how they assessed student learning. In terms of teacher leadership beliefs teachers were asked, for example, how they defined teacher leadership and how they saw themselves or others as teacher leaders. A year later, the teachers were asked the same teacher leader questions with a sharper focus on being a mathematics or science teacher leader in a rural context.

Survey. Teachers also completed a teacher leadership survey (Triska, 2007). This survey contained 13 Likert items with a 1 (Never) to 4 (Frequently) scale and 11 items with a 1 (Disagree) to 4 (Agree) scale. Sample questions from the Never to Frequently section included how often they “Tried a strategy in your classroom that you had never tried before?” or “Voiced your personal thoughts about teaching or learning with other teachers?” Sample questions from the Disagree to Agree section included “You modeled reflection leading to improvement of practices in your classroom, which may have impacted other teachers” and “You played an important role in building the professional community here at school.” A year later, teachers were administered this same survey though they were asked to do so both a written and verbal format. Teachers completed the survey by hand during the post-interview while also being asked to think aloud as they completed the survey to offer examples or additional context to their Likert scale responses.

Analysis

Data analysis included using SPSS to determine the descriptive statistics on the Triska (2007) teacher leadership survey. The teachers rated themselves highly on the pre-survey so there was no significant statistical change compared to the post-survey. Therefore, the main data analysis for this study was conducted through analysis of the teacher leadership survey think aloud alongside the pre- and post-interview responses. All interviews were audio recorded, transcribed, and inputted into Nvivo 11. Interviews were coded using a constant comparative method (Boglan & Biklen, 1989). The first two authors along with two graduate research assistants initially coded all interviews separately and a list of common consensus codes was determined through group discussion. Then, all researchers recoded the interview transcripts using the revised codes, met again to discuss any variations in the coding, and decided upon themes that represented participant perceptions and enactment of teacher leadership.

Results

Results indicated four findings with regard to the teacher perceptions and growth as teacher leaders. First, teachers are developing as teacher leaders whose focus is expanding to beyond their classrooms. Second, teachers are continuing, and more deliberately, serving as advocates for their students. Third, a more collaborative and comprehensive understanding of what content specific teacher leadership looks like is developing. Fourth, teacher leadership roles in rural districts may be more natural to obtain given the context of a sometimes smaller familiar setting, but may also be more challenging as these roles lead to other tensions including feeling overworked and stressed.

Finding 1: Expanding Focus to Beyond the Classroom

As we began the program, teacher conceptions about teacher leadership were more classroom-focused. Now, they are beginning to think about teacher leadership as also including their influences beyond the classroom. Jenny, for example, initially spoke about a teacher leader as “being receptive to her students – taking their needs and helping them grow.” Now, teachers reflect on their current conceptions of teacher leadership as not only helping students grow, but also “being a role model to and sharing with my peers” as well as “presenting at conferences.” They are beginning to feel responsibility to serve their students, colleagues, and districts.

Finding 2: Continuing to Advocate for Students

Teachers have always been champions for their students. Through the program, however, their voice as advocates for students has grown stronger. Their understanding that such a voice is part of their role as a teacher leader has also grown – part of being a teacher leader is having a “student-centered mindset” (Hunzicker, 2013). Kyana reflected, “but same is not equal in every school. Our children, being rural, need more outside experiences.” She continued to speak specifically to advocating for the best teaching practices: “Math, we have to really make sure that we push for the best way for our kids to learn.”

Finding 3: Understanding of Content Teacher Leadership

The teachers and project team are gaining a better understanding of what content-specific teacher leadership means. In mathematics, the teachers speak to the need to remain current in their knowledge of best practices for teaching mathematics. They also speak to the need to be involved with vertical teaming where they collaborate with teachers across grade bands to better understand, for example, what their algebra students learned in their previous pre-algebra course and what content they need to have a strong understanding as they progress into geometry. Science teachers speak to the need to “write grants” as teacher leaders to acquire the materials they need to complete engaging and safe laboratory activities. Mike reflected, “It takes much more to prepare for science.” Particular foci and needs are specific to mathematics and science teacher leadership.

Finding 4: Recognizing Rural Teacher Leadership May Be More Natural But Challenging

Teacher leadership roles, both formal and informal, often times come more naturally to teachers in rural settings. For some teachers, they grew up in the community and are well respected so are often asked to take on leadership roles. For other teachers, their rural school is also a small school, so they are asked more often to serve. For example, Jessica noted “wearing lots of hats” as one of two mathematics teachers in her high school. For example, her school needed last-minute prom preparation help so she took her geometry class to the gym. She integrated their polygon lesson while arranging tables: “I turn our prom experience into a math experience.” Tawanda noted, “I think it’s easier to be [a teacher leader in a rural area] because you don’t have to deal with so many. You’re on a first name basis. They know me at the district office. They know who we are. They know what we do.” However, with added roles come additional responsibility, time commitments and stress. Therefore, further reflection on how best to balance the natural yet challenging dichotomy of these roles needs exploring.

Discussion

In this initial year of the program, RSSMTL participant perceptions of teacher leadership as well as a developing picture of what it looks like to be a mathematics or science teachers leader in a rural school began to emerge. Through the program’s focus on four areas (reducing isolation, improving instruction, increasing retention, and creating instructional leaders), four findings surfaced. First, teachers began to expand their focus to beyond the classroom. They

began to think more deliberately and felt more empowered to take their expertise outside of their classroom walls to begin to impact and influence their colleagues and larger professional community (Beachum & Dentith, 2004). Second, though many had already served as advocates for their students, they learned of new ways and found an increased sense of agency to advocate for their students. In some cases, they learned of content-based extracurricular activities to offer to their students whose rural locale may have prevented their previous participation in such activities. They also began developing a new knowledge base about strong instructional practices and content expertise that enhanced their teaching and began to advocate for their subjects and these teaching practices (Hunzicker, 2013). Third, the collective knowledge of content-focused teacher leadership continues to evolve. Findings indicated that there are specific content area aspects that pertain to mathematics or science teacher leaders. For example, the concept of vertical teaming and planning within the mathematics community is a fertile ground for continued research in how best to prepare and position mathematics teacher leaders to serve in shepherding such efforts. Likewise, materials and supplies specific to successful lab and field experiences in the sciences lends itself to grant writing among science teacher leaders – and similar manipulative and resource materials in the mathematics classroom may also prove another content-specific area of mathematics teacher leadership. This finding adds to the complex nature of teacher leadership as it pertains to specific content areas (Wenner & Campbell, 2017). Finally, teacher leadership within rural schools can be more natural but at the same time challenging. The familiarity of being “known” in often smaller rural schools often makes it easier for teachers to assume teacher leader roles. With fewer administrators, there are often more opportunities for teachers to become teacher leaders. These same opportunities, however, sometimes lead to overburdening burnout (Little & Bartlett, 2002; Lieberman & Miller, 2004) so additional research into sustainable teacher leadership is warranted.

The complexity of content-based teacher leadership continues to evolve so additional research on how mathematics and science teachers perceive and enact teacher leadership in rural contexts is needed. The RSSMTL program adds to the limited literature around this field and as the program progresses and additional data is collected and analyzed, the authors hope to continue to add to this research literature so all students and teachers have access to high quality learning and leading.

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