

## **MATHEMATICS TEACHERS' CIRCLES: A RESOURCE PERSPECTIVE ON CLASSROOM TRANSFER**

Nathan Borchelt

Western Carolina University

Axelle Faughn

Western Carolina University

*In a time of national curricular transition, teachers rely on resources beyond textbooks in order to adjust their practice to new demands. Our paper addresses this issue within the context of professional development that helps support the work of teachers and ensures quality education for their students in the midst of changes. Professional Development that involve “teacher networks”, or “teacher collectives” are emerging as one meaningful way to impact teachers’ practices. We investigate one such model, namely Mathematics Teachers’ Circles, where participants engage in doing mathematics as genuine learners while effective problem solving practices are being modeled. We investigate how participating teachers transfer the MTC resources to classroom use.*

### **INTRODUCTION AND BACKGROUND LITERATURE**

This paper examines how teachers in the USA adopt resources during curricular transitions within the context of professional development that helps support the work of teachers and ensures quality education for their students in the midst of changes. We hope to contribute new ways to impact teachers’ work and practices in their classroom with their students through networking and engagement in meaningful, challenging mathematical tasks. Rather than using a specific textbook, open educational resources and online teaching materials often provide a basis for selecting classroom activities, along with other resources gathered from participation in professional development interventions and sharing with other teachers within or outside of the school. Increased electronic access to high quality research-based material, combined with a time of curricular transition, has recently translated into traditional textbooks gathering dust on the shelves of many classrooms. We take a look at how sharing and adjusting resources during professional development meetings can effectively modify a classroom culture for better enactment of the National Council of Teachers of Mathematics’ Principles to Actions document (NCTM, 2014). Professional Development that involves “teacher networks”, or “teacher collectives” are emerging as one meaningful way to impact teachers’ practices. Teacher networks are defined as “a collection of teachers who: interact voluntarily and have opportunities to take leadership roles; have a shared sense of reform purpose related primarily to school improvement and self-reflective pedagogical inquiry; and seek both learning and collegiality through collaboration” (Morrison, 2011).

We investigate one such model of teacher networks, namely Mathematics Teachers’ Circles (MTC), in which participants engage in doing mathematics as genuine learners while effective problem solving practices are being modeled. Teachers may not have had experience with such practices as students. As described on the American Institute of Mathematics MTC website, “The primary goals of MTCs are (1) to engage school math teachers in mathematical problem solving; (2) to involve them in an ongoing dialogue about math with students, colleagues, and professional mathematicians; and (3) to provide guidance, materials, and resources to middle school math

teachers that will enable them to promote open-ended problem solving as a way of learning, thinking about, and practicing mathematics in their classrooms” (mathteacherscircle.org). A look at recent research on MTCs provides evidence that participants in a MTC feel more pedagogically prepared and have increased self-efficacy as math teachers. They use more inquiry-based teaching practices in their classrooms (Marle et al., 2012). On national surveys with hundreds of respondents, teachers report increased enthusiasm for mathematics; more interactive, student-centered problem solving in their classrooms; and an increased belief that all their students are capable of doing mathematics. Many teachers say they have started seeing themselves as mathematicians (White & Donaldson, 2011). A study by the American Institute of Mathematics (Silverstein, 2014) determined that 97% of respondents said they had grown mathematically as a result of participation in MTCs, and 84% of the respondents reportedly had changed something about the way they teach mathematics.

We study the effects of MTC participation on middle and secondary school mathematics teachers in North Carolina through summer intensive residential workshops and monthly afterschool meetings centered on problem solving and community building. Our research focus is on resource use and classroom transfer. This project is particularly timely due to a combination of nation-wide curricular changes and statewide political discord regarding the future of mathematics education that has resulted in massive teacher exodus out of North Carolina over the past few years. If we want to retain our teachers, we need to find ways to provide them with adequate support in their work. The specific TSG 38 questions we wish to address are the following: What are the relationships between teachers’ individual and collective resources, and how could we model such relationships? What are the consequences of evolutions at stake for the teaching of mathematics, and for teacher knowledge and professional development? This paper is therefore geared toward Session 3 on teachers’ collective work through resources.

## **THEORETICAL PERSPECTIVE**

We adopt Adler’s definition of resources, which involves all material artifacts used by teachers in their classroom (Adler, 2000), as well as all interactions with students and/or other teachers. To meet the needs of teachers engaged in mandated changes in their classroom, NCTM published a set of guiding principles reflecting significant actions that can promote eight Mathematics Teaching Practices recognized as essential components of mathematics classrooms: (1) establish mathematics goals to focus learning; (2) implement tasks that promote reasoning and problem solving; (3) use and connect mathematical representations; (4) facilitate meaningful mathematical discourse; (5) pose purposeful questions; (6) build procedural fluency from conceptual understanding; (7) support productive struggle in learning mathematics; (8) elicit and use evidence of student thinking (NCTM, 2014). If teachers are not themselves exposed to and engaged in the type of practices we hope to see in their classroom, then change will not happen. The eight teaching practices serve as a framework for evaluating the resources and activities conducted during MTC meetings. As teachers implement these in their own classrooms when trying to replicate or adapt what they learned during MTC meetings, we want to gauge implementation of the following eight Common Core State Standards for Mathematical Practice for students (CCSSM, 2010): (1) make sense of problems and persevere in solving them; (2) reason abstractly and quantitatively, (3) construct viable arguments and critique the reasoning of others; (4) model with mathematics; (5) use appropriate tools

strategically; (6) attend to precision; (7) look for and make use of structure; (8) look for and express regularity in repeated reasoning.

#### **METHODOLOGY, DATA COLLECTION AND INITIAL RESULTS:**

We provide a platform for the teachers to acknowledge themselves not only as classroom teachers, but also as lifelong learners, as professionals, and as leaders. While participants re-ignite their interest in mathematics, we hope for them to increase their mathematical content knowledge, to gain confidence in their ability to share with others, and to initiate more student-centered, inquiry-based pedagogies in their classrooms. Data is collected from sources such as self-reported qualitative pre-/post- confidence and classroom transfer surveys in order to gauge the effect of MTC interventions on mathematics teachers' personal views of their own mathematical abilities, and ability to translate newly acquired knowledge into their classroom. We also collect data on expectations, current implementation of Problem Solving in the classroom, and changes attributed to participation in this professional development initiative. Questions to be addressed include:

- Does participation in MTC impact the type of experiences or level of mathematics that teachers share with students? In other words, is there transfer to the classroom? What is the nature of such transfer? What is the impact of resources on Problem Solving Practices?
- What experiences help make this transfer easier? What makes it difficult? What resources used in professional development are particularly conducive to this transfer?
- What are the roles and contributions of participants (Mathematics Professors, teachers, pre-service teachers) in shaping the resources and their use within the dynamic of the collective?

Initial survey responses were collected during the 2014-2015 pilot meetings, as well as the 2015 Summer workshop. Teacher's expectations could be separated in three major categories where teachers expected gain: classroom support (equally split between strategies for student engagement and resources needs), networking with a broader community, and mathematical content knowledge. When asked to describe their use of Problem Solving in the classroom in a pre-survey, teachers were very focused on the type of resources used to promote problem solving such as "challenging problems" or "weekly workouts" rather than describing the actual implementation of these tasks in the classroom. A post-summer workshop prompt on how their participation in MTC may affect classroom practices in the up-coming year provides a more specific emphasis on selecting resources that they discovered and worked with throughout the institute. Again the focus is on the type of resources with clear preference for those that provided a surprise factor or a fun component, but ongoing discussions about classroom transfer and sharing of ideas is also emerging within the group, therefore taking into account the interaction with other teachers, as evidenced by some concerns raised regarding curricular alignment, or alignment to the Principles to Action Teaching Practices listed above. The sharing time of a MTC is a crucial component that models the type of rich mathematical discussions teachers are expected to conduct in their own classroom, therefore providing first hand experience with Mathematics Teaching Practices number (4) and (5). These in turn have a direct impact on students' CCSSM mathematical practice number (3), as one teacher testified through informal feedback the day after a particularly successful workshop: "It was so fun to hear their discussion as they debated about the best operations to use on each of their moves."

In a study on MTC gains, White and Donaldson highlight 4 principal categories that participants identify as areas of growth through participation in a MTC: Mathematical Content Knowledge, Attitudes about Mathematics, Instructional Practices, and Professional Activities (White &

Donaldson, 2011). These findings overlap the categories that emerged from our data collection, but the role of resources used by the collective is not mentioned, even though that is a stated goal of MTC interventions. By Summer 2016 we hope to have filled this gap in the research and emphasize how selected resources create a nature of mathematical practices in line with Principles to Action within the work of a MTC that carries over into the classroom not only through instructional changes but also through teachers adapting their involvement with the Mathematics to engage students more meaningfully.

We are currently analysing answers from post-summer and fall workshop surveys that will provide specific insight on what teachers are looking for in resources they use with their students versus resources used for professional development. One criteria that stands out for classroom use is the readiness of implementation and adaptability of the resource for various levels. Another criteria involves how teachers felt when engaged in the activity. Further results will be detailed in the full length article. Additional research through follow-up interviews and case studies will allow us to gain an understanding of components of a resource that are crucial for teachers in helping them implement problem solving activities, as well the type of exposure they need prior to using it in their classroom.

## **CONCLUSION**

The Mathematics Teachers' Circles initiative provides a safe place for teachers to tackle open-ended challenging mathematical tasks that promote rich discussions among participants. Ultimately the goal of professional development is to witness subsequent changes in the classrooms of participating teachers. This study examines the types of support in the form of resources available to teachers during curricular transitions that are necessary to insure meaningful changes are taking place, including time spent doing mathematics with others, readability of implementation for specific tasks, curricular alignment, and adaptability to various levels of students.

## **References**

- Adler, J. (2000) Conceptualising Resources as a theme for teacher education. *Journal of Mathematics Teacher Education*, 3, 205-224.
- Marle, P. D., Decker, L. L., & Khaliqi, D. H. (2012). An inquiry into Math Teachers' Circle: Findings from two year-long cohorts. Paper presented at the School Science and Mathematics Association Annual Convention, Birmingham, AL.
- Morrison, C. (2011). Advice from the field of teacher networks: Informing a potential AP teacher network in Colorado. Unpublished master's thesis, University of Colorado Denver.
- National Council of Teachers of Mathematics (2014). Principles to Action: Ensuring Mathematical Success for All. National Council of Teachers of Mathematics. Retrieved August 25 ,2015, from <http://www.nctm.org/PtA/>
- National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards for Mathematics*. Washington, DC: Authors.
- Silverstein, H. (2014). The state of the circles: National survey shows scope of MTC impact. MTC Circular Autumn/Summer, American Institute of Mathematics, Palo Alto, CA.
- White, D., & Donaldson, B. (2011). How do Math Teachers' Circles affect teachers? Themes from teacher surveys. Paper presented at the MAA Session on Fostering, Supporting, and Propagating Math Circles for Students and Teachers, I, Joint Mathematics Meetings, New Orleans, LA.