MC² Summer Professional Learning Framework

Mathematically Connected Communities (MC²) is an implementation and research project that utilizes a systemic approach for professional learning in partner school districts in New Mexico. Using the MC² Capacity-Building Model, a series of summer professional learning experiences have been designed and implemented in multiple classrooms, as a process for supporting teaching and learning in mathematics.

MathLab™ situates professional learning for teachers and administrators in K-12 classroom practice, utilizing live video-streaming for facilitating the participants' learning environment. Video streaming the lessons from math classroom labs to teacher observation rooms allows for student voices to be at the forefront of the experience.

In the morning:

- Teacher Leaders implement a student-centered lesson in selected grade level classrooms.
- Participants observe students doing mathematics and discuss pedagogical practices with their peers.

In the afternoon, participants:

- Delve deeper into the mathematics behind the lesson.
- Leave with familiarity related to how students learn mathematics, including what they understand and don't understand.
- Gain knowledge on how to enact effective strategies that promote collaboration and conceptual understanding of math for diverse learners.

Math Institute provides partner district teachers who attended MathLab™ with the opportunity for studying mathematics to further deepen their individual understanding of mathematical concepts presented in MathLab™. The Institute is organized into grade bands so teachers can develop pedagogical content knowledge relevant to the mathematics they teach. Teachers work alongside mathematicians to deeply understand the conceptual underpinnings of the concepts in the state mathematics standards and build a repertoire of strategies for incorporating the Common Core State Standards for Mathematics Content and Mathematical Practices (CCSS-M) into daily lessons.

The overall plan for summer professional learning integrates theories, research, and models of human learning to achieve its intended outcomes (Learning Designs Professional Learning Standard, 2011). It is framed by an understanding of the systemic change process, including:

- Concerns-Based Adoption Model-CBAM (Holloway, 2003)
- Kotter 8-Step Change Process (NMCCSS Implementation Plan, 2012)
- Six Strategies for a Change (Bradley, Munger, & Hord, 2015)
- Implementing the Four Levels: A Practical Guide for Effective Evaluation of Training Programs (Kilpatrick & Kilpatrick, 2007)

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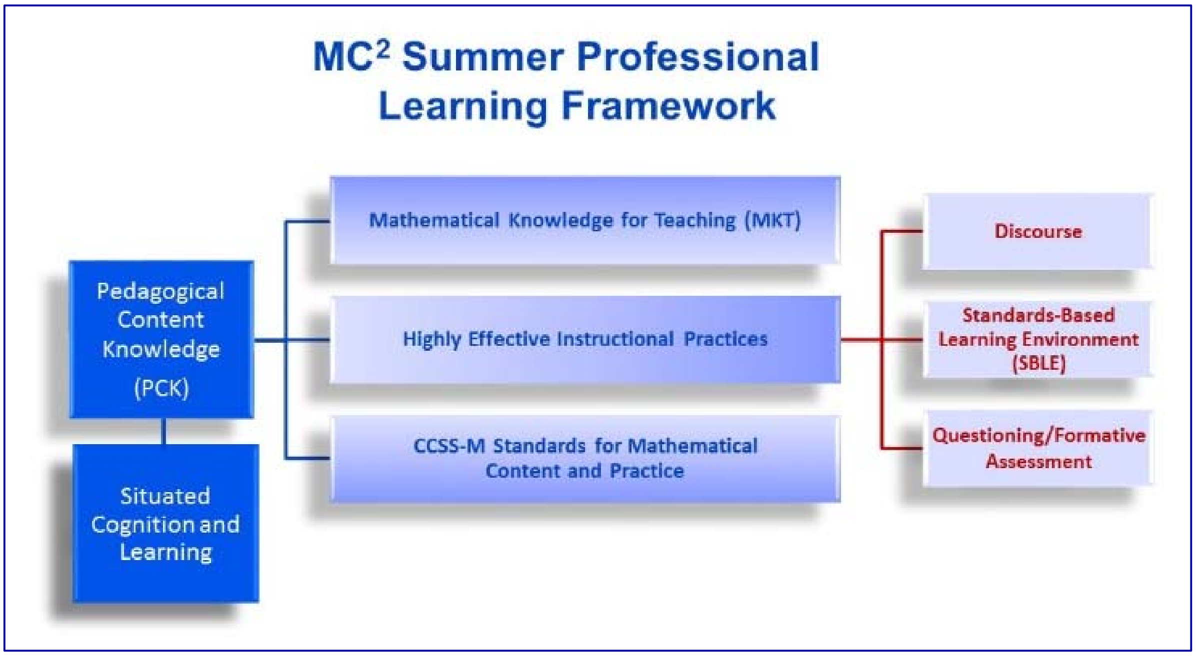
The professional organization, Learning Forward (2011), and multiple researchers (Cohen & Hill, 2001; Blank, de las Alas, N., & Smith, 2008) have found that isolated teacher professional development workshops, even when highly rated by teachers, have little effect on changing classroom practice. MC^2 summer professional learning is designed to increase student achievement in mathematics by escalating teacher knowledge/skills and providing ongoing support for changing practice. This requires at least 14 hours of relevant professional learning opportunities if student learning is to be affected (DeMonte, 2013). MC^2 provides 60 hours of summer professional learning with the opportunity for additional follow-up hours. Organized opportunities for collaboration and assessment are part of an ongoing cycle of continuous improvement, which require teachers to study mathematics content, curriculum, pedagogy, and assessment (DuFour, Eaker, DuFour, 2005). Hightower, Delgado, Lloyd, Wittenstein, Sellers, and Swanson (2011) determined that teacher quality has been consistently identified as the most important school-based factor in student achievement.

Professional learning opportunities in mathematics content and pedagogy are essential to support teachers as they encounter the higher expectations of the Common Core State Standards for Mathematics (CCSS-M) (NGA & CCSSO, 2010). All aspects of the MC^2 project are framed by research about **Teacher Professional Learning** as summarized above, In addition to research on teacher professional learning, the **MC^2 Summer Professional Learning Framework** is comprised of topics below:



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Situated Cognition and Learning for Participants

Learning exists *in situ* and is not separated from context, activity, people, culture, and language. Situated cognition focuses on interactions within a developing, interactive environment and supports individuals learning through experiences (Gee, 2010). The tools, technologies, and languages used during summer professional learning and the meanings given to these by participants, teacher leaders, and staff have an effect on the experience (Young, 2004; Barsalou, 2008). A live video feed is used to promote a dynamic learning environment that fosters a learning culture (Lock, 2006). Learning is not seen in terms of an accumulation of knowledge. Situated cognition also focuses on transfer, defined as increased participation (Lave & Wenger, 1991). In contrast, teaching approaches that focus on conveying facts and are separate from meaningful real-life contexts, do not lead to transfer (Barab & Roth, 2006).

Pedagogical and Content Knowledge (PCK)

Developing general pedagogical skills in isolation from content knowledge is insufficient for preparing mathematics teachers (Mishra, Koehler, & Henriksen, 2011). PCK is different from that of a content expert and the general pedagogical knowledge shared by teachers across disciplines. It is described as knowing:

- Which instructional approaches fit the content
- How elements of the content can be arranged for better instruction

Hill and Ball (2004) also describe curriculum as mediated by the teacher's knowledge of the subject and their knowledge of how to teach the subject effectively for diverse learners. PCK involves teaching strategies that incorporate formulation and representations of concepts, fosters students' prior knowledge, and addresses learner difficulties and misconceptions.

Understanding Mathematics for Teaching

The Teaching Gap, part of the Third International Mathematics and Science Study (TIMSS), observed that U.S. teachers thought of math as a set of tedious skills and emphasized terms and procedures while trying to interest students with praise and real-life problems. In contrast, Japanese teachers emphasized ideas, expecting concepts alone to stir students' natural curiosity. Their lessons had a distinct beginning, middle, and end. (Stigler & Heibert, 1999). "Teachers must understand both mathematics itself and how students learn mathematics in order to teach it effectively" (Van de Walle, Karp & Bay-Williams, 2010). It is imperative for teachers to have an understanding of how children learn mathematics, the standards, and the benefits of student-centered classrooms. Simply knowing math content is not sufficient to positively predict gains in student achievement.

Understanding mathematics for teaching promotes students' conceptual understanding while allowing them to explore important mathematics (Heibert & Grouws, 2007; Marzano, Pickering and Pollock, 2001). Attention to concepts involves students making connections such as the following:

- Explaining procedures
- Asking questions
- Comparing strategies and solutions of problems
- Noticing how one problem is special case of another
- Remembering main point
- Discussing lesson connections

Highly Effective Instructional Practices

According to the National Research Council (2001), teaching math involves teachers' abilities to use different approaches to engage students. Teachers need to be able to support, analyze, and asses their students' diverse needs (Thames & Ball, 2010). During MathLab™, the research-based characteristics of highly effective instructional practices conducive to a student-centered learning environment implemented are:

- Discourse
- Standards-Based Learning Environment (SBLE)
- Questioning/Formative Assessment

Traditionally classroom ***discourse*** was teacher initiated and evaluated which limited student participation to simply answering questions to which the teacher already knew the answer (Cazden, 2002). Reform-oriented teaching of mathematics recognizes communication as an essential part of modern classrooms (NCTM, 2006). Principles to Actions: Ensuring Math Success for All (2014) builds on Principles and Standards for School Mathematics which state that students should be able to:

- Communicate their mathematical thinking coherently, precisely, and clearly to peers, teachers, and others using mathematical language.

- Analyze and evaluate the mathematical thinking and strategies of others. Essentially, classroom discourse supports student conceptual development and reasoning (Chapin, O'Connor, & Anderson, 2003). Student discourse reveals understanding and misunderstanding. In addition, it supports robust learning by boosting memory, deeper reasoning, and the development of language and social skills (Chapin & O'Connor, 2013).

The vision of the Common Core State Standards for Mathematics (CCSS-M) reflects a change in the role of mathematics teachers (NGA & CCSSO, 2010). Unlike the customary role of the teacher as a dispenser of knowledge (Stein, Engle, Hughes, & Smith, 2008), the new role for mathematics teachers is to facilitate mathematical discussions with the goal of understanding and extending student thinking (Hufferd-Ackles, Fuson, & Sherin, 2004). This kind of teaching requires flexibility since different teacher responses are necessary to meet diverse needs depending on what students say, do, and understand. The goal is no longer only getting the correct answers to math problems but helping students to develop, clarify, extend, and communicate their mathematical thinking (Hufferd-Ackles et al., 2004). Classroom discussion also impacts the role of the student, as evidenced in the following CCSS-M Math Practices:

- MP3–Construct viable arguments and critique the reasoning of others.
- MP6–Attend to precision (clear communication).

A ***Standards-Based Learning Environment (SBLE)*** is focused on deepening student understanding of mathematical ideas and procedures. Student learning calls for both quality of the curriculum content and how students are able to participate in inquiry learning of mathematical practices (NCTM, 2000; Reys, Reys, Lapan, Holliday & Wasman, 2003).

The following *SBLE indicators* were identified by Tarr, Reys, Reys and Chavez (2008) to promote a learner-centered environment in which:

- The enacted lesson provides opportunities for students to make conjectures about mathematical ideas.
- The enacted lesson fosters development of conceptual understanding.
- Students explain their responses or solution strategies.
- Multiple perspectives/strategies are encouraged and valued.
- The teacher values student statements about mathematics and uses them to build discussion or to work toward shared understanding.

Questioning helps foster a sense of community in the classroom, keeps students engaged in the instructional process, and increases the level of rigor during math lessons. Bloom's Taxonomy, later revised by Anderson and Krathwohl (2001), is still the most commonly used framework for understanding the hierarchy of intellectual skills that students demonstrate.

- **Remembering** – Recognizing, recalling knowledge from memory, producing or retrieving definitions, facts, or lists, or reciting previously learned information
- **Understanding** – Constructing meaning from written or graphic messages or activities like interpreting, exemplifying, classifying, summarizing, inferring, comparing, or explaining
- **Applying** – Carrying out or using a procedure, executing, implementing using models, presentations, interviews or simulations
- **Analyzing** – Breaking materials or concepts into parts, determining how parts relate or interrelate to one another, how parts relate to overall structure or purpose by differentiating, organizing, attributing, and distinguishing between components or parts. (i.e., spreadsheets, surveys, charts, diagrams, graphic representations)
- **Evaluating** – Making judgments based on criteria and standards through checking and critiquing (i.e., recommendations, reports)
- **Creating** – Putting elements together to form a coherent or functional whole; reorganizing elements into new pattern or structure through generating, planning, producing, synthesizing

Marzano (2004) states that 80 percent of what is considered instruction involves asking questions. Multiple researchers (Marzano, et al., 2001; Black, Harrison, Marshall & Wiliam, 2002) discuss that a teacher's response to students' answers is just as important as the question asked. Research recommends:

- Redirecting students when incorrect answers are given or questions are misinterpreted.
- Probing for further explanation when partial answer is given.
- Validating correct response.

Black et al. (2002) remind us that, "It doesn't matter how good and well-structured your questions are if your pupils do not respond."

Formative assessment is defined as a "process" undertaken by teachers and students to enhance learning, during learning (Black & Dylan, 1998). It involves modifying teaching and learning to improve student outcomes on the content and their performance. Marshall and Wiliam (2002) and others (Moss

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& Brookhart, 2009; Chappuis, Stiggins, Chappuis, Arter, 2012), believe that learning targets and formative assessments are essential for students to learn. One way to do that is to answer the following questions from the student's point of view:

- What will I be able to do when I've finished this lesson?
- What idea or concept is important for me to learn and understand so that I can do this?
- How will I show that I can do this and how well will I have to do it?

The National Council of Teachers of Mathematics (NCTM) concluded that teachers who use assessment to adjust their instruction to meet their students' learning needs results in higher achievement. The *Five "Key Strategies" for Formative Assessment* (NCTM, 2007) research brief also proposes the following:

- Clarifying, sharing, understanding learning outcomes/success criteria
- Engineering effective classroom discussions, questions, tasks that elicit evidence of learning
- Providing feedback that moves learners forward
- Activating students as instructional resources for each other
- Activating students as owners of their own learning

Common Core State Standards for Mathematics and Mathematical Practices

The adoption of the CCSS-M (NGA & CCSSO, 2010) presents a challenge for teachers due to the broad scope of mandated instructional change. This change requires knowledge of the Content and Mathematical Practice Standards. Researchers in mathematics education (Hufferd-Ackles, Fuson & Sherin, 2004; McCallum, 2015) delve into learning progressions within particular domains in order to support teacher understanding of the standards across grade levels. MC^2 Summer Professional Learning utilizes research-based expertise and strategies to support the implementation of the CCSS-M. This experience may be replicated in other states regardless of their standards.

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