Photo by SHEILA HILLS

An Algebra 1 student explores equivalence of equations using colored tiles as a visual representation.

PROBLEM SOLVERS

MATHLAB'S DESIGN BRINGS PROFESSIONAL LEARNING INTO THE CLASSROOM

BY SARA MORALES AND TERRI SAINZ

Imagine teachers, administrators, and university mathematicians and staff learning together in a lab setting where students are excited about attending a weeklong summer math event because they are at the forefront of the experience.

Piloted in three New Mexico classrooms during summer 2014, MathLab expanded into 17 lab settings over six locations during summer 2015 and was implemented again in 2016. The enthusiasm of all participants witnessed by the New Mexico Public Education Department has resulted in funding to support future events.

MathLab is an innovative learning

design from New Mexico State University's Mathematically Connected Communities (MC^2), a partnership of New Mexico educators that includes mathematicians, school leaders, researchers, and teachers. Aligned to Learning Forward's Standards for Professional Learning (Learning Forward, 2011), MathLab began as an idea to shift from traditional one-shot professional development to ongoing professional learning situated in K-12 mathematics classrooms.

Student lab classrooms are videostreamed live to observation rooms, where teacher participants discuss, reflect, and collaborate on how students learn mathematics, effective pedagogical practices, and math content for teaching.

Teacher participants are also able to interact with and interview students to experience firsthand their challenges and success. In addition, school and district leaders can support and learn alongside teachers. This collaboration results in a learning community committed to continuous improvement, collective responsibility, and goal alignment, which are the key elements of the Learning Communities standard in Learning Forward's Standards for Professional Learning (Learning Forward, 2011).

As a way to revisit the teaching and learning, classroom lessons highlighting teacher and student strategies are videotaped and archived on the MC^2 YouTube channel at **http://mc2.nmsu.edu.**

MATHLAB GOALS

The MathLab learning community has established the following goals aligned with educator performance and student curriculum standards leading to effective teaching practices, supportive leadership, and improved student results — the key elements of the Outcomes standard in Learning Forward's Standards for Professional Learning (Learning Forward, 2011):

Goal 1: To study effective pedagogy in mathematics by supporting classroom practice through elements of a standards-based learning environment:

- Norms;
- Classroom discourse;
- Collaborative learning; and
- Ongoing assessment.

Goal 2: To develop conceptual understanding of mathematics by:

- Engaging students in rich mathematical tasks to build conceptual grounding for mathematics aligned to their upcoming grade level; and
- Deepening teachers' pedagogical and content knowledge in the context of teaching mathematics.

Goal 3: To support implementation at school sites including district and school administrators and teachers by providing follow-up opportunities:

- To develop a strategic plan for supporting changes in practice and learning structures for job-embedded, ongoing, site-based professional learning; and
- For teachers to engage in studying instructional practice in their classrooms (collaborative teaching and learning cycle).

Goal 4: To build a teacher leader cadre by:

- Building a network of teacher leaders who study and enhance their teaching practice while serving as leaders of professional learning at their school sites;
- Providing structure for teachers to enhance their leadership skills; and
- Partnering with practicing teachers who can inform the project of how to design effective professional learning experiences for improving teacher practice.

MATHLAB PLANNING CHECKLIST

- Select dates.
- Recruit teacher leaders and staff.
- Develop lesson plans.
- Secure facilities and contacts.
- Create and distribute flyers.
- Recruit and register students and participants.
- Contract videographers.
- Arrange student breakfast, teacher lunch.
- Arrange student transportation.
- Prepare binders (agenda, handouts).
- Create sign-ins, nametags, signage.
- Secure student incentives from businesses.
- Contact media.

WHAT MATHLAB LOOKS LIKE FOR TEACHERS

Each morning, teachers grouped in grade bands (K-3, 4-6, 7-Algebra 1) observe student learning in an adjacent 2nd, 3rd, 5th, or Algebra 1 classroom via live videostream. The student lesson is delivered by a team of two MC² teacher leaders who are masterful at building student-centered learning environments where children:

- Make conjectures about mathematical ideas;
- Explain their solution strategies; and
- Develop conceptual understanding.

In the afternoon, participants:

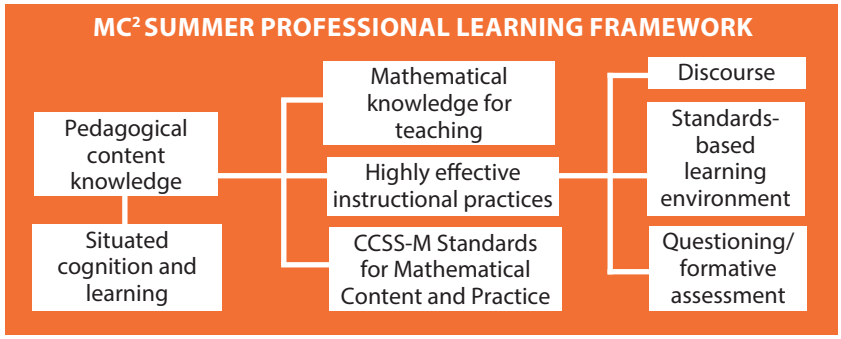
- Deepen their mathematical content knowledge by engaging in rich mathematical tasks;
- Consider lessons and instructional strategies that build conceptual understanding and foster a community of diverse students working collaboratively as young mathematicians; and
- Collaborate with peers and administrators to create an implementation plan for the upcoming school year.

WHAT MATHLAB LOOKS LIKE FOR ADMINISTRATORS

According to the Leadership standard of Learning Forward's Standards for Professional Learning, professional learning that increases educator effectiveness and results for all students requires skillful leaders who develop capacity, advocate, and create support systems for professional learning (Learning Forward, 2011). Principals have the power to make or break a school initiative. They set the tone, lead the vision, prioritize the focus, and create school cultures that promote a climate of learning and collaboration.

MathLab provides opportunities for administrators to undertake the study of mathematics and pedagogy to refine their leadership and management skills directly tied to improving mathematics teaching and learning. Administrators have time to work with participating MathLab teachers targeting these learning outcomes:

- Experience professional learning in an exemplary setting while studying highly effective mathematics teaching and learning;
- Know the characteristics of highly effective collaborative teacher professional learning;
- Observe teachers engaging in highly effective collaborative professional learning;
- Develop communication skills for co-creating highly effective collaborative environments focused on student learning; and
- Know the sequence for developing effective structures for highly effective collaborative learning groups at the school site.



FRAMEWORK

The overall plan for MathLab as part of summer professional learning integrates theories, research, and models of human learning to achieve its intended outcomes, in alignment with the Learning Designs standard of the Standards for Professional Learning (Learning Forward, 2011). It is framed by an understanding of the systemic change process. Among the change models that inform MathLab are the Concerns-Based Adoption Model (Holloway, 2003), the Kotter 8-Step Change Process (New Mexico Public Education Department, 2012), and Six Strategies for a Change (Bradley, Munger, & Hord, 2015).

Learning Forward and other research organizations have found that isolated teacher professional learning, even when highly rated by teachers, has little effect on changing classroom practice. Teacher quality has been consistently identified as the most important school-based factor in student achievement (Hightower et al., 2011).

MathLab is designed to increase student outcomes in mathematics by escalating teachers' knowledge, skills, and dispositions, and then providing ongoing support for changing practice.

DeMonte (2013) recommends 14 hours of relevant professional learning opportunities if students' learning is to be affected. MathLab provides 30 hours with the opportunity for an additional 30-plus follow-up hours. Organized opportunities for collaboration and assessment are part of an ongoing cycle of continuous improvement that requires teachers to study mathematics content, curriculum, pedagogy, and assessment (Dufour, Eaker, & Dufour, 2005). The MC² Summer Professional Learning Framework (see figure above) draws from these four areas for continuous improvement.

To download the complete framework, visit **http://mc2.nmsu.edu/project/Research_Framework.html.**

MATHLAB RESULTS AND IMPACT

MC² uses a variety of sources and types of data to plan, assess, and evaluate professional learning, which aligns with the Data standard of the Standards for Professional Learning (Learning Forward, 2011) and the Five Critical Levels of Professional Development Evaluation (Guskey, 2000). In summer 2015, 55 out of the 349 teachers who attended MathLab also participated in a weeklong math institute as a follow-up. During the math institute, teachers delved deeper in mathematics content to develop their knowledge of mathematics.

Photo by SHEILA HILLS

Elementary school students work on a collaborative task to generate classroom norms.

In fall 2015, two MC² researchers used a classroom observation protocol in eight districts to observe a random sample of 25 classrooms of teachers who attended both events. The sample included 464 students from grades K-Algebra 2 in regular, inclusion, and bilingual classrooms. The observation protocol is built on a foundation of math content, pedagogical knowledge, and student generative behavior that research suggests support deep student leaning of mathematics. MC² conducts research on observed changes in teaching practices and applies the findings to drive our professional development plan, in alignment with the Implementation standard of the Standards for Professional Learning (Learning Forward, 2011).

Fall 2015 and spring 2016 observation results indicate that **teachers** were most proficient in:

- Sharing and maintaining learning goals and targets with students;
- Supporting students making sense of mathematics by using student work and communication of ideas; and
- Asking questions about students' conceptual understanding.

In fall 2016, teachers also showed proficiency in asking questions focused on student conceptual understanding.

Fall 2015, spring 2016, and fall 2016 observation results indicate that **students** were most proficient in:

- Talking with each other about math; and
- Using appropriate math vocabulary.

The general level of implementation of a student-centered learning environment was measured on a Likert scale, rated from 0 (nonuse) to 4 (advanced). The results showed that classrooms of teachers who participated in both MathLab and math institute scored:

- Advanced/proficient/nearing proficient: 88%;
- Beginning steps: 12%; and
- Nonuse: 0%.

Researchers also conducted a plus/delta analysis. Examples include:

- Plus: Many teachers included Common Core State Standards Math Practices in student-friendly terms and revisited goals throughout lesson.
- Delta: Some goals were not fully developed or aligned to instruction.

Researchers included participant surveys and student interviews in compiling reports and shared the data with MC² staff responsible for planning and implementing MathLab. (The reports are available at **http://mc2.nmsu.edu**.)

WHAT HAPPENS AFTER MATHLAB

MathLab is part of a comprehensive professional learning system including support, implementation, and assessment as a continuous cycle. Effective professional learning requires an ongoing process for teachers to improve their instruction and for administrators to become better school leaders (Mizell, 2010). Recommendations take into account:

- Thoughtful planning;
- Teachers applying new knowledge and skills; and
- Follow-up and feedback.

BEFORE THE SCHOOL YEAR

As a follow-up to MathLab, a subset of the participating teachers and administrators attend a weeklong math institute where they, alongside mathematicians, delve deeper into mathematical content knowledge for teaching Common Core math standards.

DURING THE SCHOOL YEAR

Teachers receive ongoing support through the following:

- Collaborative teaching and learning cycle is a collaborative, nonevaluative, three-hour process in which teachers design lessons, observe and record student thinking, and debrief about student engagement, misconceptions, how the task developed student understanding, planning next steps for student learning, and reflection on teaching practices.
- Webinars provide online support communities designed to enhance teacher content knowledge, implement math practices, and develop effective instructional strategies. Webinars are archived at **http://mc2.nmsu.edu,** along with downloadable handouts of activities and strategies presented.

Administrators receive ongoing support through:

- Leadership team sessions: Three half-days during school year; and
- Principal learning communities: Four half-days, designed regionally.

Teacher leaders cadre receive ongoing support from:

- Using a multitiered approach to develop, plan, implement, and present workshops;
- Working collaboratively to promote increased student learning; and
- Deepening math understanding for teaching, and then transferring learning to other educators.

In addition, **MC² staff** provide onsite, ongoing support in the following ways:

- School-based study of Common Core State Standards for math: Partner schools work within professional learning community time or during professional development days to:
  - Study mathematical progressions of Common Core math standards; and
  - Develop units of study for classrooms that align to and develop habits of mind called for in the Common Core math standards, putting teachers (not textbooks) into the driver's seat using professional knowledge regarding children's mathematics learning to implement rich math tasks that engage students and build conceptual understanding of standards.
- Two cycles (fall and spring) of observations:
  - Researchers observe classrooms of MathLab participants as a process for informing the effectiveness using the observation protocol; and
  - Researchers provide general feedback to MC² staff working with teachers regarding specific observable behaviors in classrooms and instructional changes.

MathLab is an example of the time, materials, and human investment teachers need to increase their pedagogical and content knowledge for teaching mathematics. Effective implementation requires prioritizing, monitoring, and coordinating these resources for educator learning, as outlined in the Resources standard of the Standards for Professional Learning (Learning Forward, 2011).

Our primary purpose is strengthening the broader learning community to ultimately increase student outcomes in mathematics. Building capacity in teachers and administrators is key to sustaining support for implementation of professional learning for long-term change, as noted in the Implementation standards of the Standards for Professional Learning (Learning Forward, 2011).

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