A Continuous Improvement Approach to Mathematics Professional Learning Models (PLMs)

Researchers at the Regional Educational Laboratory Appalachia (REL AP) are partnering with four small-city school divisions[1] in central Virginia—Charlottesville, Harrisonburg, Staunton, and Waynesboro—to support college and career readiness by focusing on student success in algebra I by grade 9.[2] The Student Success in Mathematics partnership (SSMP), consists of superintendents, assistant superintendents and directors of instruction, school improvement leaders, mathematics leaders (division mathematics specialists and coordinators), and division administrators who support teaching and learning in their school divisions. The partnership is focused on understanding the efficacy of different instructional approaches and interventions to prepare students for success in algebra I and, ultimately, to increase students' success in graduating from high school and college and being career ready. To support these goals, REL AP staff and SSMP partners developed the professional learning models (PLMs) project, which is targeted at improving teacher learning as a key component of student success in mathematics. The project utilizes a continuous improvement approach to support division partners to design, test, and analyze mathematics professional learning in their local context.[3] The conceptual framework of the project includes a plan-do-study-act (PDSA) approach to continuous improvement with a focus on effective professional development strategies and effective mathematics teaching practices (figure 1). This summary describes common themes regarding lessons learned and best practices as educators implemented their PLMs using a PDSA cycle of improvement in year 1 of the project.

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[1] In Virginia, local education agencies are referred to as school divisions. Superintendents are leaders of their divisions. Principals are leaders of their schools. There are 132 school divisions in Virginia.

[2] Winchester Public Schools, originally included as part of the partnership, discontinued active participation in March 2019.

[3] See Bryk, A. S., Gomez, L. M., Grunow, A., & LeMahieu, P. G. (2015). *Learning to Improve: How America's Schools Can Get Better at Getting Better*. Cambridge, MA: Harvard Education Press, and Loucks-Horsley, S., Love, N., Stiles, K., Mundry, S., & Hewson, P. (2003). *Designing Professional Development for Teachers of Science and Mathematics* (2 ed.). Thousand Oaks, CA: Corwin Press.

Figure 1: REL AP continuous improvement approach to mathematics professional learning models (Partnership meeting, September 2018)

Adapted from Loucks-Horsley et al (2010). Designing Professional Development for Teachers of Science and Mathematics.
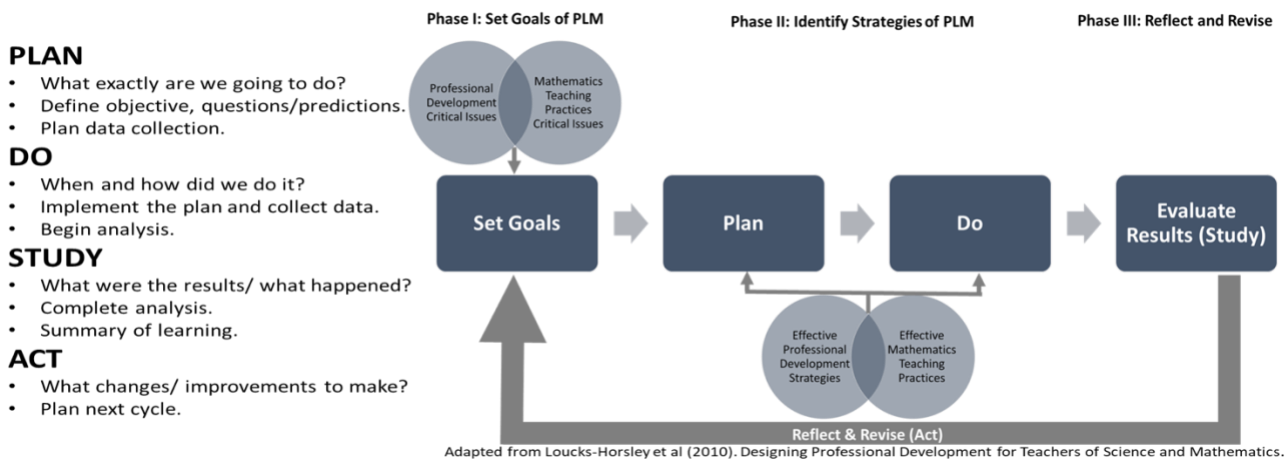
Partners from each school division developed and tested a mathematics PLM[4] utilizing a continuous improvement approach.[5] REL AP researchers provided technical assistance and coaching that included expertise in mathematics content and continuous improvement methods to inform the PDSA cycle. In face-to-face REL AP workshops and meetings, individual coaching sessions, and site visits to school divisions, REL AP researchers guided school division partners to plan their PLMs with careful attention to data collection and implementation, and also helped them interpret results, determine lessons learned, and consider the next improvement cycle (figure 2). In addition, the REL AP staff arranged research presentations for SSMP members that described methods to improve teacher pedagogy (Dr. Patricia Campbell, University of Maryland) and equity in mathematics (Dr. Toya Frank, George Mason University) and detailed how professional learning communities (PLCs) can improve teacher pedagogy (Dr. Nicole Bannister, Clemson University). Partners from the school divisions implemented their PLMs with teachers during the 2018/19 school year. One PDSA cycle occurred from September 2018 through September 2019.

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[4] Professional learning models (PLMs) refer to job-embedded, collaborative, and continuous professional learning that are tied to specific content or standards and aligned with school or district goals. See: https://ies.ed.gov/ncee/edlabs/regions/pacific/blogs/blog2_DistinguishingProfLearning.asp

[5] Continuous improvement or improvement science refers to rapid cycles testing of models that inform system improvements. The Plan-Do-Study-Act (PDSA) inquiry cycle is one tool of improvement science. See: https://ies.ed.gov/ncee/edlabs/regions/west/Blogs/Details/2

Figure 2: REL AP technical assistance and coaching activities to inform the PDSA cycle

This summary describes common themes regarding lessons learned and best practices as educators implemented their PLMs using a PDSA cycle of improvement. We present information about school division partners' reflections below.

Plan (September 2018 – December 2018)

REL AP: 1) Facilitated meetings to support PLM action planning, 2) Provided research-based practice on use of math coaches (with Dr. Pat Campbell) | **School divisions**: Drafted and finalized their PLM action plan

Do (January 2019 – June 2019)

REL AP:1) Conducted site visits to support PLM implementation, 2) Provided research-based practice on equity (with Dr. Toya Frank) | **School divisions**: Implemented PLM with teachers

Study (June 2019 – September 2019)

REL AP: Conducted virtual coaching sessions for data analysis and reflections | **School divisions**: Conducted analysis and reflections of PLM data

Act (September 2019 – December 2019)

REL AP: 1) Provided research-based practice on use of PLCs (with Dr. Nicole Bannister), 2) Facilitated meetings to support joint learnings | **School divisions**: 1) Shared lessons learned from first PDSA cycle, 2) Revised PLM action plan based on shared learnings

Invest time for intentional planning of the PLM. School division partners noted regular SSMP meetings facilitated by REL AP staff provided them with protected time needed to plan, develop, and receive feedback on their PLMs. Partners used the valuable planning time to create a cohesive set of professional learning activities aligned with evidence-based practices and guiding principles in mathematics success, to identify the persons responsible for implementation, and to create a data collection plan to evaluate the outcomes of the PLMs. See figure three below for an example Action Plan from one school division partner. Although partners acknowledged the planning process was challenging, they also agreed it was critical for educators to be intentional about linking multiple PLM activities to specific teacher learnings and PDSA cycles of improvement.

Figure 3: PLM action plan from REL AP SSMP member (October 2018)

Professional learning strategy List and briefly describe.	Guiding principles targeted Access & equity, curriculum, technology, assessment (describe)	Mathematics teaching practices List and briefly describe.	Grade span/grades targeted
Study group organized around reading book, _Math Workshop_ by Lemmp Lead teachers chosen by school administration meet with mathematics coordinator 5X during school year	Access and Equity	**Facilitating meaningful discourse**. Classrooms will have less teacher talk and more meaningful student discourse in math. **Implementing tasks that promote reasoning.** Teachers will evaluate and use tasks.	K - 5
Steps to implement strategy List and briefly describe.		Person(s) responsible Leadership support and facilitator(s)	Documentation/data
Math lead teacher meetings. 1) Number sense, 2) Routines and discourse, 3) Explore, create, and implement math tasks – What they are, when to use them, how to effectively use them (_Five Practices for Orchestrating Productive Mathematics Discussions_ by Smith & Stein), 4) Template for math tasks		Mathematics Coordinator	Teacher self report of amount of discourse Observe all teachers in PLM in January

Match the focus of the measurement to the direct recipient of the PLM. Effective mathematics teaching practices are a critical intermediate outcome of PLMs and support student learning. As such, partners realized they had to prioritize measuring teacher outcomes. For example, one partner initially planned to collect various student formative assessments to determine whether the PLM was effective in improving mathematics instruction. However, the partnership planning sessions revealed the primary outcomes targeted by the PLMs involved teacher practices and knowledge, such as their use of math talk in the classroom and self-reflection on instructional practice. This partner collected both qualitative data (e.g., open-ended self-reflections from teachers on their PLM learning) and quantitative data (e.g., teacher self-assessments using a rubric of teacher behaviors at the start of the PLM and later in the school year. Other school division partners operationalized teacher outcomes and collected data in different ways. Partners in one school division measured teachers' use of a new math curriculum using classroom observations, teacher reflections, and teacher logs and surveys. Another school division partner designed a measure of teacher learning from the PLM and asked teachers to self-rate how often they used math tasks at the start (pre-test) and end (post-test) of the PLM period. The teaching strategy included in the PLM focused on improving teachers' facilitation of meaningful student mathematics discourse (figure 4). Teachers were asked to reflect on who does most of the talking about math in class, the student (rated as 1, most of the talking done by students) vs. the teacher (rated as 5, most of the talking done by teachers) before and after the PLM (figure 4). One partner concluded, "Often the measurement is looking at teacher beliefs and attempts, which can be more nuanced to measure, but it is _doable_."

Figure 4: Measuring teacher math talk before and after the PLM (Results from partner, June 2019)

In your classroom, who does most of the talking about math?	Pre (N = 30)	Post (N = 35)	In your classroom, how often do you use math tasks?	Pre (N = 30)	Post (N = 35)
1 (Students)	0	3.2%	1 (Never)	6.9%	3.2%
2	31%	41.9%	2	51.7%	38.7%
3	55.2%	48.4%	3	27.6%	45.2%
4	13.8%	6.5%	4	10.3%	12.9%
5 (Teacher)	0	0	5 (Every Day)	3.4%	0

Use data to refine, not abandon, the PLM. As partners worked through their PDSA cycles, they examined data and results, and they acted on what they learned in the process. But rather than develop *new* PLMs after each cycle, the partners continued to *refine* their PLMs. For example, one school division team's PLM focused on deepening the use of the *Math Investigations* curricular materials in elementary classrooms. During the reflection and refinement process, this partner observed, "Last year, we created an [embedded professional learning] structure to support and guide our first year of curriculum adoption [of *Math Investigations*]. At the beginning of this year, [teacher] surveys indicate that teacher professional learning communities are now comfortable with the full arc of the curriculum and are confident that this year, they will be able to go deeper in their understandings of the mathematical practices embedded in the curriculum." Rather than starting a new PLM about another topic in mathematics, this partner's PLM continued to focus on *Math Investigations* to go deeper into specific mathematical practices with the teachers, and they continued with PDSA cycles to test changes and improvements along the way, including making changes to curriculum resources to ensure better alignment with content standards.

Refine your measurement as needed. Partners not only refined their PLMs based on their data and results, they also refined their outcome measures. Many school division teams developed more sophisticated data collection and analysis plans with each PDSA cycle. For example, one partner stated, "I wish I had asked teachers to define what they thought a 'math task' was prior to our time together. I would like to think that for some people, their definition of a 'task' changed during our work together." This partner's refined measurement plan included assessing changes in teacher knowledge and instruction by including detailed questions in a pre-post teacher survey, such as how teachers exhibit their learning from the PLM, use probing questions, and learn from formative student data to improve planning and instruction.

In summary, researchers at REL AP supported school division partners in implementing PLMs using a PDSA continuous improvement cycle. As partners discussed their lessons learned and plans for the next iteration of the PDSA cycles, they became much more comfortable reviewing and using data to enact improvements in their PLMs. In reflecting on new learnings, one partner described planning data collection in advance by exploring the question of 'What am I trying to measure?'" before implementing a PDSA. This division partner stated, "This sounds obvious if I were working with students—but it applies to working with teachers as well!" As educators, we are trained to do a PDSA cycle for student learning, from lesson planning (plan), teaching (do), assessing (study), and re-teaching (act). As our school division partners discovered, the same PDSA process is true for teacher learning and school improvement.

For more information on the REL AP mathematics partnership, go to https://ies.ed.gov/ncee/edlabs/regions/appalachia/partners-VA-student-success-mathematics.asp.