IES Institute of Education Sciences

Implementing a Professional Learning Model to Support Student Success in Mathematics

Resource Compendium

Regional Educational Laboratory Appalachia at SRI International

September 2021

These materials were prepared under Contract No. ED-IES-17-C-0004 by the Regional Educational Laboratory Appalachia, administered by SRI International. The content does not necessarily reflect the views or policies of IES or the U.S. Department of Education, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.

Contents

Resource Compendium Overview

Research suggests that teacher professional learning opportunities are positively associated with student achievement when they are content-focused, incorporate active learning, support collaboration, are job-embedded, model effective teaching practice, provide coaching and expert support, offer opportunities for reflection, and are sustained over time (Darling-Hammond et al., 2017). Findings from interviews and surveys with more than 2,900 teachers and educators nationwide, however, suggest that these components are neither systematically integrated nor consistently embedded in school culture (Bill and Melinda Gates Foundation, 2014). Furthermore, educators find their district-based professional learning fragmented and disconnected from their needs (Jensen et al., 2016). To address this problem of practice, mathematics teacher professional learning needs to be coordinated and aligned to teacher needs and district initiatives (Loucks-Horsely et al., 2010).

A professional learning model (PLM) is a cohesive system of teacher professional learning in which various educator learning opportunities—such as instructional coaching, examining student work in groups, and workshops—contribute to the same long-term goals and vision for effective teaching practices and learning. This compendium provides resources to support the design and implementation of a PLM that improves mathematics teaching and learning.

Who is the audience for the compendium?

This compendium is designed for a variety of audiences, including mathematics teacher leaders and coaches, curriculum leaders, and school administrators who create and provide mathematics professional learning activities for elementary and secondary teachers of mathematics.

The resources in this compendium are derived from a two-part webinar series hosted by the Regional Educational Laboratory (REL) Appalachia Student Success in Mathematics (SSM) partnership and co-presented with partnership members to a national audience. The REL Appalachia SSM partnership includes leaders from five school divisions in central Virginia who have been working with REL Appalachia staff since 2017 to design the PLM process and co-develop resources to help teachers support students in mastering concepts and skills related to

Algebra I. Additional activities and resources are included in this compendium based on input from SSM partnership members.

What is in this compendium?

The compendium includes two slide decks with talking points, facilitator notes, and references that can guide training and learning about cohesive models for mathematics professional learning. The slide decks are derived from the *Implementing a Professional Learning Model to Improve Mathematics Teaching* webinar series, which aimed to build participants' capacity to design and implement a cohesive professional learning model (PLM) that incorporates interconnected, evidence-based professional learning experiences, enhances mathematics teachers' ability to deliver high-quality mathematics instruction, and supports student achievement and success.

The compendium also contains:

- Tables that describe what is known from research and practice related to topics from the webinar slide decks; reference the associated slides, handouts, and resources on those topics; and offer questions to be used for individual reflection or group discussion.
- Reflections from practitioners who have implemented a PLM.
- An appendix with five handouts associated with the webinar series.

How can I use this compendium?

The compendium can be used for individual learning. Individual mathematics teacher leaders, coaches, or curriculum leaders can review the slide decks, associated notes, and handouts for personal reflection and action planning related to the design and implementation of high-quality mathematics education professional learning activities. The additional resources and reflection questions in the compendium will help users extend their learning about evidence-based strategies and conditions that need to be in place for mathematics educators to support all students to learn critical mathematics content and practices.

The compendium can also be used as a training and learning tool for teams of practitioners, including curriculum leaders and school administrators who design and provide mathematics

professional learning activities in particular schools or those who are responsible for planning professional learning across an entire district. The resources in the compendium can extend discussion and planning and help team members apply the content in their respective roles.

Implementing a Professional Learning Model to Improve Mathematics Teaching

Webinar series goals

The webinar series was designed to build the capacity of school division administrators and teacher leaders to design and implement a coherent professional learning model (PLM). A PLM that supports mathematics teaching and learning incorporates interconnected, evidence-based professional learning experiences for mathematics educators and enhances leaders' abilities to deliver high-quality mathematics instruction to support student achievement and success. *These materials were initially presented as part of a national webinar series; however, they can also be used at the district or school level to support district and school team training and learning.*

Webinar 1 objectives and overview

- Define considerations and components of an evidence-based mathematics PLM.
- Identify professional learning strategies and evidence associated with their use.
- Identify contextual factors that influence the design of professional learning in participants' school divisions.
- Apply evidence-based strategies and practices in planning a PLM using the provided template.

Time	Topic and facilitator notes
5 minutes	**Welcome** • Welcome everyone and review the agenda, webinar series goals, and Webinar 1 objectives.
10 minutes	**Overview and framing** • Discuss the role of teacher professional learning as related to district-level mathematics learning goals and provide an overview of the components of effective professional learning activities.
40 minutes	**Professional learning models: Key components** • Introduce and define PLMs as a cohesive system of professional learning in which educator learning opportunities relate to each other and contribute to the same long-term set of goals and vision for mathematics teaching and learning. • Describe key research-based considerations for planning effective professional learning activities. • Introduce the PLM template (Handout 1, PLM Planning Template) and how it presents the steps of a PLM.

Time	Topic and facilitator notes
	• Provide an overview of contextual factors in teacher professional learning (Handout 2, Contextual Factors Influencing Professional Development) and prompt participants to reflect on teacher strengths and barriers. Introduce and discuss mathematics teaching principles and practices (Handout 3, Mathematics Teaching Practices). Lead participant conversation to develop an understanding of the critical issues at the intersection of professional learning and mathematics teaching practices. • Review strategies for professional learning (Handout 4, Overview of Selected Strategies for Professional Learning) and share how these relate to the PLM.
30 minutes	**Professional Learning Model planning: Lessons from the field** • Share specific lessons learned when developing and implementing cohesive professional learning. *In the webinar, SSM partners reflected on their experiences with the PLM process; when facilitating training with these materials, consider including examples of local implementation.* • Discuss considerations related to building a successful division-specific PLM and answer any questions about how these strategies and practices fit into a PLM.
15 minutes	**Closing** • Review the webinar objectives and remind participants to complete the PLM Planning Template before the next webinar.

Webinar 2 objectives and overview

- Identify and describe possible data sources and methods to help understand teacher learning and the success of teacher professional learning activities.
- Apply learning about data collection and analysis to develop a data collection plan as part of PLM planning.
- Identify key considerations when using a PLM to design future professional learning opportunities.

Time	Topic and facilitator notes
10 minutes	**Welcome** • Welcome everyone and review the agenda, webinar series goals, and Webinar 2 objectives.
40 minutes	**Professional Learning Models: Documentation and data** • Emphasize the need to analyze whether and how teacher learning opportunities are working before looking at student and teacher

Time	Topic and facilitator notes
	outcomes. Share Handout 5, Assessing Learning Outcomes Within a Professional Learning Model, which provides examples and resources related to the five levels of assessing learning outcomes within a professional development assessment. • Discuss how data generated from the sample instruments and data collection protocols in Handout 5 are not for accountability or evaluative purposes, but rather are part of a systematic way to obtain feedback and reflection to improve a PLM. • Provide specific examples of data that could be collected during different professional learning strategies. For example, to examine coaching, highlight the types of data one would collect. Lead participant conversation to deepen understanding of the five levels of professional learning assessment, related data, measurement tools, and data use.
30 minutes	**Professional Learning Model planning: Lessons from the field** • Share experiences related to the PLM process and specific lessons learned about how data collection and analysis assisted in the design and implementation of the PLM and coordination of professional learning efforts. Discuss lessons learned and suggestions about data collection and analysis, encouraging educators and participants to attend to school contexts and concerns. *In the webinar, SSM partners reflected on their experiences with the PLM process; when facilitating training with these materials, consider including examples of local implementation.* • Present and discuss a scenario from the field; ask participants to suggest potential data sources and instruments and share how they could use data to revise and improve the professional learning opportunity. • Highlight the What Works Clearinghouse Practice Guides as a source of evidence-based recommendations for participants to use as they create and update their PLM plans.
20 minutes	**Closing** • Review the webinar objectives and encourage any final sharing or reflection.

Designing and Implementing a Cohesive Professional Learning Model

This section presents supports to design and implement a mathematics Professional Learning Model (PLM) as highlighted in the *Implementing a Professional Learning Model to Improve Mathematics Teaching* webinar series. Each table briefly describes what is known from research and practice related to topics from the webinar slide decks; references the associated slides, handouts, and resources on those topics; and offers questions to be used for individual reflection or group discussion.

Foundation of the Professional Learning Model design

The webinar began with an overview of the REL Appalachia Student Success in Mathematics (SSM) partnership and its goal to help all students master key skills, practices, and understanding of critical concepts of algebraic reasoning by grade 9. To support this goal, partnership members designed and implemented mathematics PLMs to implement evidence-based teacher professional learning to improve mathematics teaching and learning. Table 1 provides background on the foundation of the PLM design.

Table 1. Foundation of the PLM design

Background	Associated resources
After analyzing their individual and collective needs, SSM partnership members set a common goal that "all students master key skills, practices, and understanding of critical concepts of algebra by grade 9 to be able to take higher-level mathematics in high school." This goal required an intensive focus on educator professional learning in upper elementary grades (grades 3–5) and middle grades (grades 6–8) on algebra readiness, evidence-based strategies to support all learners, effective practices for mathematics instruction, and needs of teachers based on data. Planning for effective professional learning must align with a school district's vision for mathematics teaching and learning, student data and learning needs, and district-level initiatives, and it must consider school schedules, teacher professional learning beliefs and practices, and other elements of school culture (Loucks-Horsley et al., 2010). Districts can achieve this alignment of goals, vision of mathematics learning, and high-quality professional learning through the development and implementation of a professional learning model (PLM). The process of building a set of evidence-based professional learning activities, aligning them to a common vision and goals, assessing the activities' outcomes, and	Webinar 1 slides 6–7, 10–11

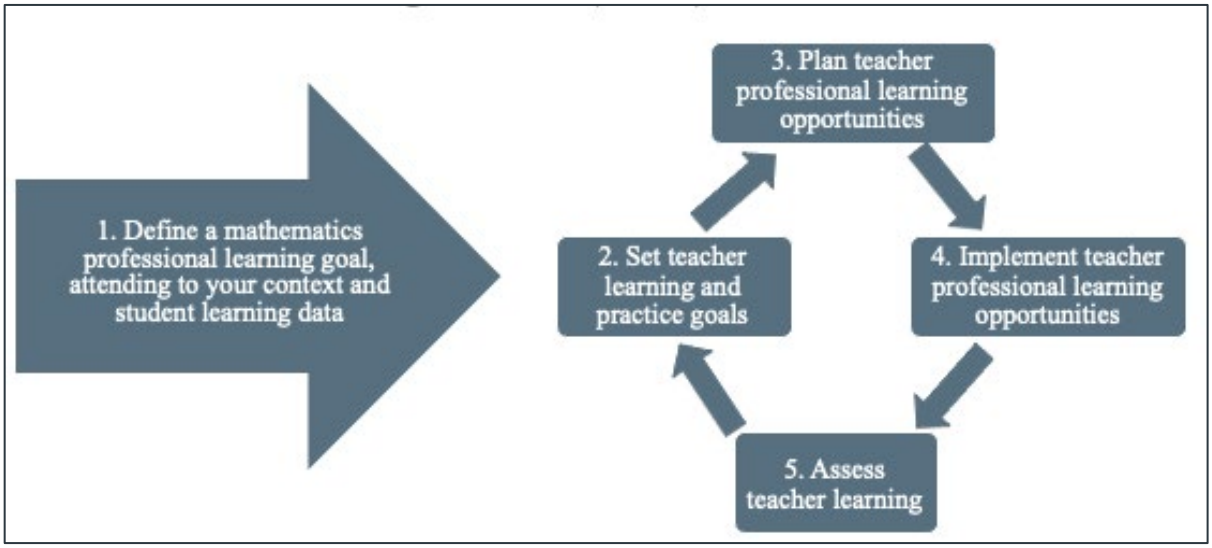
Background	Associated resources
refining components of the model deepens mathematics leaders' understandings of the learning targets for the professional learning activities and builds their capacity to design professional learning opportunities that support educators to achieve desired outcomes. **Reflection questions:** • What is your district's vision for mathematics teaching and learning? • What, if any, existing district initiatives do you need to consider when planning mathematics professional learning activities in your school or district?	
Research suggests that teacher professional learning is positively associated with student achievement when it is content-focused, incorporates active learning, supports collaboration, is job-embedded, uses models and modeling of effective teaching practice, provides coaching and expert support, offers opportunities for feedback and reflection, and is sustained over time (Darling-Hammond et al., 2017). Professional learning that incorporates content-specific pedagogical strategies and supports teachers' ability to anticipate and respond to students' ideas and misconceptions is associated with greater learning gains for students and teachers compared with professional learning that is focused solely on content (Jacobs et al., 2007). Although many agree on these critical components of teacher professional learning, teachers report two issues: that district-based professional learning is disconnected from the needs that teachers themselves identify and that professional learning activities do not connect from one activity to the next and thus feel fragmented (Bill and Melinda Gates Foundation, 2014; Jensen et al., 2016). Consider conducting a combination of surveys and focus groups or individual interviews to determine the individual and group professional learning needs of your teachers. Take stock of districtwide initiatives and consider how the professional learning activities you design can build upon these efforts. **Reflection questions:** • What existing student and teacher data will you review to determine teacher professional learning needs? • How do you ensure that your professional learning activities build upon and complement one another? • If you were to convene a small focus group to more fully understand the needs of your mathematics teachers, whom would you bring together? Why? • What two or three questions would you ask teachers to better understand their needs?	Webinar 1 slide 8

The five stages of developing a Professional Learning Model

This section describes the five stages of development (figure 1) needed to establish a system of professional learning in which educator learning opportunities relate to each other and contribute to the same long-term goals and vision for mathematics teaching and learning. The PLM Planning Template (Handout 1) is used to outline and develop a comprehensive plan for mathematics professional learning to support educators as they attain the skills, knowledge, and practices that can help ensure that each and every student—from all demographic and socioeconomic groups—meets learning goals and has opportunities to be successful in mathematics.

PLM design begins with the establishment of an overarching school or district mathematics professional learning goal that is responsive to the teaching and learning contexts and the student learning data within a school district (stage 1). Mathematics professional learning leaders then set teacher learning goals aligned with the student goals and design learning experiences directed toward the teacher learning goals (stages 2 and 3). Next, professional learning leaders implement the professional learning activities, followed by an assessment of teacher learning (stages 4 and 5). Even though assessment of teacher learning comes last in the cycle, it should be considered and planned for while setting goals and designing professional learning experiences.

Figure 1. Stages of a professional learning model



Stage 1: Establishing the goal and considering context

In the first stage of a PLM, professional learning leaders begin by establishing goals that are responsive to local contexts, aligned with research on professional learning, and shared with mathematics teacher leaders and school administrators. Examples of shared goals could include student mastery of early elementary number and computation skills in preparation for middle school, or students' demonstrated improvement in oral and written communication about mathematics by the end of each year. This section includes resources to guide conversations on defining goals and discussing contextual factors that should shape the design and facilitation of professional learning opportunities. Familiarity with school and district resources, schedules, policies, and cultures is critical to designing and implementing appropriate and realistic professional learning opportunities that address the unique local context in which teachers teach and students learn (Loucks-Horsley et al., 2010).

Table 2. Define goals and context (stage 1)

Background	Associated resources
When professional learning opportunities for teachers are aligned to a shared goal, the learning opportunities are more likely to increase teacher learning and student success (Darling-Hammond et al., 2017). In a PLM, a district leader or educator responsible for facilitating teacher learning connects educator learning opportunities to one set of related long-term goals and a vision for mathematics teaching and learning situated in the local context. To build the capacity of staff in your district, it is important to acknowledge and incorporate PLM planning relative to local contextual factors, such as curriculum, time for professional learning, school structures, and norms for teacher learning within your mathematics professional learning culture. Your PLM could also address long-term factors such as plans for sustainability, plans to address content and pedagogical knowledge, explicit strategies to address equity, and steps to build a professional learning culture (Loucks-Horsley et al., 2010). **Reflection questions:** • Describe your district's mathematics professional learning culture. • Are the following factors necessary for capacity-building currently in place in your district? - Plans for sustainability - Time for professional learning - Plans to address content and pedagogical knowledge	Webinar 1 slides 12–13 Handout 1 Handout 2

Background	Associated resources
- Explicit strategies to address issues of student access and equity related to high-quality mathematics curriculum and instruction focused on rigorous content and engagement with effective mathematical practices • Which capacity-building factors need to be developed in your district?	

Table 3. Contextual factors influencing professional development (stage 1 cont.)

Background	Associated resources
1. Contextual factors related to materials and instruction include availability of curricular materials, coherence of curricula, outlines of instructional plans, students' learning environment, and barriers that students face in accessing instruction or engaging in problem solving and reasoning. **Reflection questions:** • Are curriculum materials available to all teachers? • Are curriculum materials focused, rigorous, and coherent? • Are the mathematics instructional materials implemented as intended? • How is the learning environment conducive to all students' participation and collaboration? • What barriers, if any, prevent all students from having full access to rigorous curricula? • What barriers, if any, prevent students from engaging in problem solving and developing reasoning skills during instruction?	Webinar 1 slides 15–16 Materials and instruction section of Handout 2
2. Contextual factors related to school culture and policies include school-wide beliefs about students and their capacities, administrative policies and schedules that support teachers' collaborative practice, and assumptions about race, class, educational, and linguistic differences among students. **Reflection questions:** • Do current school policies and schedules support collaborative practice? • Are teachers involved in ongoing inquiry into their beliefs about students and their capacities? • In what ways are teachers' assumptions about race, class, educational, and linguistic differences among students talked about openly and examined critically?	Webinar 1 slide 18 Culture and logistics section of Handout 2

Background	Associated resources
3. **Contextual factors related to professional learning** include the status of teacher reflection and collaboration in your school district, particularly during teacher professional learning. **Reflection questions:** • How much do teachers focus their discussions on mathematics teaching and learning? • In what ways do teachers share their practice with others? • In what ways do teachers work collaboratively to solve instructional challenges? • Is reflective dialogue a norm in your school district?	Webinar 1 slide 19 Professional learning section of Handout 2

Stage 2: Setting learning and practice goals grounded in research

This section describes frameworks and resources to consider when planning mathematics professional learning. In stage 2, set learning and practice goals guided by mathematics education research-based frameworks and resources, and integrate overarching principles, such as the "Guiding Principles for School Mathematics" in the National Council of Teachers of Mathematics' (NCTM) book *Principles to Action* (NCTM, 2014). These frameworks help guide the development of structures, policies, and conditions to enhance mathematics learning and support the teaching required to meet students' learning needs.

Table 4. Set learning and practice goals, integrate overarching principles (stage 2)

Background	Associated resources
Draw from mathematics education research when designing the content of professional learning for teachers of mathematics, including the setting of teacher learning and practice goals. The National Council of Teachers of Mathematics (NCTM, 2014) provides a research-informed framework of mathematics teaching practices: establish math goals to focus learning; implement tasks to promote student reasoning and problem solving; use mathematical representations; facilitate meaningful mathematical discourse; pose purposeful questions; build procedural fluency from conceptual understanding; support productive struggle, and elicit and use evidence of student thinking to improve mathematics learning and teaching. Align teacher learning and practice goals to these practices as well as to NCTM's Guiding Principles for School Mathematics (NCTM, 2014). NCTM's principles, based on decades of research, constitute hallmarks of high-quality mathematics learning environments. Review the Executive Summary of the NCTM (2014)	Webinar 1 slides 6–7 Handout 3 Executive Summary of the NCTM (2014) *Principles to Action*

Background	Associated resources
Principles to Action, which lists the "Guiding Principles for School Mathematics." These principles are an example of overarching principles that guide instruction and professional learning. While these practices are universally accepted as key for student achievement, educators must specify what implementation of these practices will look like in their local teaching contexts to ensure high-quality teaching (Ball & Forzani, 2011). **Reflection questions:** • Which teaching practice(s) do you want to learn more about? • Which practice do you think teachers in your school or district need more support with to improve instruction?	

Table 5. Using What Works Clearinghouse practice guides in professional learning planning (stage 2)

Background	Associated resources
Deepen your understanding of mathematics teaching practices by using sources of research such as What Works Clearinghouse (WWC) practice guides, publications hosted on the WWC website and made available by the Institute of Education Sciences (IES) of the U.S. Department of Education. The WWC practice guides provide recommendations for educators based on in-depth reviews of research, the experiences of practitioners, and national mathematics education experts. For example, to better understand the mathematics teaching practice of implementing tasks to promote student reasoning and problem solving (NCTM, 2014), you can consult the *Improving Mathematical Problem Solving in Grades 4 Through 8* practice guide (Woodward et al., 2012). This guide, designed for teachers, math coaches, other educators, and curriculum developers, provides five recommendations and details how to carry out each one, complete with definitions, example problems, and approaches. To focus on improving the algebraic reasoning knowledge of middle grades and high school students, consult the *Teaching Strategies for Improving Algebra Knowledge in Middle and High School Students* practice guide (Star et al., 2015). All the practice guides discuss potential roadblocks and solutions that PLM designers can incorporate into professional learning activities and discussions. **Reflection questions:** • Which teaching practice do you want to learn more about? • Which practice do you think teachers in your school or district need more support with to improve practice?	Webinar 1 slides 6–7 present example learning and practice goals Handout 3 WWC Practice Guides

Stages 3 and 4: Planning and implementing teacher professional learning

Planning for professional learning should inhabit the intersection of effective, evidence-based professional learning strategies and effective math teaching practices grounded in mathematics learning research. At this intersection, mathematics education leaders can create rich professional learning opportunities for educators that have the potential to translate into powerful mathematics learning opportunities for students in the classroom.

Table 6. Plan and implement teacher professional learning opportunities (stages 3 and 4)

Background	Associated resources
Handout 4 provides a set of selected strategies, such as examining student work, coaching, or mentoring, for professional learning. The PLM should include professional learning strategies that best align with local teaching contexts and educators' needs; for example, a PLM can be designed to account for the number of teachers who teach a certain grade level, the availability of mathematics coaches, and time for professional learning workshops, as well as what is known about teacher knowledge in a particular content area. Consider including multiple strategies in a PLM because teachers in different settings or with different responsibilities may have different needs and opportunities. For example, teachers across multiple remote rural schools may benefit from an online professional learning study group, whereas teachers in the same building may engage in face-to-face study group meetings. Once the teacher professional learning opportunities are planned, address the logistics. Schedule the professional learning activities, arrange location, address technical issues, advertise the offerings, recruit the participants the activities are intended to serve, coordinate sign-up, and send reminders prior to the professional learning sessions. **Reflection questions:** • Review the teaching strategies listed on Handout 4. Which professional learning strategies are not being used in your district? Why? • Which of the strategies listed on Handout 4 will you employ to deepen teachers' knowledge and improve practice? Why?	Webinar 1 slides 24–26 Handout 4

Stage 5: Assessing teacher professional learning

At each step of the PLM, collecting and analyzing data is critical to understanding how professional learning opportunities make a difference for educators and, ultimately, student achievement. Assessing teacher learning helps leaders determine if and how professional

learning activities achieve their purposes (Guskey, 2002). Specifically, "Professional learning that increases educator effectiveness and results for all students uses a variety of sources and types of student, educator, and system data to plan, assess, and evaluate professional learning" (Guskey, 2016, p. 33).

There are five levels of professional learning assessment and evaluation (Guskey, 2016), all of which are necessary to understand if the professional learning activities are to produce the learning outcomes needed to lead to student change and success. Level 1 focuses on participants' reactions, and level 2 focuses on participants' learning. Level 3 focuses on organizational support and change, and level 4 focuses on participants' use of new knowledge and skills. Finally, level 5 focuses on student learning outcomes. Handout 5 details these levels and provides illustrative examples. Each level is also described in detail below (you may also refer to Webinar 2, slides 11–13).

Level 1: Participants' reactions

In level 1, the goal is to assess participants' reactions to professional learning after each session or event. This can be an initial step to understanding what participating educators appreciated from the learning opportunity.

Table 7. Background and resources on level 1 of professional learning assessment

Background on level 1	Associated resources
Level 1 focuses on participants' reactions, including whether participants liked the workshop, found it valuable, thought the materials made sense, or found the leader knowledgeable. Level 1 data can be collected through participant surveys, exit tickets, or brief interviews; observer notes using observation protocols can also capture participant reactions. These data can help improve program design and delivery. **Reflection questions:** • In what ways can you collect participant reactions related to current professional learning opportunities? • What do you know about how participating educators perceived recent professional learning opportunities? What would you like to know? • How can level 1 data help you reframe subsequent professional learning opportunities?	Webinar 2 slide 14 Handout 5, Level 1 Sample Instruments and Data Collection Protocols

Level 2: Participants' learning

Professional learning leaders can capture what participants are learning in many ways, including participant self-reflection and observer notes, if observers are available. Level 2 data and documentation focus on participants' self-assessment of their learning and analyses of educator artifacts such as text from online discussions or documents in educator portfolios.

Table 8. Background and resources on level 2 of professional learning assessment

Background on level 2	Associated resources
Level 2 data assesses what participants learned, as observed or reported by the participants. For example, level 2 data can be collected through teacher knowledge assessments or teacher self-reflection as well as through observers' notes on participants' opportunities for learning. At this level, the goal is to understand whether participants acquired the intended knowledge and skills. Analysis of assessments, exit surveys, and participant reflections or observations can be used to understand what participants learned during professional learning activities and to improve program content, format, and organization. **Reflection questions:** • What knowledge and skills were taught during this opportunity and how can you know if teachers acquired them? • What are the pros and cons of using participant feedback to understand their learning? What are the pros and cons of using observation data to understand participant learning? • How can you use level 2 data to improve subsequent professional learning opportunities?	Webinar 2 slide 15 Handout 5, Level 2 Sample Instruments and Data Collection Protocols

Level 3: Organization support and change

Level 3 data can come from school district leaders, school-based administrators, and teachers to help professional learning leaders understand organizational supports and changes in systems.

Table 9. Background and resources on level 3 of professional learning assessment

Background on level 3	Associated resources
To help you understand organizational supports and change, level 3 data include questionnaires and structured interviews with school and district leaders as well as with teachers and teacher leaders. These data can build understanding around whether professional learning activities provided opportunities for coaches and participants to build their knowledge and understanding or how mathematics coaches supported new instructional practices. These data around coaching can assess how teachers and coaches are working together and then support improvement and refinement. A log of educators that the coach has worked with over the course of the year is another way to track teacher and coach interactions; artifacts or detailed notes from coaching can also help determine the success of the coaching and can be used to make plans for future support. Level 3 data can also be collected through participant or administrator forms or surveys and can inform opportunities to support teacher professional learning as well as improve the scheduling, topics, or setup of professional learning opportunities. **Reflection questions:** • What are the organizational supports around professional learning opportunities? Who can provide insight into their effectiveness? • How can you use level 3 data to improve supports for subsequent professional learning opportunities?	Webinar 2 slide 16 Handout 5, Level 3 Sample Instruments and Data Collection Protocols

Level 4: Participants' use of new knowledge and skills

Professional learning leaders can collect level 4 data, or data to understand how participants are applying their new knowledge in the classroom, in various ways. Level 4 data can include teacher artifacts and observations to document the application of strategies and new learnings, which can be used to inform follow-up support and professional learning.

Table 10. Background and resources on level 4 of professional learning assessment

Background on level 4	Associated resources
Participants' use of new knowledge and skills, level 4, can be captured from classroom observations, lesson plans, or other approximations of practice; these data can then provide insight into whether and how participants are implementing new practices and the challenges—and successes!—they are experiencing in their classrooms. Note, however, that teacher surveys, coach reviews, and observation protocols will all provide different, sometimes conflicting, data on participants' use of new knowledge and skills. Therefore, more precisely defined data sources (for example, rubrics with explicit descriptors in addition to a narrative description) may enable more accurate assessment of participant knowledge and skills. Analysis of how participants use new knowledge and skills can support decisions and ideas for teacher	Webinar 2 slide 17 Handout 5, Level 4 Sample Instruments and Data Collection Protocols

Background on level 4	Associated resources
professional learning to improve implementation of new teaching practices and strategies. **Reflection questions:** • What can be learned about participants' use of new knowledge and skills from a classroom observation? What cannot be learned about participant knowledge and skills from a classroom observation? • What level 4 data could you collect outside of classroom observations?	

Level 5: Student learning outcomes

Measures of student learning can help professional learning leaders understand how teacher professional learning has contributed to student learning outcomes. Level 5 data focuses on measuring changes in student learning as a result of teacher professional learning activities. Consider including course grades, student achievement scores, self-assessments, and content assessments. Student self-reflections and survey items about self-efficacy are also useful tools to determine the effects of teacher learning.

Table 11. Background and resources on level 5 of professional learning assessment

Background on level 5	Associated resources
Level 5 focuses on identifying whether participant learning affected student performance or achievement. While summative student learning data or student state assessment data can capture some changes in student learning, consider other outcomes such as student self-confidence or student attendance, which are also considerations at this level. Many measures of student outcomes are available, including surveys of students' self-confidence, formative assessment data, and student assessment scores (see examples in Handout 5). When seeking to understand the impact of participant learning on student outcomes, be sure to map connections from a student outcome to teacher learning. Remember that some impacts of teacher learning may not directly influence every measure of student outcomes. **Reflection questions:** • What can you learn from student formative assessments that cannot be learned from summative assessments? • What student outcomes did you expect to change as a result of the teacher learning? • What student data did you or will you collect to determine if the professional learning influenced student outcomes?	Webinar 2 slide 18 Handout 5, Level 5 Sample Instruments and Data Collection Protocols

Enacting a Professional Learning Model: Insights from Practice

Each member of the REL Appalachia Student Success in Mathematics (SSM) partnership designed and used a Professional Learning Model (PLM) within their Virginia school division to improve professional learning with a long-term goal of increased learning and achievement in mathematics for all learners to prepare them for future success in college and careers. In the process of developing, using, and improving their PLMs, they gained insights and learned from practice. Below are three insights from their implementation experiences and reflections.

Insight 1: Setting goals and outcomes for professional learning activities

> **Insight #1**: To recognize and gauge student learning, setting goals and outcomes for professional learning activities is an essential first step in planning. Collecting data to assess teacher learning can assist leaders in providing the supports teachers need to integrate what they are learning into their classroom practice.

One mathematics district curriculum leader admitted that without specific goals and outcomes, it was challenging to gauge teacher learning: "In the past, I knew something good was happening, but I wasn't sure what and why." This mathematics leader recognized the importance of setting clear goals and outcomes for each professional learning session—and collecting teacher learning data associated with these outcomes—to make sense of how strategies discussed during each session translated to participating teachers' classrooms. The mathematics leader designed a series of workshops aimed at increasing teacher use of rich mathematics tasks that are accessible to students of wide-ranging abilities and often can have multiple correct solutions. These types of tasks support student problem solving, mathematical discourse, and other evidence-based mathematics practices, such as visual representations, in the classroom. Midway through the workshop series, teachers began implementing strategies from the workshops in their classrooms. During subsequent workshop sessions, participating teachers began to report small successes, such as increased student talk, as well as challenges, such as limited time for teachers to prepare rigorous tasks for students.

When teachers shared their implementation stories during a later workshop session, they highlighted their successes and challenges, but it was not clear from their recounting how the tasks had been employed. This led the mathematics leader to take time during subsequent workshop sessions to articulate the characteristics of rigorous mathematics tasks and make sure that the instructional practices and strategies from other workshop sessions were connected and linked to each other and to the tasks. Gathering feedback from teachers and learning about their implementation experiences helped clarify what teachers needed while remaining focused on the stated objectives and goals of the set of workshop sessions. Clearly presenting the characteristics of rigorous mathematics tasks and the student outcomes gave teachers more specific details about the features needed for implementation success.

The mathematics leader also began collecting data on teacher knowledge through exit tickets and feedback forms to measure their understanding of the characteristics and outcomes. The teachers responded with detailed narratives, sharing what they learned about mathematics content, tasks, and working with others. The mathematics leader next instructed teachers to bring examples of student work using the rigorous tasks back to the workshop sessions and to review and discuss one another's tasks and student work. With a clearer vision of how the tasks were used in the classroom, the mathematics leader was able to facilitate discussions about the characteristics of tasks in relation to the teachers' own practice; for example, what scaffolds could help students start the mathematics task and what information should be in the task to prompt discussion. These discussions of teacher learning and of key characteristics of tasks prompted systematic and regular data collection following each session. Through the efforts to understand what teachers learned in workshop sessions, this mathematics leader gained an understanding and appreciation of the planning, implementation, and assessment of teacher learning.

Insight 2: Conducting needs-sensing activities

> **Insight #2**: Conducting needs-sensing activities, such as teacher interviews and classroom observations, before designing professional learning activities helps mathematics education leaders construct professional learning that meets educators' needs and school district goals.

Before designing and facilitating teacher professional learning activities, engaging in needs-sensing activities encourages teachers to share their perceptions of their own learning needs and provides an opportunity for coordinators and directors to align initatives to those needs. For example, in one school district, the director of curriculum and instruction collected teachers' perspectives on their learning needs through brief written responses to survey prompts. Teachers noted that they needed support in building a mathematics learning community, fostering classroom discourse, implementing tasks that promoted problem solving, and using technology when teaching. The director then completed brief classroom observations to understand, for example, current classroom discourse and current uses of technology. The needs-sensing activities allowed the director to learn more about teachers' practices and embed teachers' needs within district-level instructional goals and student outcome goals.

Input from teachers and data associated with their learning can also help refine professional learning opportunities. After the initial professional learning activities that had been aligned with teachers' stated needs and district goals, the director asked teachers to complete brief reflections and detail their next steps to meet their instructional goals related to building a learning community, fostering discussion, implementing tasks that promoted problem solving, and using technology when teaching. The director then analyzed the teachers' reflections and their identified next steps to determine what teachers had learned in those areas and how, if at all, they were changing their instruction. The director used these data to define subsequent professional learning opportunities. Needs-sensing and regular use of teacher reflections and other qualitative data also demonstrated to teachers that the administration was listening to their needs, which may further support teacher engagement and participation in professional learning activities.

Insight 3: Situating the Professional Learning Model within district vision and initiatives

> **Insight #3:** It is vital to situate the PLM within the school district's broader vision of student success and align efforts with current district initiatives. District coordinators can create a cohesive plan that uses data on both student and teacher learning to ensure efforts meet the needs of the students, teachers, and district.

The five levels of professional learning assessment and evaluation (Guskey, 2016; see Handout 5) can be used as a framework for organizing school- and district-level professional learning activities. One district mathematics coordinator used this framework to support the district-level mathematics goal: implementing the new mathematics curriculum with fidelity. The coordinator reviewed what data could be collected at each level and how the data could be used to understand how teachers were meeting their teaching goals as aligned with the curriculum implementation goals. Through this process, the coordinator ascertained that the mathematics coaches were taking notes and communicating with each other and with administrators, and therefore, qualitative data about how the school and district were supporting professional learning (level 3) were available. In addition, the mathematics coaches were observing teacher instruction, which provided an opportunity to collect data on teachers' use of new knowledge and skills and is congruent with level 4 in Guskey's framework. However, fewer data were collected on teachers' reactions to their learning opportunities (level 1) or their learning from workshops (level 2). Many teachers participated in the professional learning activities, but it was not clear which aspects were well received by teachers or what the teachers learned in the workshops.

Using the five levels of professional learning assessment and evaluation (Guskey, 2016), the coordinator aligned current initiatives and the available data, which made it easier to see what information was missing. The coordinator developed surveys for teachers to complete after workshops or meetings led by mathematics coaches. Questions included:

- What did you learn today?
- To what extent did today's professional learning meet your professional learning needs?
- How confident do you feel about your ability to implement the math curriculum with fidelity?

Teachers completed the surveys after each meeting, and mathematics coaches reviewed the responses together and with teachers. By using data on teachers' learning to plan subsequent sessions, coaches were able to adapt and modify teacher learning activities in response to the data and map progress toward teachers' use of new knowledge and skills. In their survey responses, teachers noted that they understood more about the listed mathematics learning goals and the mathematics content. Teachers reported feeling more confident teaching the new lessons;

this finding supported additional attention to teacher content learning before moving to assessing instructional change. Reviewing data across district initiatives can illuminate how the professional learning activities support teachers and appropriate next steps. Teachers may also appreciate the attention to their needs and become more reflective on their learning.

Summary

A Professional Learning Model (PLM) can be a powerful tool for organizing and conducting a cohesive set of research-based professional learning experiences for mathematics educators and leaders in support of a broad set of strategic goals. It is a framework that helps leaders reflect on initiatives and professional learning activities, their relationship to one another, and long-term outcomes for students. Tools, such as Guskey's five levels of assessment for professional learning, help leaders determine what data to collect and how to track related outcomes. The key to a successful and coherent PLM is to make use of the PLM Planning Template (Handout 1) as part of an ongoing, iterative process informed by regular data collection, analysis, and priority-setting. The planning template is a living document, which means it should be continually reviewed and updated to make sure it still meets your needs and fits your context. At a minimum, the template should be revisited annually. Each time you review the PLM Planning Template, be sure to revisit the overarching divisionwide goals to determine whether the professional learning you are designing aligns with that goal and current mathematics research and recommendations. If the activities do not align, consider adjusting the goal or the activities. Take time to revisit current mathematics research and recommendations, and consider which evidence-based tools, resources, and strategies meet current needs.

References

Ball, D. L., & Forzani, F. M. (2011). Building a common core for learning to teach and connecting professional learning to practice. *American Educator, 35*(2), 17–21.

Bill and Melinda Gates Foundation. (2014). *Teachers know best: Teachers' views on professional development.* Author.

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development.* Learning Policy Institute.

Guskey, T. R. (2016). Gauge impact with 5 levels of data. *Journal of Staff Development*, *37*(1), 32–37.

Guskey, T. R. (2002) Does it make a difference? Evaluating professional development. *Educational Leadership, 59*(6), 45–51.

Jacobs, V. R., Franke, M. L., Carpenter, T. P., Levi, L., & Battey, D. (2007). Professional development focused on children's algebraic reasoning in elementary school. *Journal for Research in Mathematics Education, 38*(3), 258–288.

Jensen, B., Sonnemann, J., Roberts-Hull, K., & Hunter, A. (2016). *Beyond PD: Teacher professional learning in high-performing systems*. National Center on Education and the Economy.

Loucks-Horsley, S., Stiles, K. E., Mundry, S., Love, N, & Hewson, P. W. (2010). *Designing professional development for teachers of science and mathematics.* Corwin.

National Council of Teachers of Mathematics (NCTM). (2014). *Principles to action: Ensuring mathematical success for all*. Author.

Star, J. R., Foegen, A., Larson, M. R., McCallum, W. G., Porath, J., & Zbiek, R. M. (2015). *Teaching strategies for improving algebra knowledge in middle and high school students* (NCEE 2014-4333). U.S. Department of Education, Institute of Education Sciences, National

Center for Education Evaluation and Regional Assistance (NCEE). https://eric.ed.gov/?id=ED555576

Woodward, J., Beckmann, S., Driscoll, M., Franke, M., Herzig, P., Jitendra, A., Koedinger, K., & Ogbuehi, P. (2012). *Improving mathematical problem solving in grades 4 through 8: A practice guide* (NCEE 2012-4055). U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance (NCEE). https://eric.ed.gov/?id=ED532215

Appendix A. Handouts

The handouts in appendix A were developed for the REL Appalachia *Implementing a Professional Learning Model (PLM) to Improve Mathematics Teaching* webinar series and can also be used by individuals or groups who are using this compendium to learn more about the design and implementation of high-quality mathematics education professional learning activities.

Handout 1: Professional Learning Model Planning Template

This template can be used to outline and develop a comprehensive plan for mathematics professional learning to support educators in your school division to help ensure that *all students* meet specific learning goals and can be successful in higher-level mathematics.

<table>
<tr><td colspan="3">Part 1</td></tr>
<tr><td colspan="3">Division-wide mathematics professional learning goal</td></tr>
<tr><td colspan="3">The division will work toward….</td></tr>
<tr><td>Define how you will integrate attention to one or more of the Guiding Principles for School Mathematics[1]:</td><td colspan="2">Describe which of the following Effective Mathematics Teaching Practices[1] will be in the foreground of this Professional Learning Model Plan:</td></tr>
<tr><td>• Teaching and learning
• Access and equity
• Curriculum
• Tools and technology
• Assessment</td><td>• Establish mathematics goals to focus learning
• Implement tasks that promote reasoning and problem solving
• Use and connect mathematical representations
• Facilitate meaningful mathematical discourse</td><td>• Pose purposeful questions
• Build procedural fluency from conceptual understanding
• Support productive struggle in learning mathematics
• Elicit and use evidence of student thinking</td></tr>
<tr><td></td><td colspan="2"></td></tr>
</table>

[1] National Council of Teachers of Mathematics (NCTM). (2014). *Principles to action: Ensuring mathematical success for all.* Author.

Part 2					
Identify the professional learning strategies, related details, and steps you will take to implement the strategies in your school division.					
Professional learning strategies (choose from below)		Grade(s) targeted	Contextual considerations	Technology tools and supports	Documentation and data
• Examining student work and thinking • Demonstration lessons • Action research	• Coaching • Mentoring • Study groups • Workshops or seminars • Other				
Strategy 1:					
Strategy 2:					
Strategy 3:					

Handout 2: Contextual Factors Influencing Professional Development

Many contextual factors influence teacher professional development.[2] Review the four categories of contextual factors—teachers, materials and instruction, school culture and logistics, and professional learning—and the related prompts. Reflect on your current goals and priorities for mathematics professional learning in your school division. Pick one of these priorities and consider the factors that will influence the professional development related to that priority in your school division. Review the factors and respond to the prompts in the table below. Consider focusing on one grade span (such as PK–5, 6–8, 9–12) as you answer the questions. You will be provided an opportunity to reflect on your responses and share your reflections with other participants in the chat during the webinar.

[2] Loucks-Horsley, S., Stiles, K.E., Mundry, S., Love, N., & Hewson, P.W. (2010). *Designing professional development for teachers of science and mathematics*. Corwin.

Table 1. Contextual factors influencing professional development

Teachers
1. What do you see as teachers' strengths in mathematics content?
2. What do you see as teachers' pedagogical strengths?
3. What specific barriers have teachers faced when implementing new practices in their classrooms?
4. What positive or negative experiences have teachers had with professional development?
Materials and instruction
1. Are there any issues with curricular materials being available to all teachers?
2. Are there concerns about whether the curricular materials are focused, rigorous, and coherent?
3. Are there concerns about whether the curricular materials are implemented as intended?
4. What are key ways that the learning environment is conducive to all students' participation and collaboration?
5. What barriers, if any, prevent students—including those living in poverty, who are English learner students, and those with special needs—from having full access to rigorous curricula?
6. What barriers, if any, prevent students from engaging in problem-solving and developing reasoning skills during instruction?

School culture and logistics
1. Are school structures in place that support collaborative practice—for example, time for teachers of the same content and/or grade levels to meet during the school day, ready access to relevant student learning data, opportunities for professional learning tied to classroom practice?
2. In what ways, if any, are teachers involved in ongoing inquiry into beliefs about students and their capacities?
3. In what ways are assumptions about race, socio-economic status, educational, and linguistic differences among students talked about openly and examined critically?
Professional learning
1. How much do teacher teams focus their discussions on mathematics teaching and learning?
2. In what ways do teachers share their practice with others?
3. In what ways do teachers work collaboratively to solve instructional challenges?
4. Is reflective dialogue a norm?

Handout 3: Mathematics Teaching Practices

The following eight mathematics teaching practices from *Principles to Action: Ensuring Mathematical Access for All*[3] provide a research-informed framework for strengthening the teaching and learning of mathematics.

1. **Establish mathematics goals to focus learning.** Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional practices.

2. **Implement tasks that promote reasoning and problem solving.** Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies.

3. **Use and connect mathematical representations.** Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving.

4. **Facilitate meaningful mathematical discourse.** Effective teaching of mathematics facilitates discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments.

5. **Pose purposeful questions.** Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sensemaking about important mathematical ideas and relationships.

[3] National Council of Teachers of Mathematics (NCTM). (2014). *Principles to action: Ensuring mathematical success for all.* Author.

6. **Build procedural fluency from conceptual understanding.** Effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems.

7. **Support productive struggle in learning mathematics.** Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships.

8. **Elicit and use evidence of student thinking.** Effective teaching of mathematics uses evidence of student thinking to assess progress toward mathematical understanding and to adjust instruction continually in ways that support and extend learning.

Handout 4: Selected Strategies for Professional Learning

Review the following professional learning strategies from *Designing Professional Development for Teachers of Science and Mathematics*[4] and the critical elements of the strategy. Reflect on the strategies listed: **Do current professional learning opportunities in your division match any of the strategies listed below? Or is there a strategy that you'd be most interested in implementing?**

- *Examining student work and evidence of their thinking*. Critical elements include:
  - An experienced content expert guides collaborative experiences.
  - Teachers spend majority of time examining student work.
  - Discussion and examination of student work have a focused goal and purpose.
  - Structured protocols enhance the learning experience.
- *Demonstration lessons*. Critical elements include:
  - Teachers have available time and structures to meet with other teachers and to observe.
  - Groups of teachers (not individual teachers) observe each other.
  - There is a cycle of pre-discussion, observation, and post-discussion.
- *Action research*. Critical elements include:
  - Teachers contribute to or formulate their own questions and collect data to answer these questions.
  - Teachers use an action research cycle, specifically identifying a problem and a question, collecting data, analyzing data, and reformulating the problem and question to continue their action research.
  - Teachers have access to sources of knowledge and stimulation from outside their schools.
  - Teachers work collaboratively.
  - Teachers document and share what they learn from research.

[4] Loucks-Horsley, S., Stiles, K. E., Mundry, S., Love, N., & Hewson, P. W. (2010). *Designing professional development for teachers of science and mathematics.* Corwin.

- *Coaching*. Critical elements include:
  - Teachers focus on learning or improvement.
  - Coaches cultivate a climate of trust, collegiality, and continuous growth.
  - Coaches are well prepared with in-depth content knowledge and adult learning skills.
  - Mechanisms for observing practice and providing feedback are in place.
  - Teachers have opportunities for interaction.
- *Mentoring*. Critical elements include:
  - Mentors have *extensive* knowledge and skills.
  - The mentoring relationship focuses on the science and mathematics content and pedagogical content knowledge.
  - New teachers and mentors have valuable expertise to share with each other.
  - There is mutual agreement and understanding of the goal and purpose of the mentoring relationship.
- *Study groups*. Critical elements include:
  - Study groups are organized around a specific topic or issues of importance to the participants and are related to teaching and learning goals.
  - Study group activities are coherent and planned.
  - Study group teams need group interaction skills.
  - Study groups have varied designs including meeting length, questioning protocols, and facilitation roles.
  - The formation and success of study groups require direct support from school administrators.
- *Workshops, institutes, and seminars (face-to-face or online).* Critical elements include:
  - Clearly stated goals are communicated to the participants.
  - A leader or facilitator guides the participants' learning.
  - Group structures necessitate a collegial learning environment.

- *Immersion in inquiry in mathematics*. Critical elements include:
  - Engage in learning that teachers are expected to practice with their students.
  - Meaningful mathematics problem-solving.
- *Curriculum development alignment, adaptation, or implementation*. Critical elements include:
  - Learning, using, and refining use of a particular set of instructional materials in the classroom (including refining materials to align with updated standards).
  - Creating new instructional materials and strategies or tailoring existing materials to meet particular learning needs of students.
- *Partnerships with mathematicians in business, industry, and universities*. Critical elements include:
  - Working collaboratively with practicing mathematicians with a focus on improving teacher content knowledge, instruction, materials, and access to new information and facilities.
- *Professional networks.* Critical elements include:
  - Linking teachers in-person and online with other teachers, experts, and faculty to discuss topics of interest, set and pursue common goals, share research-based information and strategies, and address common problems.

Handout 5: Assessing Learning Outcomes within a Professional Learning Model

To understand if and how a cohesive program of teacher professional development meets overall goals, you must first determine if each professional learning activity achieves the stated objective.[5]

Levels of professional learning assessment

There are five levels of professional learning assessment:

- Level 1: Participants' reactions
- Level 2: Participants' learning
- Level 3: Organization support and change
- Level 4: Participants' use of new knowledge and skills
- Level 5: Student learning outcomes

Table 1 presents possible data sources, guiding questions, and data use suggestions for each level, specific to mathematics teacher professional learning.

[5] Guskey, T.R. (2002). Does it make a difference? Evaluating professional development. *Educational Leadership*, 59(6), 45–51.

Table 1. Levels of professional learning assessments and possible data, instruments, and data use

Level	Questions you can ask at this level	Data you can collect to answer the questions	Instruments and protocols you can use to collect data	How you can use the data you collect
Level 1: Participants' reactions	• Did the participants like the workshop? • Did participants think they spent their time well? • Did the material make sense? • Will the workshop be useful? • Was the leader knowledgeable and helpful?	• Participant feedback • Observer notes	• Participant survey after the workshop (figure 1) • Observations of the workshop or professional development session	• To understand participants' reactions to professional development • To improve program design and delivery
Level 2: Participants' learning	• Did participants acquire the intended knowledge and skills?	• Teacher knowledge • Teacher reflections • Observer notes	• Participant survey • Participant demonstrations in professional development • Participant reflections (oral and/or written) (figure 2) • Observation protocol (figure 3)	• To improve program content, format, and organization • To understand what participants learned during professional learning
Level 3: Organizational support and change	• Were there opportunities for coaches and participants to plan for and discuss practice? • When, how, and with what frequency did coaches support new professional development practices?	• School records • Coaching logs	• Survey or form for generating feedback from division leaders, teachers, and school leaders (figure 4)	• To identify opportunities to support the teacher professional development • To improve organization of the teacher professional development
Level 4: Participants' use of new knowledge and skills	• Did participants implement new practices? • What challenges did participants face in implementing the new practices in the classroom?	• Observation notes • Teacher lesson plans	• Teacher surveys • Peer/coaching reviews • Observation protocol for all division leaders to use in observations of teachers or participants in professional development (figure 5)	• To document and improve the implementation of new teaching practices and strategies

Level	Questions you can ask at this level	Data you can collect to answer the questions	Instruments and protocols you can use to collect data	How you can use the data you collect
Level 5: Student learning outcomes	• Did teacher learning affect student performance or achievement? • Are students more confident as learners? • Is student attendance improving?	• Student content assessments • Student self-efficacy surveys • Student attendance • Student grades	• Student assessment scores • Formative assessment on specific mathematics skills • Student surveys of mathematics engagement or self-efficacy (figure 6)	• To understand what students know • To understand how students understand themselves as math learners

Sample instruments and data collection protocols

Level 1: Participants' reactions

Collect participant feedback or observer notes to assess participants' reactions to professional learning. For example, figure 1 presents an example participant survey that can be used as an "exit ticket" after a teacher workshop.

Figure 1. An example of a participant survey

Thank you for your participation in today's workshop. Please circle the statement that best describes your experience in the workshop to help us improve the design and facilitation of future workshops.

1. To what extent did today's workshop **meet your professional learning needs?**	It addressed my professional learning needs **completely.**	It addressed **some** of my professional learning needs.	It **did not address** my professional learning needs.	I was **already familiar** with this topic, so it didn't help much.
2. To what extent was today's workshop **aligned with your school's priorities** for improving instruction?	The workshop content was **very closely aligned** with my school's priorities for instructional improvement.	The workshop content was **somewhat aligned** with my school's priorities for instructional improvement.	The workshop content **was not aligned** with my school's priorities for instructional improvement.	The workshop content was **inconsistent** with my school's priorities for instructional improvement.
3. Please share suggestions for improving today's session: a. I would have liked to spend more time on: b. I would have liked to spend less time on:				

Level 2: Participants' learning

There are many ways to capture what participants are learning, including participant self-reflection and observer notes. This level focuses on participants' self-assessment of their learning and possible opportunities to learn. Figure 2 provides an example of participant reflection prompts, and figure 3 presents an example protocol for observing teacher learning.

Figure 2. Example of a reflection sheet for participants

Thank you for your tremendous work in our workshop this week. Please respond to the question below about your learning related to the course goals.

1. Do you think you are better at using visual representations to solve mathematics problems by taking this course? Please explain in detail.

2. Which aspects of the course do you think have helped you get better at using visual representations to solve mathematics problems? Consider readings, math tasks, applets, discussions, notebook reflections, etc.

Figure 3. Example of an observation protocol for observing teacher workshop

Observer Instructions: Take running notes during the workshop. After the workshop, summarize observations related to the notes listed.

Agenda Items	Notes	Summary observations
Connecting Visual Representations and Symbolic Approaches (8:45 to 10:30 am) Covering tables task • Experiences with language strategies • Debrief *Participant learning goals:* • Identify quantities and relationships and then connections among visual representations, algebraic expressions, procedures/computations, and ratio tables • Identify how both ratio tables and Double Number Lines (DNLs) show multiplicative relationships *Purpose of activity*: • Engage teachers in mathematics tasks that encourage both visual representations and symbolic approaches • Model language strategies to support teacher learning of language strategies	*Record start and end time for each activity* *Record notable reactions and responses to each activity by participants*	*For the activities in this time block, describe/summarize:* Noteworthy participant struggles/frustrations signs of participant confusion, misunderstandings, frustration, etc. factors that may hinder participant learning Noteworthy participant successes, positive engagements in learning, or satisfaction signs of participant engagement, learning, satisfaction, etc. factors that may facilitate participant learning

Level 3: Organizational support and change

To understand organizational support and change, collect data from school division leaders, school-based administrators, and teachers. Data collection methods can include school meeting agendas, questionnaires, structured interviews with administrators or participants, or mathematics instructional coaching logs. Figure 4 presents examples of a set of mathematics instructional coaching logs that you can use to collect data on mathematics coaches and their work with participating teachers.

Figure 4. Example of mathematics instructional coaching logs

Mathematics Instructional Coaching Log		
Date	**Name**	**Notes**
2/12	Susan	Focused coaching on mathematical communication; interested in more formative assessment prompts
2/14	Akilah	Discussed importance of productive struggle and how to foster it
2/15	Derek	Used visual representations and discussed student examples

Date:	Teacher:
Mathematics Coaching Log	
Date	**Pre-Conference**
	Focus of observation:
Date	**Observation**
	Notes:
Date	**Post-Conference**
Date	**Next Steps/Follow-up**

Level 4: Participants' use of new knowledge and skills

There are various ways to collect data to understand how participants are applying their new knowledge in the classroom. For example, data collection measures can include teacher lesson plans, self-assessment of learning, and observation rubrics. An example rubric in figure 5 presents one way to measure classroom discourse in a mathematics classroom.

Figure 5. Example rubric for observation focusing on a classroom centered on discourse (Hufferd-Ackles et al., 2004)[6]

	Teacher role	Questioning	Explaining mathematical thinking	Mathematical representations	Building student responsibility within the community
Level 0	Teacher is at the front of the room and dominates conversation.	Teacher is only questioner. Questions serve to keep students listening to teacher. Students give short answers and respond to teacher only.	Teacher questions focus on correctness. Students provide short answer-focused responses. Teacher may give answers.	Representations are missing, or teacher shows them to students.	Culture supports students keeping ideas to themselves or just providing answers when asked.
Level 1	Teacher encourages the sharing of math ideas and directs speaker to talk to the class, not to the teacher only.	Teacher questions begin to focus on student thinking and less on answers. Only teacher asks questions.	Teacher probes student thinking somewhat. One or two strategies may be elicited. Teacher may fill in an explanation. Students provide brief descriptions of their thinking in response to teacher probing.	Students learn to create math drawings to depict their mathematical thinking.	Students believe that their ideas are accepted by the classroom community. They begin to listen to one another supportively and to restate in their own words what another student has said.
Level 2	Teacher facilitates conversation between students, and encourages students to ask questions of one another.	Teacher asks probing questions and facilitates some student-to-student talk. Students ask questions of one another with prompting from teacher.	Teacher probes more deeply to learn about student thinking. Teacher elicits multiple strategies. Students respond to teacher probing and volunteer their thinking. Students begin to defend their answers.	Students label their math drawings so that others are able to follow their mathematical thinking.	Students believe that they are math learners and that their ideas and the ideas of their classmates are important. They listen actively so that they can contribute significantly.
Level 3	Students carry the conversation themselves. Teacher only guides from the periphery of the conversation. Teacher waits for students to clarify thinking of others.	Student-to-student talk is student initiated. Students ask questions and listen to responses. Many questions ask "why" and call for justification. Teacher questions may still guide discourse.	Teacher follows student explanations closely. Teacher asks students to contrast strategies. Students defend and justify their answers with little prompting from the teacher.	Students follow and help shape the descriptions of others' math thinking through math drawings and may suggest edits in others' math drawings.	Students believe that they are math leaders and can help shape the thinking of others. They help shape others' math thinking in supportive, collegial ways and accept the same support from others.

[6] Hufferd-Ackles, K., Fuson, K., & Sherin, M. G. (2004). Describing levels and components of a math-talk learning community. *Journal for Research in Mathematics Education,* 35(2), 81–116.

Level 5: Student learning outcomes

Collecting data from students, for example, measures of student learning or student self-assessments can help you understand how teacher professional learning has influenced student learning outcomes. Figure 6 presents an example of a student self-understanding assessment.

Figure 6. Example of an instrument to measure student mathematics self-concept and mathematics anxiety (OECD, 2013)[7]

Math self-concept questions				
To what extent do you agree with the following statements?				
	Strongly Agree	Agree	Disagree	Strongly Disagree
I am just not good at mathematics.	1	2	3	4
I get good grades in mathematics.	1	2	3	4
I learn mathematics quickly.	1	2	3	4
I have always believed that mathematics is one of my best subjects.	1	2	3	4
In my mathematics class, I understand even the most challenging work.	1	2	3	4
Math anxiety questions				
To what extent do you agree with the following statements?				
	Strongly Agree	Agree	Disagree	Strongly Disagree
I often worry that it will be difficult for me in mathematics classes.	1	2	3	4
I get very tense when I have to do mathematics homework.	1	2	3	4
I get very nervous doing mathematics problems.	1	2	3	4
I feel helpless when doing a mathematics problem.	1	2	3	4
I worry that I will get poor grades in mathematics.	1	2	3	4

[7] Organization of Economic Cooperation and Development (OECD). (2013). *PISA 2012 results: Ready to learn: Students' engagement, drive and self-beliefs (Volume III)*. PISA, OECD Publishing. https://www.oecd.org/pisa/keyfindings/pisa-2012-results-volume-III.pdf