Framework for Innovative Professional Learning for Teachers of Mathematics

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Recent developments in mathematics education research have shed light on innovations that can transform professional learning (PL) for mathematics educators. The purpose of this *Framework for Innovative Professional Learning for Teachers of Mathematics* is to outline some of these transformative practices, focusing on the implementation strategies and content that can make PL impactful for mathematics teachers.

New insights into how students learn (Immordino-Yang et al, 2019; NASEM, 2018), reflected in the *Science of Learning and Development* (Cantor et al., 2019; Darling-Hammond et al., 2020), justify a need to shift the content and delivery of PL (Darling-Hammond et al., 2022). The goals of education include not only developing students' cognitive skills (reasoning and memory), but also developing their competencies around metacognition (awareness and adjustment of learning process), communication, and the transfer and application of knowledge (NRC, 2012). These goals are reflected in the *New York State Portrait of a Graduate* that was recommended by the Blue Ribbon Commission on Graduation Measures (New York State Education Department, 2023). The dispositions, knowledge, and skills of teachers need to align with these goals.

Through effective PL, teachers can learn about how to apply educational research to their classroom settings. However, there is very limited causal evidence of the impact of math teacher PL on student achievement (Gersten et al., 2014), and math teachers find many PL experiences to be ineffective in improving their teaching (Hill, 2009; Markinson & Berger, 2025).

Hence, it is clear that there is a pressing need to reform PL so that it is meaningful for teachers and ultimately beneficial for their students. This framework presents rationale, resources, and action steps to help get there.

Our Process

This framework is rooted in the belief that PL should be driven by 1) research about what works in mathematics education and 2) the expressed needs of teachers.

To ensure that our recommendations were grounded in research, we conducted a literature review of scholarly articles, reports, and books related to mathematics education and PL. We also sought evidence from randomized controlled trials through sources such as the What Works Clearinghouse and meta analyses of published research.

To ensure that our recommendations were grounded in practitioner experience, we spoke with stakeholders throughout rural, urban, and suburban parts of New York State. Stakeholders included teachers, administrators, PL providers, researchers, professors, and state policy makers, all representing a wide variety of experience in education.

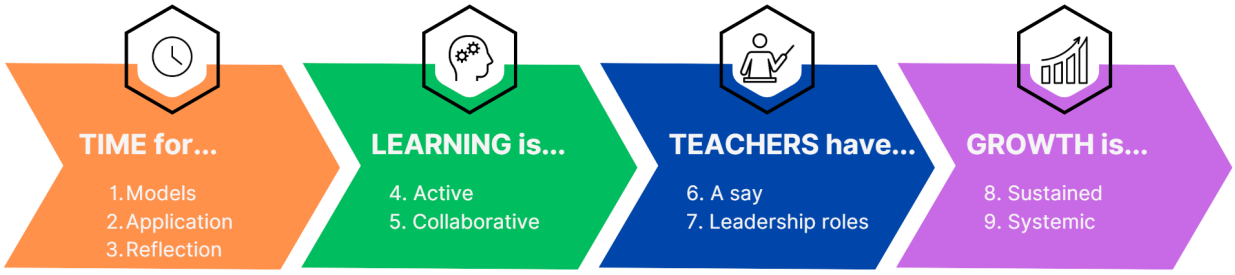
We engaged these stakeholders through the following means, conducted during 2024-2025:

- Nine one-on-one interviews
- Twelve small-group interviews with a total of 50 participants
- Two sessions at the November 2024 meeting of the Association of Mathematics Teachers of NYS (AMTNYS), where participants learned about, and gave input on, the content and delivery of PL
- A survey, completed by 82 teachers from New York State

The reader will hear the voices of these stakeholders in paraphrased quotes throughout this framework.

Implementation of Professional Learning

How should PL be implemented to maximize teacher learning and growth? PL is most impactful when it is structured around the following nine principles, organized around four themes:



Time should be given during PL activities for teachers to see models of effective practice, apply what they have learned to their own classrooms, and to reflect on their learning.

Learning should be active and collaborative, with teachers working together to solve mathematics problems, create instructional materials, analyze student work, and discuss changes to their practice.

Teachers should be more than simply participants in their PL. They should have a say in the types of PL they experience, and teachers should be involved in the design and implementation of PL.

Finally, professional growth should be approached through a variety of PL experiences that are sustained and revisited throughout each teacher's career. Professional growth should be a shared goal of all members of the school system, including administrators, and PL experiences should align with district and state goals.

These principles are expounded more fully in the section, implementation guide. This section also includes suggestions for scheduling PL and guidelines for PL facilitators.

Content of Professional Learning

What should teachers be learning through their PL activities? During PL, teachers should be developing the following knowledge, skills, and dispositions, organized in three domains:

Cognitive Domain: Teachers...

1. Have strong pedagogical content knowledge
2. Build upon students' prior knowledge
3. Develop students' conceptual understanding and procedural fluency
4. Engage students in problem-solving and inquiry
5. Incorporate real-life connections
6. Differentiate instruction

Interpersonal Domain: Teachers...

7. Promote student discourse

Intrapersonal Domain: Teachers...

8. Create safe and nurturing environments
9. Develop students' metacognition

The Cognitive Domain refers to the knowledge and skills that students need in order to learn mathematics deeply. This requires the proficiency of teachers in the activation of prior knowledge and the development of conceptual understanding and procedural fluency, as well as the transfer of knowledge to new contexts.

The Interpersonal Domain centers around making students' thinking visible and developing their ability to communicate using precise mathematical language.

The Intrapersonal Domain refers to an individual's emotions, as well as their capacity to manage them and their behavior to achieve their goals. It encompasses both environmental factors as well as metacognition. Metacognition is central to a student's ability to learn as it reflects their ability to monitor their thought process, evaluate their progress towards a goal, and adjust their learning strategies. Teachers need to learn how to optimize the environmental factors that impact their students' learning and to develop metacognitive abilities in their students.

These domains, along with accompanying classroom practices and PL recommendations to support them, are expounded more fully in the section, high-impact practices.

Resources

What does effective PL look like in practice, and what impact can it have on teachers and their students? The section case study examines an example PL based around Lesson Study, with a discussion of how it exemplifies the content and implementation principles from this framework.

The section supplemental materials provides ready-made resources for PL organizers to use as they plan and implement PL.

The appendix includes extra research behind the high-impact practices discussed in this framework, and the glossary provides extra clarification of key terms.

The section references includes citations to the literature used to inform this framework.

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