Teacher expertise makes high-quality curriculum work

BY KATHERINE L. McNEILL AND RENEE AFFOLTER

You walk into the first lesson of a 6th-grade science unit and see participants gathered in small groups sharing experiences about when they or someone they knew healed from an injury. When you ask them what they are doing, they excitedly show you the doctor reports, X-rays, and operation notes for a middle school student who injured his foot and show you their models full of pictures and words for how they think he healed.

After the students have shared their own healing experiences, the teacher asks them to record questions on sticky notes about the topics they discussed. They pose questions and post them on a big chart: Why did the student lose feeling in his foot? What holds bones and skin together? Why do some things heal faster than others? What does swelling do?

Then they work with a partner to generate ideas for how they can collect data to answer some of their questions, suggesting options like finding time-lapse video of the healing process and viewing more X-ray images from

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bones in various stages of healing. One student who recently broke her arm asks the teacher if she can bring in the X-ray images from her own experience to help students answer their questions.

In this example, we see many of the instructional shifts advocated for in recent science education reform efforts to make science classes more connected to real-world events and centered around student sensemaking.

Students start by exploring a meaningful anchoring phenomenon — a middle schooler's foot injury. This is different from a traditional science unit, in which the teacher usually starts by explaining that the class will be learning about the human body systems and cells. In another shift, the teacher elicits and values students' ideas, related experiences, and questions, rather than looking to an exact set of prompts or a predetermined learning trajectory in a curriculum script.

Although this example may sound like a description of adolescents engaged in a science lesson, the students are 6th-grade teachers experiencing the first lesson in a curriculum-based professional learning approach to using a new science curriculum. This type of professional learning experience, which is new for many teachers, can be critical in supporting instructional shifts called for in science education reform efforts (Wilson et al., 2015).

High-quality curriculum materials are a key resource for school improvement because they illustrate and support changes in classroom instruction that research shows lead to more student learning (Harris et al., 2015). But curriculum materials alone are not enough. Teachers need support to make the instructional shifts embodied in the curriculum. This can be accomplished through curriculum-based professional learning.

Curriculum-based professional learning leverages high-quality materials, but then layers on top of them important professional learning design elements to support teachers' reflection on their instructional practice (Short & Hirsh, 2020). Curriculum-based professional learning is not just having teachers read curriculum materials, but rather includes carefully crafted experiences to support their sensemaking, deep understanding of the curriculum and its pedagogy, and ability to transfer that knowledge into practice.

The teachers in the opening vignette were engaged in curriculum-based professional learning as they experienced the anchoring phenomena in which their own questions (e.g., what does swelling do?) and experiences (e.g., the student who broke her arm) help to drive the instruction. This instructional model requires that teachers be responsive to their students and use their professional agency to craft a customized enactment of the curriculum materials.

BUILDING CONSISTENCY AND TEACHER AGENCY

The vignette at the beginning of this article comes from the curriculum-based professional learning we designed and led for the OpenSciEd middle school curriculum. OpenSciEd is a consortium of researchers, developers, and partner states that have developed open source science curriculum and professional learning materials for multiple grade levels (**www.openscied.org**). The figure on p. 34 includes our model of curriculum-based professional learning for equitable science sensemaking that informed the design of the OpenSciEd professional learning materials.

The box on the left focuses on the design of the curriculum-based professional learning and includes four key elements we integrate to support teachers in rich sensemaking during professional learning. The center box describes the types of teacher discussion, writing, and actions we have observed as teachers engage in sensemaking.

Model of curriculum-based professional learning for equitable science sensemaking

Design of curriculum-based professional learning
Practices, tools, and tasks

Offer the student perspective.

Provide images of classroom instruction.

Encourage collaborative teacher reflection and application.

Attend to the teacher-curriculum relationship and customizing curriculum.

Teacher sensemaking during curriculum-based professional learning

Experience dissonance between previous instruction and new model, particularly for students.

Grapple with the new role of students, particularly in relation to empowerment and equity.

Voice concerns about the approach for their students and context.

Shift from seeing curriculum as a script to a productive tool.

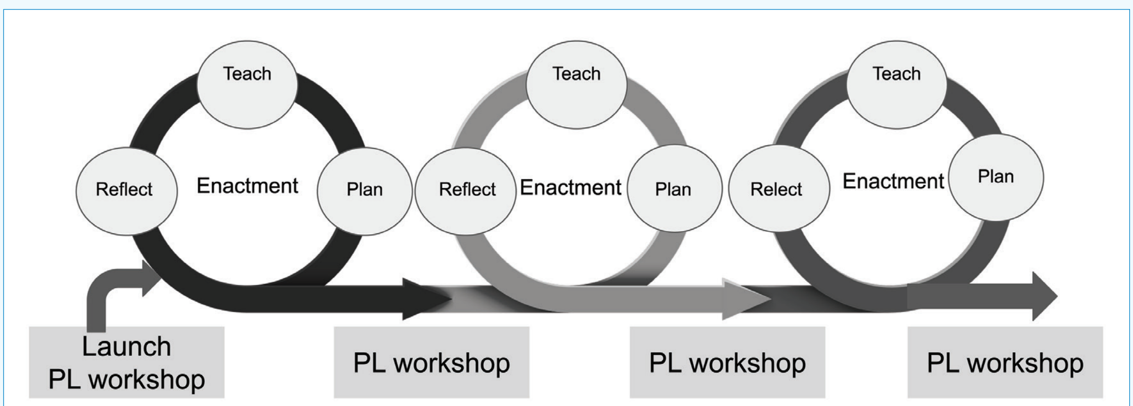
Teacher outcomes

Teachers' instructional vision includes that science instruction focuses on students figuring out the natural world based on their questions and ideas.

Teachers view curriculum as a tool to customize for their own classroom.

Teachers' instructional practice is responsive to students, creating a classroom culture in which students collaboratively drive equitable scientific sensemaking.

Cycles of OpenSciEd curriculum-based professional learning over time



As reflected in the figure, the kinds of instructional shifts teachers are expected to make with OpenSciEd are challenging. Consequently, during the curriculum-based professional learning, we often observe teachers experiencing dissonance between their previous instruction and this new model, particularly related to the role of students.

Creating space for teachers to voice concerns and grapple with these new instructional elements is essential for the ultimate desired teacher outcomes in their vision and instructional practice for science. Those outcomes are summarized in the box on the right in the figure, including teaching with an instructional vision that values students' active engagement and teaching in responsive, equitable ways.

The design elements in the left box are essential to ensuring that this process works as intended and leads to better teaching and learning. In a previous article for *The Learning Professional*, we described the first three design elements in detail (McNeill & Reiser, 2018). Briefly, they are as follows:

- Offering the student perspective means that teachers engage in some of the science lessons from the viewpoint of their students, such as sharing the ideas, language, questions, and emotions their students might have.
- Providing images of classroom instruction includes using classroom video and student artifacts to illustrate what the curriculum can look like in practice.
- Encouraging collaborative teacher reflection and application supports teachers to think critically about the curriculum and what it might look like in their own classroom.

We recently added the fourth design element: attend to the teacher-curriculum relationship and customizing curriculum. In our research with districts implementing the OpenSciEd professional learning (Lowell et al., 2024; McNeill, Affolter et al., 2024), we came to see that some teachers felt like the curriculum adoption was negatively impacting their own agency and professionalism.

For example, one teacher stated he was under the impression that "deviating from the script was this broken commandment," and another said, "You're telling us to just follow the script. We feel like robots now" (Lowell et al., 2024, p. 1459). These types of reactions led us to realize the need to talk explicitly with teachers about their essential role in curriculum enactment and the fact that the lessons can and should look different in every classroom as teachers are being responsive to their own students and school contexts.

We integrated this element into the middle school OpenSciEd professional learning in multiple ways. At the beginning of our work with teachers, we now introduce the idea that it is important to customize the curriculum for equitable sensemaking. We talk about the importance of ensuring students feel known, heard, and supported with access and opportunities for learning that are responsive to them.

We then introduce a model for curricular customization that includes four stages: Establish an equity goal with data, analyze curricular materials to plan customizations, enact and collect student data, and reflect on equity goal and customization (McNeill, Lee et al., 2024).

When we asked teachers after the workshop that included the customization model if their thinking about OpenSciEd had changed at all, the majority of teachers talked about how they appreciated the focus on customization (McNeill, Affolter et al., 2024).

For example, one teacher said, "I appreciated the opportunity to learn about customizing lessons. It made me feel that the curriculum wasn't as 'scripted' (as I thought) and that I can use my judgment to make adjustments to the delivery of the instruction to help my students more readily interact with the content." Teachers also brought up teacher agency, such as one who said, "I think the customizations will allow teachers to be more autonomous and excited."

LEARNING CYCLES BUILD CAPACITY AND CONFIDENCE

Because shifts to phenomena-based science curricula are often challenging, it is important that teachers engage in multiple cycles of curriculum-based professional learning over time.

As part of the field test of OpenSciEd, we conducted a study in which we worked with 322 teachers over two years (Lowell & McNeill, 2023), during which teachers participated in multiple cycles of curriculum-based professional learning (see figure on p. 34). Teachers began with four days of professional learning, which we called Launch PL, during which they explored the OpenSciEd instructional model by engaging with the first science curriculum unit.

After the learning experience, teachers planned, taught, and reflected with colleagues about the curriculum using educative guides. Educative materials are explicitly designed to help teachers understand and apply the curriculum. The schools with the greatest success set aside structured time during the day for teachers to collaboratively plan with grade-level teams for upcoming lessons.

Teachers then returned for two days of professional learning focused on a second science unit and built on teachers' emerging knowledge and recent reflections. They continued with multiple cycles of curriculum-based professional learning over the two years.

Over the learning cycles, we tracked changes in teachers' instructional beliefs about science and their confidence in teaching with the OpenSciEd phenomena-based approach (Lowell & McNeill, 2023). Although their beliefs and confidence significantly changed in a positive direction, this did not occur at the same rate.

Teachers' instructional beliefs changed in the first year, while their confidence in implementing this new instructional vision required more time and continued to increase over the second year. For example, one teacher said, "For me, having the opportunity to attend a second (learning session) in one academic year was pivotal in my own understanding of the curriculum and shifts that OpenSciEd requires. Taking the moment to pause and reflect on the first enactment of units helped me to identify the pitfalls that I was unintentionally creating for myself and for my students. From there, I was able to make those small changes in the following units to avoid those pitfalls."

These findings reinforce our belief that curriculum-based professional learning should not be one solitary workshop that teachers experience. Teachers need the opportunity to engage in multiple learning cycles over two or three years to support important shifts in their instructional practice.

HOW INSTRUCTIONAL LEADERS SUPPORT TEACHERS' LEARNING

Instructional leaders play essential roles in curriculum-based professional learning. Not only can they ensure teachers' access to learning cycles, but they can also convey a clear and consistent vision of curriculum-based professional learning, one that supports teachers' agency while also ensuring integrity to the vision and instructional model of the curriculum.

We saw the importance of this kind of leadership in a contrasting case study of two middle schools implementing new curricular materials and engaging in curriculum-based professional learning (Lowell et al., 2024). In one school, leaders messaged the importance of teachers' voices and decision-making in customizing and enacting the curriculum materials in their classrooms.

For example, one instructional leader said, "High-quality instructional materials need to be positioned as a primary resource that teachers adapt based on the needs of the students in front of them … By both centering the teachers' role of differentiating a primary resource and creating a culture where teachers feel safe to try out new innovations, it messages to teachers that they are professionals who are trusted and valued, which, in turn, results in additional agency and ownership in the work."

Not surprisingly, the teachers in that school felt invested in the customization and enactment of the new curriculum with their students.

In contrast, at the other school, teachers reported that their leaders saw the curriculum as a script and that they felt like robots. This reduced teachers' feelings of professional autonomy, and many teachers felt negatively about the curriculum.

As such, it is important that the vision and messaging from leadership align with the design feature in curriculum-based professional learning focused on the teacher-curriculum relationship and the importance of customizing curriculum to leverage and support students and the local context.

SUPPORTING TEACHERS TO BE INSTRUCTIONAL EXPERTS

There is an inextricable link between teacher professionalization and equity-centered science classrooms (Miller et al., 2024). Engaging in high-quality curriculum-based professional learning over time that positions teachers as experts who need to customize the curriculum for their own classrooms can support teacher agency and key instructional shifts in science.

Teachers need this support for their own professional growth and to support the development of instruction in which students' questions and ideas drive science learning as the classroom community engages in rich sensemaking about phenomena.

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