Introduction

Teacher mentoring has long been recognized as a key strategy for many facets of educational change and reform (see here a policy brief from Pacific Resources for Education and Learning). It is well documented that a trusted and skilled mentor can be a crucial aid in the preparation and induction of new teachers, as they confront the challenge of learning to manage a class, and understand the constraints and supports provided by their students, their school culture, their administration, and their colleagues — their "systemic content knowledge." It is in this complex context that they are also seeking to put what they know of pedagogy and of their subject into action. Research has shown that good mentoring during this intense learning time can increase the likelihood that new teachers are able and willing to persist in the profession. Veteran teachers who may have developed a clear sense of their work and their identity as teachers are also always learning, and as they confront a period of constant change in standards, expectations, and resources, must make adjustments, often dramatic ones, to their practice. Whether the reform or other demand stresses dramatic new views of curricular content, or pedagogical practice, or new approaches to classroom assessment, a strong mentorship can support a teacher in his or her growth and sense of success.

In a generic sense, the nature of good mentoring is well known, from research across fields, from education to industry (e.g. see this White Paper from the Plank Center). Articles such as this from ASCD provide a summary of these principles as applied in education. In this theme of the Month, our expert panelists focused on the practice and the characteristics of effective mentoring.

Our expert panel

The moderator for our expert panel was K. Renae Pullen, who has been the elementary science specialist for Caddo Parish Public Schools in Shreveport, LA for six years. Ms. Pullen is a member of the NSF’s STEM Education Advisory Panel, and Teacher Leader Advisor for the Louisiana Department for Education in 2018-2021. In 2008, she was honored with the Presidential Award for Excellence in Math and Science Teaching. Richard Velasco is a clinical assistant professor of mathematics and science education at the University of Iowa (UI). Earlier, Richard was a secondary math teacher for twelve years, a recipient of the Presidential Award for Excellence in Mathematics and Science Teaching, and an NSTA/NCTM STEM Teacher Ambassador funded by the National Science Foundation. Suzanne Botta Sullivan is the grade 5-8 Science and STEM Coach at Francis Walsh Intermediate School in Branford, Connecticut.
She is a member of Branford Public Schools Engineering and Design Committee. Before this, she taught 7th and 8th grade science for almost ten years. Jeanane Charara is an elementary science instructional coach and professional development provider currently working for SOLIDStart. She also is an elementary NGSX pathway designer and a NextGenScience Peer Review Panelist. Jeanne Norris is an Instructional Specialist at the Institute for School Partnership, designing K-12 science curriculum and professional development for teachers. Before joining the ISP, Jeanne taught high school science in the St. Louis Public Schools for six years.

Teachers, especially STEM teachers, can feel somewhat isolated and in need of collegial feedback and support, based on the practicalities of the work. New teachers naturally are learning at every level how to guide a class, and foster a culture of inquiry, and in a sense being forced to test everything they've learned during their preparation in the crucible of practice. More experienced teachers are also learning as they see the need to incorporate new content or materials, expand or refine their pedagogical repertoire, and strengthen their approach to assessing student learning. This challenge to update, or even transform, their practice is often felt as teachers respond to new standards or assessments. As Renae Pullen said, STEM mentor teachers can provide their colleagues with the support that’s based in their experience and expertise. Mentors build strong relationships with their mentees, they identify and address needs of their colleagues and they deliver resources and coaching to teachers to help them improve their practice.

While teachers in every grade can benefit from such a collegial relationship, the needs to be addressed vary from elementary to secondary school. In elementary school, science teachers face two factors that are absent or less pressing in higher grades. In the first place, high-stakes testing for this age group focuses on the foundational skills of literacy and mathematics, and in the struggle for resources and attention, these subjects will often limit the amount of time and other resources that are available for science. In the second place, many elementary teachers come with little science background, so that their own challenge is to address that knowledge gap in a way that allows them to bring science as a way of knowing to their students. As Jeanane Charara told us, a key strategy to this end is to make sure that teachers have the experience of doing the science inquiry that they will want their students to do (she calls this the "switching hats" method). Inquiry science requires a focus on phenomena, and on formulation and reformulation of descriptions and models of process. Unless a teacher has some personal experience of that kind of tentative, question-driven meaning making, it can be scary to let it happen in the class. When a mentor allows teachers to "switch hats" and become learners, The mentor can help in the reflection that brings out the value of the experience. Not only does this give insight into the learning challenges that their students will face, but it also helps prepare the teachers to support the kinds of student talk that both help the students learn with each other and enables the teacher to hear their thinking as they grapple with concepts and the epistemology of science. Jeanane explains:

*My favorite example...that came out of the sand lesson was one student said, "I think it [weathering from stone to sand] is because of snow." And the class kind of started to snicker a little bit. ... but then the teacher did an amazing thing and she pulled out this talk move: "Can you say more about that?" And the student said, "Well, I think the*
snow freezes the rocks on the mountains and they break into smaller pieces and then they fall down and that's what forms the sand." And the kids were like, "Oh, actually, yeah, that kind of makes sense." And we wouldn't have had that discussion if teacher didn’t use that talk moves. So in our reflection time, we talked about the power of that and how we use the model to help us understand her idea better.

Another thing that mentorship can do is to help teachers consider their own learning trajectory, building an image of professional growth. Suzanne Sullivan, after recommending a wide range of helpful materials, stepped back to describe 5 principles she bears in mind when designing PD for teachers (see figure below from her slides). If the overall goal is to rethink approaches to science education, then good PD should provide teachers with images of classroom instruction, offer the student perspective and encourage reflection & collaboration about how to apply these principles in practice. For lasting effect, there should be put in place a coordinated system of support in the school or district, to allow teachers to continue their development.

The key is to put the teachers "in the driver's seat" of their own learning. The aim of the mentor or coach is therefore multilevel, and builds the teacher's capacity to integrate the perspective of a STEM learner, of a teacher, and of active practitioner in a learning profession. A good mentor (as one participant said in the chat) is to "give teachers the space to bring their expertise to the class and then support those ideas." This suggests that a good mentor will model the kind of teaching they are hoping to support — not only in the classroom with students, but also in PD with teachers. This means acknowledging and building from teachers' prior knowledge, attending carefully to teachers' thinking — whether about content, or pedagogy, or their own professional growth, and in dialogic fashion connecting their ideas and dilemmas to key principles of teaching, learning, and subject-matter content. No matter how centered your PD work is on particular course materials, the other "meta" questions of practice and professional growth are present as well, if only in the background. A mentor can be on the lookout for opportunities to step back to examine those aspects of the teachers' work, grounded in the practical focus of the mentoring session or PD workshop. Jeannie Norris contributed to the conversation by providing rich resources that mentors and coaches can use in professional development. She also spoke to the benefits of involving retired teachers in the process of mentorship.

Richard Velasco exemplified many of the strategies mentioned above by talking first about his experiences being mentored (analogous to teachers reflecting on their experiences as learners). The most essential ingredient, which in a sense makes possible an effective mentoring relationship, is the building of relationship, a relationship of trust that enables "intentional noticing" and honest critique, permits (perhaps welcomes) questions and uncertainty, and consistently takes a constructive view of the work the mentee and the mentor are doing together. He spoke of the impact that a "volunteer mentor" had on him during his first year of teaching. He spoke of the impact that a "volunteer mentor" had on him during his first year of teaching. Beyond the practical advice that an experienced teacher could offer, her greatest impact on him came from her desire to see other teachers succeed, to see him succeed. She instilled in him a sense of confidence, and a conviction that one can and will keep growing throughout one's career. (See related blog by Richard Velasco.)
This kind of work, which can call upon all the experience and resources that a mentor has, in the service of the teachers (and their students) with whom they are engaged, can both support the teacher in his or her immediate work and professional growth, and stimulate the emergence of new mentors.

**Recommendations for Teacher Leaders**

There is a broad range of materials to support someone seeking to implement or improve a mentoring program in your school or district — a good place to start is the resources mentioned in this month’s Theme of the Month. The example of some our panelists suggests that as part of developing mentorship skills is to spend time reflecting on your own experiences of guidance, support, or nurture in practice from peers or more experienced colleagues. The principles of reflective practice are at the core of mentoring work.

**Recommendations for administrators**

The best practices for teacher professional development emphasize that PD should be a continuous thread in the life of the school and embedded in the settings and challenges of practice. Mentorship can be a core ingredient of such a PD approach, including peer-mentorship among the teachers themselves. Such PD requires space and time, representing a commitment to teacher learning as a consistent element of school culture.

**Recommendations for researchers**

Much of the research on teacher mentorship focuses on specific techniques and cases; the theoretical framing often draws on principles of good teaching practice, or the demands placed on a teacher by the standards and assessments which constrain and direct teaching. While many PD materials and guidelines for mentoring have an empirical basis, there is little research on their effectiveness with teachers, mentors, and school culture — much less on teacher practice. There is also much room for research from a learning sciences perspective exploring different models of mentoring from a theoretical perspective, such as cultural-historical activity theory (CHAT) or some other approach to situated learning.