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Science Learning for Teachers That Improves *Students'* Achievement

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Many professional development programs can document a positive impact on teachers who participate. But does the professional development make any difference for students?

Remarkably few programs can answer that important question positively (or at all). But for WestEd's Making Sense of SCIENCE professional development, according to several rigorous large-scale research studies, the answer is a resounding yes. The professional development improves teachers' science and literacy understanding, as well as pedagogical content knowledge so effectively that their students' learning benefits significantly. According to a recent study, students whose teachers participated in the professional development outperformed comparable students by more than 40 percent.

Teachers and teacher educators across the country have been taking note. As director of education at Discovery Place, a science and technology museum center in Charlotte, North Carolina, Stephanie Hathaway often provides resources and training for teachers in the region. So when she got the opportunity several years ago to learn a method of showing teachers how to deepen their own science knowledge while also clearing up students' misconceptions, she quickly signed on. Now the center has partnered with local schools to broadly adopt Making Sense of SCIENCE professional development.

"My colleagues and I believe the WestEd program is the most impactful professional development we've ever participated in," Hathaway says. "Breaking down some of the misconceptions people usually have about science content is one of the most powerful things I've seen with teachers. The curriculum is geared toward teachers rather than students, and it's not the kind of make-and-take activity you typically get."

Using a case-based approach, similar to what helps doctors, lawyers, and other professionals wrangle with the ambiguities of knowledge in practice, Making Sense of SCIENCE provides teachers with tools to examine common misunderstandings about science topics — for example, incorrectly equating the concept of energy with a *force* or *power*. After collaboratively analyzing student work in the case, teachers work with colleagues to identify effective interventions for students. Teachers also focus on literacy by exploring the language of science and how to use it to communicate with students and represent concepts in different ways.

"Teachers typically say this is the hardest professional development they've ever been to, but also the best," Hathaway says.

Proven Effectiveness

Research backs up that claim. Multiyear randomized controlled studies involving middle and elementary school students show that Making Sense of SCIENCE has a statistically significant impact on both teachers' and students' learning. The results hold true across multiple states, in districts of various sizes, with novice and veteran teachers, and with students from a range of socioeconomic backgrounds and English proficiencies. Teachers' science knowledge is shown to increase at levels normally attained only from one-on-one tutoring, and their students significantly outperform control groups on tests of science content knowledge.

Perhaps most impressive are results showing that English language learners and low-performing students made the biggest strides in understanding science. "Those who had the most to gain gained the most," says Kirsten Daehler, WestEd Senior Research Associate and director of the Understanding Science for Teaching team, which began developing Making Sense of SCIENCE in 1998. The research reveals what Daehler calls "a cascade of influences" from the professional development to the teacher to the classroom to the students.

Another crucial finding is that the learning lasts. Teachers retain knowledge well beyond the initial training. As they gain confidence in their own understanding and become more comfortable sharing insights and problems with colleagues, they also develop a wider range of strategies to help students.

"I think it's such in-depth learning that it sticks with them. That is not typical," says Kevin Niemi, outreach program manager with the Institute for Biology Education at the University of Wisconsin-Madison.

Niemi works with teachers in the Madison Metropolitan School District, one of the implementation sites for Making Sense of SCIENCE. He says the WestEd courses proved so beneficial and rigorous that the university and the district adopted a plan to let participating Madison teachers earn graduate credits in science education.

"I think what's unique about WestEd's program is the application of the knowledge," Niemi says. "It creates discourse between teachers. It's not the expert standing at the front of the room. It's we as a group of professionals who help each other."

Moving From Science Myths to Mastery of Learning

The Making Sense of SCIENCE series focuses on core topics in earth, life, and physical science for grades K–8. Each of the 15 courses in the series, such as the one on Force & Motion, provides 40 hours of professional development: a Core Course, which includes intensive science and literacy learning, typically done during a one-week summer institute; and Looking at Student Work, a set of follow-up activities teachers use during the school year to collaboratively examine work samples from their own students.

Each course provides a mix of direct instruction, discussion, hands-on learning, reading and writing, and reflection. Core components include:

- **Science Investigations.** Teachers work through hands-on experiments and other activities that often mirror what students might do in a classroom, but in a way geared to adult

learners. The activities enable teachers to acknowledge their own misunderstandings about science topics and build bridges to common pitfalls that students might have.

- **Literacy Investigations.** Scientists communicate with a variety of words, images, symbols, and actions — from reading graphs and diagrams to writing lab protocols. Based on work of the National Writing Project and WestEd's Reading Apprenticeship program, each Making Sense of SCIENCE course focuses extensively on literacy to build teachers' understanding of and facility with these science-specific ways of reading and writing.
- **Teaching Investigations.** Through discussion of written cases about actual classroom practices and by sharing their own experiences, teachers reflect on ways of translating science to students and then evaluating their students' understanding.
- **Classroom Connections.** Making Sense of SCIENCE courses include time to read about and discuss why some students fail to learn. Teachers move from avoiding the most vexing instructional challenges to collaboratively confronting them, so teachers can anticipate and be able to solve common classroom problems in learning science. "We go for the jugular," Daehler says. "We don't waste time on things that are easy."

Kathy Huncosky, a science instructional research teacher in Madison, describes herself as someone trained predominantly in general elementary teaching methods who later specialized in science. After WestEd's training and then becoming a facilitator of Making Sense of SCIENCE courses, she discovered the difference between listening to a science lecture and working like a scientist.

Matthew Ellinger, a former elementary teacher and principal who wrote some of the case studies, says working on Making Sense of SCIENCE gave him a clearer sense of the trajectory of science education, such as why textbooks introduce magnets before motors. It also helped him see that while his science lessons were often engaging to students, they were not necessarily enduring. "From my casual stance [my students] seemed to learn a lot of science, but I didn't know how to back that up with samples of student work or with what students actually said or did," he says. "It was an important shift for me."

"I think there is something really transformative for teachers who participate," Daehler says. "They start off thinking their job is to teach science to kids, and then come to recognize the importance of understanding kids' ideas and helping their students move toward more accurate and complete mental models in science."

The development and evaluation of the Making Sense of SCIENCE courses has been supported by the National Science Foundation, the Stuart Foundation, the Institute of Education Sciences, and the W. Clement & Jessie V. Stone Foundation. In June 2011, WestEd in partnership with the National Science Teachers Association (NSTA) began publishing a series of books with companion CDs that provide all the materials needed to implement the courses for teachers and to learn how to facilitate them.

That's good news for educators such as Kathy Huncosky, who says the Madison district has chosen to adopt Making Sense of SCIENCE as its K–8 professional development model. Many Madison teachers who completed the WestEd courses have continued to collaborate on their own time and have asked for supplemental training. Huncosky says teachers throughout the district, including those at the high school level, have asked how they can take part.

The Making Sense of SCIENCE model is both adaptable and sustainable because it builds the capacity of districts by training staff developers and teacher leaders to facilitate the professional development in their districts. The growth potential from having locally trained facilitators is key, Huncosky says, as it ensures that districts have the capacity to effectively guide the use and expansion of the program.

Similarly, Kevin Niemi says districts and states must recognize that deep conceptual understanding requires adequate time for teachers to learn. Research supports WestEd's finding that teachers need a minimum of 40 hours of targeted and measurable professional development to change classroom practices.

"What WestEd does is focus that 40 hours on one topic, such as energy or electric circuits. And those topics are the tough ones to teach when you don't know the content well," Niemi says. "On the one hand, that's a lot of time to invest, but that's what it takes to substantially improve teacher and student learning."

For information about Making Sense of SCIENCE, including information about attending a Facilitation Academy or Teacher Course, visit the project website at wested.org/mss or contact Kirsten Daehler at 650.381.6402 or kdaehle@WestEd.org.