Ambitious Science Teaching

Feature

by Melissa Braaten, May 2019

A few weeks ago, I sat in Mrs. Champion's fifth-grade science classroom listening to children grapple with a question: Why is our weather so weird? Instead of the usual "weather" science unit, the teacher capitalized on shared experiences of extreme hail storms, a snow day in early fall followed by sunshine, and windy and stormy afternoons. Two students suggested that perhaps snow days and hail storms both have something to do with very cold temperatures high in the sky that we may not feel down on the ground on a warm day. A boy in the group listened intently to the girls' ideas and used a series of sentence starters taped to his desk to help him ask questions about evidence for the idea of extreme temperature differences. As the bell signaled the end of the school day, students scrambled to pack backpacks and organize desks. The boy jogged to where Mrs. Champion and I were standing. With a huge smile on his face, he said: "I had so many ideas today, I could feel them!" He wiggled his fingers above his head as if to show ideas bubbling from his mind.

The events in this classroom ought not to be rare. It shouldn't be rare for two bilingual girls of color—a Latina student and an Afro-Caribbean student—to have the chance to propose tentative scientific explanations of their own in pursuit of understanding a real-world phenomenon important to their lives. It shouldn't be rare for children to be treated as thoughtful people with something to say about science. It shouldn't be rare for an African American boy with learning disabilities to feel joy and bubble over with ideas. These experiences shouldn't be rare, but they are.

Science learning experiences happen on a daily basis in fewer than 30% of elementary classrooms (Trygstad, Smith, Banilower, and Nelson 2013). This means that most children do not have consistent science learning experiences throughout their K–5 education. When science teaching does happen in elementary classrooms, one instructional approach is used more often than others: teacher-led delivery of information (Banilower, Smith, Weiss, Malzahn, Campbell, and Weis 2013). Student-powered sense-making is a rarity in schools with students like those above treated more often as passive recipients than as active knowledge-builders. Providing consistent, high-quality science learning experiences is a central goal advanced by the National Science Teachers Association as a call to action to improve the quality and consistency of science learning experiences for all students beginning in the earliest grades (NSTA 2018).

Mrs. Champion, like many other teachers, began searching for new tools and ideas to enhance her science teaching because she wanted more depth, more complexity, more relevance, and more justice for her students who were often marginalized in schools and society. We found each other through the growing community of educators using tools and ideas from *Ambitious Science Teaching* (Windschitl, Thompson, and Braaten 2018). Mrs. Champion first found the ambitious science teaching framework, tools, and resources through the Tools for Ambitious Science Teaching website (https://ambitiousscienceteaching.org/) which had been shared by school and district science education leaders.

In many ways, Mrs. Champion's story is exactly what my colleagues and I had hoped for when we first started working together; we knew that other teachers like us existed and craved the chance to strive for something more in their teaching. Over a decade ago, my colleagues and I began designing, testing, and refining tools for supporting ambitious and equitable science teaching. This effort spread to include dozens of teachers working toward a shared goal of making exemplary science learning experiences commonplace for students. Our recent book, *Ambitious Science Teaching*, captures this growing effort by providing a cohesive framework for science teaching complete with pedagogical tools, illustrative examples from classrooms, and insights gained from teams of educators collaborating on ambitious science teaching.

What Is Ambitious Science Teaching?

Ambitious science teaching is a framework providing a coherent vision for science teaching with tools and examples to support students' unlimited potential to make sense of science together. Our work as science teacher educators is grounded in decades of research demonstrating that with supportive conditions, children are capable of learning, reasoning, and building understanding together in ways that far exceed what typically happens in schools. Teachers in these studies ensured that the majority of learners were actively engaged in sense-making during science learning activities. Teachers created experiences where learners routinely shared each other's thinking, drew upon other people's ideas as resources for further sense-making, and embraced a norm of revising ideas. Teachers created and used scaffolding—structures that support learners to reason and grapple with new practices and ideas—across learning experiences in the form of well-designed, productive learning tasks, sense-making talk, and a host of tools. And, notably, teachers were adept at orchestrating and facilitating productive and equitable talk so that sense-making happened publicly, out loud, and with students' voices taking the lead. Although these findings are clear, it remains rare to see such learning in most classrooms. More work is needed to support teachers' professional learning and pedagogical practice.

The ambitious science teaching framework consists of four sets of science teaching practices that foreground intellectual engagement and educational equity for all learners:

- *Planning for Engagement with Big Science Ideas*. Not every science idea included in textbooks, curricula, or standards is worth teaching. This claim often provokes a collective gasp as teachers learn to construct or modify coherent learning experiences that help students build knowledge rather than haphazardly jumping from idea to idea or activity to activity.
- *Eliciting Students' Ideas.* Research on learning has clearly shown that people continuously draw upon experiences, language, and cultural resources to make sense of the world. Teachers need to elevate and talk about these sense-making resources to see how contributions can be used to advance students' sense-making and to help students construct knowledge together.
- *Supporting Ongoing Changes in Students' Thinking.* Much of the sense-making work that we do when learning involves making ongoing changes to our thinking. However, these changes to our thinking look more like subtle revisions and less like cut-and-paste edits. Careful attention to the structure of learning experiences, sense-making talk surrounding these activities, and tools used to support sense-making are essential for this component of ambitious science teaching.
- *Drawing Together Evidence-Based Explanations.* Rather than stockpiling knowledge, ambitious science teaching aims for deepening student understanding of science ideas by drawing together ideas and examples, bodies of evidence, and different ways of reasoning and using language to advance students' own scientific explanations and models. Teachers are integral for designing and facilitating experiences that make space for students' sense-making and press students to consider and communicate one another's evidence and reasoning.

We focused on these four foundational sets of practices because they allow for beginners and experienced teachers alike to try out and refine an essential repertoire of practice. Like musicians learning a common playlist of standard songs, coherent practice sets give teachers something to work on and refine together and helps teachers then branch out to improvise, innovate, and expand their repertoire of practice well beyond the foundational core.

Over the years, we've identified seven elements of ambitious and equitable science learning experiences that pay off for students in the long run:

1. Teachers anchor students' learning experiences in complex and puzzling science phenomena.
2. Students' hypotheses, experiences, cultural knowledge, and questions are treated as resources to help the class build toward big science ideas.
3. Students use ensembles of scientific practices for testing ideas they believe are important to their developing explanations and models.
4. Teachers provide varied opportunities for students to reason through talk.
5. Students have access to specialized tools and routines that support their science writing, talk, and participation in activity.
6. Student thinking is made visible and subject to commentary by the classroom community.
7. Learning experiences are selected to help students build toward cumulative and nuanced understanding of big science ideas.

Mrs. Champion's class embodies many of these elements by focusing on a shared, local observation of a puzzling phenomenon about weather. Students feel encouraged and empowered to contribute their own questions and tentative hypotheses suggesting that, perhaps, our weird weather has something to do with rapidly changing temperatures or different layers of air in the atmosphere. After hearing students' ideas, the teacher connected students with library and media center resources to gather historical weather data. Tools from the library's makerspace provided an opportunity to fill an aquarium with two different temperatures of colored water to observe how fluids create layers, mix, and swirl together. Each week, students also used video and green screen tools in the makerspace to create and communicate their current and evolving scientific explanations and models in the form of a weather broadcast complete with "breaking news" when students had new evidence or ideas to share. The library played a central role in Mrs. Champion's ambitious science teaching.

How Can Teachers, Librarians, and Other Educators Use It?

Whether working alone or together in teams, teachers and librarians can begin with any chapter in the *Ambitious Science Teaching* book. Great starting places include chapters about talk as a tool for learning science and chapters about making student thinking visible through scientific models that allow students to show what they know. Each chapter concludes with a section entitled "How to Get Started" which can jump start experimentation with ambitious science teaching. Appendices offer additional tools and ideas useful for everything from analyzing students' spoken contributions, pressing students to deepen scientific explanations, and supporting students' design of experiments and scientific writing.

Librarians and other educators who help to coordinate and orchestrate teachers' professional learning opportunities can find specific guidance, tools, and professional learning routines for working collaboratively through professional inquiries into teaching and learning. A chapter about organizing with colleagues offers an example from one of our research partners which can anchor efforts to refine and adapt tools and resource from this book for your own needs and contexts.

Librarians curating professional learning libraries for schools and districts can include this book in collections designed to support teachers' learning and practice. We wrote this book specifically with a hope that it would become a valuable resource for teachers' professional libraries. Nothing gives us more satisfaction than meeting teachers who have found renewed support and fuel for professional growth through using tools and resources in our book. We love to see how teachers innovate and generate examples far beyond anything we imagined and would love to see teachers in your schools join the growing ambitious science teaching community.

Works Cited

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Further Reading

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