# With new science standards, coaching is key

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As the world races to combat a pandemic, slow climate change, and solve many other public health challenges, it's clear that developing young people's scientific knowledge should be an urgent priority in schools.

The goal of the Next Generation Science Standards (NGSS) is to foster scholars and citizens who can think critically and creatively to address such problems and contribute to other scientific advances. The standards are based on *A Framework for K-12 Science Education* (National Research Council, 2012) and its vision to actively engage students over multiple years of school in three dimensions of science learning: scientific and engineering practices, the application of crosscutting concepts to deepen student understanding, and mastery of disciplinary core ideas (National Research Council, 2015).

This kind of thinking is not only important for future scientists. Recent trends show that more and

more citizens question the validity of science. Everyone could benefit from understanding the values and stakes of scientific inquiry.

But many schools have struggled to implement the standards. The learning called for in three-dimensional standards is demanding and rigorous (Lee et al., 2015), and the inquiry-based delivery necessary for a teacher to reach students at this level is a complex shift from more traditional teaching methods.

With inquiry-based teaching, teachers support students and students support each other in understanding their work instead of students being asked to complete tasks on their own. The classroom culture welcomes mistakes, and students learn by *doing* instead of memorization.

Because of these significant shifts, there is an urgency to identify professional learning that will best prepare teachers to meet the challenges of the Next Generation Science Standards (Haag & Megowan, 2015). In Omaha Public Schools in Nebraska, district science leaders turned to a form of instructional coaching called transformational coaching to complement and deepen other professional learning experiences while supporting the implementation of science standards.

The growing urban district, with 53,000 students, has experienced increased socioeconomic challenges, and student demographics show a greater diversity of backgrounds, with 114 languages spoken.

The district's science office, in an effort to support equity and diversity, recognized how the Next Generation Science Standards aligned with this goal and identified 12 successful educators to guide classroom teachers through the implementation of the new standards.

### ADDITIONAL PROFESSIONAL LEARNING OPPORTUNITIES

**Conferences:** Short bursts of training focused on a specific area of content or pedagogy, such as National Science Teaching Association national or regional conferences, the state science teachers conference, or other professional conferences.

**Immersion experiences:** One-time intensive engagement opportunities to immerse participants in inquiry for a specific science content area. Generally, these took place over several days or weeks.

**Lesson study:** An intensive curriculum development inquiry cycle consisting of identifying a curricular topic of interest, planning and conducting a research lesson, and using data to illuminate student learning, lesson design, and broader issues within teaching and learning (Lewis & Hurd, 2011).

**Curriculum writing:** Training in the five tools and processes for Next Generation Science Standards instruction (American Museum of Natural History, 2016) and five practices for orchestrating student discussion (Cartier et al., 2013). Working as a team of four to five teachers plus an instructional coach to create lesson plans and course guides for all units and instructional sequences in the new curriculum.

**Graduate coursework:** University courses that fit into advanced degrees, as well as courses that supported lesson study, curriculum writing, and immersion experiences.

An educational evaluation team partnered with the science office to help identify progress in the programming.

Data indicate that teachers gained confidence in their ability to implement the new science standards, while students experienced increased interest and engagement in the classroom when they engaged in inquiry-based learning opportunities that support the new science standards.

## WHAT IS TRANSFORMATIONAL COACHING?

Transformational coaching (Aguilar, 2013) employs a variety of instructional strategies, including directive and facilitative approaches. With directive coaching, a coach imparts his or her knowledge and expertise to the teacher to help the teacher reach his or her goals. In contrast, facilitative approaches allow coach and teacher to collaborate as equals, with a focus on reaching goals that they have established together.

Coaches combine these two types of strategies to meet teachers at their current level of understanding and facilitate growth toward defined goals (Aguilar, 2013). Omaha chose this approach after district science leaders reviewed several coaching programs and attended in-depth coaching workshops with Jim Knight and Elena Aguilar. The leadership team crafted the transformational coaching program with influence from both models and worked with Aguilar and her professional development team to mentor the new coaches.

Over a 15-month period, the district collected data on 68 teacher participants, ranging from kindergarten to high school, who took advantage of the opportunity to design professional learning for themselves that would include support from an instructional coach.

The district invited all science teachers, special education teachers, and English learner teachers who support science students to apply to participate, with selection based on applicants' intended goals and principal approval. The program was flexible and adaptive to each teacher's professional learning goals and to emerging needs in the district, such as renewed focus on issues of diversity, equity, and inclusion, as well as the transition to the new science standards.

Ten experienced science teachers (four elementary and six secondary) served as instructional coaches, undertaking ongoing training in transformational instructional coaching.

Instructional coaches and teacher participants met with each other one-on-one several times a month for planning, learning sessions, observations, and reflective conversations. Coaches supported teachers to use student data to reflect on needs and plan future instruction; monitored teacher and student progress; led action research opportunities; and scaffolded teachers' adoption of the Next Generation Science Standards based on each teacher's individual readiness.

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For example, a teacher may set a goal to improve student engagement in a biology classroom. A coach would work with the teacher to find interesting lesson ideas and other strategies to get learners more involved, such as inquiry learning opportunities. Along with inquiry learning, the coach and the teacher would set out to learn more about science and engineering practices that can provide rigor to inquiry learning. The coach would support the teacher in the implementation of these lessons in the classroom.

Coaches also helped teachers connect other professional learning experiences — which they chose from a menu of options such as graduate coursework and curriculum writing — with classroom practices. (See sidebar on p. 45.)

## IMPACT ON TEACHERS IN THE CLASSROOM

Education Northwest, serving as external evaluators for the program, collected interview, survey, and observational data from teachers and coaches, along with student survey and achievement data, during the 15-month period. (See graphic on p. 47.) Education Northwest interviewed participating teachers, school and district leadership, and coaches, and surveyed students.

Evaluators observed teachers' lessons, observed coaching conversations between teachers and coaches, and surveyed participating teachers' students twice in each school year, once in the first semester and once in the second. They interviewed participants and stakeholders once or twice per school year. Evaluators used scores from state science tests, administered at the end of each school year, to examine student academic achievement.

Results indicate that sustained, multiyear professional learning opportunities in tandem with instructional coaching were key in helping teachers adapt to the principles of three-dimensional learning, such as student inquiry (Davidson et al., 2019).

### Coaching practices

Observations of coaching conversations between coaches and

**CORRELATIONS BETWEEN TEACHER SELF-REPORTED PRACTICE DIMENSION SCORES AND STUDENT SURVEY ITEMS**

| Teacher dimension: Communicative interactions | Teacher dimension: Student-teacher relationships | Teacher dimension: Procedural knowledge | Student surey item |
|---|---|---|---|
| 0.56 | 0.59 | **0.68*** | My teacher thinks mistakes are okay as long as we are learning. |
| 0.55 | **0.67*** | **0.70*** | My teacher wants us to understand our work, not just memorize it. |
| 0.58 | **0.70*** | **0.74*** | My teacher gives us time to really explore and understand new ideas. |
| 0.62 | **0.76*** | **0.77*** | In my science lessons, I get a better understanding of the world outside of school. |
| 0.58 | **0.70*** | 0.67 | In my science lessons, I explain my ideas to other students. |
| 0.55 | 0.60 | 0.58 | In my science lessons, other students explain their ideas to me. |
| 0.64 | 0.62 | 0.64 | During science lessons, my teacher asks me questions. |
| 0.42 | 0.50 | 0.56 | In my science lessons, we learn by doing experiments rather than being told the answer. |

More agreement between students and teachers — Less agreement

Note: Values reported are Pearson's correlation coefficients (r), which measure the strength and direction of linear relationships between two variables. In social sciences, correlations with a magnitude above 0.6 are typically considered strong. Correlations found to be statistically significant at the 0.05 level are shown in bold with an asterisk.

**Source:** Education Northwest analysis of 2018-19 student survey data and teaching beliefs and practices survey data.

teachers showed evidence of best coaching practices and best practices in Next Generation Science Standards, including:

- A frequent focus on students (85% of observations);
- Coaches making reference to the teacher's goal (71% of observations); and
- Coaches encouraging teachers to promote student inquiry in their classroom (75% of observations).

**Changes in instructional practice**

Multiple data sources suggest that participating teachers' instructional practices reflected best practices in inquiry-based science instruction throughout their participation in the program, and particularly at the end of the cycle.

- According to teachers' self-reports, the majority reported using hands-on/manipulative activities (72% of teachers who joined the program in the second iteration and 86% of teachers who participated in both iterations) and having students make conjectures and explore possible methods to solve a problem at least once or twice a week (61% of new teachers and 83% of returning teachers).
- According to instructional coaches' reports, 92% of participating teachers used hands-on/manipulative activities sometimes or most of the time, and 82% engaged students in making conjectures and exploring possible methods to solve a problem sometimes or most of the time.
- More than half (56%) of students perceived inquiry happening in their classrooms, reporting that "in my science lessons, we learn by doing experiments rather than being told the answer" in almost all lessons.

**Student engagement and understanding**

Teacher practices and student

outcomes were positively correlated.

For example, student interest and engagement in science was correlated with:

- Teacher perception of how inquiry-based their lessons were;
- Teacher reports of feeling more comfortable allowing students to think about and challenge ideas;
- Teacher reports of working to build relationships with their learners and student engagement;

Also, students of teachers who self-reported higher procedural knowledge (thinking critically and challenging ideas) were more likely to report that:

- "My teacher gives us time to really explore and understand new ideas" (r = 0.74); and
- "In my science lessons, I get a better understanding of the world outside of school" (r = 0.77).

## APPLICATION

All students deserve access to instruction that puts them more in control of their own learning and motivates them to engage deeply with challenging material. Purposeful and focused professional learning is necessary to support teachers in refining their classroom practices to equitably provide access to this type of instruction.

Like Passmore (2015), we have seen benefits for educators and students when teachers enter into a combination of high-quality learning experiences and deep and lasting collaborations with coaches. We believe this combination is particularly important for implementation of new content standards that involve increased complexity in teaching and learning.

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These components, the least familiar of the science standards, are key to the implementation of three-dimensional curriculum. While the content for many grade levels has not changed much across different standards, what students are being asked to do with the content and how they are being asked to learn have changed.

Translating new and complex standards into classroom practices takes time and focused, purposeful hard work, but that work is paying off. Coaches and teachers tell us that their confidence and understanding are growing as they continue working together.

To continue this momentum, we are establishing and supporting curricular development teams. Participating teachers collaborate on a common goal, writing and expanding curriculum inspired by the Next Generation Science Standards, with grade-level colleagues from across the district or with a team in the same school. Instructional coaches will continue to support all participating teachers, limited only by the number of available coaches, to advance their understanding and implementation of three-dimensional science teaching and learning aligned with the state standards that were built in *A Framework for K-12 Science Education*.

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