Good science teaching matters

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A summary of the findings from the NSF CAREER project "A study of teaching practices and students' science identities" (REC #0546078)

Good science teaching matters. This claim seems self-evident, but it has been remarkably under-examined. The justification for good science teaching is that it promotes students' knowledge and understanding of scientific ideas and abilities to conduct scientific inquiry. But, does it promote students who want to understand the world scientifically? Students who increasingly recognize themselves and get recognized by others as science people? Can science interest cultivated in one year endure over the longer term? For whom? These questions push science education's definition of "effectiveness" beyond producing students who know and can do science to questions about students' enduring sense of self as science learners, doers, and future participants. These are questions about students' identities as science learners. Good science education is about cultivating students' identities as science learners— their competence in and successful performance of relevant scientific practices, meaningful knowledge and understanding of science, motivation to understand the world scientifically, and recognition of self and by others as scientific. The project's goals and outcomes are described below.

What practices cultivate strong science identities for diverse students?

"Whatever is on my mind that has to do with science, I'll literally just say it out loud. In science, I like to be heard."

-Aaliyah, 6th-grade

Year-long studies of 4th, 5th, and 6th grade classrooms revealed that equitable science classrooms include:

1. Teachers who hold students accountable to perform themselves scientifically. In many science classrooms, being "scientific" is equated with behaving, doing well on tests, doing your work, and displaying static knowledge. This creates hierarchies between students. In equitable classrooms, teachers co-create norms and practices for scientific work with students, make accessible those norms and practices for all learners, and hold all students accountable for performing themselves in ways that align with those norms and practices. Those norms and practices should be closely tied to the disciplinary work of "real" scientists (see *Next Generation Science Standards, 2013*, for example).
2. Practices that leverage students' social identities in service of their scientific understanding and engagement. For example, a student who likes to "be heard" (see Aaliyah's quote in insert) is encouraged to claim voice in service of science learning and engagement, while also being mindful, appreciative, and empathetic of classmates' needs. In equitable science classrooms, "being me", "being a good community member", and "being scientific" are mutually reinforcing, overlapping performances.
3. Practices that emphasize scientific knowledge as socially constructed versus individually owned. When students are held accountable for sharing knowledge, the space for what counts as "being scientific" is broadened considerably; all learners feel they have a stake in and responsibility for their peers' learning. When sharing the "right answers" are celebrated over sharing scientific thinking, divisions between students become more pronounced.

(continued)

Equitable science teaching, continued

4. Practices that minimize differences between "smart" and "struggling" students. School science often reproduces sorting mechanisms and hierarchies between students who seem to "naturally" understand science and those who do not. In equitable classrooms, these hierarchies are disrupted when the teacher celebrates and provides robust opportunities for a wide range of competencies, including, but not limited to, innovative problem solving, out-of-the-box thinking, unique scientific observations, persistence through a task, insightful inferences, intense curiosity, risk-taking, tolerance for ambiguity, working well with peers, and abilities to focus. Further, equitable classrooms celebrate many students' contributions to the class's collective scientific meaning-making.

5. Practices that connect students to established disciplinary networks so that they can thrive in the science pipeline. Equitable science teachers held robust expectations for their students' scientific performances. For students from nonmainstream groups, school science may be their only access to the science pipeline, making the importance of quality in-school science education all the more critical.

Equitable teachers celebrate a wide range of scientific competencies beyond having the right answer and doing one's work.

What happened to students' science identities from elementary to middle school?

During the year of excellent science teaching…

1. When principles of equitable science teaching were regularly enacted in fourth- and fifth-grade science class, most students performed themselves as engaged, interested, and intellectual contributors.
2. One year of excellent science teaching in fourth- and fifth-grade engendered many students' interests, understanding, and identities.
3. In other words, good science teaching matters!

"I think she likes doing stuff with her hands and thinking."

"To be in it academically, she's got to be in it emotionally."

After the year of excellent elementary science teaching…

1. All students who experienced "traditional" middle school science teaching (emphasizing facts, memorization, worksheets), regardless of science interests, academic achievement, race, class, or gender, were affected negatively. Scientific performances were less robust, science interests waned, and/or students embraced "doing school" performances that embodied significantly lower expectations.
2. Race, class, and gender became more salient aspects of students' identity work than did "being scientific".
3. Some of the negative effects of narrow, traditional school science were countered by enriching out-of-school science experiences. Out-of-school science experiences matter!
4 In all but one sixth-grade classroom, students were not held accountable to performing themselves scientifically. Instead, they were asked to "do school" well. Therefore, many began to disaffiliate from science, saying things like, "I'm not really a sciencey person."

Some References from this Project

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