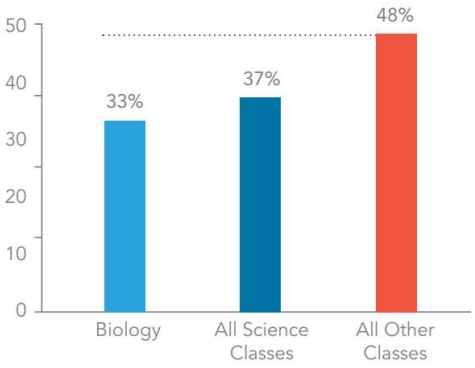
Genomics Salon XXII: Science Education

Cecilia Noecker and Bryce Taylor

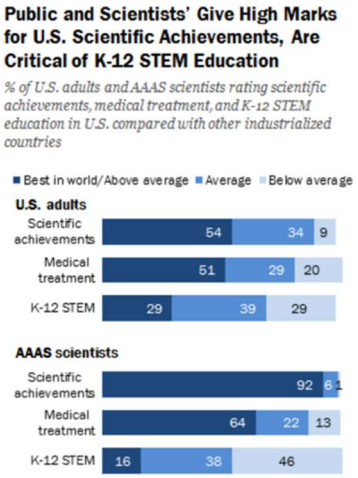
Part 1: Challenges in Science Education

In a recent study by *Amgen* and *Change the Equation*, 81% of high school students reported an interest in science. However, only 37% of students reported liking their science classes "a lot", compared to 48% who liked their non-science classes. Additionally, a 2015 study of 15-year-olds around the world by *OECD* found that while 38% of students expected to work in a science-related career (2nd in the world), these same students were ranked 19th out of 35 countries in science proficiency. An additional study by PEW, which polled both US adults and AAAS scientists, found a massive gap between US scientific achievement and K-12 STEM education. Scientists showed a much greater gap in perception than the general public.

Figure 1: Percentage of teens who report liking their classes "a lot"[1]



Credit: Amgen/Change the Equation



Credit: PEW

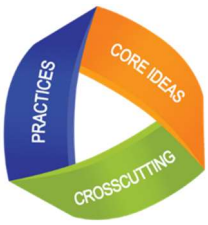
Part 2: Goals of Science Education

If you oversaw STEM education, what goals would you set? What should science classes enable every student to do or know when they graduate high school? Should STEM education be focused on interpretation of scientific evidence? Basic concepts of the field? Inspiring students to a career in science? Make a list ranking these goals by importance. We will then discuss as a group and compare the lists we made to the goals of the Next Generation Science Standards (NGSS) (see next page).

Part 3: Methods and Impacts of Science Education

We'll discuss individual science education objectives identified in Part 2. Consider the following questions for each one:

- How well is this goal currently achieved in U.S. high schools? How should it be achieved?
- What are the impacts of achieving this goal?
- How would achieving it affect the practice of science?
- What teaching tools, classroom methods, or assessments could be helpful for achieving this goal?
- How should teachers be prepared to achieve this goal?
- Is there a role that professional scientists could play in relation to this goal?



The Next Generation Science Standards (NGSS) are an updated set of goals for science education nation-wide. These standards emphasize inquiry-based learning, favor conceptual understanding of core ideas, and include "crosscutting concepts" that unify STEM disciplines. The NGSS website is very clear, well organized, and filled with excellent information. https://www.nextgenscience.org/

Practices for K-12 Science Classrooms

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Seven Crosscutting Concepts

1. Patterns.
2. Cause and effect: Mechanism and explanation.
3. Scale, proportion, and quantity.
4. Systems and system models.
5. Energy and matter: Flows, cycles, and conservation.
6. Structure and function.
7. Stability and change.

Core and Component Ideas in Life Sciences

Core Idea LS1: From Molecules to Organisms: Structures and Processes

LS1.A: Structure and Function
LS1.B: Growth and Development of Organisms
LS1.C: Organization for Matter and Energy Flow in Organisms
LS1.D: Information Processing

Core Idea LS2: Ecosystems: Interactions, Energy, and Dynamics

LS2.A: Interdependent Relationships in Ecosystems
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
LS2.C: Ecosystem Dynamics, Functioning, and Resilience
LS2.D: Social Interactions and Group Behavior

Core Idea LS3: Heredity: Inheritance and Variation of Traits

LS3.A: Inheritance of Traits
LS3.B: Variation of Traits

Core Idea LS4: Biological Evolution: Unity and Diversity

LS4.A: Evidence of Common Ancestry and Diversity
LS4.B: Natural Selection
LS4.C: Adaptation
LS4.D: Biodiversity and Humans

Further Reading

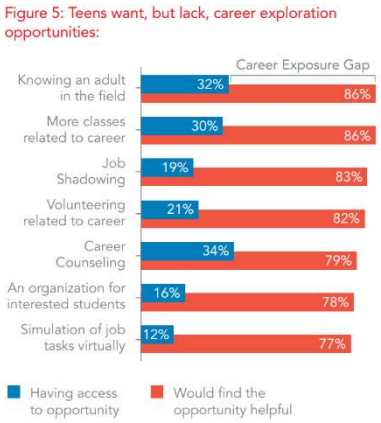
The American Society of Human Genetics (ASHG) has authored several assessments of genetics standards used across the US.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3164571/pdf/318.pdf

> States vary widely in the quality of their science education standards based on comparison to ASHG guidelines. **85% of states rated inadequate in their coverage of genetics concepts.**

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4519196/pdf/pone.0132742.pdf

> Authors warn the Next Generation Science Standards (NGSS) may be inconsistently implemented because of phrasing, as a panel of experts did not uniformly interpret base standards as intended by NGSS. The standards as described don't cover all topics in ASHG guidelines. However, NGSS do a better job of covering genetics concepts than most state standards in the US.

Amy Harmon of The New York Times has compiled an excellent collection of articles on science education and climate change across the country. https://www.nytimes.com/by/amy-harmon?action=click&contentCollection=U.S.&module=Byline&region=Header&pgtype=article



Amgen* and *Change the Equation studied teenager's interest in science, likes and dislikes in their science classes, and their access to science education resources outside the classroom. This summary document is full of interesting stats, but this figure really hit home for us. **Students report a huge gap between their career interests and access to opportunities for career exploration.** This includes access to **job shadowing, volunteer opportunities,** or simply **getting to know a scientist**. Our department has a fantastic set of outreach opportunities, so if this is something you'd like to help with contact Maureen Munn and keep an eye out for emails from her in your inbox!

http://changetheequation.org/sites/default/files/CTEq%20Amgen%20Brief_FINAL.pdf