Science educators analyze genetics content of Next Generation Science Standards

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The genetics content of the Next Generation Science Standards (NGSS) - a recent set of performance-based expectations for elementary, middle, and high school students in science classes - represents, on average, a modest improvement over state standards, but is missing core genetics concepts and is difficult to interpret, according to research published today in *PLOS ONE* by science education specialists at the American Society of Human Genetics (ASHG).

Developed in 2013 by the nonprofit organization Achieve, Inc., along with officials in 26 partner states, the NGSS aim to update the National Science Education Standards, which were issued in 1996, as well as harmonize current state standards, which vary in scope and depth. To date, 13 states have adopted the NGSS, and several others are considering whether to do so. In the new study, researchers focused on the genetics content of the NGSS, evaluating it against a consensus list of 19 ASHG core concepts developed in 2011 and against the genetics content of existing state science standards.

"As states continue to compare the NGSS to their current standards, a closer look at the newer standards' genetics content is important and timely," said Michael Dougherty, PhD, Director of Education of ASHG, who led the study. "The NGSS are the first comprehensive science standards recommendations issued in nearly 20 years, and to the extent that states adopt them, the effects on public genetic literacy could be far-reaching."

The study authors recruited 92 volunteers with expertise in genetics education to rate how well each ASHG core concept was represented in the NGSS, and compared those results to past data on their representation in the state standards. The reviewers evaluated the NGSS performance expectations on their own and in conjunction with a supporting list of disciplinary core ideas (DCIs), developed by the nonprofit National Research Council to provide context for and clarify the content addressed by the NGSS.

When analyzed with the DCIs, the NGSS were found to adequately address 10 of the 19 ASHG core concepts. In contrast, state standards adequately addressed an average of five core concepts, though the results varied widely across states. When compared to each state's standards, the NGSS addressed genetics core concepts considerably better in 15 states, about equally well in 28 states, and not as well in 7 states.

"The NGSS address the genetic basis of evolution, genetic variation, and gene expression and regulation quite well, but they do not adequately address patterns of inheritance - Mendelian or otherwise," said Katherine S. Lontok, PhD, first author on the study. "This omission is important because deciphering inheritance patterns is one of the central aims of genetic science, and understanding these patterns is an important first step to grasping more complex ideas."

Interestingly, the consensus among reviewers was fairly low, both in terms of rating how well concepts were addressed in the standards and in identifying which specific standards were related to genetics. Unlike previous sets of standards, which have been organized as lists of facts and concepts students should know, the NGSS are framed as performance expectations that also address the process of scientific inquiry and learning. The DCIs describe the scientific knowledge students need in order to meet the standards. Perhaps unsurprisingly, reviewers who used the DCIs to supplement their evaluations tended to

rate the standards more consistently than those who assessed the NGSS performance expectations alone.

"The DCIs helped reviewers understand the scope of the standards, and we strongly recommend that whenever possible, they be used in its interpretation," Dr. Lontok said.

"Overall, one of our key findings was that the scope of genetics content addressed by the NGSS is open to interpretation, which could lead to inconsistent implementation," Dr. Dougherty said. "Even within our sample set of reviewers, who underwent the same training module and framed their analysis in the same way, there were significant differences."

"When the NGSS are interpreted and implemented in the real world, diverse stakeholders with varied backgrounds and working in varied environments will be involved. This matters because an important goal of the NGSS was to ensure a more consistent and high-quality science education experience across states for all students," he added.

While the authors caution that this study's results apply only to genetics, they point to the potential benefit of similar analyses for other disciplines addressed by the NGSS. They also encourage states and stakeholders that are considering using the NGSS to consult with the scientific community to guide its implementation.

More information: Lontok KS, Zhang H, and Dougherty MJ. (2015 July 29). Assessing the genetics content in the Next Generation Science Standards. *PLOS ONE*. DOI: 10.1371/journal.pone.0132742.

Dougherty MJ, et al. (2011 Fall). A comprehensive analysis of high school genetics standards: Are states keeping pace with modern genetics? CBE-Life Sciences Education. DOI: 10.1187/cbe.10-09-0122.

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