Upcoming AAAS Project 2061 Presentations

2016 American Educational Research Association (AERA) Annual Meeting
April 8-12, 2016
Washington, DC

Factors Associated with Differential Performance of English Leraners on Science Assessments: The Role of Cognitive Complexity

George E. DeBoer, AAAS Project 2061; Cari, F., Herrmann-Abell, AAAS Project 2061;
and Sarah Glassman, AAAS Project 2061
Sat., April 9, 12:25 – 1:55 p.m., Convention Center, level Two, Exhibit Hall D, Section C

This paper reports on the development and validation of measures that were used to score the cognitive complexity of test items used in a study of factors related to the differential performance of English Learners (ELs) on science assessments compared to native English speakers. The measures were used to analyze the cognitive complexity of 476 middle school assessment items previously developed by the American Association for the Advancement of Science (AAAS). In another part of the study not reported on here, we focus on the development, validation, and reliability of measures of linguistic complexity and the results of applying these measures to the same set of test items.

Designing a New Next Generation Science Standards–Aligned High School Biology Curriculum Unit and Associated Teacher Professional Development

Louisa A. Stark, University of Utah; Nicola Barber, University of Utah; Kristin M. Bass, Rockman et al;
Molly Malone; and Jo Ellen Roseman, AAAS Project 2061
Sun., April 10, 2:45 - 4:15pm, Convention Center, Level One, Room 101

The Next Generation Science Standards (NGSS) introduce a new vision for science education in which the integration of disciplinary core ideas, crosscutting concepts, and science practices facilitates student sense-making about natural phenomena. However, there are few models for high school biology curricula to support teachers in implementing this new approach. To address this challenge we are developing and testing a six-week high school evolution unit and an associated 30-hour teacher professional development workshop.

The curriculum unit is designed as a modular set of lessons that explicitly integrate science practices and crosscutting concepts into activities that guide student exploration of evolution core ideas along with prerequisite heredity ideas. While the unit realizes the three-dimensional vision of the NGSS as a whole, particular emphasis is put on integrating the science practices of data analysis and argumentation, and the crosscutting concepts of patterns, and cause and effect. Students investigate evolutionary phenomena by analyzing real data from published scientific literature to craft evidence-based arguments and explanations.

The three-dimensional construction of the curriculum materials, coupled with the disciplinary and practice-based content, is designed to be educative for teachers as well as students. In addition to directly supporting teachers in implementing the NGSS in the classroom, the materials serve as a model for meaningfully integrating disciplinary core ideas, crosscutting concepts, and science practices. Educative curriculum materials should support teacher learning and build upon teachers' existing subject matter knowledge and pedagogical content knowledge (Davis & Krajcik, 2005). The new unit is designed to support learning about evolution core ideas and how ideas about heredity underlie evolutionary theory. These materials are also designed to build pedagogical content knowledge for teaching these topics. Building pedagogical content knowledge of science practices is critical in order to support teachers' implementation of the new NGSS vision. The evolution materials are particularly designed to improve teachers' pedagogical content knowledge of the practices of data analysis and argumentation. The associated professional development workshop will introduce teachers to the NGSS-aligned curriculum materials, provide instruction on three-dimensional learning, and provide opportunities to engage with the science practices from the perspectives of a student and a teacher.

We will share our iterative design model for developing the curriculum and professional development resources that support teacher implementation of the NGSS. In addition, we will share measures that will provide information about implementation of the new materials and teacher preparedness. Results of alpha testing the curriculum materials will be discussed along with resultant design decisions. We will highlight our design of integrated argumentation lessons, and an associated evidence-based argumentation measure, as well as a measure to assess teachers' abilities to a) deconstruct students' arguments b) evaluate argument validity and c) diagnose sources of argumentation difficulties. Our findings will provide useful lessons for researchers and developers of NGSS-aligned curricula and teacher professional development.

Integrating Next Generation Science Standards Core Ideas and Practices: Supporting and Studying Teachers' Implementation

Jo Ellen Roseman, AAAS Project 2061; Rebecca A. Kruse, National Science Foundation
Sun., April 10, 2:45 - 4:15pm, Convention Center, Level One, Room 101

Perspectives of the teacher-curriculum relationship and implications for the development of educative curriculum materials (Ball & Cohen, 1996; Davis & Krajcik, 2005; Remillard, 2005) suggest that curriculum materials can be powerful tools in supporting teachers implementation of the Next

Generation Science Standards (NGSS Lead States, 2013), provided they (a) align with and support teachers' understanding of learning goals, (b) employ instructional strategies that support student learning and help teachers understand the pedagogical purpose(s) of each activity, and (c) include assessments to help teachers monitor their students' progress, provide students with feedback, and inform instructional decisions.

This paper describes a curriculum-focused research study and, specifically, our efforts to support and understand teachers' implementation of explanation writing with this NGSS-aligned curriculum. Over 5 years, we developed an 8th grade curriculum unit that (a) aligns to physical and life science core ideas and crosscutting concepts about atom rearrangement and conservation, and (among others) the science practice of explanation to make sense of phenomena involving chemical reactions in non-living and living systems; (b) supports teaching and learning through sequenced activities and scaffolded tasks that guide students' reasoning about phenomena and underlying molecular mechanisms; (c) includes embedded assessments requiring students to construct explanations of phenomena that allow teachers to elicit students' initial ideas and skills and monitor their progress; and (d) supports teacher learning through print and online teacher resources and professional development.

An examination of student notebooks revealed that teachers did not provide feedback on students' explanations. Teacher materials were revised with rubrics, scoring guidelines, and suggestions for providing feedback (Achieve, 2014). Professional development (PD) was offered to experienced curriculum implementers to introduce these revisions and allow teachers to practice applying them to samples of student work. Teachers were given financial incentives to (a) evaluate explanations of a representative sample of their students while teaching the unit, (b) summarize findings across the responses they sampled, and (c) provide feedback to students.

For each explanation task, teachers submitted scanned copies of their sampled students' explanations, data on how they rated each explanation, a brief summary of findings for the sample, and a description of how they provided feedback. A comparison of teacher ratings to ratings of experts was used to determine how well teachers used the rubrics and summarized their findings and, based on this, their capacity to provide useful feedback to students. In a separate study, we examine how the quality of feedback influenced the quality of student explanations.

On average, teacher ratings differed from expert ratings on less than one-third of students' explanations. Consistency between teacher and expert ratings positively correlated with teachers' years of experience implementing the curriculum and number of exposures to our curriculum-based PD. Few teachers provided written feedback on students' explanations.

The significance of these findings suggest that realizing the vision of \NGSS may exceed typical instruction in US classrooms, and that high quality curricular supports, curriculum-based professional development, and other incentives may be needed to support teachers' effective implementation of this vision.

Using Rasch Modeling and Option Probability Curves to Diagnose Students' Misconceptions

George E. DeBoer and Cari F. Herrmann Abell, AAAS Project 2061

Mon., April 11, 12:25 - 1:55pm, Marriott Marquis, Level Two, Marquis Salon 4

Understanding students' misconceptions and how they change is an essential part of supporting students in their science learning. This paper presents results from distractor-driven multiple-choice assessments that target students' misconceptions about energy. The assessments were administered to 6,540 elementary, middle and high school students from across the U.S. Rasch modeling was used to estimate item and student measures. Option probability curves were used to represent the distribution of correct answers and misconceptions across the range of student achievement levels. Analysis of the shapes of the curves and where they occur as a function of student achievement provides insights on changes in students' thinking as they learn more about a topic. These data can then be used to inform instruction.

Fostering Model-Based Learning of Human Body Systems During Simulation-Based Investigations

Barbara C. Buckley, WestEd; Daniel Brenner, WestEd; George E. DeBoer, AAAS Project 2061; Andrew Grillo-Hill, WestEd; and Kim Luttgen, WestEd

Mon., April 11, 4:05 - 5:35pm, Convention Center, Level One, Room 150 B

The NSF-funded SimScientists Human Body Systems (HBS) project is testing simulation-based instructional modules with embedded formative assessments and a summative benchmark assessment for high school biology. Our theoretical framework integrates model-based learning (Author, 2000, 2012) with complex systems (Goldstone & Wilensky, 2008) in an evidence-centered design process (Behrens et al, 2004). After pilot-testing the modules in classrooms and making revisions, we conducted a randomized controlled trial in the classrooms of 40 teachers. From preliminary analyses we observed that despite a significantly lower mean pretest score than the control group, the treatment group posted significantly higher gains on the posttest. While the pretest score was the major predictor of gain on the benchmark test, there was also a significant dosage effect.

Using Rasch Modeling to Investigate a Learning Progression for Energy Ideas

Cari F. Herrmann-Abell, AAAS Project 2061 and George E. DeBoer, AAAS Project 2061
Fri., April 14, 10:15 - 11:45am, Federal Hill

Energy is a core concept in the teaching of science. Therefore, it is important to know how students' thinking about energy grows in complexity so that elementary, middle, and high school students can be appropriately supported in their understanding of energy. This paper tests the validity of a theoretical model of students' growth of understanding about energy that moves from a phenomenological understanding, to explaining phenomena with energy-related concepts, to explaining phenomena using atomic/molecular explanations. The study examines results from the administration of 372 distractor-driven, multiple-choice items aligned to a wide range of energy ideas from energy forms and transformations, to energy transfers, to energy dissipation and degradation, to energy conservation. Test items were administered to 6,540 students from across the U.S. Rasch modeling provided linear measures of student performance and item difficulty. For most of the energy ideas, an analysis of the item difficulties validated the study's description of the energy concept and how it progresses in conceptual complexity. Additionally, a cross-sectional analysis of student performance revealed that the high school students performed significantly better than the elementary and middle school students and that there was no significant difference in performance between the elementary and middle school students.

Differential Performance of English Learners on Science Assessments: The Role of Cognitive Complexity

George E. De Boer, AAAS Project 2061; Cari F. Herrmann Abell, AAAS Project 2061; and Sarah Glassman, AAAS Project 2061
Sun., April 17, 2:45 - 4:15pm, Baltimore Salon B

This paper reports on the development and validation of a measure to score the cognitive complexity of test items used in a study of factors related to the differential performance of English Learners (ELs) on science assessments compared to native English speakers. This measure of cognitive complexity will then be used along with measures of linguistic complexity to investigate the relationship between cognitive and linguistic complexity and their ability to explain performance differences between EL and non-EL students.

Connecting Complex Human Body Systems During Model-Based Investigations

Barbara C. Buckley, WestEd; Daniel Brenner, WestEd; Andrew A. Grillo-Hill, WestEd; George DeBoer, AAAS Project 2061; and Kim Luttgen, WestEd

Sun., April 17, 2:45 - 4:15pm, Maryland Salon A

Abstract not available.