AAAS Testing Web Site Probes Students’ Misconceptions About Science

First, the good news: 95% of middle and high school students know that DNA contains genetic information that is passed from parent to offspring. But 57% of them incorrectly believe that a gene is a trait—like having blue eyes—and not a segment of DNA.

Those insights and others like them are at the core of a new assessment Web site developed by AAAS Project 2061, the science literacy initiative, to track what students know—and don’t know—about science. With a focus on students’ misconceptions, the site is a practical guide for educators as they create multiple-choice tests and diagnose whether their students truly understand the science concepts they are taught.

With increasing calls for national science standards and a common core curriculum for middle school and high school students, it is more important than ever to get assessment right, said George DeBoer, deputy director of Project 2061. “Good assessments can be used to actually improve students’ learning and not just to hold teachers and schools accountable,” said DeBoer, the principal investigator for the project. “Assessments that are designed to diagnose students’ misconceptions can be powerful educational tools.”

AAAS’s Project 2061, founded in 1985 as a long-term effort to improve science education, began work in 2004 with support from the National Science Foundation. Its Web site (http://assessment.aas.org) presents detailed information on how a national sample of students answered 600 multiple-choice questions on topics from cell biology to plate tectonics. The test questions were developed by AAAS staff and doctorate-level research associates, and evaluated by experts in science, science education, and science assessment.

Each question typically was answered by at least 2000 students in field tests involving school districts across the nation. In 2010, for example, more than 90,000 students in 814 schools participated in the field tests. Project 2061 researchers also conducted on-site interviews with students to gauge the effectiveness of the questions.

As a whole, the new Web site offers an unusually detailed picture of what middle and early high school students across the United States know about science, broken out by grade level, gender, and primary language.

There was “essentially zero” difference in how well girls and boys answered the questions, said DeBoer, with only two-tenths of a percentage point separating their scores. Students whose primary language was not English scored seven percentage points lower on the test, even though the AAAS team took pains to address issues of potential bias and used plain language in the questions.

The assessments also counter the widely held view that multiple-choice questions are useful only for testing recall of memorized definitions and trivial facts, DeBoer said. “As a result of our efforts, many of the test questions included in the new Web site not only measure knowledge of factual information, but they also probe a student’s ability to explain real-world phenomena, reason logically through problem situations, or identify the reason why a claim is true,” he explained.

The site has received early positive reviews from teachers and curriculum specialists, who noted that the AAAS assessment contains valuable information beyond the data typically contained in progress reports such as the National Assessment of Educational Progress or the Trends in International Mathematics and Science Study.

The site’s emphasis on student misconceptions is particularly helpful, said Deagan Andrews, a curriculum and assessment specialist in the Greeley, Colorado, school district. Referring to some of the major standardized test programs, he said: “No one releases any information about misconceptions. They are interested in whether students got it right or wrong.”

AAAS’s assessment, Andrews added, offers teachers an opportunity to “think about their instruction and what they may be doing that may be perpetuating misconceptions.”

“It becomes more difficult to teach students without actually addressing the misconception first,” agreed Anu Malipati, a school administrator for a network of charter schools in New York and Connecticut. The AAAS test items, she said, can be used by teachers to diagnose potential problem areas and find out how many students in a classroom have misconceptions about key concepts.

—Earl Lane
Alzheimer’s Experts Share Diverse Insights on Disease

Some 5.4 million Americans have Alzheimer’s disease, and given longer lifespans ahead, “we’re facing quite a crisis,” David M. Holtzman said during a recent AAAS event intended to stimulate new thinking and speed medical advances. The number of Alzheimer’s patients is likely to triple within 50 years, but researchers still can’t detect the disease until it’s too late to prevent dementia and death, said Holtzman of the Washington University School of Medicine in St. Louis (WUSTL).

Yet, optimism prevailed 6 April as researchers spoke to a packed AAAS auditorium about “Breaching Barriers in Alzheimer’s Disease.” Reisa Sperling of Brigham and Women’s Hospital and Massachusetts General Hospital announced a proposal for a new clinical trial. Other speakers described insights into amyloid plaque formation in the brain—a hallmark of the disease—as well as genetic factors, imaging techniques, and lessons from other neurodegenerative diseases.

Late-onset Alzheimer’s disease, affecting people who are 60 or older, accounts for 99% of all cases. Although much rarer, the early-onset familial form can be especially devastating, striking those as young as 30. “Age and family history are the biggest risk factors,” explained WUSTL’s Alison Goate. “Even though genes are playing a role, that’s not all it is,” she said. A number of disease-causing genetic mutations as well as the risk factor apolipoprotein E4 have been identified.

Remaining physically active can promote overall good health, Sperling said, but avoiding Alzheimer’s isn’t as simple as playing Sudoku. As Mark Mintun of Avid Radiopharmaceuticals noted, a gene-environment interaction seems likely. Two radiotracers, combined with PET scanning, make it possible to visualize amyloid plaques, he said. Cerebrospinal fluid analysis can also be used to detect the plaque components tau and amyloid-beta 42 peptide, but Holtzman said high levels probably signal advanced deterioration, even if cognitive symptoms are mild.

An array of presentations offered support for the amyloid hypothesis, which assumes that amyloid-beta peptide is the key culprit in plaque formation. But Mathias Jucker of the Hertie Institute for Clinical Brain Research and the University of Tübingen also posed unconventional questions, such as whether environmental factors may trigger plaque formation. Steven Finkbeiner of the Gladstone Institute of Neurological Disease asked whether neuroinflammation may be a common thread among various neurodegenerative diseases. Don W. Cleveland of the University of California, San Diego urged looking beyond neurons to assess the role of other brain cells.

Richard Ransohoff of the Cleveland Clinic offered intriguing clues to the function of nonneural cells called microglia and a microglia modulator, the fractalkine receptor, which seems to affect disease outcomes. Andrew Dillin of the Salk Institute for Biological Studies described an aging “toggle switch” that might help prevent diseases that involve protein misfolding. Sperling proposed a trial “to test the hypothesis that interfering with amyloid accumulation upstream will affect downstream neurodegeneration.”

The public event, supported by The Agouron Institute, honored the late Science editor emeritus and AAAS senior advisor Philip Hauge Abelson. A related workshop, chaired by Marc Tessier-Lavigne of The Rockefeller University and Tom Maniatis of Columbia University Medical Center, will result in a white paper in Science Translational Medicine.

(For video and a complete list of speakers, see www.aaas.org/go/abelson2011.)

—Ginger Pinholster

Graceful Aging.
France’s Jeanne Louise Calment lived to be 122 years old, riding a bicycle at age 100. Andrew Dillin of the Salk Institute wants to know how she beat the genetic odds.

INTERNATIONAL
Asia-Pacific Leaders Explore Ambitious S&T Cooperation

A group of leaders from the Asia-Pacific science community, convened by AAAS, explored a selection of possible actions that could be taken by governments, universities, funding agencies, and businesses to strengthen cooperation and innovation throughout the region.

In all, the roundtable involving more than 30 leaders from across the region yielded nearly two dozen possible steps for developing “a more coherent and compatible scientific system.” According to a summary of the event released this month, ideas ranged from identifying common challenges and developing shared ethics to making universities hubs for regional collaboration and problem-solving.

The discussion showed how increased science cooperation could play a vital role in supporting the Asia-Pacific research enterprise, said AAAS Board Chair Alice S. Huang: “Given the growth and potential contributions from scientific developments in the Pacific Rim countries, the extraordinarily candid and focused discussion during this initial meeting was an extremely promising start to productive collaboration among scientists and institutions in this part of the world.”

The roundtable, organized by Huang and the AAAS International Office, brought scientists, policy-makers, educators, and others to AAAS headquarters for a full day of discussion on 16 February, the eve of the association’s Annual Meeting. They met under Chatham House Rule, assuring that participants will not be identified or quoted.

The Asia-Pacific region—which includes nations as diverse as China, India, Japan, Australia, Mexico, and Canada—accounts for more than 40% of the world’s population and over half of its economic output. It is also a growing science power. But while important networks such as the Asia-Pacific Economic Cooperation forum have developed, the summary suggests that more support is needed from political leaders to drive science cooperation.

As a start, it says, they “could endorse informal, regular discussions by scientific leaders (e.g., science advisers) on S&T cooperation to address regional challenges, barriers, and opportunities.” Among other potential steps outlined in the five-page summary:

- Broad efforts to build partnerships among universities, including curriculum, faculty exchanges, and tenure policies to support regional science;
- Collaboration by policy-makers, educators, funding agencies, and others to identify regional issues—and mechanisms for addressing them;
- Initiatives led by science organizations to build compatible scientific norms and ethics that could help knit together a regional scientific culture.

(Read the full summary at www.aaas.org/go/191summary.)