

SCIENCE EDUCATION IN VIRGINIA

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Introduction

The revision and adoption of the *Science Standards of Learning for Virginia Public Schools* in 1995 reinforced the Commonwealth’s longstanding emphasis on high-quality science programs and student achievement [1]. Virginia is fortunate to have a highly integrated system of standards, regulations, public processes, and rigorous course pathways that is the foundation to educate science-literate graduates. This system has necessarily functioned in concert with a respected *tradition of practice* within Virginia’s science education community and its shared vision for science for all students beginning at the earliest grades. There is much to be proud of in Virginia, but we must understand that challenges remain abundant.

Status of Science Program Quality/Performance Indicators

Objective measures of inputs and outcomes are required for framing a clear perspective on science education in the Commonwealth—but what are those measures? It is at this point that we consider the quote (often misattributed to Albert Einstein), “Not everything that counts can be counted, and not everything that can be counted counts.” Data are often difficult to obtain on many important measures, but the following samples can serve as indicators that are objective, can be used in comparisons, and/or were systematically developed.

The State Science Standards — The 2013 Thomas B. Fordham Institute report on the *Next Generation Science Standards* concluded that Virginia’s science standards were superior to the recent national effort [2]. In the Institute’s earlier state-by-state review of science standards, Virginia’s *Science Standards of Learning* were rated among the very best in the nation with only two states having higher rankings:

The Old Dominion’s science standards are among the few that we would cheerfully recommend as models for other states (and for drafters of “common” standards for this field). They are thorough and rigorous, particularly in the areas of mathematical applications and evolution, and they clearly provide a solid foundation for a rigorous K-12 science curriculum [3].

Science Graduation Requirements and Diplomas Awarded — Virginia’s two college- and career-ready diplomas, the Standard Diploma (SD) and the Advanced Studies Diploma (ASD), require three and four laboratory science credits for graduation, respectively. These credits must be distributed among the biological and physical sciences [4]. In 2013, 47,872 students achieved the ASD, while 35,357 students achieved the SD, indicating that 58% of students earning one of these college- and career-ready diplomas had completed four or more science credits [5]. National data indicate that only two states require four science credits of all students [6].

National Assessment of Education Progress (NAEP) Performance — The NAEP is the largest nationally representative and continuing assessment of what students in the United States know and can do in various subject areas. Assessments are conducted periodically in mathematics, reading, science, writing, the arts, civics, economics, geography, and U.S. history. The NAEP results serve as a common metric for all states and selected urban districts. The assessment difficulty level stays essentially the same from year to year, with only carefully documented changes. This permits NAEP to provide a clear picture of student academic progress over time.

The last NAEP assessment released for grade 4 science (2009), Virginia fourth graders ranked at the top of the national assessment. Virginia achievement exceeded all but two states [7].

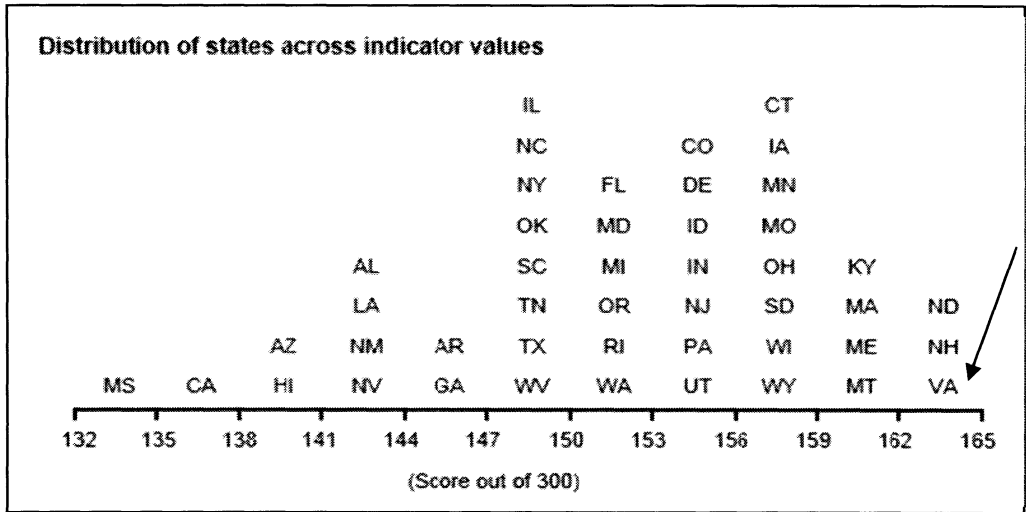


Figure 1. The NAEP “Fourth Grade Science Performance”(2009), as reported on the National Science Foundation website.

In the most recent NAEP assessment released for grade 8 science (2011), Virginia eighth graders ranked among the highest performing states on the national assessment. Achievement exceeded all Southern and Mid-Atlantic states [8].

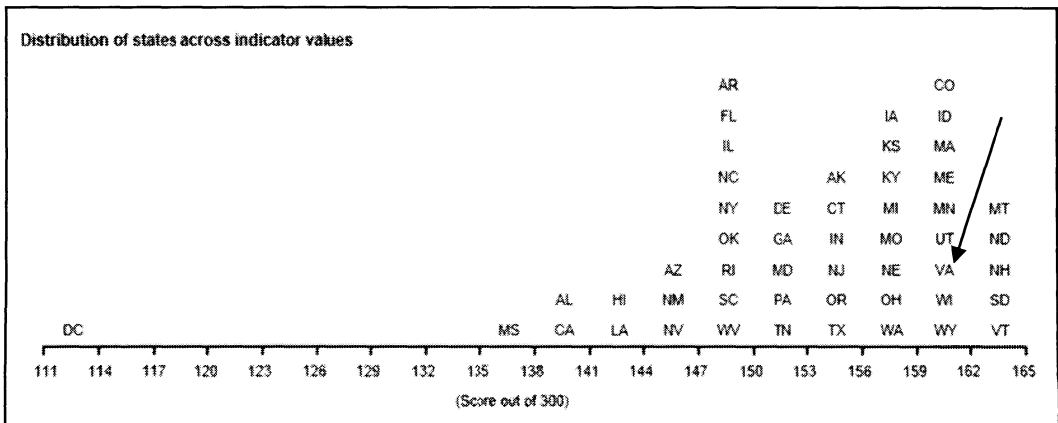


Figure 2. The NAEP “Eighth Grade Science Performance” (2011), as reported on the National Science Foundation website.

International Science Assessment Linking Study: TIMSS and NAEP — The October 2013 release of a major international linking study, *U.S. States in a Global Context*, by the National

Center for Education Statistics connected science scores of U.S. students on the 2011 NAEP with results from the 2011 Trends in International Mathematics and Science Study (TIMSS) [9]. The study concluded that Virginia’s eighth graders achieved at a statistically higher level in science than students in thirty-seven countries and systems. Students in only four countries—Singapore, Taiwan, South Korea, and Japan—scored statistically higher. Virginia’s average grade 8 science score was only six points below the TIMSS benchmark for high achievement and 69 points above the intermediate achievement benchmark [8].

Advanced Placement Science Courses — The number of Virginia students taking Advanced Placement (AP) courses and tests has increased significantly since 2004, as have their scores on AP science tests. In February 2014, The College Board’s *AP Report to the Nation* announced that Virginia again boasted the nation’s third-highest percentage of public high school seniors qualifying for college credit on Advanced Placement (AP) examinations [10]. Only two states had higher percentages of seniors earning qualifying scores. The College Board, in its *Virginia Student Achievement Report 2012-2013*, showed that the number of Virginia students taking Advanced Placement Tests for AP Biology, AP Chemistry, and AP Physics B *and* achieving qualifying scores for college credit exceeded 50% and had noteworthy year-over-year gains [11].

Science*	2004	2010	2011	2012	2013
Total Tests Taken	2,829	14,725	16,809	19,137	20,356
Total Scores 3 or Above	1,849	7,316	8,398	9,662	11,132

*Science includes Biology, Chemistry, Environmental Science, Physics B, and Physics C.

Figure 3. Advanced Placement Tests in Virginia, 2004-2013.

State Science Accreditation — Accreditation status is provided by the Virginia Department of Education (VDOE) based on the *Science Standards of Learning* assessments at grades 3, 5, and 8 and at end-of-course in Earth science, biology, and chemistry for high schools. Schools that did not achieve an aggregate student pass rate of at least 70% in science had the status of “Accredited with Warning.” Accreditation information for 2013-2014 (based on assessments taken during the 2012-2013 school year) is posted on the VDOE website for over 1,800 elementary, middle, and high schools [12]. Among these, there are four high schools, eight middle schools, and twenty-nine elementary schools that are “Accredited with Warning” in science.

Review of Partnership and Collaboration Indicators

It is clear from the data from various external sources that science education in Virginia has great potential. However, it is important for all of the stakeholders to realize that there must be continuous focus and effort made to retain and improve science education for Virginia's students. Since the person who makes the difference in a student's academic career is the teacher, much of the focus and effort is on teacher professional development [13]. Members of the science education community work collaboratively to provide high-quality professional development for teachers of science in Virginia.

Professional and Leadership Organizations — Virginia's science education professional organizations are an integral component of the science education community. The Virginia Association of Science Teachers (VAST) and the Virginia Science Education Leadership Association (VSELA) are critical to the success of science education. Over the past several years, each organization has been a key player in the development and implementation of Virginia's *Science Standards of Learning*. Their members have provided expertise in grade-level and subject areas during the standards revision process, as well as provided the VDOE important time during their meetings to allow for sessions to build coherence around the goals of the standards and other important implementation matters. Over the past several years, thousands of teachers of science and science educator leaders attend their annual professional development institutes. These institutes allow teachers to connect in a setting that encourages professional learning and growth.

Another organization that provides leadership in the area of science education is the Virginia Mathematics and Science Coalition (VMSC). The mission of the VMSC is "to bring together education, scientific, corporate, and public policy leaders committed to the sustained elevation of mathematics and science education to ensure that all Virginia's students and citizens have the foundation required for lifelong success in their daily lives, careers, and society." The VMSC supports efforts by school systems, teachers, parents, students, the Commonwealth of Virginia, and other interested parties to achieve and sustain excellence in Science, Technology, Engineering, and Mathematics (STEM) education for Virginia's K-12 and higher education students. Over the past several years, the VMSC has focused efforts on communicating the importance of science education through identifying highly effective science programs through "Programs That Work" which was initiated by the Honorable Mark Warner during his tenure as the president of the VMSC. The VMSC provides an important perspective and research-based information to the science education community and its stakeholders through its white papers and

journal. Recently, the VMSC developed and is implementing a strategic plan, “Achieving Excellence in Mathematics and Science Education,” which outlines goals, objectives, and strategies in four key areas:

- 1) Curriculum and Assessment
- 2) Instructional Delivery
- 3) Human Capital
- 4) VMSC Organizational Structure

Mathematics and Science Partnership Program — The Mathematics and Science Partnership (MSP) program is intended to increase the academic achievement of students in mathematics and science by enhancing the content knowledge and teaching skills of classroom teachers. Annually, partnerships between high-need school divisions and the Science, Technology, Engineering, and Mathematics (STEM) faculty in institutions of higher education collaborate to focus on improving science teaching and learning through intense, sustained professional development.

Each state determines priorities for the use of MSP funds based on statewide needs. In recent years, Virginia has had the following priorities:

- Nature of Science and Scientific Inquiry;
- Discourse and Argumentation in Science;
- Conceptual Modeling Instruction; and,
- Integration of Mathematics and Science using Interdisciplinary Strategies.

Since 2008, many partnerships among Virginia school divisions and institutions of higher education have been developed, resulting in nearly 2,000 science teachers having received intensive professional development through the MSP program.

These MSP grant-funded projects have also resulted in the sharing of professional development models and materials, as well as curriculum materials such as lesson and unit plans, developed as a result of the projects. These materials serve as a starting point for school divisions, schools, and teachers as they work toward improving science education.

The Virginia Initiative for Science Teaching and Achievement (VISTA) — VISTA is a statewide partnership among more than eighty Virginia school divisions, six Virginia universities (George

Mason University, The College of William & Mary, Virginia Commonwealth University, Virginia Tech, James Madison University, and the University of Virginia), and the Virginia Department of Education. This partnership has leveraged the established partnerships within the science education community in order to provide a multifaceted approach to science education reform. Elementary and secondary science teachers, school division science leaders, and university science education faculty all experience the impact of VISTA programs through professional development.

The initiative is funded by a five-year, \$34 million grant from the U.S. Department of Education through the Investing in Innovation (i3) program, which includes a \$5.7 million private sector matching requirement. Oregon State University directs the independent evaluation of the VISTA program. The objectives of VISTA include the following:

- Increasing student learning in science, including students with special needs and Limited English Proficiency (LEP);
- Enhancing the quality of elementary science teaching by including inquiry-based teaching;
- Enhancing the quality of teaching of new, underprepared secondary science teachers, including having their students conduct inquiry-based activities;
- Increasing the number of certified middle school and high school science teachers;
- Increasing access for rural teachers to professional development;
- Building the state infrastructure to support effective science teaching and learning; and,
- Conducting research to determine what makes the most significant difference in helping teachers to help students learn.

The VISTA professional development programs are empowering hundreds of science educators across Virginia to use an active style of teaching that engages students in the classroom and beyond. These science educators (science teachers, school division science leaders, and science education faculty) collectively impact around 625,000 students statewide [14]. The impact of VISTA will likely continue long after the grant funding from the U.S. Department of

Education runs its course. The partners have clearly taken the opportunity to leverage relationships and resources to impact science teaching and learning in the Commonwealth.

The Virginia science education community has systematically leveraged relationships and resources to ensure that the goals of Virginia's *Science Standards of Learning* are enacted by science educators. Processes and systems are in place to ensure that students exiting Virginia public schools are scientifically literate and prepared to be career and college ready. However, it is imperative that the science education community, the policymakers, business leaders, and the community only consider changes to this system that will ultimately improve the outcome: a scientifically literate society.

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