Arlington Public Schools

Science Evaluation Report

Prepared by the Office of Planning and Evaluation

Response from the Science Office

May 2014

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Appendices are available at www.apsva.us/evaluationreports.

EXECUTIVE SUMMARY

Introduction

This evaluation examines the success of the Science program from 2008–09 to 2012–13. It is the second comprehensive evaluation of the Science program and follows the initial evaluation reported in 2007. In particular, this report addresses the following three evaluation questions outlined in Arlington Public Schools (APS) policy and procedures (45-3) for accountability and evaluation:

1. How effectively was the Science program implemented?
2. What were the outcomes for the targeted populations?
3. How satisfied are users with the Science program?

Science Program

The APS Science Program serves to inspire an enthusiasm for scientific literacy, foster an inquisitive spirit in learners through inquiry-based experiences in real-life contexts, and create a community of scientifically literate individuals who are able to make informed decisions.

At the elementary level, students learn scientific concepts that align to strands of knowledge:

- scientific investigation, reasoning, and logic;
- force, motion, and energy;
- matter;
- life processes;
- living systems;
- interrelationships in earth/space systems;
- Earth patterns, cycles, and change; and
- Earth resources.

At the secondary level, students have opportunities to learn science in areas that include but are not limited to Biology, Earth and Space Science, Chemistry, Physics, Environmental Science, Animal Science, Biotechnology, Astronomy, Forensics, Physical Therapy/Sports Medicine Technology, and Basic Anatomy/EMT.

Methodology

This evaluation uses a variety of sources of information to assess program implementation, outcomes, and user satisfaction. Implementation of the program was assessed through classroom observations, focus groups, and surveys. Multiple science assessments were analyzed to assess student outcomes. Surveys provide information about stakeholder satisfaction.

Findings

Delivery of Instruction

Strengths

A high percentage of teachers at all levels reported regularly integrating science content with other content areas. Teachers across grade levels reported that the Outdoor Lab experience supports science instruction and extends student learning.

Areas that Need Improvement

There is a high level of variation in the amount of time elementary students receive science instruction. This is a concern in conjunction with the finding that instructional time had a significant impact on 2012–13 grade 5 SOL science test scores.

A majority of 4th grade teachers report that not all of the Grade 4 science standards are taught in 4th grade.

Just 14% of middle school teachers and 26% of high school teachers say they collaborate with other teachers to create cross-curricular units.

Quality of Instruction

Strengths

CLASS observations across grade levels indicate high levels of emotional support, classroom organization, and student engagement. Elementary classrooms received high ratings on the Science content observation tool for articulating science lesson objectives and aligning their lessons to those stated objectives.

Observations yielded high rankings across grade levels for engaging students in hands-on learning, providing students with equal opportunities to engage, differentiating instruction to meet the needs of all students, and demonstrating scientific content knowledge.

Areas that Need Improvement

CLASS observations across grade levels yielded relatively low scores for Instructional Support, particularly in the area of *Analysis and Problem Solving*. High school classrooms received relatively low ratings on the Science content observation tool in the area of articulating science lesson objectives and aligning lessons to stated objectives. In addition, observations indicate a need for improvement in the areas of providing opportunities for scientific discourse and providing opportunities for inquiry-based approach to science instruction.

Participation in Enrichment and Acceleration

Strengths

Enrollment in accelerated science courses has increased over the last five years.

Areas that Need Improvement

At the high school level, white students are overrepresented in accelerated science courses, including intensified, AP, and IB science courses. Black, Hispanic, economically disadvantaged, LEP, and SWD students are underrepresented in accelerated science courses.

Outcomes

Strengths

Overall Science SOL pass rates are generally high, ranging from 87% to 94% at the elementary and middle school level in the four years prior to the implementation of the new test in 2013. End of course Biology and Chemistry pass rates ranged from 86% to 91%.

Between 2008-09 and 2011-12, the gap between black and white students and between Hispanic and white students decreased on all three SOL science EOC tests.

APS students generally perform as well as or better than students in the state of Virginia on five of the six AP science exams, and perform better than students in the nation on four of the six exams.

Areas that Need Improvement

SOL results at all levels indicate that, while many gaps decreased between 2008–09 and 2011–12, gaps for all groups of students increased in 2012–13, when the new science standards were implemented.

Pass rates for the Earth Science SOL test are consistently lower than other end of course SOL tests. APS Earth Science pass rates are lower than statewide pass rates.

Satisfaction

Strengths

A majority of students at all levels reported that they enjoy learning about science. This rate was highest among elementary students, lower among middle school students, and lowest among high school students.

The majority of teachers across the division report being satisfied or very satisfied with the amount of support they receive from the division for science instruction.

More than 85% of parents reported being somewhat satisfied or very satisfied with the science instruction their child is receiving.

Areas that Need Improvement

More than 50% of the elementary lead teachers and middle school science teachers, and more than 40% of the high school science teachers, reported that they were dissatisfied or very dissatisfied with the quality of the professional development opportunities offered by the division in science.

Recommendations

Recommendations Specific to the Science Office

1. Develop and implement a grade K–5 science pacing guide and grade 2–5 formative assessment program to determine the extent to which students are on track to meet the grade-level standards.
2. Evaluate and redesign the Science Office professional development program with specific focus on
    a. improving teacher participation and satisfaction,
    b. emphasizing best practices in science education including safe scientific investigative practices, and
    c. continuing to focus on areas of need that are identified by assessments and other data sources, particularly instructional support as defined by CLASS, articulating objectives, and ensuring that objectives align to lessons
3. Support underrepresented populations and struggling students in the area of science to address the existing achievement gap. Specifically:
    a. Offer targeted professional development,
    b. Work with high school teachers in the use of formative assessment to identify struggling students and address instructional needs, and
4. Develop additional pathways for students to achieve an advanced studies diploma. Provide alternative courses to ensure that students can move through the pathway.
5. Continue to monitor relationship between elementary instructional models and SOL results.

Recommendations with Policy and Budget Implications

6. Implement scheduling requirements at the elementary level that mandate the amount of time students are required to participate in science instruction each week by grade. Mandate formative assessment in grades 2–5.

Staff Response and Action Plan — *Prepared by the Science Office*

Recommendation #1: Develop and implement a grade K–5 science pacing guide and grade 2–5 formative assessment program to determine the extent to which students are on track to meet the grade-level standards.

Response: The program evaluation indicates that time devoted to science instruction at the elementary level varies tremendously across school buildings, which impacts teachers' ability to cover the entire grade level curriculum. We are particularly concerned with science instruction at the fourth grade level, as the program evaluation indicates that many of the fourth grade science standards are not covered during the fourth grade academic year. To address the scheduling difficulties and time constraints on teachers, the Science Office is looking at ways to integrate science content with other curricular areas.

The Science Office will work to implement the following action steps:

- Create a K–5 pacing guide to coincide with the implementation of the new textbook adoption materials in 2013–14 school year to ensure that all grade level science standards are addressed during the academic year.
- Design formative assessments using Interactive Achievement, the formative assessment software used by APS, for evaluation of student progress in grades 2–5 using the prescribed pacing guide.
- Make formative assessments available quarterly to track student progress toward the grade level science standards.
- Expand the "Infusion of Science into Language Arts" initiative, which provides science activities and lessons that accompany elementary literature and professional development on how to use them effectively in the classroom.
- Work with the Summer School Office to integrate science content into the elementary summer school curriculum.

Recommendation #2: Evaluate and redesign the Science Office professional development program with specific focus on

a. improving teacher participation and satisfaction,
b. emphasizing best practices in science education including safe scientific investigative practices, and
c. continuing to focus on areas of need that are identified by assessments and other data sources, particularly instructional support as defined by CLASS, articulating objectives, and ensuring that objectives align to lessons

Response: The Science Office provides a schedule of professional development offerings that are occurring at the elementary and secondary level each school year. For the 2013–14 school year, the Science Office offered four optional professional development sessions to all secondary teachers, as well as three optional sessions to all elementary teachers. The Science Office also provides quarterly professional development for elementary and secondary science lead teachers, as well as monthly county-wide meetings for all secondary science teachers. Some optional professional development offerings have been poorly attended and the program evaluation shows that teachers are dissatisfied with the professional development provided. The Science Office is invested in providing quality professional development offerings that meet the needs of our teachers and students.

The Science Office will work to implement the following action steps:

- Conduct an anonymous survey of secondary staff members to explore the source of the dissatisfaction with the current professional development offerings by considering factors such as timing, location, topic, format, delivery, schedule demands, etc.
- Collaborate with teachers and other stakeholders to improve the professional development offerings based on survey results.
- Analyze anonymous survey data regarding professional development as well as student assessment results to identify areas in need of professional development.
- Implement identified changes to the professional development program.

Recommendation #3: Support underrepresented populations and struggling students in the area of science to address the existing achievement gap. Specifically:

- Offer targeted professional development, and
- Work with teachers in the use of formative assessment to identify struggling students and address instructional needs.

Response: The Science Office recognizes that the achievement gap persists. While the gap had been narrowing in recent years, the testing of the new, more rigorous, science Standards of Learning in the 2012–13 school year showed a widening of the gap across all subjects.

The Science Office will work to implement the following action steps:

- Continue SIOP training and increase accountability for its implementation through classroom observations, work products, and peer observations.
- Collaborate with principals and counselors to promote appropriate student placement along science course pathways as outlined in Recommendation #4.
- Develop pacing guides at the secondary level to support all teachers responsible for science instruction, including our special education and HILT teachers as well as teachers who are new to the curriculum.
- Encourage the use of formative assessments at the secondary level to catch struggling students earlier, differentiate instruction, and address individual instructional needs.
- Work with Student Services to identify pathways for providing support to teachers and students with disabilities in the self-contained setting.
- Identify instructional materials which allow for the differentiation of curriculum to meet the needs of all learners.

Recommendation #4: Develop additional pathways for students to achieve an advanced studies diploma. Provide alternative courses to ensure that students can move through the pathway.

Response: Additional course pathways will provide students with greater opportunities and flexibility in how they can achieve an advanced studies diploma. This will be particularly helpful in light of the elimination of the modified standard diploma.

The Science Office will work to implement the following action steps:

- Collaborate with principals and counselors to promote appropriate student placement.
- Establish new recommended courses of study for students to achieve standard and advanced studies diplomas, for example offering the Environmental Science course at all comprehensive high schools.
- Develop and promote a course articulation document which will outline the criteria for recommending students for advanced course work.
- Explore additional online course opportunities for students to fulfil graduation requirements.

Recommendation #5: Continue to monitor relationship between elementary instructional models and SOL results.

Response: The Science Office is concerned with the findings from the Hanover report that indicate a correlation between some instructional models at the fifth grade level and lower SOL outcomes. While we are unsure as to the cause of this correlation, the office will research and monitor these results to ensure that all students are receiving quality science instruction. The Science Office will work to implement the following action steps:

- Track SOL outcomes for students in each of the instructional models.
- Monitor the level of integration of science with other subject areas.
- Support teachers with the integration of science with other subject areas through existing resources and providing professional development sessions.

Recommendations with Policy and Budget Implications

Recommendation #6: Implement scheduling requirements at the elementary level that mandate the amount of time students are required to participate in science instruction each week by grade. Mandate formative assessment in grades 2–5.

Response: According to the Hanover analysis of the effect of elementary delivery models and instructional hours on science proficiency, there is a direct positive correlation between the number of minutes that are devoted to science instruction and SOL outcomes at the fifth grade level. The Science Office firmly supports this recommendation, which is reflective of the work and recommendations of the Science Advisory Committee. According to the National Science Education Standards, "Time is a major resource in a science program. Science must be allocated sufficient time in the school program every day, every week, and every year."[1] In addition, the National Science Teachers Association (NSTA) not only recommends science instruction on a daily basis, but also that "all students at the preschool and elementary level should receive multiple opportunities every week to explore science labs."[2]

[1] National Research Council. *National Science Education Standards*. Washington, DC: The National Academies Press, 1996.

[2] NSTA Board of Directors. *The Integral Role of Laboratory Investigations in Science Instruction*. Web. 5 Feb. 2014. <http://www.nsta.org/about/positions/laboratory.aspx>.

SECTION 1: BACKGROUND

The evaluation of the Science program began in 2010–11 with the creation of a program evaluation design. Data collection was delayed one year to accommodate the accelerated schedule for the evaluation of services for English language learners. This evaluation employed various methodologies to collect data with which to examine the success of the Science program over time. In particular, this report addresses the following three evaluation questions outlined in Arlington Public Schools (APS) policy and procedures (45-3) for accountability and evaluation:

1. How effectively was the Science program implemented?
2. What were the outcomes for the targeted populations?
3. How satisfied are users with the Science program?

This report is divided into three main sections: (1) background on the Science program and the methodology used to evaluate it; (2) findings related to implementation, outcomes, and satisfaction; and (3) recommendations for program improvement.

Appendices that contain definitions, original datasets, and various reports used to inform this evaluation are located online at www.apsva.us/evaluationreports.

Science Program Description — *Prepared by the Science Office*

Program Overview

The APS Science Program serves to inspire an enthusiasm for scientific literacy, foster an inquisitive spirit in learners through inquiry-based experiences in real-life contexts, and create a community of scientifically literate individuals who are able to make informed decisions.

Goals and Objectives

The goals and objectives for science instruction in APS reflect the Standards of Learning (2010) adopted by the State of Virginia, and the National Science Education Standards (1996) developed by the National Research Council and recognized and adopted by the National Science Teachers Association (NSTA). The Science program supports APS in meeting its overall Strategic Plan Goals:

Goal 1: Ensure that Every Student is Challenged and Engaged

Goal 2: Eliminate Achievement Gaps

Goal 3: Recruit, Retain and Develop High-Quality Staff

Goal 4: Provide Optimal Learning Environments

Goal 5: Meet the Needs of the Whole Child

To support these goals, the APS Science Office works with building administrators to support science teachers and science instruction. This includes reviewing available courses to ensure that course offerings match the needs of students in the district, identifying gaps in student achievement and developing plans for addressing these gaps, supporting teachers with curriculum and resources that reflect best practices in science education, and providing equipment necessary to perform effective hands-on science lessons and teaching science through inquiry-based instruction.

The APS Science Office emphasizes improving science achievement for all students across all disciplines, and is also focused on eliminating achievement gaps by identifying areas of need through data analysis.

Attributes of Success

Through successful implementation, the APS Science program should develop and exhibit the following characteristics:

- Achievement is rising for all students (report card grades; SOL passing rates; and advanced science course enrollment).
- All students have the opportunity to actively engage in a variety of challenging and relevant experiences in science that provide for independent application of skills, procedures, and processes.
- The core curriculum contains clear and rigorous content and performance standards for all learners while aligning with desired results, provides variety for teachers and students, and emphasizes conceptual organization.
- Staff provides learning experiences that reflect instructional best practices and emphasize depth of understanding and a lifelong commitment to learning.
- Family and community members are involved in science experiences (as measured by attendance to Science Nights, Smithsonian Family Nights, Outdoor Lab family events, etc.).
- Professional development is ongoing, addresses specific needs of participants, and is measurable.

Students participate in school-based science fairs and the Virginia Junior Academy of Science (VJAS). The progress of students in science is measured through standardized tests at various grade levels and teacher-developed assessments based on best practices in science education. These tests include Virginia Standards of Learning (SOL) tests at grade levels 3, 5, 8, and end of course (EOC) for Biology, Chemistry, and Earth Science. National assessments include Advanced Placement (AP) exams and International Baccalaureate (IB) exams. Progress is also measured by the number of science courses each student takes, as well as their enrollment in advanced science courses.

Program Attributes

The science program serves both APS students and staff. The intended recipients of science services include more than 23,000 children who comprise the K–12 population of APS. The APS science program incorporates best practices in science instruction including hands-on and inquiry-based learning, investigative laboratory experiences, and independent research projects.

The challenge faced by the Science Office is to meet the varied curricular needs of each of these students, including those identified as gifted and talented, learning English as a second language, or needing special education services. For this reason, the Science Office staff meet frequently with teachers at all grade levels and with those who work with special populations of students to disseminate information and discuss and resolve teacher and student concerns as they relate to science.

Elementary Level

At the elementary level, students learn scientific concepts that align to the following strands of knowledge:

- scientific investigation, reasoning, and logic;
- force, motion, and energy;
- matter;
- life processes;
- living systems;
- interrelationships in earth/space systems;
- Earth patterns, cycles, and change; and
- Earth resources.

Secondary Level

At the secondary level, students have opportunities to learn science in areas that include but are not limited to Biology, Earth and Space Science, Chemistry, Physics, Environmental Science, Animal Science, Biotechnology, Astronomy, Forensics, Physical Therapy/Sports Medicine Technology, and Basic Anatomy/EMT.

Curriculum

Tables 1 and 2 show each SOL course including, but not limited to, major topics of study that are part of the Virginia standards for each course. The science curriculum is developed in accordance with the Virginia State SOL requirements. The courses listed in the tables do not constitute a comprehensive list of the courses offered, as they represent only those courses that are governed by the state SOLs.

Table 1: Major Topics of Study, Elementary

SOL Course	Major Topics of Study
K	Five senses; descriptions; sequencing; magnets; physical properties; basic life needs; shadows; patterns; routines; change; reusing; recycling; conserving.
1	Classifying; measuring; predicting; moving objects; interactions with water; plant and animal needs, parts, and characteristics; night and day; effects of the sun; seasons; limitations of resources; air and water quality.
2	Measurement; classification; graphs; magnetism; states of matter; changes in state; mass and volume; stages in animal life; flowering plants; habitats; weather; effects of weather and seasonal changes on growth and behavior; benefits of plants.
3	Making predictions, observations, and drawing conclusions; simple and complex machines; physical properties; animal adaptations; food chains; environments; soil; animal and plant life cycles; phases of the moon; survival of species; sources of energy.
4	Hypotheses; measurement; characteristics of motion; friction; kinetic energy; electricity; electromagnets; plant anatomy and reproduction; photosynthesis; ecosystems; weather measurements and predictions; solar system; relationship between earth, sun, and moon.
5	Classification keys; graphing data; variables; sound; light; matter; cell structure and function; oceans; rock cycle; plate tectonics; erosion.

Table 2: Major Topics of Study, Secondary

SOL Course	Major Topics of Study
6	Use of models; metric measurement and tools; procedures; sources of energy and their transformations; solar energy; atoms; water properties and characteristics; earth's atmosphere; watersheds; solar system organization and interaction; and environmental policy.
Life Science–7	Experimental error; variables and constants; cells; classification of organisms; populations and ecosystems; photosynthesis; genetics; adaptations, natural selection, and evolution.
Physical Science–8	Metric conversions and prefixes; nature of matter; atomic structure; chemical bonding; periodic table; forms of energy and their conversions; heat measurement and transfer; waves; electricity; magnetism; motion; force; work; power; and efficiency.
Earth	Reading maps and globes; characteristics of earth and the solar system; properties of rock and ore minerals; rock cycle; rock types; renewable and nonrenewable resources; plate tectonics; influences of geologic processes and human activity on freshwater resources; evolution through the fossil record; ocean variations; atmosphere and the influences that affect it; weather patterns; and theories of the origins of the universe.
Biology	Chemical and biochemical principles essential for life; cell structure and function; life functions of Archaea, Bacteria, and Eukarya; inheritance; protein synthesis; classification; changes in populations; and equilibria within populations, communities, and ecosystems.
Chemistry	Structure of the periodic table; conservation of energy and matter; stoichiometry; chemical bonding; Acids and Bases; concentrations and molar relationships; kinetic theory of matter; phases of matter; and chemical properties related to organic and biochemistry.
Physics	Kinematics; gravitation; conservation of mass, energy, momentum, and charge; transfer of energy to provide work; waves; electromagnetic spectrum; gravitational, magnetic, and electric fields; circuits; and understanding of the non-uniform application of scientific law.

Best and Current Practices

Science instruction in Arlington Public Schools is built around the principles of scientific inquiry and engaging students in scientific discourse. The National Science Education Standards defines scientific inquiry as "the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities through which students develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world. [3]"

Through inquiry-based instruction, students learn how to ask questions, design controlled experiments to test the question, and interpret the results of the experiment to generate conclusions that can be applied to the world around them. These skills are developed through a scaffolding approach across the K–12 science curriculum. Engaging in complex classroom discussion with teachers and classmates allows students to learn the important communication skills necessary to share what they have learned and comment on the work of others.

The Science Office staff

- provides curriculum guides to teachers of science at the elementary and secondary levels;
- provides expertise in science instruction for all elementary, middle, and high school students;
- supports ESOL/HILT and Special Education science instruction;
- sponsors, organizes, and implements the Northern Virginia Regional Science Fair, which includes students from APS, Alexandria City Schools, and Falls Church City Schools, as well as the private schools in the three jurisdictions;
- organizes and supports student participation in state and national science competitions, such as Virginia Junior Academy of Science (VJAS), Virginia Science and Engineering Fair and International Science and Engineering Fair (ISEF);
- coordinates district-wide science activities including scientist guest speakers; Smithsonian Family Science Night; and Scientist in the Classrooms;
- works with Human Resources to attract and select highly qualified candidates;
- coordinates and supports summer school courses at the high school level and Outdoor Lab summer camp opportunities at the elementary and middle school levels;
- coordinates the review and selection of science textbooks and support materials at the elementary and secondary levels, to include ESOL/HILT and Special Education; assist teachers with the science supply and equipment reorders; manage textbook supplemental and ancillary material reorders;
- coordinates the inventory, management and disposal of chemicals at middle and high schools
- provides curriculum, program review and purchase, coordination of transportation, and delivery of services for school field trips to the Planetarium and the Outdoor Lab;
- develops and maintains the science program Web site;

[3] *National Science Education Standards: observe, interact, change, learn* (4. printing. ed.). (1996). Washington, DC: National Academy Press.

- participates in ongoing communication with other departments and offices, including but not limited to Mathematics, Social Studies, English Language Arts, Gifted Services, Early Childhood Education, Minority Achievement, ESOL/HILT, Special Education, Career and Technical Education, and Professional Development;
- participates as active members of state and national organizations; and
- serves on national, state, and local committees dedicated to the improvement of science education.

Professional Development

The Science Office staff provides staff development and curriculum development opportunities for the elementary and secondary programs. Using achievement data, the Science Office provides professional development to assist teachers in addressing areas of need. The professional development activities are delivered in a variety of methods including, but not limited to, after-school workshops, countywide meetings, teacher in-services, and one-on-one supports. In addition, the Science Office

- coordinates district-wide science activities including scientist guest speakers; Smithsonian Family Science Night; and Scientist in the Classrooms;
- provides support and evaluation of science teachers at all levels;
- coordinates quarterly Science Lead Teachers at the elementary and secondary levels;
- coordinates monthly mandatory countywide meetings for all secondary staff to support professional learning communities (PLCs) and Sheltered Instructional Observation Protocol (SIOP); and
- provides optional teacher workshops addressing office initiatives and identified areas of need, such as the 2013–14 offerings listed below.
    - new textbook adoption materials
    - safety and chemical management
    - instructional technology training, specifically using scientific probeware for data collection
    - sustainability education
    - strategies for working with English Language Learners (ELLs)
    - planetarium
    - engineering in the elementary classroom
    - animal care
    - infusion of science into language arts

Resources

The budget for the Department of Instruction includes funds for approved curriculum and staff development. The FY 2014 budget includes $932,365 that is shared among **all** instructional programs to pay for

- salaries for curriculum work done by teachers;
- salaries and costs for in-service professionals, including outside consultants, contract courses, and staff participating in professional learning outside of their contract hours; and

- conference registration fees for both presenters and attendees.

In addition, the Department of Instruction provides funds for purchase of science textbooks and support materials in an adoption year. In FY2013, $1,100,000 was used to purchase elementary school science textbook adoption materials. In addition to materials provided by the Department of Instruction, all school budgets provide resources to replace and supplement instructional materials and supplies each year.

Implementation of the Science Program is the responsibility of the four employees in the Science Office (Science Supervisor, two Science Specialists, and an Administrative Assistant) as well as elementary and secondary teachers of science (including ancillary leadership positions), principals, assistant principals, and costs associated with use of the Outdoor Lab and Planetarium program extensions.

The primary responsibilities of the four Science Office employees are described in Table 3:

Table 3: Science Office Staff and Responsibilities

Employee	Primary Responsibilities
Science Supervisor (fulltime)	The Supervisor for the Science Program is responsible for the development, implementation, and evaluation of the Science Program at the elementary and secondary levels, including coordination of the Outdoor Lab and Planetarium. The Supervisor also recommends appropriate changes in the program to reflect trends in science education based on current research. The Supervisor is the functional unit manager for system-wide local, state, and federal funds designated for the Science Program. The Science Specialists, Outdoor Lab Director, and Planetarium Director work with the Supervisor to provide the previously outlined services. The Science Supervisor • interviews potential science teachers and assists administrative staff at schools in the hiring process; • supervises programs at the Outdoor Lab and Planetarium; • observes and evaluates all secondary probationary science teachers; • serves as Director for the Northern Virginia Regional Science Fair; • provides leadership in countywide science instruction; • acts as staff liaison to the Science Advisory Committee; • acts as staff instructional liaison to the Superintendent's Committee of Sustainability; • provides leadership in review of instructional materials, including textbooks; and • Coordinate the elementary Scientists in the Classroom program
Science Specialists (1 fulltime and 1 halftime)	The Science Specialists are responsible for coordinating the elementary and secondary programs, working directly under the supervision of the Science Supervisor. The Science Specialists • plan and provide staff development and curriculum development for elementary and secondary students and teachers of science; • provide direct assistance to elementary and secondary science teachers; • revise and adapt curriculum to ensure system-wide consistency of standards; • oversee the secondary science summer school program;

	• work with other instructional programs and departments to provide effective instructional programs that integrate with science; • serve as Assistant Director for the Northern Virginia Regional Science Fair; • serve as Scientific Review Committee Chair for science research projects; • coordinates APS participation in the Virginia Junior Academy of Science; • assist with textbook adoption at the elementary and secondary levels; and • provide support with curriculum and instructional support for ESOL/HILT teachers.
Administrative Assistant (fulltime)	The Administrative Assistant is responsible for supporting the facilitation of the Science Program. The Administrative Assistant • coordinates efforts with the Outdoor Lab and Planetarium Director to schedule and plan classroom visits; • assists with planning for the Northern Virginia Regional Science Fair; • maintains databases for the Northern Virginia Regional Science Fair, including judges, student entries, and awards; • manages federal, state, and local financial accounts for science; • manages accounts for the Outdoor Lab and Planetarium; • assists in coordination of professional development activities; • processes information related to the science program; and • coordinates registration, hiring and budgeting for the Outdoor Lab camps.

The teaching staff for FY 2014 is funded through school planning factors and includes the following positions that support Science instruction:

Elementary Level

- All classroom teachers
- Science Specialists (teach only science)[4]
- Special Project Coordinators[4]
- Gifted and Talented Resource Teachers

Secondary Level

- 107 science teachers
- Special Project Coordinators[4]
- Gifted and Talented Resource Teachers

In addition, many special education teachers and ESOL/HILT teachers are responsible for the education of students in the area of science. The average teacher salary in FY2014 is $74,384.

Program Extensions: Outdoor Lab and Planetarium

Both the Outdoor Lab and the Planetarium are funded by APS but are not part of the Science Program budget. The Outdoor Lab has an overall budget of $387,130 in FY2014, including a $106,668 annual lease payment. Maintenance and upkeep are the responsibility of the Arlington Outdoor Education Association (AOEA). The Planetarium has an overall budget of $208,176 in FY2014. Maintenance and

[4] Specialists and Project Coordinators are not county-wide positions and exist in select elementary schools.

upkeep are the responsibility of APS. Both the Outdoor Lab and the Planetarium are run by two fulltime directors who report to the Science supervisor.

Table 4: Program Extension Staff and Responsibilities

Employee	Primary Responsibilities
Outdoor Lab Director (fulltime T-scale)	• oversees day-to-day operations; • develops and implements curriculum appropriate for outdoor education; • works with teachers at the elementary and secondary levels to provide an effective instructional program that extends classroom instruction and supports student learning; • supervises additional Outdoor Lab personnel (2 fulltime instructional assistants); • coordinates and/or performs necessary repairs and alterations to the land, buildings, and overall learning environment; • assesses overall health of the water, land, and additional resources; • coordinates and participates in environmental studies; • develops a yearly schedule for district-wide participation in Outdoor Lab experiences at various grade levels; • serves as a liaison between APS Science Office and Arlington Outdoor Education Association (AOEA); • oversees the implementation of the Outdoor Lab summer camp; and • implements a budget in coordination with the Science Supervisor.
Planetarium Director (fulltime T-scale)	• oversees day-to-day operations; • develops and implements appropriate programs for students and community members; • works with teachers at the elementary and secondary levels to provide effective programming that extends classroom instruction and supports student learning; • coordinates necessary repairs to equipment; • works with APS teachers as well as non-APS teachers to schedule program attendance; • implements a budget in coordination with the Science Supervisor; and • assists in providing evening and weekend programs for the community.

Status of Recommendations Made in Previous Evaluations

The Science Program was last evaluated in 2007 and included the following recommendations:

To Be Completed by Science Program Staff

Recommendation	Status
To be completed by Science Program Staff:	
1. Identify strategies that would alleviate the enrollment imbalances by gender and ethnicity.	Ongoing. This includes discussions with central office staff and school based staff.
2. Renew emphasis on curriculum alignment in professional developments efforts.	Completed. Last update revision was in 2012.
3. Identify and increase teacher awareness of curriculum, textbook and resources materials that embed technology in science instruction	Ongoing. In addition to electronic communication, sharing and dissemination has occurred at countywide, lead teacher and principal meetings.
4. Continue to increase awareness and promote the mandated time commitments for science instruction.	Promotion of mandated science time is ongoing. There is still no mandated instructional time in elementary school.
5. Determine instructional goals for the Planetarium, and review the current programs to determine if they are aligned with the APS curriculum and developmentally appropriate.	Ongoing. Several new programs with SOL alignment have been implemented.
6. Revisit the district's vision and goals for its science program. Consider using an established strategic planning protocol, such as that offered by the National Science Resources Center (see www.nsrc.org).	Revisited program mission and vision. Currently working on process improvement plan with school district.
7. Continue the development of the curriculum as defined and outlined in a "Process for Designing a Curriculum Program" (see Designing Mathematics or Science Curriculum Programs), National Research Council, National Academy Press, Washington DC, 1999).	Completed. Curriculum updated in 2012.
8. Review current research and best practice standards for professional development and develop a strategic plan for professional development that is aligned with a district vision and goals for improving science instruction.	Ongoing.
9. Develop a strategic plan for professional development that is aligned with a district vision and goals for improving science instruction.	Ongoing. Working with the Office of Professional Development to develop a strategic plan that aligns with the mission and vision for APS science program.
10. Engage each school in developing a vision and measurable goals for science instruction that are aligned to and supportive of the district's plan.	Ongoing. Science Office has met with individual schools to discuss goals for programming and student achievement.

Requiring Work with Others at the School Level

Recommendation	Status
Requiring work with others at the school level:	
11. Involve representatives of all stakeholder groups in strategic planning, including leaders of alternative science programs.	Ongoing. Working with Science Advisory Committee and Lead Science Teachers for strategic planning purposes. Lead Science teachers include representatives of all buildings, including alternative programs.
12. Institute strategic, ongoing professional development for lead teachers, science teachers, and administrators focused on proven or promising strategies and best practices for meeting specific goals for science program improvement.	Ongoing. Recent initiatives include inquiry based science and the SIOP model.
13. Establish an Instructional Materials Review committee; review current research on effective instructional materials; and establish criteria with which to evaluate science instructional materials including those currently used in classrooms and alternative programs.	Accomplished. This was done in preparation for the textbook adoption process of 2012–13.

Expressed Concerns

A number of concerns have been identified through discussions with teachers and members of the Science Citizens Advisory Committee. Issues discussed include scheduling, staffing, achievement, and enrollment trends.

Scheduling is a concern, particularly at the elementary level. The National Science Education Standards recommend that "Science must be allocated sufficient time in the school program every day, every week, and every year." For many teachers, this goal is difficult to achieve, given the current constraints from other curriculum areas. Anecdotal comments provided additional evidence in this regard. In 2011, as part of the program evaluation process, written schedules were requested and provided by each school that showed scheduled science time. These schedules also contained additional comments from elementary science lead teachers such as:

> "Science is not being taught that day."
>
> "Science is not being taught that week."
>
> "We are having a special event that week, so we are not having science."
>
> "We have a field trip, so we are not having science."
>
> "Nobody seems to have a set time for science."
>
> "[The] science [we teach] is not in line with the county curriculum."
>
> "The time could be either science or social studies."
>
> "We teach science for a few weeks and then social studies for a few weeks."

Gaps in student achievement and enrollment in advanced science courses are another concern. In both of these measures, Black and Hispanic students lag compared to White and Asian students.

A lack of sufficient funding for professional development denies teachers the opportunity to improve instruction (delivery methods, alignment to curriculum, and strategies), especially for special populations, such as students with disabilities and English language learners.

Funding shortages also impact the ability to purchase and maintain quality equipment used for experimentation. Increasing class size poses a safety concern in the science laboratory setting. As class sizes increases, the ability to conduct experiments safely is compromised.

A concern for the Outdoor Lab is one of capacity. Currently, the lab is only able to serve students in grades 3, 5, and 7. As enrollment increases in Arlington, the level of service for these groups will not be sustainable.

Methodology

Evaluation Design and Questions

Data collection for this evaluation started in the fall of 2011–12 and was then delayed to accommodate the accelerated schedule for the evaluation of services for English language learners. Data collection resumed in the fall of 2012–13. The evaluation design process began with a review of the previous Science evaluation (2007). A draft design was developed following the guidelines in *APS Policy Implementation Procedure 45-3, Accountability and Evaluation*, and was revised based on input from Science lead teachers and the Science Citizens Advisory Committee. The Science evaluation design can be found in Table 5.

Table 5: Science Evaluation Design

Program/Service Objective	Program/Service Question	Data Source(s)
Evaluation Question 1: Implementation *How effectively was the Science program implemented?*		
All elementary students participate in the recommended time for science instruction.	1a To what extent is time for instruction consistent for elementary students? 1b To what extent do elementary teachers report that students are pulled from science instruction?	Existing Tools, Data Sources: • Classroom Assessment Scoring System (CLASS) Tools to be Developed: • Science Observation Checklist • Teacher survey
Best instructional practices for emotional support, classroom organization, instructional support and student engagement are evident across instruction in Science.	2a To what degree are best instructional practices evident in K-12 Science classrooms?	Existing Tools, Data Sources: • CLASS
Science instruction follows the VA/APS curriculum framework.	3a To what extent is observed science instruction aligned with the state standards and APS curriculum? 3b To what extent are grade 4 Science standards addressed, either in grade 4 or in grade 5? 3c To what extent is science instruction integrated with other content areas? 3d To what extent does outdoor learning occur at the school site?	Existing Tools, Data Sources: • Outdoor lab participation Tools to be Developed: • Science Observation Checklist • Teacher survey
All science teachers have the necessary content knowledge to successfully teach the curriculum.	4a To what degree are elementary teachers trained in scientific concepts? 4b Are elementary teachers confident about their science knowledge in order to teach the science content effectively?	Tools to be Developed: • Science Observation Checklist • Teacher survey
The Outdoor Lab supports teacher instruction and extends student learning.	5a To what degree do the outdoor lab and outdoor classrooms (K–12) support instruction and extend student learning?	Tools to be Developed: • Teacher survey

Program/Service Objective	Program/Service Question	Data Source(s)
Evaluation Question 1: Implementation, continued *How effectively was the Science program implemented?*		
All APS students participate in science and develop the scientific knowledge and skills to become part of a productive global workforce of problem solvers and innovators.	6a To what degree do all high school students and all groups of high school students participate in science instruction beyond the minimum requirements for graduation? 6b To what degree are secondary students across grade levels required to participate in school-based science fairs? To what degree are students across grade levels required to conduct an independent science project? 6c To what extent do APS students participate in the Virginia Junior Academy of Science (VJAS) science fair? 6d What factors influence high school students' decisions to enroll in regular or intensified science courses?	Existing Tools, Data Sources: • Student information system (SIS) reports on the percentage of grade 9–12 students annually participating in science instruction • Secondary science fair requirements by school and course • Virginia Junior Academy of Science (VJAS) Report for participation rate Tools to be Developed: • Student focus groups

Program/Service Objective	Program/Service Question	Data Source(s)
Evaluation Question 2: Outcomes *What were the outcomes for the targeted populations?*		
All APS students participate in science and develop the scientific knowledge and skills to become part of a productive global workforce of problem solvers and innovators.	7a To what degree do students develop proficiency in science as demonstrated through state and national assessments? And how does Arlington's performance on assessments compare with state and national results?	Existing Tools, Data Sources: • Science SOL (Grades 3, 5 and 8) by competencies/strands • Science End-of-Course SOL (Earth Science, Biology and Chemistry) • AP and IB (Grades 11 & 12)
	8a To what extent do elementary students demonstrate proficiency based on the delivery of science instruction and the amount of time devoted to science instruction?	Tools to be Developed: • Commissioned analysis of the relationship between elementary SOL scores and instructional delivery model, time devoted to science instruction, and site-based survey responses • Elementary teacher survey
Program/Service Objective	**Program/Service Question**	**Data Source(s)**
Evaluation Question 3: Satisfaction *How satisfied are users with the Science Program?*		
Science instruction supports a variety of relevant science experiences for all students.	9a Are students actively engaged in science instruction as evident in observations? 9b Are students enthusiastic about science instruction across all grade levels? 9c How satisfied are parents with the science program?	Existing Tools, Data Sources: • CLASS • Site-based Survey • Student focus groups

Study Measures

Primary data sources were used to inform this evaluation and are described in detail.

Program Implementation—Observations of Teacher-Student Interaction Using CLASS

In 2010–11, APS adopted the Classroom Assessment Scoring System (CLASS) protocol to observe teacher-student interactions for all program evaluations. CLASS was developed at the University of Virginia's Curry School of Education and provides a common lens and language focused on classroom interactions that encourage student learning.

The CLASS framework is derived from developmental theory and research suggesting that interactions between students and adults are the primary mechanism of child development and learning. Research conducted in more than 6,000 classrooms concludes that grades Pre-K–5 classrooms with higher CLASS ratings realize greater gains in achievement and social skill development.[5] Research using the CLASS-S (secondary) has shown that teachers' skills in establishing a positive emotional climate, their sensitivity to student needs, and their structuring of their classrooms and lessons in ways that recognize adolescents' needs for a sense of autonomy and control, for an active role in their learning, and for opportunities for peer interaction were all associated with higher relative student gains in achievement.

The CLASS tool organizes teacher-student interactions into three broad domains: emotional support, classroom organization, and instructional support. The upper elementary and secondary tools include an additional domain: student engagement. Within all domains except student engagement, interactions are further organized into multiple dimensions. These domains are described in detail in Appendix C1.

The Office of Planning and Evaluation recruited administrators and retired teachers to become certified CLASS observers through in-depth training provided by the University of Virginia. Over the course of two years (2011–12 and 2012–13), certified CLASS observers visited approximately 700 classrooms to obtain the data reflected in this report. Roughly 59% of the classes observed were elementary Science classes; 16% were middle school Science classes; and 25% were high school Science classes. In addition, self-contained special education Science classes, ESOL/HILT Science classes that serve LEP (limited English proficient) students, and Spanish immersion Science classes were also observed for this report.

Details on CLASS scores by level and program can be found in Appendix C3.

Program Implementation—Observations of Content Instruction Using the Program Checklist

The Science Office and the Office of Planning and Evaluation developed an additional observation tool to assess best practices specific to science instruction that were not addressed by CLASS. In March 2013, both offices conducted an observer training for individuals who were retired APS elementary classroom or secondary science teachers. During the full-day training, ten observers developed a consistent understanding of the observation tool and were assessed for inter-rater reliability. Altogether, 102 elementary, 48 middle, and 77 high school Science classrooms were rated with the Science Checklist. Each classroom was observed only once, and each observation generally lasted 30 minutes. The classes selected reflected the range of Science instruction provided across APS and included special education, ESOL/HILT, Spanish Immersion, and accelerated classes in addition to mainstream instruction.

Checklist results by level and program can be found in Appendix C4.

Program Implementation—Enrollment

The Office of Planning and Evaluation used data collected through the APS student information system to report on enrollment in high school science classes. Specific information on enrollment by course type and by demographics can be found in Appendix D1.

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[5] http://curry.virginia.edu/uploads/resourceLibrary/CLASS-MTP_PK-12_brief.pdf Center for Advanced Study of Teaching and Learning Charlottesville, Virginia, **Measuring and Improving Teacher-Student Interactions in PK–12 Settings to Enhance Students' Learning.**

Program Implementation—Science Fair

During the 2012–13 school year, the Science Office collected information from secondary schools about each school's requirements for creating science projects and participating in the school-wide Science Fair. This information is summarized in Appendix E3.

Program Implementation—Virginia Junior Academy of Science

The Science Office provided the Office of Planning and Evaluation with data on the number of students participating in the Virginia Junior Academy of Science (VJAS) over the past five years. This information is summarized in Appendix E4.

Program Implementation—Outdoor Lab Visits

The Science Office provided a summary of which grade levels visit the Outdoor Lab each year. This information is available in Appendix E5.

Student Outcomes—Standards of Learning (SOL)

The Commonwealth of Virginia measures academic achievement through annual Standards of Learning (SOL) assessments. Students are expected to take grade-level science tests in grades 3, 5, and 8 as well as secondary end-of-course (EOC) tests upon completion of Biology, Chemistry, or Earth Science. The Office of Planning and Evaluation used SOL assessment data to report on academic achievement. Details on SOL results for students can be found in Appendix F1.

Student Outcomes—Relationship between Elementary Delivery Model and SOLs

In October 2013, the Office of Planning and Evaluation commissioned a report from Hanover Research (Hanover) on the relationship between 2013 elementary science SOL scores and instructional delivery models and time for science instruction at each school. Information about delivery models was collected by the Science Office from lead teachers. Information about time for instruction was collected from teachers via the teacher survey. The Hanover report can be found in Appendix F2.

Student Outcomes—Advanced Placement (AP) and International Baccalaureate (IB)

Advanced Placement (AP) and International Baccalaureate (IB) courses offer students college-level credit during high school. Colleges vary in how they apply the credit but, generally, students earning scores of 3 or higher on AP exams or scores of 4 or higher on IB exams are awarded college credit or advanced standing. All AP and IB students in APS must take the exams associated with the courses in which they are enrolled. APS assumes the costs for these exams.

Through 2012–13, the College Board offered six AP science courses, and all were available to APS high school students: Biology, Chemistry, Environmental Science, Physics B, Physics C: Electricity and Magnetism, and Physics C: Mechanics. (In 2013–14, AP Physics B was converted into two new courses and corresponding exams: Physics 1 and Physics 2.) Students at Washington-Lee may enroll in the following IB science courses: Biology, Chemistry, Environmental Systems, or Physics.

The Office of Planning and Evaluation used AP and IB data to report on academic achievement for students enrolled in advanced science coursework. Details on AP exams and student outcomes can be found in Appendix F3. Details on IB exams and student outcomes can be found in Appendix F4.

Stakeholder Feedback—Teacher Survey

Four parallel teacher surveys were developed by the Science Office and the Office of Planning and Evaluation for elementary classroom teachers and science specialists, elementary science lead teachers, secondary science teachers, and secondary science lead teachers and department chairs. The surveys were pretested and revised in March 2013, then administered to all elementary classroom and secondary science teachers in April. A summary of survey responses can be found in Appendix B1.

Stakeholder Feedback— Site-based Survey

Bi-annual site-based surveys are designed to provide school-level feedback from students, teachers, and parents on issues including school climate, instructional support, cultural competence, the physical condition of the buildings, and related information. In 2013, questions about science instruction were added to the site-based surveys for the purpose of program evaluation. A summary of site-based survey responses regarding science instruction is included in Appendix B1.

Stakeholder Feedback— Student Focus Groups

APS contracted with an independent evaluator to conduct six focus groups in April and May of 2013: two with 8th graders, two with 9th and 10th graders, and two with 11th and 12th graders. The overarching goals of the focus groups were to learn about students' decision-making process when choosing science courses, to understand students' thoughts regarding science fair and its role in their course selections, and to explore students' levels of enthusiasm for science and their participation in science activities beyond the classroom. A summary of the middle school focus groups can be found in Appendix E1. A summary of the high school focus groups can be found in Appendix E2.

SECTION 2: FINDINGS

This section presents the findings associated with the three evaluation questions outlined in APS policy and procedures (45-3) for accountability and evaluation.

Evaluation Question #1:
How effectively was the Science program implemented?

To address this question, this evaluation focused on several areas: the delivery of science instruction, the quality of science instruction, the level of expertise held by APS science teachers, and student participation in science coursework and programs.

Delivery of Science Instruction

At the secondary level, science teachers teach course-specific science curriculum associated with the Virginia Standards of Learning (SOL), Advanced Placement (AP), or International Baccalaureate (IB) objectives. At the elementary level, all classroom teachers are expected to be able to teach science curriculum associated with the Virginia SOLs; however, some schools choose to assign science instruction to one or more particular teachers per grade level. In addition, a select number of elementary schools employ a science specialist who, at the discretion of the school, either teaches all science classes or supports classroom teachers in the delivery of science instruction.

Time for Science Instruction

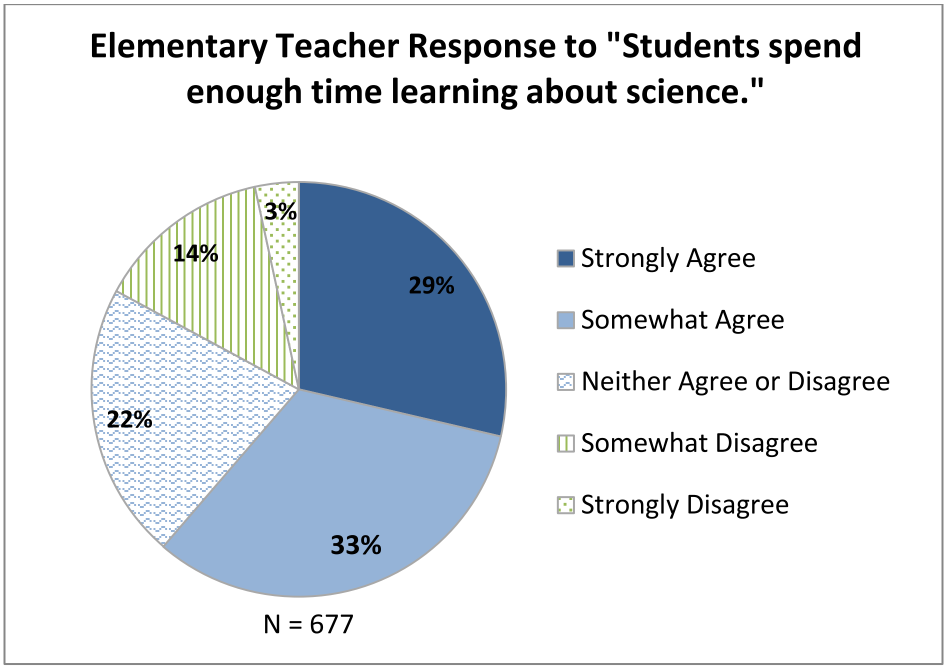
The Science Office suggests that 45 minutes of science instruction be provided each day at the elementary level. Currently, elementary schedules are left to the discretion of school administrators and the science instruction time varies depending on the grade level and school. At the secondary level, students attend science classes as scheduled.

In the spring of 2013, trained observers who were retired science teachers observed 102 elementary, 48 middle, and 77 high school science classrooms to determine the degree to which science content was being taught effectively. They used an observation tool, or checklist, created by the Planning and Evaluation Office and the Science Office to record their findings. Ninety-nine percent of the high schools observed taught science during the scheduled observation time, compared to 94% of the middle schools observed and 59% of the elementary schools. The primary reason for this, according to anecdotal feedback from elementary observers, was that another content area was being taught instead, typically Social Studies. (See Figure 13 in Appendix C4.)

According to the spring 2013 teacher survey, between 38% and 45% of Kindergarten, grade 1, and grade 2 teachers provide fewer than two hours of Science instruction per week. Teachers surveyed reported a higher amount of instructional time in the upper elementary grades, but still below the Science Office recommendations. Teachers reported providing fewer than three hours of science instruction per week in 12% of the 5th grade classrooms, 39% of the 4th grade classrooms, and 55% of the 3rd grade classrooms. (See Figure 1 in Appendix B1.)

When surveyed about whether the time devoted to science instruction at the elementary level was adequate, 17% of the elementary teachers surveyed stated that it was not.

Figure 1: Elementary Teacher Perception of Amount of Time Devoted to Science Instruction



Another factor that affects the amount of time students are exposed to science instruction is support services and activities (e.g., reading support or instrumental music). At the elementary level, students may be pulled out of their regular classes in order to participate in these services and activities. Twenty-two percent of the elementary teachers surveyed reported that their students are "sometimes" or "often" pulled out of science class. Of the elementary lead teachers surveyed, more than 50% reported that, to the best of their knowledge, students are pulled out of science instruction "sometimes" or "often." (See Figure 2 in Appendix B1.)

SOL Standards Addressed During Science Instruction

An SOL science assessment is administered for the first time in grade 3, and students are tested on objectives that align with the Virginia science standards taught in grades K through 3. Elementary students are tested in science again in grade 5 on standards taught in grades 4 and 5. These comprehensive assessments have bearing on how schools choose to address the standards over time.

According to 4th grade teachers who teach science, grade 4 science standards are not always taught in 4th grade. Thirty-five percent of the elementary teachers surveyed and 25% of the elementary lead teachers surveyed reported that 100% of the grade 4 science curriculum is taught in grade 4, while 10% of elementary teachers and 6% of elementary lead teachers reported that less than 25% of the grade 4 science curriculum is taught in grade 4. (See Figure 3 in Appendix B1.)

Grade 5 teachers who teach science and lead teachers were also surveyed to determine how much of the grade 4 science curriculum is covered as new material in grade 5. Twenty-eight percent of classroom teachers and 56% of lead teachers reported that more than half of the 4th grade science curriculum is taught as new material in grade 5. (See Figure 4 in Appendix B1.)

Integrating Other Content Areas into Science Instruction

Teachers at every level report taking deliberate steps to integrate curriculum from other disciplines into their science lessons. Ninety-five percent of elementary teachers, 83% of middle school teachers, and 74% of high school teachers reported that they "sometimes" or "often" integrate other content areas into science instruction. (See Figure 5 in Appendix B1.)

Collaboration with teachers in other subject areas for the purpose of pursuing cross-curricular units is not as frequent. On the secondary teacher survey, 14% of middle school science teachers and 26% of high school science teachers reported that they never collaborate with teachers in other subject areas. Fifty-six percent of middle school science teachers and 47% of high school science teachers reported that they collaborate with other teachers once or twice a year. (See Figure 6 in Appendix B1.)

Utilizing Outdoor Learning for Science Instruction

Every APS school has an outdoor space that may be used for science instruction. Elementary teachers reported using these spaces more than any other group. Approximately 30% of the elementary teachers surveyed said that they use their outdoor learning spaces more than 10 days per year. The majority of middle school teachers (72%) and high school teachers (55%) said they utilize their schools' outdoor learning spaces one to five days per year. Eleven percent of middle school science teachers and 26% of high school science teachers say they never use their outdoor learning spaces compared to 6% of elementary teachers. (See Figure 7 in Appendix B1.)

Teachers were asked to rate the degree to which outdoor learning spaces at their school supported science instruction and extended student learning. On a scale of 0 (not at all) to 5 (a great deal), the elementary school teachers gave outdoor learning spaces a mean score of 2.95. The mean score from middle school teachers was 1.42. The mean score from high school teachers was 1.82. (See Figures 8 – 12 in Appendix B1.)

In addition to these on-site spaces, there is an Outdoor Lab in Fauquier County that serves APS students across the division. Students in grades 3 and 7 may visit the Lab one day each year. Students in grade 5 are offered two consecutive days and may stay overnight, if desired. Due to an increase in elementary enrollment, the number of days allocated to each high school and secondary program has decreased to just one day per year beginning in 2013–14. (See Appendix E5.)

Teachers whose students had been to the Outdoor Lab were asked to rate the degree to which the Outdoor Lab experience supported science instruction and extended student learning. Using the same 0 to 5 scale, the mean score from elementary teachers was 4.03. The mean score from middle school teachers was 4.54, and the mean score from high school teachers was 4.45. (See Figures 13 – 17 in Appendix B1.)

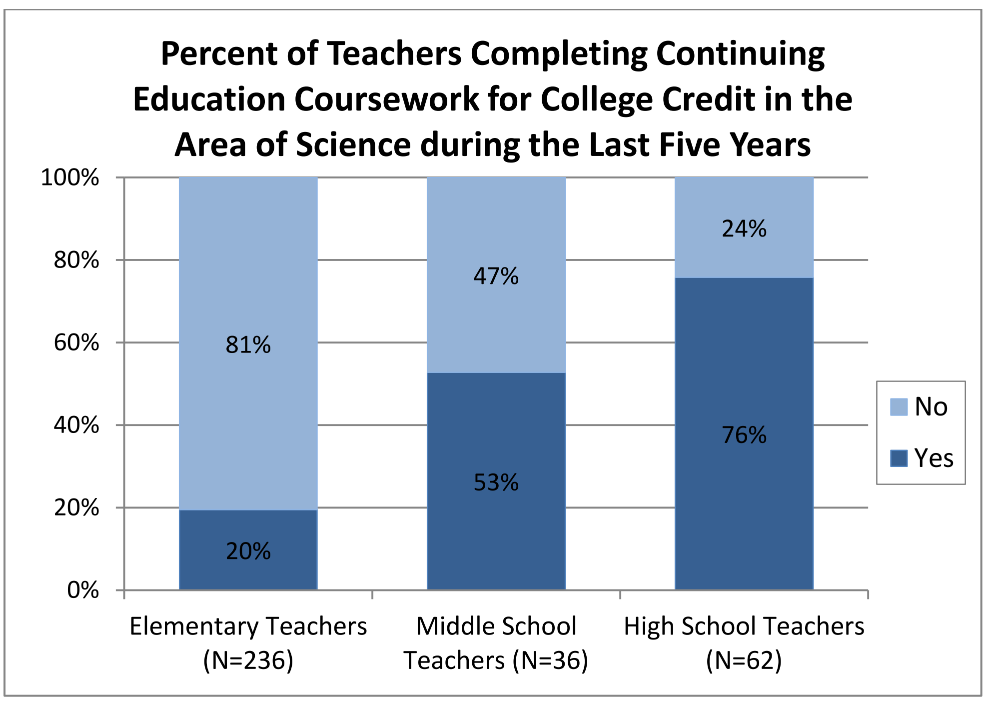
General Findings for Delivery of Science Instruction: *Based on over 100 elementary classroom observations, 59% of elementary classrooms held science instruction during scheduled times. The amount of time devoted to science instruction at the elementary level gradually increases between grades 2 and 5. A majority of elementary teachers say that not all of the grade 4 science standards are taught in 4th grade.*

More than 90% of the elementary teachers, more than 80% of the middle school teachers, and more than 70% of the high school teachers surveyed said they are working to integrate information from other subjects into their science lessons, but fewer than 30% of secondary teachers say they collaborate with other teachers to create cross-curricular units. Over 50% of elementary teachers use the outdoor learning spaces at their schools to support science instruction compared to roughly 17% of secondary teachers. Teachers across grade levels gave higher ratings to the Outdoor Lab than to their schools' outdoor learning spaces for effectively extending students' learning.

Quality of Science Instruction

Generally, secondary teachers are considered specialists, and elementary teachers are considered generalists. Whereas all secondary teachers must be certified in science in order to teach science, elementary school teachers do not have that requirement. However, to maintain their teaching certification, all teachers must periodically prove they are continuing to learn in their field. A greater percentage of high school teachers than middle school teachers, and a greater percentage of middle school teachers than elementary school teachers, reported that they had enrolled in science courses for college credit.

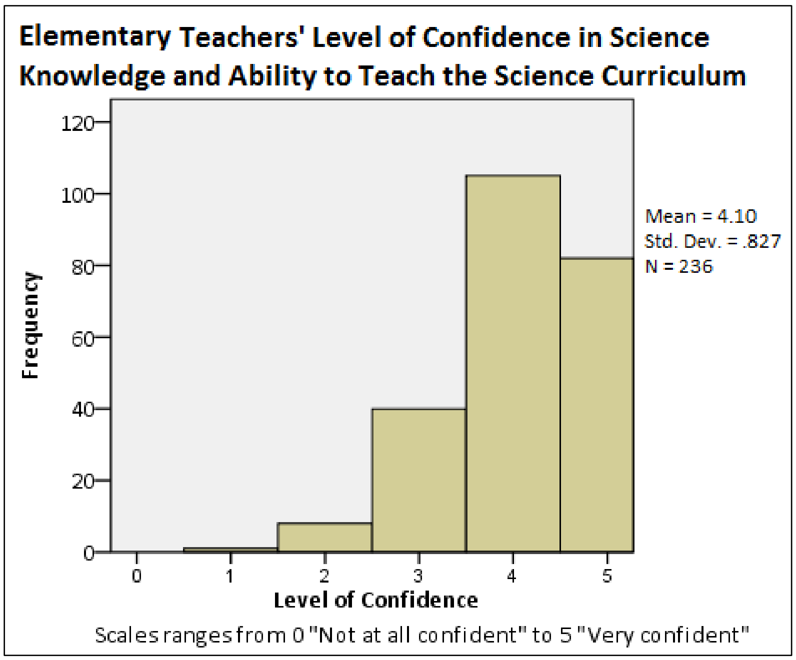
Figure 2: Percent of Teachers Completing Science Coursework for College Credit in the Last Five Years



Similarly, over the last five years, more high school science teachers (92%) than middle school science teachers (86%), and more middle school science teachers than elementary school teachers (50%) completed professional development in science. However, it should be noted that APS historically has not provided many professional development opportunities in science to elementary school teachers. (See Figure 19 in Appendix B1.)

Elementary teachers reported that they are confident in their ability to teach the science curriculum. When asked to rate their level of confidence in understanding the science curriculum, elementary teachers responded with high confidence levels on a scale of 0 (not at all confident) to 5 (very confident).

Figure 3: Elementary Teachers' Level of Confidence in Teaching the Science Curriculum



Elementary lead teachers provided a similar confidence level. (See figure 23 in Appendix B1.)

CLASS Assessment of Best Instructional Practices

The CLASS observation tool, developed by the University of Virginia's Curry School of Education, was used to assess the interactions between teachers and students to help evaluate the degree to which best instructional practices were utilized during APS science lessons. The CLASS tool organizes these interactions into three broad domains: (1) Emotional Support, (2) Classroom Organization, and (3) Instructional Support. The upper elementary and secondary CLASS tools employ an additional domain: (4) Student Engagement. Each domain contains specific observable dimensions that are age-appropriate.

Table 6: CLASS Domains and Dimensions

Domain	Dimension	Grade Level	Measures
Emotional Support	***Positive Climate***	K – 12	Emotional connection among teachers and students, verbal and non-verbal
	Negative Climate	K – 12	Expressed negativity among teachers and students, verbal and non-verbal
	Teacher Sensitivity	K – 12	Teacher awareness and responsiveness to students' academic and developmental needs
	Regard for Student/Adolescent Perspectives	K – 3	Degree to which lessons tap into students' interests and promote responsibility
		4 – 12	Degree to which lessons value students' ideas and opinions and promote autonomy
Classroom Organization	***Behavior Management***	K – 12	Teachers' use of clear behavioral expectations and effectiveness at redirecting misbehavior
	Productivity	K – 12	How well the teacher manages time and routines so instructional time is maximized
	Instructional Learning Formats	K – 12	Teachers' employment of lessons and materials to support different learning styles
Instructional Support	***Concept Development***	K – 3	Use of instructional discussions to promote higher level thinking skills
	Content Understanding	4 – 12	Depth of lesson and approaches used to support comprehension
	Analysis and Problem Solving	4 – 12	Degree of higher-level thinking skills, such as metacognition (i.e., thinking about thinking)
	Quality of Feedback	K – 12	Degree to which feedback expands learning and understanding
	Language Modeling	K – 3	Quality and amount of language-stimulation and facilitation techniques
	Instructional Dialogue	4 – 5	Use of purposeful dialogue distributed among students and with teacher
Student Engagement		4 – 12	Degree to which all students are focused and participating

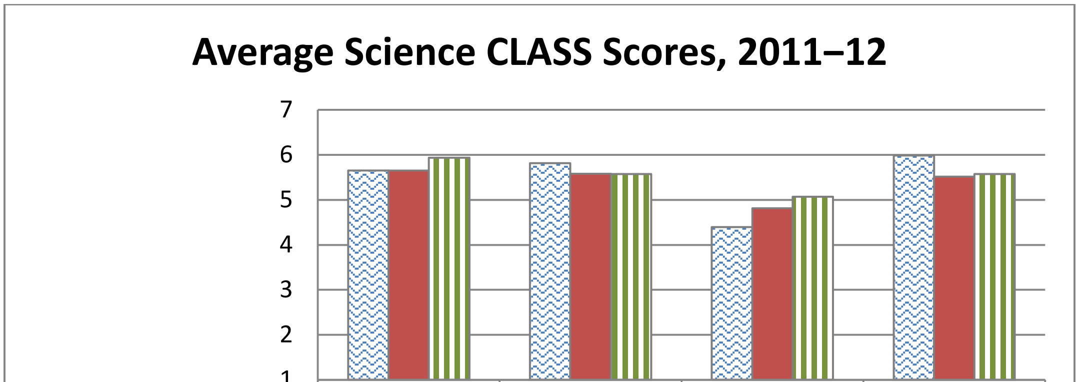
Additional information on CLASS and its alignment with APS Best Instructional Practices can be found in Appendix C1 and Appendix C2.

Certified CLASS observers visited approximately 700 classrooms over two school years (2011–12 and 2012–13) to obtain the CLASS data reflected in this report. Roughly 59% of the of the classes observed were elementary science classes, 16% were middle school science classes, and 25% were high school science classes. These observations included self-contained special education science classes, ESOL/HILT sciences classes, and Spanish immersion science classes.

Each dimension is scored on a 7-point scale consisting of Low (1, 2), Mid (3, 4, 5), and High (6, 7) ranges.

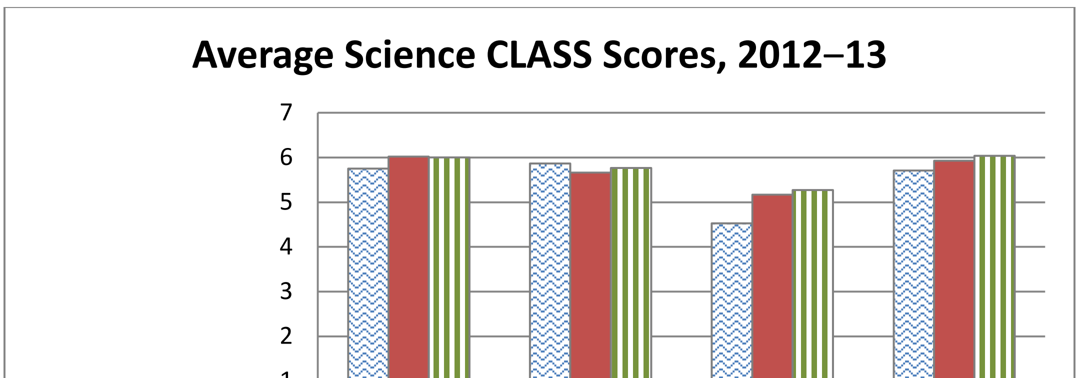
All grade levels received high mid-range to high scores in three domains: Emotional Support, Classroom Organization, and Student Engagement. Elementary, middle, and high school classrooms achieved mid-range scores in the Instructional Support domain.

Figure 4: Average Science CLASS Scores by Domain and Grade Level, 2011–12



	Emotional Support	Classroom Organization	Instructional Support	Student Engagement (4–12)
Elementary (n=226)	5.6	5.8	4.4	6.0
Middle School (n=60)	5.7	5.6	4.8	5.5
High School (n=94)	5.9	5.6	5.1	5.6

Figure 5: Average Science CLASS Scores by Domain and Grade Level, 2012–13



	Emotional Support	Classroom Organization	Instructional Support	Student Engagement (4–12)
Elementary (n=192)	5.7	5.9	4.5	5.7
Middle School (n=54)	6.0	5.7	5.2	5.9
High School (n=81)	6.0	5.8	5.3	6.0

Taking a closer look at the Instructional Support domain, the dimension that received the lowest average score at all three grade levels was *Analysis and Problem Solving*. This dimension, which measures how well higher order thinking skills were incorporated into a lesson, achieved its highest average score (5.1) at the high school level in 2012–13.

Table 7: Average Dimension Scores for the Instructional Support Domain, 2011–12 and 2012–13

Average Domain and Dimension Scores	Year	Elementary School			Middle School			High School		
		N	Mean	Std. Deviation	N	Mean	Std. Deviation	N	Mean	Std. Deviation
Instructional Support	2011–12	226	4.4	1.4	60	4.8	1.3	94	5.1	1.0
	2012–13	192	4.5	1.3	54	5.2	1.1	81	5.3	1.2
Content Understanding (4–12)	2011–12	66	5.0	1.4	60	5.1	1.4	94	5.4	1.2
	2012–13	51	4.9	1.2	53	5.3	1.2	81	5.3	1.3
Analysis and Problem Solving (4–12)	2011–12	66	4.2	1.6	60	4.5	1.6	94	4.5	1.3
	2012–13	51	4.0	1.4	54	5.0	1.3	81	5.1	1.4
Concept Development (K–3)	2011–12	159	4.3	1.5	n/a	n/a	n/a	n/a	n/a	n/a
	2012–13	141	4.4	1.4	n/a	n/a	n/a	n/a	n/a	n/a
Quality of Feedback (all grades)	2011–12	226	4.5	1.4	60	4.9	1.3	94	5.3	1.1
	2012–13	192	4.6	1.5	53	5.2	1.1	81	5.4	1.1
Language Modeling (K–3)	2011–12	160	4.3	1.6	n/a	n/a	n/a	n/a	n/a	n/a
	2012–13	141	4.6	1.5	n/a	n/a	n/a	n/a	n/a	n/a
Instructional Dialogue (4–5)	2011–12	66	4.5	1.6	n/a	n/a	n/a	n/a	n/a	n/a
	2012–13	51	4.2	1.7	n/a	n/a	n/a	n/a	n/a	n/a

Additional information on CLASS scores can be found in Appendix C3.

Checklist Assessment of Best Instructional Practices

An additional observation tool—the Science Observation Checklist—was created by the Office of Planning and Evaluation and the Science Office to assess best instructional practices specific to the APS science curriculum that were not addressed with the CLASS observation tool. While CLASS focused on the quality of teacher-student interactions, the Science Observation Checklist focused on how well science content was taught in the classrooms.

In the spring of 2013, trained observers visited 102 elementary science classrooms, 48 middle school science classrooms, and 77 high school science classrooms. These observations included self-contained special education science classes, ESOL/HILT sciences classes, and Spanish immersion science classes.

Observers were trained to assess 12 best practices within 4 categories: lesson planning, the learning environment, instructional delivery, and student assessment. A 4-point rating scale was used to assess each item: ineffective, developing/needs improvement, effective, and highly effective.

LESSON OBJECTIVES

Eighty-four percent of the elementary classrooms observed during science lessons were rated as effective or highly effective in articulating the science lesson objectives to students. The percentage was lower at the middle school level (65%) and even lower at the high school level (30%).

Among those classrooms assessed on item 2 (*Lesson aligns to stated objectives.),* a greater percentage effectively aligned the science lesson to the stated objectives by grade level. Elementary and middle school classrooms achieved higher ratings in this area than high school classrooms. For this item, 39 observations were marked n/a. In the majority of these cases, these observations were also rated infective for item 1, articulating objectives to students.

Table 8: Percent of Classrooms Demonstrating Best Practices in Lesson Planning

			SCORES			
Lesson Planning Observations	**Level**	**N**	**Ineffective**	**Developing/ Needs Improvement**	**Effective**	**Highly Effective**
Science lesson objectives are visible and clearly articulated to students.	Elementary	102	7%	10%	64%	20%
	Middle	48	13%	23%	23%	42%
	High	77	34%	36%	21%	9%
Lesson aligns to stated objectives.	Elementary	98	6%	5%	76%	13%
	Middle	41	0%	17%	24%	59%
	High	49	2%	39%	27%	33%

LEARNING ENVIRONMENT OBSERVATIONS

Ninety percent of high school science classes, 92% of elementary school science classes, and 100% of middle school science classes were rated as "effective" or "highly effective" in their use of appropriate science materials to support instruction. In terms of safety, 30% of elementary and middle school classrooms and 23% of high school classrooms received ratings of "ineffective" or "developing/needs improvement" in their use of safe scientific investigative practices.

INSTRUCTIONAL DELIVERY

Seven areas related to the quality of instructional delivery were assessed using the Science Observation Checklist. Across the grade levels, observers witnessed a high degree of effectiveness (ratings of "effective" and "highly effective") in the following five areas:

- Teachers made connections to prior and/or future scientific concepts (78% for elementary schools; 92% for middle schools; 88% for high schools).
- Teachers differentiated instruction to meet the needs of all students (85% for elementary schools; 92% for middle schools; 87% for high schools).

- Teachers provided all students with equal opportunities to engage (91% for elementary schools; 100% for middle schools; 96% for high schools).
- Teachers demonstrated scientific content knowledge (93% for elementary schools; 91% for middle schools; 90% for high schools).
- Students were engaged in hands-on learning/experimental lab work (92% for elementary schools; 87% for middle schools; 96% for high schools).

Three categories are worth recognizing as areas of concern:

1) 41% of high school classrooms were rated "ineffective" or "developing/needs improvement" in the area of aligning their lesson to stated objectives.
2) 20% of the elementary science classrooms observed received ratings of "ineffective" or "developing/needs improvement" in the area of providing opportunities for inquiry-based science instruction.
3) 17% of the elementary science classrooms, 13% of the middle school science classrooms, and 21% of the high school science classrooms received ratings of "ineffective" or "developing/needs improvement in the area of active student engagement in learning through scientific discourse.

STUDENT ASSESSMENT

Observers looked for evidence of ongoing assessment to inform instruction. This included checks for understanding, journal responses, and skill drills. Ninety percent of elementary science classrooms, 83% of middle school science classrooms, 90% of high school science classrooms received ratings of "effective" or "highly effective" in this area.

Additional information on Science Observation Checklist results can be found in Appendix C4.

General Findings for Quality of Science Instruction: *Secondary science teachers reported participating in science classes (college courses for credit or local professional development courses) at a much greater rate than elementary school teachers. For example, 20% of elementary teachers surveyed had enrolled in continuing education science coursework compared to 47% of middle school science teachers and 76% of high school science teachers.*

Based on approximately 700 classroom observations over two years, science classrooms across the grade levels achieved average CLASS scores between 5.5 and 6.0 on a scale of 1 to 7 for Emotional Support, Classroom Organization, and Student Engagement. Scores were lower (4.4 to 5.3) in the Instructional Support domain. Within that domain, the dimension of Analysis and Problem Solving received the lowest scores (4.0 to 5.1).

It was observed that elementary classrooms were most effective at articulating science lesson objectives and aligning their lessons to those stated objectives. High schools were least effective in this area; over 40% of the classes observed were classified as "ineffective" or "developing/needs improvement."

Classrooms at all levels received high ratings for the appropriate use of science materials to support instruction. However, 30% of the elementary and middle schools received "ineffective" or "developing/needs improvement" ratings in the area of safe scientific investigative practices.

Concerning instructional delivery, high scores were given to teachers across grade levels for engaging students in hands-on learning, for providing students with equal opportunities to engage, for differentiating instruction to meet the needs of all students, and for demonstrating scientific content knowledge. Teachers received lower scores in two areas: providing opportunities for scientific discourse and providing opportunities for inquiry-based approach to science instruction. This finding aligns with the lower scores assigned to categories within the Instructional Support domain of the CLASS observation tool.

Science Participation: Course Enrollment

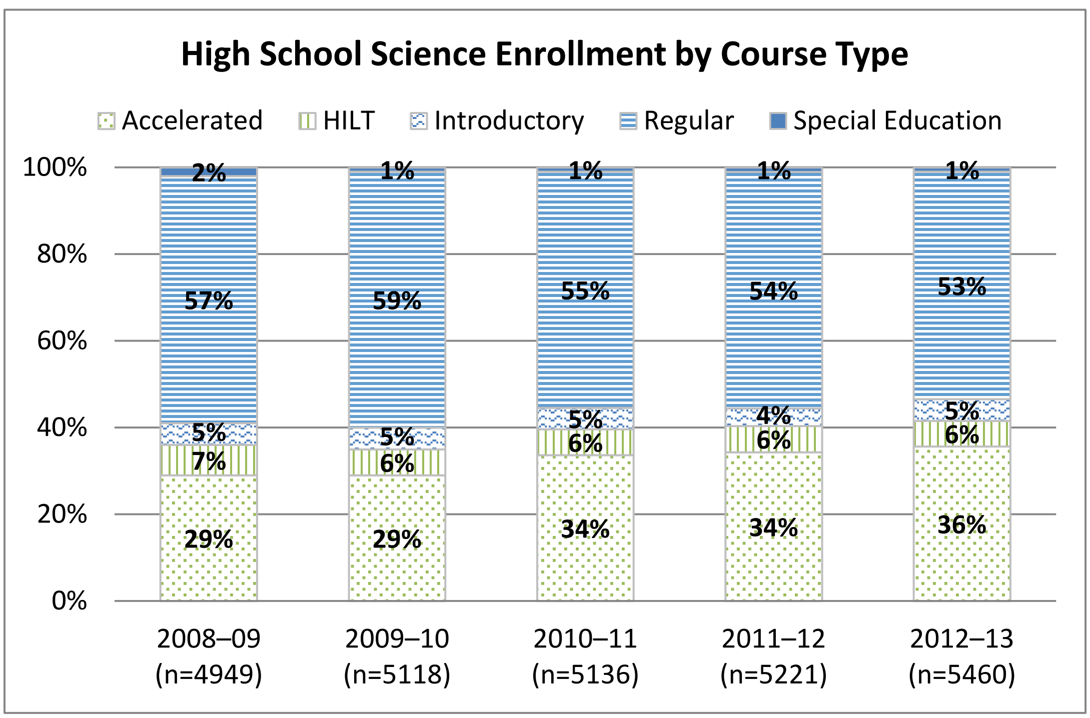
For purposes of this report, high school science course enrollment was examined by grade level, course type (i.e., introductory, regular, accelerated, HILT, and special education), and demographics over five years. Data is reported by the number of science course enrollments—not the number of students.

Data are reported for the high school population overall, and for 12th graders only. Enrollments in grade 12 are examined separately to offer insight into the extent to which students participate in science instruction beyond the minimum requirements for graduation.

In Virginia, an advanced diploma requires four science credits (two must be verified) in three different areas of study. A standard diploma requires three science credits (one must be verified) in two different areas of study.

The percentage of high school enrollments in accelerated science courses (intensified, AP, or IB) has increased over the last five years. The same trend can be seen at the grade 12 level. (See figure 27 in Appendix D1.)

Figure 6: High School Science Enrollment by Course Type



Enrollment by Course and Race/Ethnicity[6]

Total high school enrollment percentages by race/ethnicity have remained relatively constant over the last five years. White students were overrepresented in accelerated science course enrollments (between 58% and 64%). Hispanic students made up the majority of high school HILT science enrollments (between 55% and 69%) and special education science enrollments (between 54% and 60%). (See figures 2–6 in Appendix D1.)

The percentage of enrollments by race/ethnicity in accelerated science classes at the 12th grade level was similar to the distribution within the high school total. White students were overrepresented in the grade 12 enrollments for accelerated science courses, while Hispanic students were overrepresented in the grade 12 enrollments for introductory science courses. (See figures 28–32 in Appendix D1.)

The number of AP and IB science course enrollments has fluctuated over the last five years, but the majority of students enrolled in these courses have been white, an overrepresentation of the white enrollment figures at the high school level overall. In contrast, the percentage of Hispanic and black student enrollments in AP and IB science courses is lower than the student percentages these groups represent in overall high school enrollment figures. Only the Asian enrollment in these accelerated courses matches the total high school enrollment figures for that group. (See figures 53–57 in Appendix D1.)

Table 9: AP and IB Science Enrollment by Race/Ethnicity

High School Science Enrollment		#	White	Hispanic	Black	Asian
2012–13	**AP**	430	65%	16%	7%	12%
	IB	238	65%	14%	8%	12%
	Total High School	**5200**	**46%**	**30%**	**12%**	**12%**
2011–12	**AP**	370	62%	15%	9%	15%
	IB	216	65%	14%	8%	12%
	Total High School	**4988**	**46%**	**30%**	**12%**	**12%**
2010–11	**AP**	339	55%	20%	8%	17%
	IB	246	63%	15%	10%	11%
	Total High School	**4928**	**43%**	**39%**	**14%**	**12%**
2009–10	**AP**	314	63%	14%	6%	16%
	IB	158	65%	13%	9%	13%
	Total High School	**5081**	**44%**	**28%**	**16%**	**12%**
2008–09	**AP**	319	59%	16%	8%	16%
	IB	158	69%	11%	6%	13%
	Total High School	**4912**	**43%**	**29%**	**15%**	**12%**

[6] The total numbers used to represent the student population by race/ethnicity do not include students who were classified as "other." Therefore, the total figures for race/ethnicity are lower than the total figures for other demographic groups.

Enrollment by Course and Gender

In each of the last five years, slightly more females than males have enrolled in accelerated high school science courses, though historically there are slightly more male students overall than females students.

Table 10: Accelerated High School Science Course Enrollment by Gender

	2008–09		2009–10		2010–11		2011–12		2012–13	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Accelerated Enrollment	47%	53%	46%	54%	46%	54%	48%	52%	49%	51%
High School Enrollment	51%	49%	50%	50%	51%	49%	51%	49%	52%	48%

A similar pattern emerged in grade 12 where 49% to 55% of the enrollments in accelerated science courses were female.

More males than females have been enrolled in high school HILT science classes (between 53% and 65%) or special education science classes (between 60% and 74%) over the last five years. (See figures 7–11 and figures 33–37 in Appendix D1.)

Enrollment by Course and Economic Status

The vast majority of accelerated high school and grade 12 science course enrollments represent non-disadvantaged students. At the high school level, 32% to 33% of the student body was classified as disadvantaged during the last five years, and 30% to 32% of science course enrollments consisted of students classified as disadvantaged. Approximately 16% of accelerated course enrollments in each of the last five years are for students who are classified as disadvantaged. At the high school level, more than 78% of the HILT science enrollments and more than 62% of the special education science enrollments represent students classified as disadvantaged. (See figures 12–16 and figures 38–42 in Appendix D1.)

Over the last five years, fewer than 20% of the AP science course enrollments and fewer than 14% of the IB science class enrollments represent students classified as disadvantaged. (See figures 63–67 in Appendix D1.)

Enrollment by Course and LEP Status

Between 2008–09 and 2012–13, 22% to 25% of the high school student population was classified as LEP. Over 90% of the accelerated science course enrollments at both the high school and grade 12 levels were for students classified as non-LEP. Likewise, most introductory science class enrollments (58% to 73%) represented students who were classified as non-LEP. Between 63% and 71% of the special education science enrollments over the last four years were for LEP students. (See figures 17–21 and figures 43–47 in Appendix D1.) Less than 10% of the AP or IB science course enrollments over the last five years consisted of students who were classified as LEP. (See figures 68–72 in Appendix D1.)

Enrollment by Course and Disability Status

A large majority of students (90% to 98%) enrolled in accelerated science classes over the last five years at the high school level or grade 12 level were classified as non-SWD. Those students classified as students with a disability (SWD) were most often enrolled in regular science classes at both the high school level and the grade 12 level. (See figures 22–26 and figures 48–52 in Appendix D1.)

Less than 6% of the AP science course enrollments and less than 5% of the IB science course enrollments in each of the last five years represent students who were classified as SWD. (See figures 73–77 in Appendix D1.)

General Findings for Course Enrollment: *Enrollment in accelerated science courses has increased over the last five years. White students are overrepresented in accelerated science courses, including intensified, AP, and IB science courses. Black students and Hispanic students are underrepresented in accelerated science courses at both the grade 12 level and in high school overall.*

While there are slightly more males than females enrolled in APS high school science classes overall, female students were overrepresented in accelerated classes by roughly four percentage points. Disadvantaged students make up less than 20% of the accelerated science course enrollment and were underrepresented by roughly 15 percentage points. LEP students make up less than 10% of the accelerated science course enrollments and were underrepresented by roughly 14 percentage points. Students with disabilities make up less than 6% of the accelerated course enrollments and were underrepresented by roughly nine percentage points.

Science Participation: Science Fairs and Science Projects

Each year, science fairs are held in all APS middle and high schools. Participation is encouraged by the Science Office, but participation requirements are up to the individual schools. Many schools or classes require a science project while not requiring participation in the science fair.

Jefferson Middle School requires its 6th, 7th, and 8th grade students to complete a science project. Gunston, Kenmore, and H-B Woodlawn require their 7th and 8th grade students to complete a science project. Science projects are optional for 7th and 8th grade students at Swanson and Williamsburg.

Only one middle school (Jefferson) requires students to participate in the science fair at the 6th, 7th, and 8th grade levels. One other middle school (Kenmore) requires students to participate at the 7th and 8th grade levels. Two other middle schools (Gunston and H-B Woodlawn) require participation at the 8th grade level only. Science fair participation is optional for 7th and 8th grade students at the two remaining middle schools (Swanson and Williamsburg).

All three comprehensive high schools require students who have enrolled in specific intensified courses to complete a science project; selected courses vary among the schools. Science fair participation is required for students enrolled in Intensified Biology or Chemistry at Washington-Lee. Participation for students attending Wakefield and Yorktown High Schools is optional. Science fair participation is optional for students enrolled in Intensified Biology at HB Woodlawn.

For more information on secondary science fair and science project requirements, see Appendix E3.

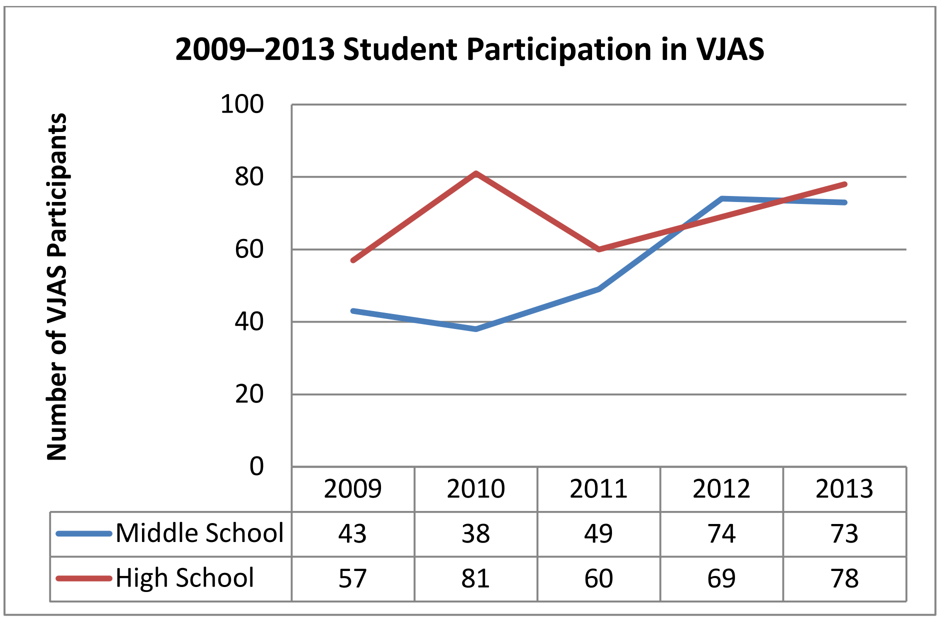
Science Participation: Virginia Junior Academy of Science (VJAS)

The Virginia Junior Academy of Science (VJAS), a state chapter of the American Junior Academy of Science, is dedicated to the advancement of science by encouraging scientific aptitude among Virginia's middle and high school students.

Students who are interested in participating in the VJAS must submit a research paper to the American Junior Academy of Science in early March. The authors of selected papers are invited to present their research at the annual VJAS Symposium in May. Students are given 10 minutes to present in front of a panel of judges. Awards are given to students whose research is recognized as top in their category. These students may also be provided with an opportunity to publish their research and obtain scholarships.

Since the spring of 2009, participation in the VJAS has increased at both the middle and high school levels.

Figure 7: APS Student Participation in the VJAS



Additional information on the VJAS and symposium can be found in Appendix E4.

Science Participation: Factors that Influence Enrollment Choices

To better understand the factors that influence science course enrollment, science fair participation, and enthusiasm for science beyond the classroom, an independent researcher was employed to conduct focus groups at the middle school and high school levels. Fifteen 8th grade students from two APS middle schools and thirteen high school students from two APS high schools participated in the discussions.

Middle School

The middle school focus groups were comprised of nine females and six males from two middle schools. Many of the students in the middle school focus groups identified 10th grade as their first chance to select a science class. When asked to explain the difference between “regular,” “intensified,” and “AP” science classes, about half said they did not know. When the time comes for them to make course decisions, these students said they would turn to their teachers and parents more often than school counselors for advice.

> *In science class, our teacher gave us index cards and said, “Write what science class you think you should take next year. If I think that is right for you, I will recommend you. And if I don’t agree with you, then I will talk to you later about it.”*

Though most of the students in the middle school focus groups regarded science fair as unpleasant, nearly all said they would not reject a class simply because participation was required. However, for those students who attended schools where science participation was optional, the overwhelming response was that they did not plan to participate in the science fair because the additional work would impinge on other activities and participation was stressful. Several students who had started science fair projects for extra credit reported that they had dropped out early in the process because they lost motivation. However, those who had completed a project became very animated when they talked about their experiments.

> *Calling it “intensified” makes it seem harder. Everybody already realizes that science is pretty hard in 8th grade. So, it’s like, “regular” science next year is going to be harder. And “intensified” science is gonna be harder than that!*

Some of the students said that a presentation by a VJAS winner was slightly demotivating because the projects shared were so far beyond the scope of what students could see themselves doing.

Several of the 8th graders expressed general worry about the high school science course load, which may influence their decisions to enroll in intensified courses. However, many saw the appeal in pursuing a scientific career though they admitted it would “take a lot of education” to reach that goal.

Additional information on the questions posed during middle school science focus groups and student responses can be found in Appendix E1.

High School

Among the participants of this focus group were seven males and six females, including three freshmen, three sophomores, five juniors, and two seniors from two high schools. When choosing a science course, these high school students discussed several criteria: a school’s overall requirements; how course choices fit into their schedule by year over four years; advice from counselors, teachers, parents, and friends; and whether the course would benefit them on their transcript. Most students perceived intensified and AP classes to have the greatest value on college applications.

> *An “A” in a regular class is not the same as an “A” in intensified. – Freshman*
>
> *Regular classes are for people who don’t really care that much. – Junior*

Counselors and the high school course catalogue are the key resources students identified to help them learn which science courses were available. Unlike the 8th grade focus group, high school students said counselors played a bigger role than parents or teachers in helping them select their science courses. Overall, course selection was guided mostly by normal progression of the scientific concepts (i.e., biology to chemistry to physics) and one's level of interest.

For most of the students, science fair did not factor in to their course decision-making, but science fair also did not receive popular support. In fact, it was generally disliked by this group as being more of a hassle—due to "annoying" paperwork—than a benefit. Students said they did not like it when teachers were "hands off" about science fair. They appreciated a more direct approach towards their work.

Additional information on the questions and responses regarding high school science focus groups can be found in Appendix E2.

General Findings for Science Fairs and Science Projects: *Science projects are required of most middle and high school students in APS; participation is optional at Swanson and Williamsburg Middle Schools. Science fair participation is optional at most schools. Gunston, Jefferson, and Kenmore Middle Schools, and certain high school teachers at Washington-Lee High School, require at least some students to participate.*

Grade 8 students who participated in focus group discussions regarded science fair as unpleasant yet said they would not reject a class if participation was required. High school students who participated in focus group discussions were also not enthusiastic about science fairs but said participation requirements did not factor in to their course decision-making process.

Students are also encouraged to participate in the VJAS Symposium. Though it is not a requirement, participation has been growing at both the middle and high school levels.

Eighth graders voiced concern over the science coursework that awaited them in high school. They said they would likely turn to their parents and teachers for advice on course enrollment decisions. Many were intrigued by the idea of pursuing a scientific career. High school students, on the other hand, were committed to enrolling in advanced science classes, which they felt would benefit them on college applications. These students said they turned to their counselors for advice on course enrollments and relied on their own level of interest.

Evaluation Question #2:
What Were the Outcomes for the Targeted Populations?

To address this question, this evaluation focused on science proficiency as demonstrated through state and national assessments. In addition, science instructional time and delivery models at the elementary level were examined to determine if it had any bearing on proficiency.

Science Proficiency

For purposes of this report, science SOL results, AP exam results, and IB exam results were examined by grade level and/or course across demographics.

This program evaluation includes adjusted and unadjusted SOL scores. Unadjusted data includes the scores of all students, including failing scores that are removed for federal accountability purposes. In addition, scores for alternatives assessments, and scores for retakes, are excluded from unadjusted data. Adjusted scores are also included in this report as a means to compare APS performance to Virginia performance. Adjusted data comes from the state report cards published on the Virginia Department of Education (VDOE) website. (http://www.doe.virginia.gov) See Appendix F5 for further information about the differences between the two types of SOL data.

VDOE adopted new science standards in 2010. Teachers implemented these new standards in their lessons for the first time in the fall of 2011, and students were tested on them for the first time in the spring of 2013. The new standards have an increased focus on rigor and higher order thinking skills. In 2013, SOL science tests (administered online) included technology-enhanced items (TEI), which accounted for 15% of the test questions. As a result of these changes, **2013 results are not comparable to the results of previous years**. They are, however, included in this report as a baseline for the new assessments.

Science Proficiency at the Elementary School Level

Elementary students participate in science SOL assessments in grades 3 and 5. Third graders are tested on knowledge and skills acquired in science content taught in kindergarten through grade 3. Fifth graders are tested on knowledge and skills acquired in science content taught in grades 4 and 5.

Between 92% and 94% of the students tested passed the grade 3 science test between 2008–09 and 2011–12. In 2012–13, when the new science standards were first implemented, the pass rate was 87%. In grade 5, 87% to 89% of the students passed the science SOL test between 2008–09 and 2011–12. In 2012–13, when the new science standards were first implemented, the pass rate was 80%.

The adjusted APS results at the 3rd and 5th grade levels were slightly higher than the results for Virginia between 2010 and 2013. (See Appendix F1.)

Asian and white students consistently passed at higher rates than their Hispanic and black peers. In grade 3, the white/Hispanic gap ranged between 10 and 17 percentage points under the previous standards; the white/black gap ranged between 17 and 21 percentage points. At grade 5, the white/Hispanic gap ranged between 19 and 25 percentage points under the previous standards; the white/black gap ranged between 18 and 27 percentage points. All gaps increased under the new standards of 2012–13, especially in grade 5.

Table 11: Elementary School Science SOL Pass Rates by Race/Ethnicity

Race/ Ethnicity	Grade	2008–09	2009–10	2010–11	2011–12	2012–13
White	Grade 3	98%	98%	98%	98%	96%
	Grade 5	96%	98%	97%	98%	96%
Black	Grade 3	79%	77%	80%	81%	73%
	Grade 5	75%	76%	79%	71%	59%
Hispanic	Grade 3	83%	81%	85%	88%	73%
	Grade 5	73%	73%	78%	74%	59%
Asian	Grade 3	96%	95%	89%	94%	88%
	Grade 5	89%	87%	90%	87%	82%

When the data was adjusted, the pass rate for grade 3 Hispanic students in 2012–13 was 72%, which was seven percentage points below the state average. The pass rate for grade 5 Hispanic students was 59%, which was four percentage points below the state average. APS Asian students in grade 3 scored a pass rate of 87% in 2012–13, which was seven percentage points below the state average; Asian students in grade 5 scored a pass rate of 81%, which was five percentage points below the state average.

There was little difference in test scores when they were disaggregated by gender.

Non-disadvantaged students in grade 3 achieved pass rates ranging between 94% and 97%—as much as 19 percentage points above their disadvantaged peers. The gap increased to 27 percentage points in 2012–13 under the new science test. Non-disadvantaged students in grade 5 achieved pass rates ranging between 91% and 97%—as much as 27 percentage points above their disadvantaged peers. The gap increased to 34 percentage points in 2012–13. When the data was adjusted, APS disadvantaged students achieved slightly lower pass rates than their peers across the state.

Non-LEP students in grade 3 achieved pass rates eight to 17 percentage points above their LEP peers. Under the new science test of 2012–13, the gap increased to 19 percentage points. Non-LEP students in grade 5 achieved pass rates 17 to 23 percentage points above their LEP peers. The gap increased to 35 percentage points in 2012–13.

The gap between non-disabled students and students with disabilities (SWD) was wider in grade 5 than in grade 3. The gap was as wide as 20 percentage points in grade 3 and 27 percentage points in grade 5. In 2012–13, non-disabled students achieved pass rate results 24 points higher and 23 points higher than their disabled peers (at grades 3 and 5, respectively). Overall, APS students with disabilities achieved higher pass rates than their peers across the state.

Additional SOL science data for elementary schools can be found in Appendix F1.

This evaluation also examined whether classroom teaching models and time devoted to science lessons had any bearing on SOL science test scores. Five instructional models were identified:

MODEL 1: Standard classroom teacher (The homeroom teacher teaches science)

MODEL 2: Standard classroom teacher plus enrichment

MODEL 3: Rotating teachers for science instruction (One particular teacher is responsible for science instruction at a certain grade level)

MODEL 4: Rotating teachers for science instruction plus enrichment

MODEL 5: Science specialist (One teacher is assigned to a school to teach only science)

APS contracted with Hanover Research (Hanover) to conduct an analysis of the relationship between instructional time, instructional model, and science SOL scores. Hanover found that the number of hours devoted to science instruction and the classroom model employed for science instruction had no effect on 3rd grade test scores. This was not the case, however, at the 5th grade level.

Grade 5 students who received additional instructional hours in science achieved higher scores on the science SOL test. There is strong evidence that these students will have a higher probability of both passing and passing at an advanced level.

Grade 5 students who received science instruction from their classroom teacher (Model 1) performed significantly better on SOL science tests than those students who received instruction with any other instructional model. Students benefitting from Model 1 instruction scored 14 points better than students in Model 2 classrooms, 19 points better than students in Model 3 classrooms, and 34 points better than students in Model 5 classrooms.

The complete report on the *Effects of Delivery Model and Instructional Hours on Elementary Science Proficiency* can be found in Appendix F2.

General Findings for Science Proficiency at the Elementary Level: *At the elementary level, grade 5 science SOL pass rates are slightly lower than the grade 3 science SOL rates. However, the APS science pass rates for grades 3 and 5 are both higher than the pass rates for the state of Virginia overall.*

The white/Hispanic gaps and the white/black gaps are wider in grade 5 than in grade 3. In 2013, when the new science standards were implemented, APS black students and Hispanic students in grade 5 achieved pass rates more than 30 percentage points below APS white students. These pass rates were within five percentage points of the group pass rates for the state of Virginia. Though Asian students scored higher than black and Hispanic students, they scored lower in each of the last three years than Asian students across Virginia on both the grade 3 and grade 5 science tests.

The elementary SOL science pass rates for disadvantaged students, LEP students, and students with disabilities were noticeably lower in grade 5 than they were in grade 3. Over the last three years, APS disadvantaged students in grade 5 achieved adjusted pass rates slightly lower than Virginia's disadvantaged students, but APS LEP students had slightly higher pass rates than the state's LEP students.

At the grade 5 level, instructional time had a significant impact on SOL science test scores. In addition, students pass at higher rates when they are taught by their classroom teacher rather than a specialist or a rotating teacher.

Science Proficiency at the Middle School Level

At the middle school level, students participate in the grade 8 science assessment, which tests students on standards outlined in the 6th, 7th, and 8th grade Virginia SOL science test blueprints.

The 8th grade pass rate rose from 88% to 93% between 2008–09 and 2011–12. In 2012–13, when the new SOL science standards were first tested, the pass rate was 80%. When results were adjusted, APS scores were in line with state results in 2010–11 and 2011–12, but were slightly higher than state results in 2012–13.

Asian and white students consistently scored higher than their Hispanic and black peers on the grade 8 science SOL test. The white/Hispanic gap decreased over four years, from 25 percentage points in 2008–09 to 12 percentage points in 2011–12. In 2012–13 when the new science standards were first tested, white students achieved a pass rate of 95% compared to 62% for their Hispanic peers, representing a gap of 33 percentage points. The white/black gap also decreased over four years, from 15 percentage points in 2008–09 to eight percentage points in 2011–12. In 2012–13, black students achieved a pass rate of 60%, representing a gap of 35 percentage points.

Table 12: Grade 8 Science SOL Pass Rates by Race/Ethnicity

Race/Ethnicity	2008–09	2009–10	2010–11	2011–12	2012–13
White	99%	97%	98%	98%	95%
Black	75%	84%	84%	86%	60%
Hispanic	74%	78%	81%	86%	62%
Asian	90%	87%	95%	94%	72%

When data was adjusted, the 2012–13 pass rate for APS Hispanic students was four percentage points lower than the statewide pass rate for Hispanic students while the pass rate for APS black students was four percentage points higher than the statewide pass rate for black students.

It is worth noting that while science pass rates for the grade 8 Asian population ranged between three and 10 percentage points lower than the pass rates for the white population between 2008–09 and 2011–12, the gap in 2012–13 was 23 percentage points. When adjusted, the APS Asian pass rate was 15 percentage points lower than the statewide Asian pass rate.

The gap between the pass rates for non-disadvantaged students and disadvantaged students decreased between 2008–09 and 2011–12, from 27 percentage points to 16 percentage points. However, in 2012–13 with the introduction of the new science test, the gap was 36 percentage points.

Non-LEP students achieved pass rates 16 to 29 percentage points above their LEP peers over four years. In 2012–13, the gap was 44 percentage points. Similarly, non-disabled students achieved pass rates 15 to 28 percentage points above the SWD population, and in 2012–13 the gap was 31 percentage points.

APS students with disabilities, however, achieved an adjusted pass rate of 62% in 2012–13, which was seven percentage points above the state average.

Additional SOL science data for middle schools can be found in Appendix F1.

General Findings for Science Proficiency at the Middle School Level: *The pass rates for grade 8 black and Hispanic students in APS rose between 2008–09 and 2011–12. In 2013, with the introduction of the new science test, pass rates fell at a greater rate for black, Hispanic, and Asian students than they did for white students. When compared to state results, white students in APS scored 10 percentage points higher on the grade 8 science test than white students across the state, APS black students scored four percentage points higher than black students across the state, APS Hispanic students scored four percentage points lower than Hispanic students across the state, and APS Asian students scored 15 percentage points lower than Asian students across the state.*

The pass rate for students with disabilities increased between 2008–09 and 2011–12, from 66% to 80%. Though the 2012–13 adjusted pass rate for SWD under the new standards was just 50%, it was seven percentage points above the state pass rate.

Science Proficiency at the High School Level

STANDARDS OF LEARNING (SOL)

At the high school level, students enrolled in Biology, Chemistry, or Earth Science courses participate in End-of-Course (EOC) SOL testing. Students who fail the test are given an opportunity to retest. For purposes of this report, only the first attempt was used in calculations. However, adjusted data is also provided so comparisons can be made between APS and state results.

Between 2008–09 and 2011–12, the pass rate for Biology rose five percentage points to 91% and the pass rate for Earth Science rose 11 percentage points to 87% while the pass rate for Chemistry held steady at 90%. The pass rates for all three courses were lower in 2012–13 when students were first tested using the new state standards.

Table 13: High School SOL Science Pass Rates, 2008–09 to 2012–13

SOL Test	2008–09	2009–10	2010–11	2011–12	2012–13
Biology	86%	86%	90%	91%	81%
Chemistry	90%	89%	86%	90%	83%
Earth Science	76%	82%	79%	87%	75%

When the data was adjusted, APS had slightly higher pass rates over the last three years on the Biology SOL test than the state of Virginia as a whole. The APS pass rates for Chemistry were slightly lower than the Virginia pass rates in 2010–11 and 2011–12 but slightly higher in 2012–13 when the new science standards were first assessed. In Earth Science, the statewide pass rates were slightly higher than APS pass rates in all three years. (See Section 3 in Appendix F1.)

White students had pass rates ranging from 95% to 99% on all three tests between 2008–09 and 2011–12. In 2012–13, white students achieved a pass rate of 91% on the Chemistry SOL test and 95% on both the Biology SOL and Earth Science SOL test. Between 2008–09 and 2011–12, Asian students scored 7 to 11 percentage points below their white peers on the Biology test, 5 to 10 percentage points below their white peers on the Chemistry test, and 15 to 18 percentage points below their white peers on the Earth Science test. The gaps were even wider on the Biology and Earth Science tests in 2012–13 (18 percentage points and 25 percentage points, respectively.)

Between 2008–09 and 2011–12, the black/white gap and the Hispanic/white gap both decreased from 24 percentage points to 18 percentage points on the Biology test. Over the same time period, the black/white gap decreased from 32 percentage points to 21 percentage points and the Hispanic/white gap decreased from 27 percentage points to 13 percentage points on the Earth Science test. On the Chemistry test, the gap held steady for black students at 21 percentage points; the gap decreased for Hispanic students from 23 percentage points to 17 percentage points. In 2012–13, the gap between white and black students was wider on all three tests than it had been in the previous three years, while the gap between white Hispanic students was wider on the Biology and Earth Science tests.

Table 14: High School SOL Science Pass Rates, 2007–08 through 2012–13

Race/ Ethnicity	Grade	2008–09	2009–10	2010–11	2011–12	2012–13
White	Biology	97%	97%	98%	99%	95%
	Chemistry	97%	96%	95%	97%	91%
	Earth Science	95%	95%	96%	97%	95%
Black	Biology	73%	71%	83%	81%	69%
	Chemistry	76%	78%	72%	76%	65%
	Earth Science	63%	75%	73%	76%	65%
Hispanic	Biology	73%	75%	79%	81%	64%
	Chemistry	78%	80%	75%	80%	72%
	Earth Science	68%	75%	69%	84%	65%
Asian	Biology	89%	90%	87%	91%	77%
	Chemistry	91%	89%	90%	87%	81%
	Earth Science	69%	78%	78%	82%	70%

Adjusted data show that black students in APS scored slightly higher than the statewide black population on both the Biology and Earth Science tests while APS Hispanic students scored slightly lower than the statewide Hispanic population on the Earth Science test. Adjusted data show that Asian students in APS consistently achieve lower pass rates on the Biology, Chemistry, and Earth Science tests than statewide Asian students.

There was little difference in results between genders on both the SOL Biology and Chemistry tests. However, male students achieved pass rates 2 to 10 percentage points higher than their female peers in each of the last five years on the Earth Science test. And when the data was adjusted, female students in APS scored slightly lower on the Earth Science test than their female peers across the state.

Over five years, non-disadvantaged students achieved pass rates between 18 and 25 percentage points higher than their disadvantaged peers on the Biology SOL test, 12 to 22 percentage points higher on the Chemistry SOL test, and 13 to 24 percentage points higher on the Earth Science SOL test.

When the SOL science data was disaggregated by LEP status, the gaps were wider in 2012–13 on all three science tests than they had been in previous years. LEP pass rates had improved on the SOL Biology and Earth Science tests over four years, but pass rates fell considerably in 2012–13, creating the lowest LEP pass rates in five years: 56% for Biology, 59% for Chemistry, and 51% for Earth Science. Adjusted data show that APS LEP students achieved higher pass rates than Virginia's LEP students on both the SOL Biology test and the SOL Chemistry test.

Non-disabled students achieved higher pass rates than students with disabilities (SWD) on all three SOL science tests. Between 2008–09 and 2011–12, pass rates increased for both groups of students on all three tests except for students classified as SWD on the Chemistry test; their pass rate slipped from 82% to 77%. Students with disabilities attending APS high schools consistently scored higher on all three SOL science tests than their statewide SWD peers.

Additional SOL science data for high schools can be found in Appendix F1. An explanation of adjusted and unadjusted SOL data can be found in Appendix F5.

ADVANCED PLACEMENT (AP)

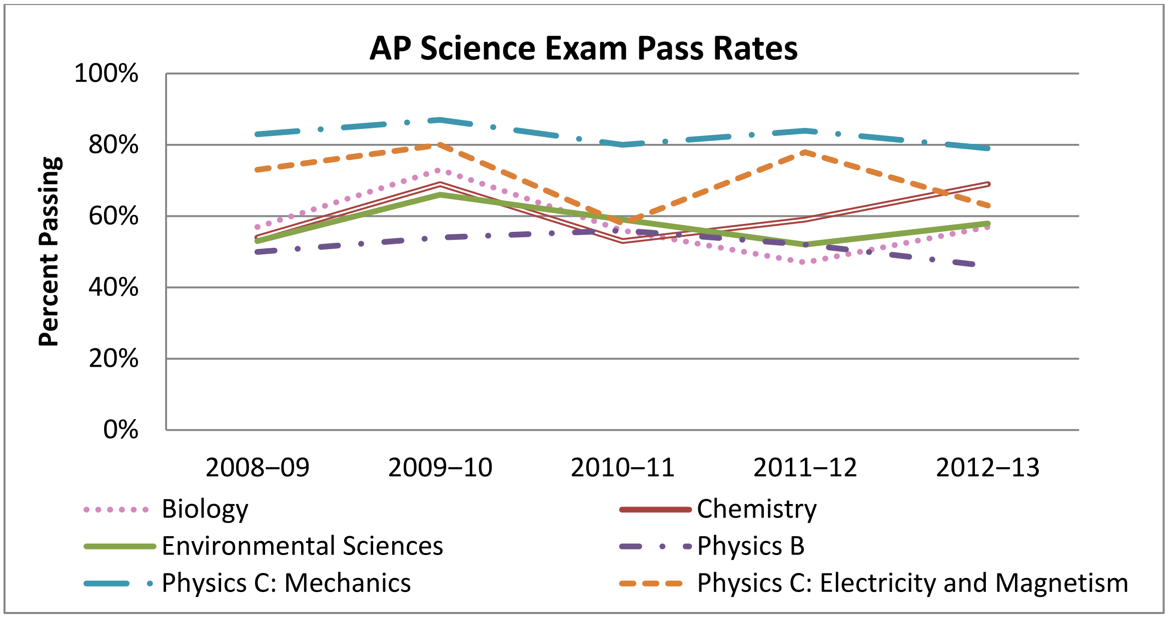
Six AP science courses are available to APS students for college credit: Biology, Chemistry, Environmental Sciences, Physics B, Physics C: Mechanics, and Physics C: Electricity and Magnetism. The majority of students that enroll in an AP science course enroll in either Environmental Sciences or Biology. Enrollment in all six courses has increased between 2008–09 and 2012–13.

Table 15: Participation in AP Science Exams, 2008–09 to 2012–13

	2008–09		2009–10		2010–11		2011–12		2012–13	
AP Exam	# tested	% passed	# tested	% passed	# tested	% passed	# tested	% passed	# tested	% passed
Biology	93	57%	55	73%	84	56%	75	47%	82	57%
Chemistry	50	54%	51	69%	51	53%	51	59%	89	69%
Environmental Sciences	109	53%	96	66%	123	59%	108	52%	130	58%
Physics B	30	50%	41	54%	54	56%	94	52%	74	46%
Physics C: Mechanics	40	83%	69	87%	50	80%	69	84%	81	79%
Physics C: Electricity and Magnetism	40	73%	56	80%	50	58%	69	78%	81	63%

Over the last five years, between 79% and 87% of the APS students enrolled in Physics C: Mechanics have passed the corresponding AP exam. Less than 80% have passed the remaining five exams in any given year, and there is no clear pass rate pattern.

Figure 8: AP Science Exam Pass Rates, 2008–09 through 2012–13



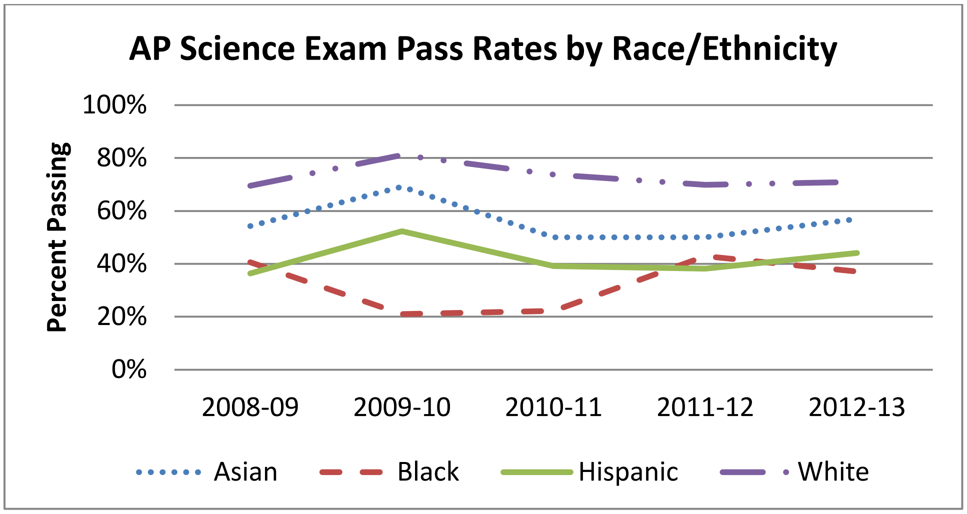
APS students have generally achieved higher pass rates than Virginia's students overall on the Biology, Chemistry, Environmental Science, Physics C: Mechanics, and Physics C: Electricity and Magnetism exams. APS students have generally achieved higher pass rates than the nation's students overall on the Biology, Chemistry, Environmental Science, and Physics C: Mechanics exams. Generally, APS students have performed as well as Virginia's students on the Physics B exam, but not as well as students across the country. See Tables 1 through 6 in Appendix F3.

Over the last five years, the pass rates on AP science exams have ranged between 69% and 81% for white students, between 50% and 69% for Asian students, between 36% and 52% for Hispanic students, and between 21% and 43% for black students.

Table 16: AP Science Exam Pass Rates by Race/Ethnicity, 2008–09 through 2012–13

Group	2008–09		2009–10		2010–11		2011–12		2012–13	
	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed
Asian	59	54%	68	69%	68	50%	62	50%	65	57%
Black	32	41%	19	21%	27	22%	35	43%	35	37%
Hispanic	55	36%	42	52%	74	39%	68	38%	77	44%
White	213	69%	233	81%	221	74%	282	70%	334	71%

Figure 9: AP Science Exam Pass Rates by Race/Ethnicity, 2008–09 through 2012–13



The pass rates for female students have consistently fallen short of the pass rate for male students. Non-disadvantaged students have scored 24 to 35 percentage points above their disadvantaged peers. Non-LEP students have scored 18 to 31 percentage points above their LEP peers.

In each of the last five years, students with disabilities (SWD) achieved pass rates higher than their non-disabled peers. It should be noted, however, that only a small number of SWD participate in AP science testing (between 5 and 27 students each year).

Additional information on AP science pass rates can be found in Appendix F3.

INTERNATIONAL BACCALAUREATE (IB)

Four IB science courses are available to students enrolled in Washington-Lee High School: Biology, Chemistry, Environmental Sciences, and Physics. The number of students participating in the corresponding course exams has been relatively low in each of the last five years: between 20 and 37 students in Biology, fewer than 20 students in Chemistry, 39 to 92 students in Environmental Sciences, and 12 to 77 students in Physics.

Table 17: Participation in IB Science Exams, 2008–09 through 2012–13

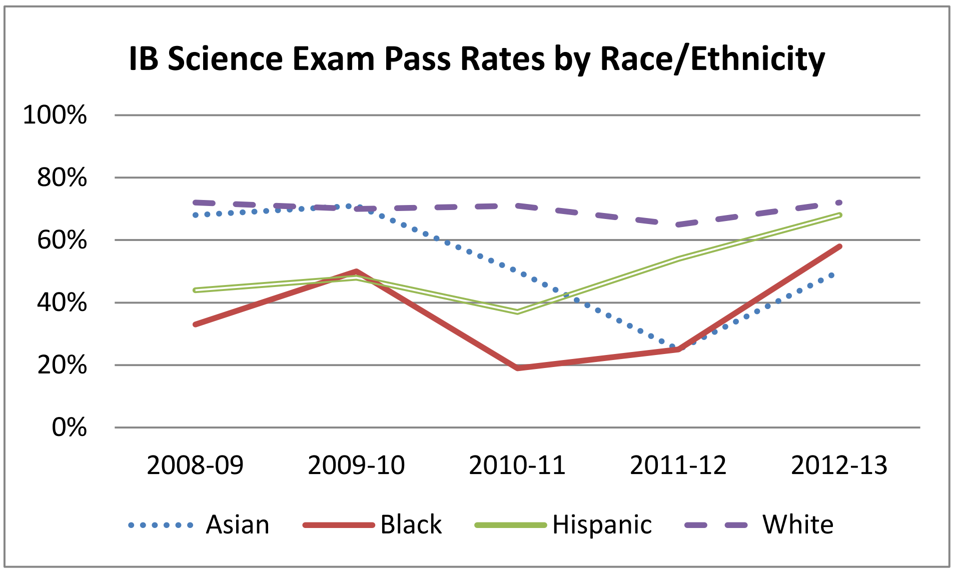
	2008–09		2009–10		2010–11		2011–12		2012–13	
IB Exam	# tested	% passed	# tested	% passed	# tested	% passed	# tested	% passed	# tested	% passed
Biology	20	55%	25	16%	21	52%	24	71%	37	54%
Chemistry	12	33%	18	33%	6	0%	12	75%	*	n/a
Environmental Systems	77	60%	39	87%	92	60%	72	44%	72	68%
Physics	49	86%	77	77%	12	58%	38	66%	43	77%

*Fewer than 5 students, not reported.

The Biology pass rate has ranged from 16% to 71%. The Chemistry pass rate has ranged from 0% to 75%. The Environmental Sciences pass rate has ranged from 44% to 87%. The Physics pass rate has ranged from 66% to 86%.

The majority of students enrolled in IB science courses are white, and their exam pass rates exceed all other races/ethnicities, ranging from 65% to 72%. Between 12 and 22 Asian students participate in IB science testing each year, and their pass rates range from 25% to 71%. Between 18 and 28 Hispanic students participate in IB science testing each year, and their pass rates range from 37% to 68%. Fewer than 16 black students participate in IB science testing each year, and their pass rates range from 19% to 58%. In 2012–13, white, Hispanic, and black students achieved their highest IB pass rate to date.

Figure 10: IB Science Exam Pass Rates by Race/Ethnicity, 2008–09 through 2012–13



Male students achieved higher IB science pass rates than female students between 2008–09 and 2010–11. But female students achieved higher IB science pass rates in the last two years of testing.

Non-disadvantaged students have scored 10 to 42 percentage points above their disadvantaged peers.

Fewer than eleven LEP students have participated in IB science testing in each of the last five years. In 2009–10, the five LEP students who tested achieved a pass rate of 80%—24 percentage points above their non-LEP peers. But in 2011–12 when 10 LEP students tested, their pass rate was 0%.

Fewer than nine students with disabilities (SWD) have participated in IB science testing in each of the last five years, with pass rates ranging from 20% to 50%. The pass rates for non-disabled students have ranged from 57% to 68%.

Additional information on IB science pass rates can be found in Appendix F4.

General Findings for Science Proficiency at the High School Level: *Between 2008–09 and 2011–12, overall SOL pass rates rose in Biology and Earth Science. Compared to state scores, APS achieved slightly higher scores over the last three years on the Biology SOL test and slightly lower scores on the Earth Science test.*

White students consistently outscored their black, Hispanic, and Asian peers at the division level as well as their white peers at the state level on all three tests. APS black students outscored their black peers at the state level on the Biology test over three years. But APS Asian students scored below their Asian peers at the state level on all three tests in each of the last three years.

Between 2008–09 and 2011–12, the black/white gap and the Hispanic/white gap decreased on all three SOL science tests. In 2012–13 the gaps were wider than they had been in the previous three years for black students on all three tests and for Hispanic students on the Biology and Earth Science tests.

Changes in the science standards, reflected in the 2013 SOL science tests, disproportionately affected APS student groups—particularly LEP students who had been narrowing the gap with their non-LEP peers on all three science tests. The 2012–13 gaps for all groups were wider than they had been in the previous four years.

APS students generally perform as well or better than students in the state of Virginia on five of the six AP science exams, and perform better than students in the nation on four of the six exams. The national pass rates on the Physics B exam, however, exceed the pass rates for both the state and APS. Within APS, white students consistently score higher than their Asian, black, and Hispanic peers.

It is difficult to draw conclusions about IB results based on demographic results due to the low number of participants.

Evaluation Question #3:
How satisfied are users with the Science Program?

To gauge the level of satisfaction stakeholders have with the APS science program, students, teachers, and parents were asked to respond to several specific survey questions, and a sample of students participated in focus group discussions. In addition, data collected during CLASS observations revealed the level to which students were actively engaged in their science lessons.

Student Satisfaction

The CLASS domain called “Student Engagement” looks for evidence of students being actively engaged in the lessons being taught. On a scale of 1 to 7, this domain received scores that were generally in the high range at the elementary, middle, and high school levels, indicating high levels of student engagement in science classrooms.

Table 18: Average CLASS Scores for Student Engagement, 2011–12 and 2012–13

CLASS Domain	Year	Elementary School			Middle School			High School		
		N	Mean	Std. Deviation	N	Mean	Std. Deviation	N	Mean	Std. Deviation
Student Engagement (4–12)	2011–12	66	6.0	1.1	60	5.5	1.1	94	5.6	1.2
	2012–13	51	5.7	1.1	54	5.9	0.9	81	6.0	0.9

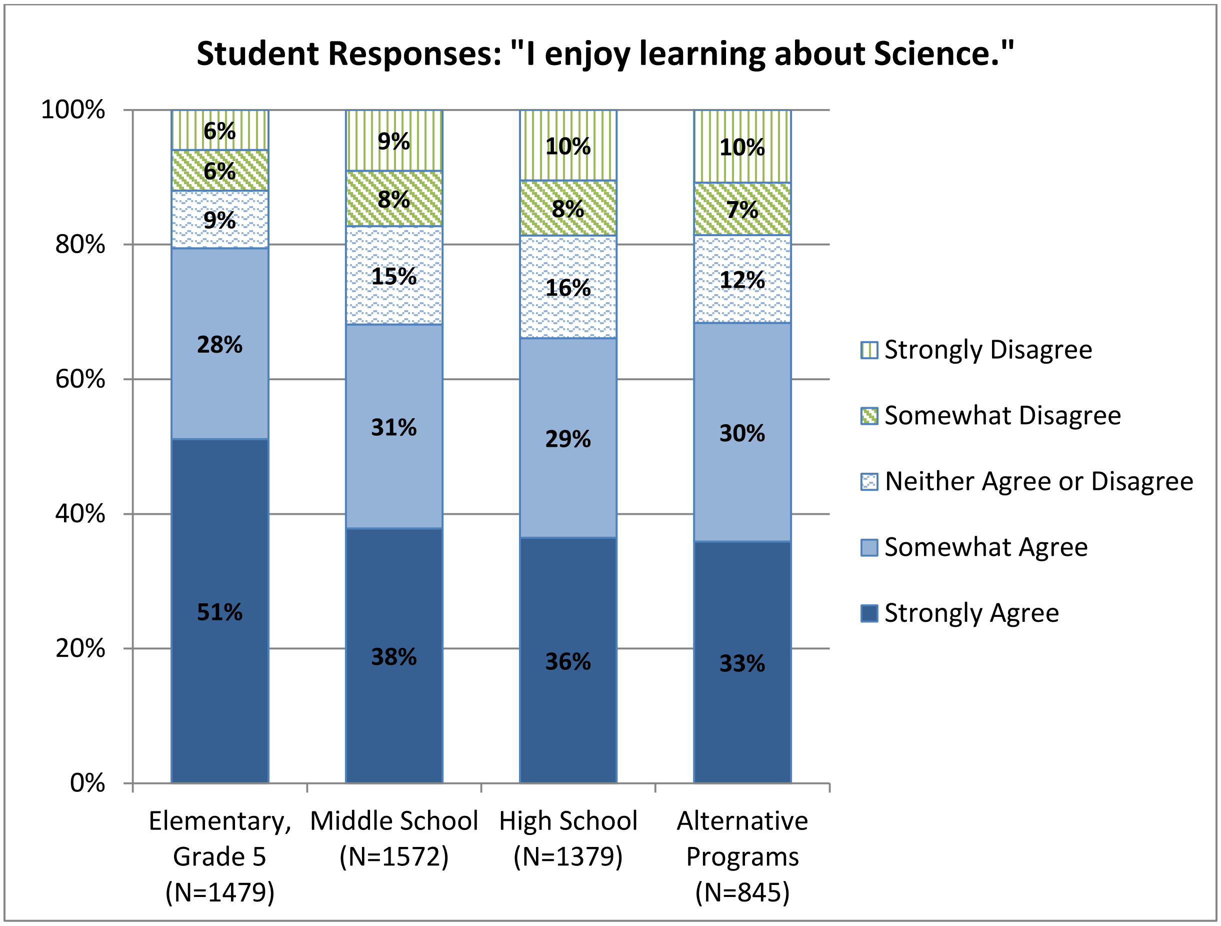
Additional information on the Classroom Assessment Scoring System (CLASS) can be found in Appendix C1.

In 2013, questions about science instruction were added to the bi-annual site-based survey. At the student level, 5th grade students, middle school students, high school students, and students enrolled in alternative programs were asked to rate their level of enjoyment in science instruction by responding to the following item:

> Indicate the degree to which you agree or disagree with this statement:
> *I enjoy learning about Science.*

Close to 80% of the elementary respondents agreed with that statement, compared to 69% of the middle school respondents, 65% of the high school respondents, and 63% of the alternative program respondents.

Figure 11: Student Enjoyment with Learning about Science



A sample of middle and high school students participated in focus groups to help determine their level of enthusiasm for science overall. About half of the 15 middle school participants felt their interest in science had grown during middle school, while the other half felt it had waned. The students said that they valued hands-on learning through lab work and outdoor activities and cited several memorable moments from science classes, such as extracting DNA from strawberries, dissecting a mushroom, constructing plastic water bottle rockets, and participating in outdoor labs. None of the participants, however, reported participating in activities beyond the classroom that involve science.

Enthusiasm for science instruction at the high school level depended largely on the students' opinion of the classroom teacher. They specified that "good" teachers were organized, clear about assignments and expectations, offered students hours for extra help, and provided support for science fairs. Among the 13 participants, there was wide variation as to whether student's enthusiasm increased, decreased, or stayed the same during high school. However, many students who said their enthusiasm had decreased attributed it to the fact that their interest in another subject had increased. Beyond the classroom, few students said they were engaged in activities that had a scientific bias. However, about a third of the group stated that their future careers would likely involve science.

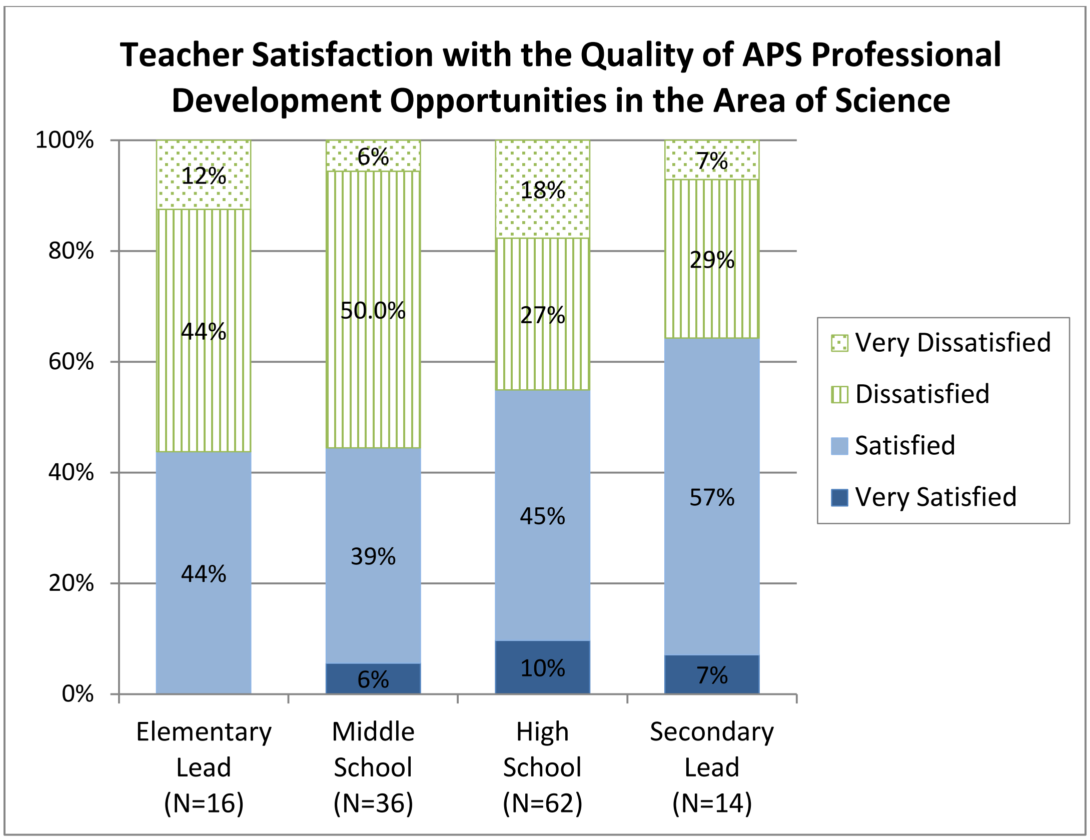
Additional focus group findings can be found in Appendix E1 (Middle School) and Appendix E2 (High School).

Teacher Satisfaction

According to responses on the teacher survey, teachers are generally satisfied with the support they receive from the division for science instruction. Seventy-four percent of elementary science teachers, 94% of middle school science teachers, and 74% of high school science teachers said they were satisfied or very satisfied with the division-level support they receive in science. Similarly, 79% of secondary lead teachers and 94% of elementary lead teachers rated their satisfaction as satisfied or very satisfied.

While satisfied with the division-level support they receive, science teachers are less satisfied with the quality of the science professional development opportunities offered by the division. More than half of the elementary lead teachers and middle school science teachers surveyed said they were dissatisfied or very dissatisfied with the quality of APS professional development opportunities provided to them. Forty-five percent of the high school science teachers surveyed and 36% of the secondary lead science teachers surveyed said they were dissatisfied or very dissatisfied with the quality of science professional development offered in APS.

Figure 12: Teacher Satisfaction with Quality of APS Science Professional Development Opportunities



Fewer professional development opportunities at the elementary level are offered by the Science Office, so elementary teachers were not included on this survey question.

Parent Satisfaction

Parents with children in elementary school, middle school, high school, and alternative programs responded to the following item on the bi-annual site-based survey: *Please rate your level of satisfaction with the overall quality of instruction that your child is receiving in science.*

More than half of the parents responded that they were very satisfied with APS science instruction. Less than 12% in any grade level responded that they were dissatisfied with the quality of the instruction their child receives in science.

Table 19: Parent Satisfaction with Science Instruction by Grade Level

Parent Group	N	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	I Don't Know
Elementary	2861	56%	32%	7%	3%	2%
Middle	1141	54%	34%	8%	3%	1%
High	976	57%	32%	7%	2%	1%
Alternative	98	57%	28%	4%	2%	9%

Science results from the bi-annual site-based survey can be found in Appendix B1.

General Findings on Student, Teacher, and Parent Satisfaction: *Based on CLASS observations, students at the elementary and secondary levels are actively engaged in science lessons. When asked to rate their level of enjoyment, elementary school students gave science lessons a higher rating than middle school students, and middle school students gave science a higher rating than high school students. Middle and high school students who participated in focus groups valued hands-on science activities, and high school students attributed their science enthusiasm to the quality of the teacher.*

The majority of teachers across the division report being satisfied or very satisfied with the amount of support they receive from the division for science instruction. Lead teachers had an even higher satisfaction rating. However, more than 50% of the elementary lead teachers and middle school science teachers, and more than 40% of the high school science teachers, said they were dissatisfied or very dissatisfied with the quality of the professional development opportunities offered by the division in science.

More than 85% of parents reported being somewhat satisfied or very satisfied with the science instruction their child is receiving.

SECTION 3: RECOMMENDATIONS

Recommendations Specific to the Science Office

1. Develop and implement a grade K–5 science pacing guide and grade 2–5 formative assessment program to determine the extent to which students are on track to meet the grade-level standards.
2. Evaluate and redesign the Science Office professional development program with specific focus on
    a. improving teacher participation and satisfaction,
    b. emphasizing best practices in science education including safe scientific investigative practices, and
    c. continuing to focus on areas of need that are identified by assessments and other data sources, particularly instructional support as defined by CLASS, articulating objectives, and ensuring that objectives align to lessons
3. Support underrepresented populations and struggling students in the area of science to address the existing achievement gap. Specifically:
    a. Offer targeted professional development,
    b. Work with high school teachers in the use of formative assessment to identify struggling students and address instructional needs, and
4. Develop additional pathways for students to achieve an advanced studies diploma. Provide alternative courses to ensure that students can move through the pathway.
5. Continue to monitor relationship between elementary instructional models and SOL results.

Recommendations with Policy and Budget Implications

6. Implement scheduling requirements at the elementary level that mandate the amount of time students are required to participate in science instruction each week by grade. Mandate formative assessment in grades 2–5.