MEMORANDUM

TO: Arlington School Board

FROM: Science Advisory Committee

DATE: November 11, 2013

SUBJECT: Recommending Year Report

Introduction

For the past several years, the Science Advisory Committee (SAC) for the Arlington Public Schools (APS) has focused on science instruction in the APS elementary schools. Our concern originates with the previous Science Education Evaluation in 2007, which found that science instruction time in elementary grades was highly variable and unpredictable among APS schools. At that time, national data, reported by the Center on Education Policy, were showing that as schools strive to reach goals in reading and math, instruction time in science and other subjects was decreasing.

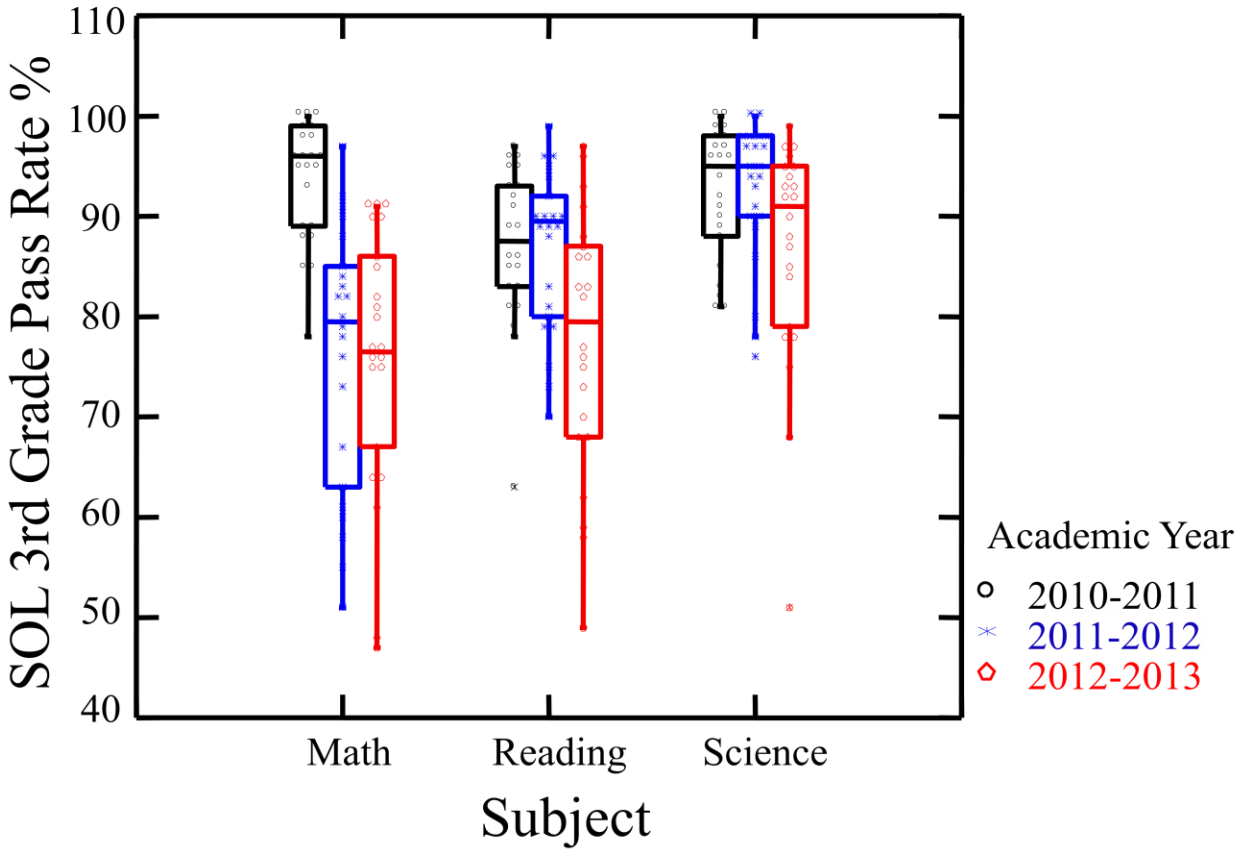
In each of the past three annual reports, SAC presented analyses of multi-year data on Standards of Learning (SOL) scores and pass rates in science and other core subjects for APS elementary schools, with particular attention to heterogeneity among schools and grade levels and for various demographic cohorts of students. These analyses point to a systemic weakness in elementary school science instruction that, while not unique to APS, is of particular concern in those APS elementary schools with large populations of Economically Disadvantaged, Hispanic, Black, and Limited English students. In this report, we summarize our findings and present a number of linked recommendations to improve science instruction for all students in APS elementary schools.

Background Findings

In examining SOL results we focus on broad and consistent patterns; while APS staff shared classroom level (anonymous) data our concern is not at that level. It is important to recognize that even at the level of averages for entire schools and grade levels there is substantial variation from year to year.

In the past two years, the SOL tests have changed in ways that make the test more difficult for all students. Consequently, average APS pass rates in all elementary grades have declined, as illustrated in Figure 1 for 3rd grade. This average decline has been seen across all Virginia school districts, and in itself does not suggest a concern with student learning. However, the lower average pass rates have revealed far greater variation among APS schools than was evident with the less rigorous testing.

Figure 1[1]. Recent trends in SOL test results for APS 3rd grade are similar to trends for all of Virginia and reflect increased difficulty in the tests starting in 2012 for math and in 2013 for reading and science.



Two questions arise when looking at these SOL results. 1) Why do some schools have such low pass rates compared to other schools? 2) Are these the same schools across subjects and years?

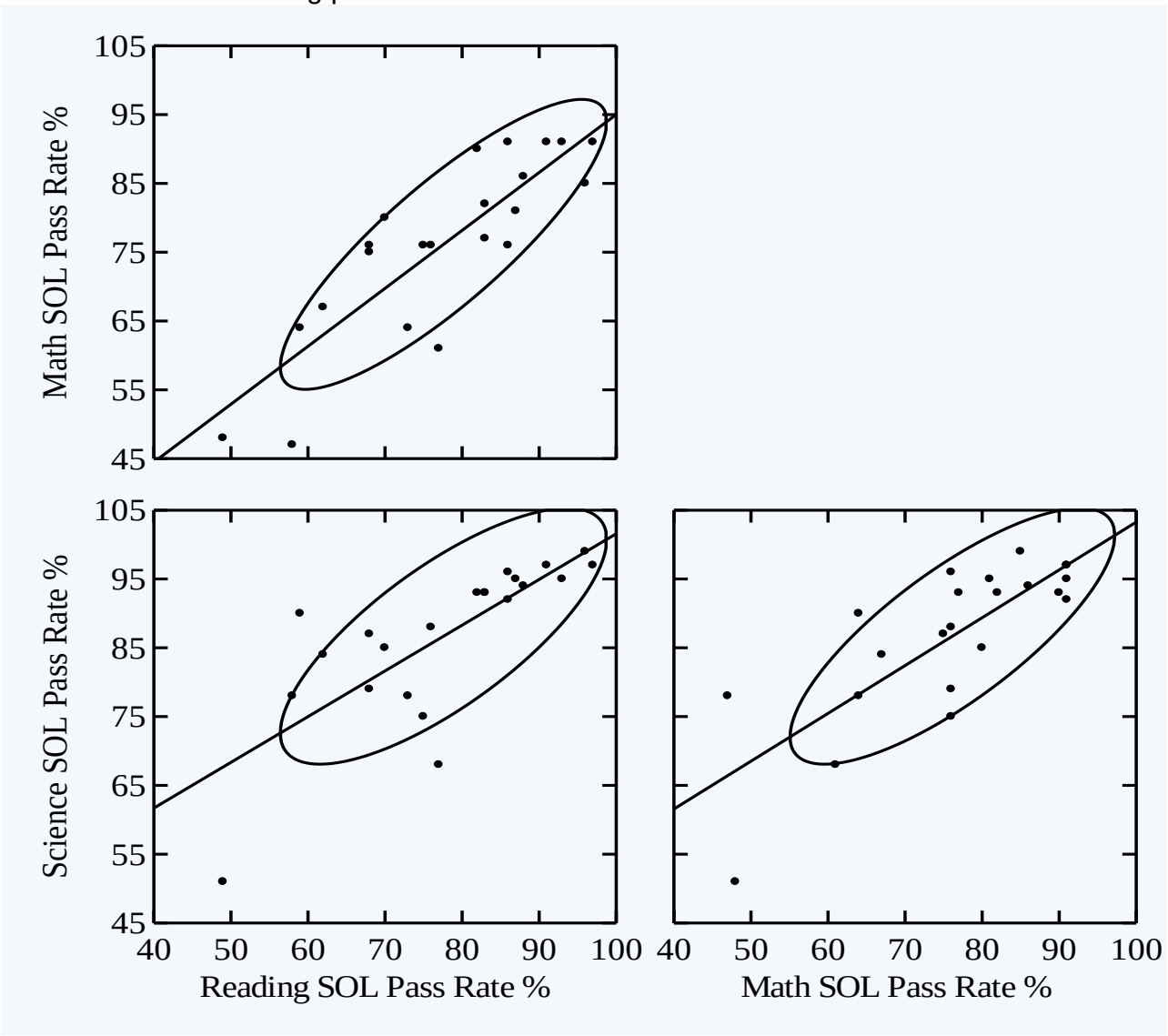
We previously addressed the first question in our 2011 SAC report, in which we showed how these school level differences in SOL pass rates are related to differences in the demographic makeup of the school's student population. In short, the school level differences reflect the achievement gap that has long concerned APS.

Therefore, it is not surprising that the answer to the second question is yes. A striking pattern is apparent across the 22 APS elementary schools; SOL test results for different subjects (math, reading, science) are strongly correlated. Schools that have low pass

[1] Figure 1 shows a box plot in which the data (individual dots for each of the 22 elementary schools) are the average pass rates for all 3rd grade students in a school. The box plot boundaries denote the 1st (25 percentile) and 3rd (75 percentile) quartiles, and the horizontal dividing line represents the median for all APS elementary schools.

rates in one subject tend to have them in the other subjects. Although individual school pass rates vary across years, this correlation is relatively consistent across the past three years. Figure 2 illustrates this pattern for the most recent testing year (2013).

Figure 2. SOL test results for APS 3rd grade show strong correlations among Science, Math and Reading pass rates[2].



If we restricted our analysis to 3rd grade only, science instruction would not be of any greater concern, and perhaps less of a concern (Figure 1), than that of math and reading. However, when SOL pass rates are followed through grades 4 and 5, it

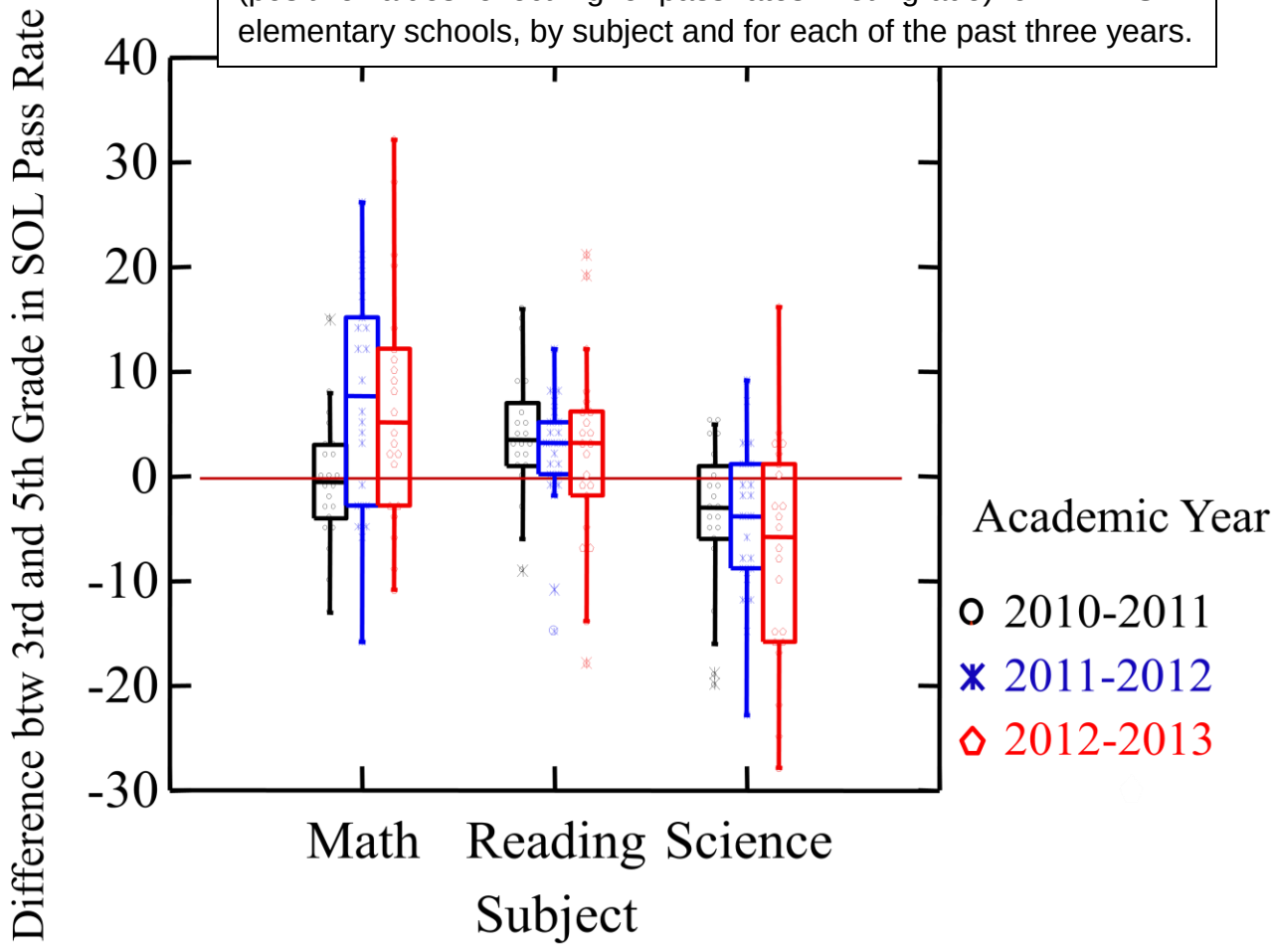
[2] Figure 2 illustrates correlations among the SOL pass rates for Math, Reading and Science across the 22 APS elementary schools (each dot reflects the average 3rd grade pass rates for a given school). The line reflects a linear smoothing (running average) to show the general trend and the ellipses reflect confidence limits around the correlation.

becomes apparent that science instruction suffers disproportionately and in ways that exacerbate the achievement gap.

In each of the past two SAC reports, we showed how pass rates for science decline between 3rd and 5th grades in most of APS elementary schools. We further noted that this trend was in contrast to pass rates for math and reading, which generally improve between 3rd and 5th grade for APS schools.

In the most recent test year (2013) in which the new, more difficult SOL science test was implemented, the difference in science pass rates between 3rd and 5th grade has become even more dramatic. Figure 3 contrasts this difference in science pass rates with that of math and reading[3].

Figure 3. Differences in SOL pass rates between 3rd and 5th grade (positive values reflect higher pass rates in 5th grade) for 22 APS elementary schools, by subject and for each of the past three years.



[3] Figure 3 is a box plot in which the data (individual dots for each of the 22 elementary schools) represent the difference in pass rates between grades 3 and 5 (i.e., pass rate for grade 5 minus pass rate for grade 3). Negative values indicate lower pass rates in 5th grade. The box plot boundaries denote the 1st (25 percentile) and 3rd (75 percentile) quartiles, and the horizontal dividing line represents the median. The horizontal line shows the expected value of zero change if 5th and 3rd grade pass rates were similar.

The data illustrate that science instruction not only suffers between 3rd and 5th grades, but that it suffers most strongly in those schools that have the lowest SOL pass rates in all subjects. Science instruction appears to lose out to an emphasis on math and reading instruction, which generally improves between 3rd and 5th grades. Significant gains in math and reading, which occur in the schools with the lowest SOL pass rates during the elementary grades, comes at the expense of science instruction. One way to view these data is that in addressing the achievement gap in math and reading at the elementary school level, the achievement gap in science is substantially exacerbated.

Unlike math and reading, there is no SOL testing for science in 4th grade. In addition, since SOL pass rates for science have been historically higher than in math and reading in 3rd grade, an instructional emphasis for 4th and 5th grades has not been on science, especially in the schools with lower math and reading SOL pass rates.

This conclusion is confirmed by a recent survey undertaken as part of the 2013 science education evaluation (SAC provided input to the survey design and has examined a preliminary draft of the report). Elementary teachers acknowledged that science instruction time is often very restricted, is often sacrificed to other activities, and that substantial portions of 4th grade science material are often postponed until 5th grade. The consequence is that an achievement gap in science that was very small in 3rd grade becomes quite large by 5th grade.

SAC proposes the following set of recommendations to address the problem of a widening inequality in science instruction and learning among APS elementary schools.

Recommendation #1

The APS should implement the Science portion of the Interactive Achievement - Formative Assessment for grades 2 through 5 to monitor the progress of students in science in those elementary schools whose science SOL pass rates are at or below 70%.

Rationale:

We applaud the fact that APS purchased a benchmarking product that contains formative assessments for Reading, Math, and Science. However, we are disappointed that APS is not requiring the Science assessment to be used. Only one school, Hoffman-Boston has opted to pilot the use of the science assessment for the 2013-2014 school year.

The benefits of using a systematic interactive achievement assessment as identified by APS for Reading and Mathematics include:

- a consistent and comparable review of student achievement
- immediate, accurate, valid and reliable data on the assessments
- a user-friendly paperless electronic system for students and teachers
- a consistent measure of effectiveness for interventions

- the recapture of instructional time for students due to electronic administration
- access to user-friendly reporting for teachers

Essentially, the formative assessment provides teachers with rapid feedback on whether students are learning at the pace expected within a school year, such that the necessity of interventions can be identified and applied before gaps in learning become too large.

SAC acknowledges that testing of students can be a distraction for learning in all subjects. Unlike for reading and math assessments, which are being implemented for all APS elementary schools, our recommendation specifies that science assessments should only be implemented in those schools where there is evidence (low SOL pass rates in 5th grade) that science instruction is failing to keep up with grade level expectations. In addition, interactive achievement formative assessments are not available for grade levels K-1 since students in those grades have not fully developed reading skills to answer test questions.

Budgetary Implications:

The Interactive Achievement Formative Assessment software purchased by APS schools for elementary school in Math and Reading already includes the Science assessment component. Hence, there is no direct budgetary implication to recommendation #1; it is simply a policy change to treat Science on par with Math and Reading as a core subject of equal concern in regards to the achievement gap.

Committee vote: 7-0

Recommendation #2

APS should help schools and teachers implement and interpret the results of the science assessments and react to classroom and individual student scores through development of instructional pacing guides, linked to the new science text books recently purchased for all elementary schools and professional development activities as needed.

Rationale:

The interactive achievement formative assessments are linked to Virginia SOL at the grade level. However, to be effective for teachers the questions should be linked to the sections of the textbooks through detailed pacing guides for instruction, covering the entire school year. In addition, it is important to train teachers in the use and interpretation of results from the formative assessments.

Teachers at Hoffman-Boston are piloting the Science assessment this year and APS science staff has been working to develop a pacing guide, linked to specific sections of the new science textbooks. SAC recommendation #2 would take lessons learned from this pilot at Hoffman-Boston to refine the pacing guide and formative assessment for implementation at the elementary schools with low Science SOL pass rates, and to serve as a resource for teachers at all other elementary schools.

Budgetary Implications:

Based on the textbook adoption training model of one lead teacher from each grade level for each school, the estimated cost for training would be about $12,000. This would include training for teachers grades 2-5 (4 teachers per school) x 22 schools= 88 substitute full days. The total cost is approximately $9,689 ($110/day). In addition to consultant and supply costs of about $2,000, the total estimated cost would be $12,000.

Committee vote: 7-0

Recommendation #3

APS should foster greater integration among instructional disciplines through an expanded effort to link science instruction and pacing guides with language arts instruction at all elementary schools.

Rationale:

An overarching theme science educators have mentioned and SAC has discussed in past reports is the value of integration of science with other subjects and into everyday lives of students. One way for students to experience this is to integrate teaching of science and other subjects at the same time. Science is a subject that can easily be taught within the context of other subjects.

Specifically, the integration of science literacy into reading and writing instruction in grades 2-5 holds the potential for APS to better address the achievement gap evident in school level SOL performance. Current trends, which suggest that science instruction may be sacrificed to instruction time for other subjects, can be reversed if science, reading and writing are more effectively integrated.

In recent SAC reports, we recommended a pilot project to integrate reading with science by creating a K-5 non-fiction reading list that includes scientific topics or biographies, complementary to the K-5 novel reading list. APS teachers and staff worked to prepare an online set of science readings linked to grade level and SOL reading standards resources – Infusion of Science into Language Arts: http://www.apsva.us/Page/19272

SAC recommends that further development, expansion, and promotion of these resources to all elementary school teachers are now warranted. SAC surveyed elementary school teachers in 2013 to see whether they were aware of the Infusion of Science into Language Arts project and whether they thought it was useful. Of the 138 respondents to the survey, only 28% were aware of the project, and only 21% had visited the website. However, among the respondents that made use of the books in their classrooms, there was strong positive feedback, and much interest in expanding the project to include more book options.

Budgetary Implications:

$6,000 is requested in each of the next two years to support groups of elementary teachers to work during the summer to expand the set of reading resources available on the Infusion of Science and Language Arts website, and for professional development of all elementary school teachers to make better use of these resources.

Committee vote: 7-0

Recommendation #4

Re-establish a Science Computer Fund (separate line in the APS science budget) dedicated to providing middle and high school science classrooms with modern laptop computers and replacing them on a 3 year cycle.

Rationale:

In 2008, APS responded to repeated recommendations from SAC and the secondary school science teachers and implemented a 3-year, phased-in purchase of 6 laptops computers for dedicated use in each science laboratory. This funding was dedicated for laptop computers for science instruction and was highly successful in increasing the level of technology and hands-on science instruction in all secondary grades.

The first of these laptops purchases are now > 5 years old and sorely in need of replacement. In addition, the number of students (and science classrooms) has grown by ~15% but without additional laptop computers. Furthermore, some schools have re-assigned the older computers for use in other subjects. Consequently, some science classrooms no longer have dedicated laptop computers for instructional use, or have fewer than the recommended 6 laptops to 1 teacher ratio.

APS schools have invested in a large amount of Vernier probeware[4] for use in science classes, and APS has purchased in a district wide license for use of the software.

[4] Vernier is a supplier of sensors and software for measuring a wide range of parameters useful in hands-on teaching of all scientific disciplines: http://www.vernier.com/products/

Some of the funding for the probes comes from external grants. However, to make effective use of these sensors and software in science laboratories, it is important that updated laptop computers be dedicated for science classrooms.

Budgetary Implications:

SAC requests $125,000 per year as an ongoing technology expense dedicated to science laboratories. To maintain/upgrade 6 computers per classroom, the estimated cost is approximately $450,000. This is based on 6 laptops @$600 each = $3,600 per classroom teacher. APS currently has 112 teachers x $3,600= $403,200, but given enrollment growth, SAC recommends planning for 125 teacher x $3600= $450,000. If the purchases are phased in over 3 years and then laptops replaced on a 3 year cycle, the ongoing cost is $150,000 per year. No additional software costs are needed.

Committee vote: 7-0

Update of Previous Recommendations:

Past Recommendation #1:

The APS should implement the Science Assessment portion of the K-8 Formative Assessment Initiative now to monitor the progress of students in Science.

Status:
Despite strong support for this recommendation from ACI, it has not been implemented. The vendor originally contracted to supply the formative assessment failed to deliver. A new vendor was secured but schools are not required to use the science portion of the product. There is currently no benchmarking of science instruction and learning in elementary schools.

2011 – 2017 Strategic Plan Alignment:

Goal One: Ensure that every student is challenged and engaged
A. Present high and clear expectations
B. Create engaging and motivating educational program choices

Goal Two: Eliminate Achievement Gaps
A. Provide equitable educational opportunities
B. Provide effective and dynamic classroom instruction
C. Provide necessary and appropriate support for all students and all identified groups

ACI Vote:
19-Yes, 0-No, 5-Abstaining

Budgetary Implications:
Minimal

Past Recommendation #2:

APS should develop increased integration among instructional disciplines.

Status:
The Infusion of Science into Language Arts project was launched in 2012-13 as a pilot to better integrate reading and science. As we report above, SAC is monitoring the use and value of this project, and believes a strong effort is now justified to expand and promote the resources for use in elementary schools.

2011 – 2017 Strategic Plan Alignment:

Goal One: Ensure that every student is challenged and engaged
A. Present high and clear expectations
B. Create engaging and motivating educational program choices

ACI Vote:
24-Yes, 0-No, 0-Abstaining

Budgetary Implications:
$2,000

Past Recommendation #3:

Middle school students should participate in inquiry-based science projects tied to the curriculum via modules developed by APS staff and teachers.

Status:
Science project modules have been developed for 6th, 7th and 8th grade science teachers to use for open ended student inquiry projects. The modules are focused on the Nature of Science and incorporate strands of the science SOL for these grade levels. However, APS middle schools still vary in their requirement for independent science projects and participation in science fair. As in our previous report, which highlighted Jefferson Middle School's requirement for a science project in all grades, SAC will continue to monitor the impact of science project requirements on middle school student achievement in science.

It is notable that the 2012 Intel International Science Fair grand prize winner, high school freshman Jack Andraka from Anne Arundel County, Maryland, who developed a rapid, low cost means of detecting several human cancers at an early stage, attributed his interest and achievement in science to his middle school's requirement that all students do an annual science project beginning in 6th grade.

2011 – 2017 Strategic Plan Alignment:

Goal One: Ensure that every student is challenged and engaged
A. Present high and clear expectations
B. Create engaging and motivating educational program choices

ACI Vote:
22-Yes, 0-No, 2-Abstaining

Budgetary Implications:
$5,000

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APS Staff:

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