

## **Impact on Achievement of a Five-Year Intensive Professional Development Program in Elementary Science**

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ASSET (Achieving Student Success through Excellence in Teaching) is a STEM (Science, Technology, Engineering and Mathematics) education improvement nonprofit established by Bayer Corporation and several business, education and community organizations in 1994. It inspires innovation and excellence by providing highly effective educator professional development, hands-on, minds-on STEM classroom materials and consulting services to schools, universities and organizations. All of its programs are results-oriented, research- and inquiry-based and align with national and state standards.

ASSET based its model of science education reform on the National Science Resources Center's (a joint project of the National Academies and the Smithsonian Institute) five-component model for exemplary science education. The five components include: 1) Standards-based curriculum materials; 2) Ongoing rigorous professional development; 3) Centralized materials support; 4) Program and student assessment; and 5) Community/administrative involvement.

Using a “teachers teaching teachers” model, Professional Development sessions are facilitated by ASSET professional development facilitators. Previous evaluations of ASSET's Professional Development model has been called effective because: a) teachers learn from their peers; b) professional development is directly related to standards-based curriculum; c) sessions incorporate research-based effective classroom practices; d) teachers experience firsthand what students will experience; e) facilitators model inquiry-based teaching and learning; f) sessions include time for reflection/meaning making; and g) the program cultivates a pathway from classroom teacher to teacher leader to professional development facilitator or resource teacher.

Throughout its 20+ year history, ASSET has been a catalyst in the pursuit of STEM education improvement by maintaining its focus on teachers as the targets and agents of classroom change. In 2006, the Pennsylvania Department of Education (PDE) and Governor Edward Rendell launched a \$10 million statewide initiative to power the improvement of elementary science education called *Science: It's Elementary* (SIE). ASSET was selected to design, manage and implement this important statewide initiative in partnership with the Pennsylvania Department of Education. *Science: It's Elementary* garnered national attention from President Barack Obama, who singled out the program “as an example of a state taking steps to encourage inquiry-based science statewide.” The National Science Resources Center calls the ASSET program “a model for the nation.”

ASSET received an i3 (Investing in Innovation) Validation grant during the first round of grant awards in 2010. At the start of this i3 grant, ASSET, had impacted 125,000 students and 4,000 teachers in more

than 100 school districts, charter, private and resource-challenged schools across Pennsylvania. Students from both rural and urban status districts of varying socio-economic statuses and backgrounds have been served by ASSET.

ASSET's i3 intervention was replicating, expanding, and sustaining ASSET's proven K-6 standards-aligned STEM education program statewide through a variety of intensive professional development for teachers of science and math in grades K through 6. In addition to participating in the foundational and introductory courses that are an integral part of SIE, teachers had opportunities to engage in ongoing, rigorous, higher-level Professional Development that is a key component of the ASSET model. Through the i3 validation grant funding, ASSET offered rural and high-needs schools fully-subsidized Professional Development services, including ASSET's Curriculum Alignment Planning Service (CAPS), Vision Conference, Strategic Planning Institute, and higher-level Institutes for Inquiry, Assessment, Science & Literacy, and Math as well as pathways to develop Coaches.

The intervention components of the Advanced ASSET Professional Development were:

- Higher-level four and five consecutive-day summer professional development trainings delivered through the Institute for Inquiry, Institute for Assessment, Science & Literacy Institute, and Foundations for Teaching Inquiry-Based Math
- Three years of a three consecutive day Leadership Academy, designed to encourage teacher leadership within a school building through the development of a Professional Learning Community (PLC).
- Four years of a one day Content Enrichment session designed to deepen teachers' content knowledge in four strands: life science, earth science, physical science and engineering and technology.
- A two year Coaching Pathway designed to provide schools with the resources to develop their own coaches or access to coaching services from ASSET Professional Development Staff.

There were two Key Components of ASSET's Advanced Professional Development Model: (1) Development of a Professional Learning Community School Culture and (2) Comprehensive Professional Development to Increase Teacher's Content Knowledge and Self-Efficacy in Science. The primary outcome of interest was the impact of this two-stranded professional development model on student achievement in science.

### **The Intervention and Comparison Groups**

A subset of 23 SIE schools constituted the intervention group, i.e., the Advanced ASSET Professional Development group. Intervention schools were selected based on several criteria. A high priority was placed on schools that served high-needs students and met at least one the following criteria: (1) 40% or more students receiving free or reduced price lunch; (2) A Race to the Top Turnaround School that was Title I eligible with at least 50% of students at below basic (25th percentile) and have both 30% or more students below basic (10th percentile) and less and 6.6% improvement in percent of students below basic since 2005 (75th percentile); or (3) A Rural and Rural Low Income Schools based on the population density of the school district according to federal guidelines. Addition selection criteria

included: (1) previously participated in *Science: It's Elementary (SIE)*; (2) Former SIE participant teachers still using Full Option Science System (FOSS) and/or Science and Technology Concepts (STC) science modules; and (3) Schools whose teachers participated in ASSET's SIE professional development on the FOSS and/or STC science modules.

A comparison group of 23 schools was created using propensity score matching. This group consisted of schools in Pennsylvania that had not participated in *Science: It's Elementary* or any other statewide science initiatives, including: MSP Southwestern Pennsylvania, MSP Philadelphia Area, Science Wise, and Science Matters. This group is referred to as comparison group 1. A second group of 23 schools who previously participated in *Science: It's Elementary* constituted a second comparison groups.

Both comparison groups were identified using propensity score matching. The following school-level data were used for propensity matching: (a) the percent of students reaching proficiency on the state 4<sup>th</sup> grade science assessment in 2008, 2009, and 2010; (b) the percent of students reaching proficiency on the 3<sup>rd</sup> grade state math assessment in 2008, 2009, and 2010 as well as the 4<sup>th</sup>, 5<sup>th</sup>, and 6<sup>th</sup> grade math assessment; (c) the percent of students reaching proficiency on the 3<sup>rd</sup> grade state reading assessment in 2008, 2009, and 2010 as well as the 4<sup>th</sup>, 5<sup>th</sup>, and 6<sup>th</sup> grade state reading assessment; (d) percent of low income families; (e) total enrollment for each school; and (f) school locale (urbanicity using the federal coding system)

### **Achievement Measures**

Average school performance on the state assessments in science and mathematics (i.e., PSSA Science and PSSA Math) were used as the outcome measure. While the percent of students reaching proficiency was used for propensity matching, the average scale score was used for determining baseline equivalence. The Pennsylvania System of School Assessment (PSSA) in science was first administered in 2007. Results from years 2008 through 2010 were used for propensity matching, the 2011 results were used to determine baseline equivalence and the 2014 results were used as the final outcome measure. While the primary analysis of interest was the impact on science scores, a secondary analysis was also conducted on math scores.

All of the data from the PSSA Science and PSSA Math assessments during the timeframe for this study, were based on the same set of state standards and the same definition of proficiency. Historical data has shown that a high percentage of fourth grade students across the state reach proficiency in science. During the first year of testing science in Pennsylvania (2008) 81.5% of 4<sup>th</sup> graders reached proficiency, 83.4% in 2009, 81.4% in 2010, 82.9% in 2011. Therefore, the actual examination of baseline and impact data was based on the actual student scale scores in science. Data used in this analysis were obtained via a confidentiality agreement with the Pennsylvania Department of Education and all data files were redacted of individual identifying information.

Table 1 contains the reliability estimates of the PSSA Science and Math for the years where data was collected and examined.

### **Table 1 – PSSA reliability**

	2008 (matching)	2009 (matching)	2010 (matching)	2011 (Baseline)	2014 - (Impact)
<b>PSSA Science Grade 3</b>	0.91	0.91	0.93	0.92	0.93
<b>PSSA Math Grade 3</b>	0.92	0.92	0.91	0.92	0.95
<b>PSSA Math Grade 4</b>	0.93	0.93	0.92	0.92	0.94
<b>PSSA Math Grade 5</b>	0.93	0.93	0.93	0.93	0.95
<b>PSSA Math Grade 6</b>	0.93	0.93	0.93	0.94	0.94

## Baseline Equivalence

The intervention for teachers (i.e., the intensive professional development program) began in the spring of 2011. The spring 2011 PSSA Science and Math results comprised the baseline data. Table 2 shows the 2011 PSSA results for both science and math. Ten contrasts were examined, two confirmatory (those involving PSSA Science) and eight exploratory (those involving PSSA Math.)

**Table 2 – 2011 PSSA Science and Math Baseline Results**

Intervention Group			Comparison Group 1 No Formal Science PD			Comparison Group 2 Former SIE Schools		
Sample Size	Mean	Standard Deviation	Sample Size	Mean	Standard Deviation	Sample Size	Mean	Standard Deviation
21	1466.68	78.60	18	1463.92	70.71	20	1472.59	57.83
21	1331.25	57.60	20	1337.69	76.93	20	1368.53	41.96
21	1462.03	75.20	19	1435.45	105.51	20	1481.01	66.87
17	1417.14	75.87	19	1432.52	109.51	17	1482.18	67.49
11	1421.15	90.10	13	1426.32	119.75	10	1514.57	56.71

Two contrasts met the baseline equivalence standard: (1) the confirmatory contrast comparing PSSA 4<sup>th</sup> grade science scores for the intervention group with those from comparison group 1; and (2) the exploratory contrast comparing PSSA 6<sup>th</sup> grade math scores for the intervention group with those for comparison group 1. Three contrasts indicate a statistical adjustment must be made when calculating impact estimates based on the post-test scores, i.e., the 2014 PSSA scores. These three contrasts are: (1) the confirmatory contrast comparing PSSA 4<sup>th</sup> grade science scores for the intervention group with those for comparison group 2; (2) the exploratory contrast comparing PSSA 3<sup>rd</sup> grade math scores for the intervention group with those for comparison group 1; and (3) the exploratory contrast comparing PSSA 5<sup>th</sup> grade math scores for the intervention group with those for comparison group 1. All other contrast (which were all exploratory in nature) did not satisfy the baseline equivalence standard.

Statistical adjustments were included when analyzing the differences in the PSSA 2014 scores for all ten contrast. The confirmatory contrasts, therefore, meet the WWC standards for baseline equivalence.

## Impact Measure

The impacts in Table 3 and 4 clearly show statistically significant differences between the intervention group and comparison group 1 for both PSSA Science Grade 4 and PSSA Math Grade 3. ASSET’s outcome of increasing science achievement was met for the comparison group 1 contrast. The originally submitted i3 proposal included just one control group; a group without any ASSET or other science professional development programs, which is comparison group 1. Comparison group 2 was added after acceptance of the i3 proposal so that differential impacts could be examined.

**Table 3 – Impact Results for Intervention vs Comparison Group 1**

Outcome Measures	Intervention Group		Comparison Group 1 No Formal Science PD		Estimated Effects	
	Mean	Standard Deviation	Mean	Standard Deviation	Impact Estimate	p-value
PSSA Science Grade 4	1472.25	88.49	1428.06	102.30	39.95	0.036
PSSA Math Grade 3	1320.48	67.53	1283.80	92.22	52.50	0.013
PSSA Math Grade 4	1426.63	93.70	1384.88	111.99	49.98	0.062
PSSA Math Grade 5	1413.10	112.69	1442.34	114.75	32.97	0.358
PSSA Math Grade 6	1421.05	99.76	1453.74	122.17	-7.27	0.851

While no statistically significant results were found when comparing the intervention group with comparison group 2, the PSSA Science Grade 4 results were higher for the intervention group and approached the .05 significance level.

**Table 4 – Impact Results for Intervention vs Comparison Group 2**

Outcome Measures	Intervention Group		Comparison Group 2 Former SIE Schools		Estimated Effects	
	Mean	Standard Deviation	Mean	Standard Deviation	Impact Estimate	p-value
PSSA Science Grade 4	1472.45	88.49	1458.94	67.34	26.36	0.060
PSSA Math Grade 3	1320.48	67.53	1339.64	57.25	12.78	0.423
PSSA Math Grade 4	1426.63	93.70	1440.07	78.42	26.34	0.150
PSSA Math Grade 5	1413.10	112.69	1452.38	84.10	19.77	0.518
PSSA Math Grade 6	1421.05	99.76	1472.85	102.62	63.15	0.170

For the primary measure of science achievement, the three group scale score means are 1472, 1428 and 1459 for the Intervention, comparison Group 1 and comparison Group 2, respectively. While the schools in the comparison group 2 were not participating the Advanced Professional Development provided via the i3 grant, they may have participated in other professional development offerings of ASSET.

In summary, ASSET’s primary goal of increasing student achievement in science was met.

**Discussion**

ASSET applied for and was awarded a Validation grant, with the very first round of *Investing in Innovation* (i3) grants in 2010. The purpose of a Validation grant is to conduct an independent

evaluation of a program that has previous evidence of effectiveness, based on evaluations which may not have been independent and/or which may not have met the What Works Clearinghouse standards. Previous evaluations of ASSET’s Professional Development model have concluded the program to be effective because: a) Teachers learn from their peers; b) Professional Development is directly related to standards-based curriculum; c) Sessions incorporate research-based effective classroom practices; d) Teachers experience firsthand what students will experience; e) Facilitators model inquiry-based teaching and learning; f) Sessions include time for reflection/meaning making; and g) The program cultivates a pathway from classroom teacher to teacher leader to professional development facilitator or resource teacher.

The major outcome of this five-year grant is the statistically significant differences found in 4<sup>th</sup> grade PSSA Science for the intervention schools vs the comparison group 1 schools. This finding went beyond the previous evaluation studies, which examined primarily the process of ASSET’s professional development model.

Recall that comparison group 2 consisted of former SIE schools. These schools had received much professional development from ASSET prior to 2011, but not in the intensive, multi-day format that was used with the 23 intervention schools during this five year timeframe. Table 5 contains the unadjusted PSSA Science grade 4 group means for 2011 and 2014.

**Table 5**

**Unadjusted Mean PSSA Science Scale Scores for Treatment and Control Groups: Pre vs Post**

	<b>Intervention Group</b>	<b>Comparison Group 1</b>	<b>Comparison Group 2</b>
<b>PSSA Science 2011</b>	1466.7	1463.9	1472.6
<b>PSSA Science 2014</b>	1472.5	1428.1	1458.9

The statewide 4<sup>th</sup> grade PSSA Science results have historically been very high. The state releases the percentage of students scoring in each of the four performance levels of Below Basic, Basic, Proficient, and Advanced. In fact, in 2011, 83% of fourth graders across the commonwealth scored proficient or higher. In 2014, 79% of 4<sup>th</sup> graders were proficient or higher. At the start of the grant, concerned about seeing any differences on a test that fourth graders score very high, it was decided to look not at the percent of student reaching each performance level, but rather to look at differences in scale score points. For reference, the Proficient scale score range goes from 1275 to 1482. A scale score of 1483 is considered Advanced. All means in Table 5 fall within the Proficient performance level.

The scale scores in Table 5 show some interesting results. Statistically speaking, the post-test scores for the intervention group is significantly higher than the post-test scores for comparison group 1. What is more educationally significant is the trend in Table 5. The PSSA scores have declined in both comparison groups, while they have increased slightly in the intervention group. Also, comparison group 2 started out where the intervention group ended, with an average PSSA score around 1472. Does this suggest an

impact of sustained professional development? It is not known to what degree (if at all) the former SIE schools continued receiving professional development services. Was the drop in scores for the SIE schools due to a discontinuation of professional development?

One thing is very clear from these results: The ASSET Professional Development model used in the i3 program has major positive impacts on teachers and students as compared to schools who do not have a comprehensive, sustained, multiple-year professional development plan for science teachers.