Virginia Department of Education
Mathematics and Science Partnership Program
Progress Report Template

The progress report should contain the components indicated below. If there are components that are not applicable at the time of the report, please indicate when those portions are expected to reach completion. Completed reports should be submitted electronically to Eric M. Rhoades, director, Office of Science and Health Education at Eric.Rhoades@doe.virginia.gov by **September 30**.

I. Introduction

A. Name of Institution: Longwood University

Project Title: K-5 SCIEnCE

Project Period: March 1, 2013 - September 30, 2014

Grant Award: $65,081

PI: Dr. Suzanne Donnelly
Co-PI: Dr. Paula Klonowski Leach

Contact Information: Dr. Donnelly: donnellysm@longwood.edu,
Dr. Leach: paula@ittip.org, (804) 301-3172

B. Goals and objectives of the project

Goals	Strategies	Assessment
Goal 1: Develop and implement high-quality professional development activities through the integration of UbD, IBL, performance assessments, and 5e instructional models to improve teacher's knowledge of science concepts and the Nature of Science.	• Enhance the content knowledge of the teachers through the week-long summer workshop from June 24 – 28, 2013 at Longwood University, focusing on the force, motion, energy, and matter K-5 Science SOL strand. • Use self-paced, targeted professional development for individual teachers through NSTA Learning Center for all science content areas. • Model inquiry-based learning during PD for teachers to understand the difference between the Nature of Science and Scientific Method. • Provide opportunities for	Pre-test and post-tests on knowledge on science content, nature of science, inquiry based learning, science teacher efficacy

	science teachers to understand the use of probeware, simulations, and models.	
Goal 2: Develop and model exemplars integrating IBL, UbD, and Nature of Science for improving science achievement and reducing achievement gaps in subgroups of students with disabilities.	• Demonstrate modeling and other research-based practices during PD • Provide the unit plan template that integrates the instructional models demonstrated to the teachers during professional development • Facilitate opportunities for teachers to explore various levels of inquiry • Provide and use models of performance assessments during PD.	Self-assessment, peer feedback, and instructor feedback using unit plan rubric
Goal 3: Facilitate collaborative online learning community of teachers to develop, share, and implement units of instruction and support the teachers through classroom observation and feedback.	• Build professional community of teachers in rural schools who will work together on unit plans, provide peer reviews and support each other to alleviate issues regarding teacher efficacy (Garet, et al, 2001; Holloway, 2003) using NSTA Learning Center. • Visit classrooms twice during the project and provide feedback to the teachers. • Facilitate a culminating activity in Spring 2014 for teachers to share their units with reflection after implementation in the classroom.	Unit plan rubrics and checklist of best practices to look for during science instruction

List partners and roles.

Partner	Role
Longwood University ITTIP, Longwood University College of Arts and Sciences	Implement and manage MSP program, provide face-to-face week-long institute in summer, classroom observations and feedback, Saturday session in Spring.
NSTA Learning Center	Provide online learning resource during the school year for all teachers.
Amelia, Buckingham, Cumberland, Nottoway	Partner school divisions, recruited teachers for program.

C. **Data Collection**:
Evaluator(s): Jesse Senechal, JK Stringer, Heather Carlson-Jaquez, Metropolitan Educational Research Consortium, Virginia Commonwealth University

The K-5 SCIEnCE project evaluation is being conducted by VCU's Metropolitan Educational Research Consortium. The design of the SCIEnCE project evaluation is twofold: to provide both a formative, systematic means to monitor progress toward program goals as well as useful information to program staff during program implementation, and to provide a summative measure of effectiveness of the program in reaching its goals. Both the formative and summative components of the evaluation will address each of the three program goals.
Evaluation Questions: Below are the evaluation questions, related to each of the project goals that will be addressed through the program evaluation:

1. What is effect of the SCIEnCE K-5 weeklong professional development on the content knowledge and pedagogical knowledge of participants? (Goal 1)

2. What is the effect of the individualized National Science Teachers Association Learning Center courses on the content knowledge and self-efficacy for science pedagogy of participants? (Goal 1)

3. What are participants' perceptions of the relevance and effectiveness of the SCIEnCE K-5 professional development? (Goal 1)

4. To what extent are teachers implementing the exemplars and integrating the content and pedagogical practices gleaned from the SCIEnCE K-5 workshops into their teaching? (Goal 2)

5. What evidence is there that the knowledge and skills gained through the SCIEnCE K-5 professional development is having an impact on student achievement and achievement gaps between student sub-groups? (Goal 2)

6. What are participants' perceptions of the effectiveness of the *SCIEnCE* K-5 online learning community and classroom observation and feedback for facilitating the application of exemplars, content, and pedagogical knowledge learned through the *SCIEnCE* K-5 program into their practice? (Goal 3)

To answer these questions the following data were collected.

- ***Post-Summer Institute Survey***. This survey collected demographic data as well as (1) teacher perceptions of program effectiveness, (2) self-reported growth as a result of the program, (3) teacher plans to implement material presented through the program, (4) assessment of the usefulness of various components, (5) questions about teachers' perceptions of the NSTA

Learning Center resources; and (6) two open-ended questions that asked participants to identify the best parts of the program as well as give suggestions for program improvement.

- ***End-of-Program Survey.*** The end-of-program survey included most of the same sections as the pre-survey, however it did not include the questions about workshop lesson effectiveness. It also included a question that asked teachers to report the frequency of use of the NSTA Learning Center.
- ***Teacher Focus Groups.*** The focus group was conducted in May of 2014 at the SCIENCE program culminating event. The focus group consisted of five teacher participants who discussed overall program perceptions.
- ***NSTA Learning Center Data.*** Data were collected from the NSTA Learning Center about participants' engagement with the online activities.

II. Project Implementation

Activity	Date Range	Contact Hours	Number of Teachers Planned	Number of Teachers Served
Week-long Institute at Longwood University	June 24 – June 28	40	20	18
NSTA Learning Center	June 24, 2013 – June 30, 2014	20 (varies)	20	17

Five Day Summer Institute

A week-long institute was held on June 24 – June 28, 2013 on the Longwood University campus. Twenty teachers were anticipated for the workshop and 18 actually attended starting June 24. An additional teacher dropped out on Wednesday and did not wish to continue in the program.

Dr. Suzanne Donnelly, Assistant Professor of Science Education, Dr. Patty Horne, Assistant Professor of Education, Dr. Paula Leach, ITTIP Learning Specialist and NSTA staff members provided instruction during the week. The topics covered included:

1) Nature of Science
2) Force, Motion, and Energy SOL content
3) Problem-Based Learning
4) Performance Assessments
5) 5E Learning Cycle
6) NSTA Learning Center

The teachers were provided with materials to conduct hands-on investigations each day during the week. Additionally, resources were provided to the teachers for their own use and learning.

School Year Activities

There were several components of the program that kept teachers engaged with the science content through the school year. A core component of the school year activities involved the teachers developing and implementing a unit based on the pedagogical strategies covered during the summer workshop. During the school year, teachers regularly logged on to the NSTA Learning Center, an online professional learning site that provided targeted learning modules related to course content. In addition program leaders from ITTIP provided individual support through ongoing electronic communication as well as individual school visits and classroom observations.

Culminating Event

The culminating event occurred in May of 2014 at Longwood University. This event brought together all of the participating teachers. Each teacher presented the unit that was developed through the grant and shared the results of integrating the unit into classroom practice.

II. Evidence of Impact

Impact on Pedagogical Content Knowledge

One of the core goals of the SCIEnCE K-5 professional development program was to improve the science pedagogical content knowledge of participating teachers. The section below discussed the observed impact on both the scientific content knowledge as well as on teachers' growth in the understanding of science pedagogy. The full program evaluation (attached) contains more detail as to the specific questions and data collected.

There are several key findings from this data.

- Overall, the survey items from the two time points indicate that there was agreement among participants that the program improved their knowledge and understanding of the majority of targeted science content.
- There is some range in teachers' perceptions of knowledge growth across items. For example, on both pre and post surveys, the highest scores went to the item about "the production of scientific knowledge," while the teachers' understanding of the "calculations related to the transfer of energy" received the lowest level of agreement.

- There was some drop off on the level of agreement across the two time periods, suggesting that teachers' perceptions of their knowledge growth was highest directly after the workshop, and that their sense of their knowledge growth faded somewhat through the school year.

Qualitative data from the focus group support the data from the surveys. In the focus group, when asked about the key concepts that were learned, the teachers discussed the nature of science. For example one teacher stated, "We talked about the nature of science as well, I remember that was a big thing, because a lot of us hadn't heard of it, but it is actually in our SOLs." Within the focus group there was also recognition of the value of the pedagogical focus of the workshop. Many teachers indicated that they appreciated the "hand-on" nature of the workshop activities. For example, one teacher stated, "I really liked building a rollercoaster. That gave a good example. You start with a problem and then we had to meet in our groups to design this, problem solve, think critically, and think like a student. What would a student be thinking during this time? Because we were kind of starting fresh ourselves and had not really done a lot of that kind of hands on learning as much." Along the same lines another teacher stated that the most significant aspect of the program "was when we talked about designing the lesson plan," and that in regards to PBL "at the beginning of last summer I kind of knew what it was but I didn't really. But now seeing it and being in the group and learning how to actually design the lesson, it made it a lot easier and I understand it more."

Changes in Practice

Another goal of the SCIEnCE K-5 program was to impact the pedagogical practice of the teacher participants. To assess change in practice, a retrospective self-report pretest/posttests (Lam & Bengo, 2003) was used. This instrument asked teachers to indicate the likelihood of engaging in particular pedagogical strategies both "prior to" and "after" participation in the SCIEnCE professional development. The strategies asked about included Inquiry-based Learning, Understanding by Design, Nature of Science, the 5e instructional model, and technology integration.

This data suggest that teacher participants were much more likely to incorporate the targeted instructional strategies after their participation in the SCIEnCE K-5 professional development program. Results of paired *t*-tests indicate that the change in teacher behavior is statistically significant for all pedagogical methods.

These findings are supported by the qualitative data collected through the focus groups and open-ended survey questions. All of the teachers in the focus groups discussed how the units and lessons developed through the workshop were integrated into their teaching. However, teachers also mentioned

that the integration of the new techniques was difficult. One teacher stated that didn't do as much "as I would have liked to, I think I will more next year after I have gotten my feet wet." However, there was also a resolve among the teachers that these strategies were valuable and worth pursuing. For example one teacher stated, "I definitely think I would continue with the problem based learning with different lessons."

Impact on Students

Although student level data was not collected, teachers were asked during the focus group to report on their perceptions of the impact of the targeted pedagogical practices on student motivation, engagement, and achievement. Overall teachers indicated that their students were "more focused and more involved," and that Inquiry-based learning activities helped students to connect classroom activities with a real world purpose and to realize that "this makes sense." Another teacher mentioned that because of the project-based nature of the instructional techniques, students were taking more ownership for their work and were more interested in doing a good job. She stated, when "they take ownership, it empowers them more, so they have a stake in it." Teachers also suggested that "if it is used properly," and appropriate guidance is given to students, then PBL will help students to think better and achieve more highly on standardized testing. The focus group data suggest that students were interacting well with SCIEnCE techniques, and if the teachers' beliefs are correct, there will be a positive impact on academic achievement.

III. Summary & Conclusion

The findings from this evaluation suggest that the SCIEnCE professional development program is having a positive impact on teacher pedagogical content knowledge and teacher practice. There is also some anecdotal evidence that these strategies are having a positive effect on student engagement and achievement. Overall, the participating teachers rated the program as an effective and relevant professional development experience.

The findings from the evaluation also lead to several recommendations for future program development and evaluative work.

- ***Assessing the content relevance of the program.*** Many teachers commented on the content level of the science content and strategies. In certain cases, teachers felt that the materials were not usable at the lower grade levels, while other teachers saw value in knowing what upper grade students were moving toward. This reaction from the teachers suggests that it would be valuable to evaluate the level of the content in relation to participating teacher grade level. Program

leaders could shift content to better align with the curriculum of the participating teachers' grade levels. Alternatively, the program could provide support for adapting more advanced content to lower grade levels.

- ***Review of the effectiveness of the NSTA Learning Center***. The data from the evaluation pointed to some concerns among teachers related to the NSTA Learning Center. While there seem to be some teachers that embraced the resources, many seemed frustrated in attempts to use it. This suggests that if the NSTA Learning Center is used again, more time should be spent establishing the value of the resource and helping teachers navigate it.
- ***Determining ways to assess impact on students***. Ultimately the goal of any teacher professional development is improved student outcomes. However, determining the impact on students in programs like this is difficult because of the range of grade levels and participating schools and school divisions. Developing a common assessment that is valid and reliable across this range of settings and populations is challenging. Nonetheless, it is important to develop program and evaluation strategies that allow for a deeper understanding of student impact. Future work should go into assessing the impact of these strategies across a broad spectrum of contexts.

Science Collaborative for Innovative and Enhanced Content Excellence: K-5 (SCIEnCE)
Independent Evaluation
September 30, 2014

Jesse Senechal
JK Stringer
Heather Carlson-Jaquez
Metropolitan Educational Research Consortium
Virginia Commonwealth University

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The Longwood University College of Arts and Sciences and the Institute for Teaching through Technology and Innovative Practices (ITTIP) at Longwood University, in partnership with six local school divisions, developed and implemented the *Science Collaborative for Innovative and Enhanced Content Excellence: K-5 (SCIEnCE)* in response to a needs assessment that indicated the need for improvement in the following SOL strands: nature of science (NoS), scientific investigation, force, motion, energy, and matter. The *SCIEnCE* K-5 program provided sustained professional development to seventeen elementary teachers from six schools in Southside, Virginia through the 2013-2014 school

year. The participating teachers attended a weeklong institute in the summer of 2013 at Longwood University and then received ongoing support from the ITTIP staff through the 2013-2014 school year. The SCIEnCE K-5 program sought to accomplish the following goals:

1. Improve the science content knowledge of elementary teachers
2. Enhance teachers' knowledge of the NoS SOL strand
3. Develop instructional practices that require more rigorous science inquiry
4. Incorporate problem-based assessments
5. Provide opportunities for teachers to learn, practice, develop, and implement authentic inquiry-based learning and interdisciplinary activities to enhance science learning experiences.

This report presents findings of an external evaluation of the SCIEnCE K-5 professional development grant. The report is based on results of pre and post teacher surveys, a focus group of participating teachers, and data that documents the teachers participation on the National Science Teachers Association (NSTA) online Learning Center, a key component of this professional development model.

Evaluation Questions and Design

To assess the degree to which the SCIEnCE K-5 grant met its stated goals the following evaluation questions were asked:

1. What is the effect of the SCIEnCE K-5 weeklong professional development on the content knowledge and pedagogical knowledge of participants?
2. What are participants' perceptions of the relevance and effectiveness of the SCIEnCE K-5 professional development?
3. To what extent are teachers implementing the exemplars and integrating the content and pedagogical practices gleaned from the SCIEnCE K-5 workshops into their teaching?
4. What evidence is there that the knowledge and skills gained through the SCIEnCE K-5 professional development is having an impact on student achievement and achievement gaps between student sub-groups?
5. What are participants' perceptions of the effectiveness of the SCIEnCE K-5 online learning community and classroom observation and feedback for facilitating the application of exemplars, content, and pedagogical knowledge learned through the SCIEnCE K-5 program into their practice?

Data sources

To answer these questions the following data were collected.

- ***Post-Summer Institute Survey (Appendix A)***. This survey collected demographic data as well as (1) teacher perceptions of program effectiveness, (2) self-reported growth as a result of the program, (3) teacher plans to implement material presented through the program, (4) assessment of the usefulness of various components, (5) questions about teachers' perceptions of the NSTA Learning Center resources; and (6) two open-ended questions that asked participants to identify the best parts of the program as well as give suggestions for program improvement.
- ***End-of-Program Survey (Appendix A).*** The end-of-program survey included most of the same sections as the pre-survey, however it did not include the questions about workshop lesson effectiveness. It also included a question that asked teachers to report the frequency of use of the NSTA Learning Center.
- ***Teacher Focus Groups (Appendix B)***. The focus group was conducted in May of 2014 at the SCIENCE program culminating event. The focus group consisted of five teacher participants who discussed overall program perceptions.
- ***NSTA Learning Center Data.*** Data were collected from the NSTA Learning Center about participants' engagement with the online activities.

Appendix C presents an evaluation matrix that connects evaluation questions with data sources and data collection schedules.

Data Analysis

Quantitative data was analyzed using SPSS 22.0, and included both descriptive and inferential analyses. Focus group data was analyzed using ATLAS.ti, a qualitative data analysis software allowing for thematic analysis. Field notes and unit plan analysis provided additional qualitative insight into the program's progress toward the three program goals.

Professional Development Profile

The SCIEnCE K-5 program included both a week-long intensive summer program, school year follow up activities, and a culminating event in the spring of 2014. Below are the descriptions of these key program components.

Five Day Summer Institute

The weeklong professional development institute integrated each of the project components (science content, NoS, IBL, Understanding by Design (UbD), technology, performance assessments) throughout

the week to model an integrated approach to teaching and learning. Lessons focused on the scientific investigation strand; force, motion, energy, and matter; and the NoS Documents provided by VDOE (*2010 Science Standards of Learning, Science Curriculum Framework, Enhanced Scope and Sequence)* were used as the foundation for content during the week. Additionally, teachers were provided with resources related to UbD, performance assessments, the NSTA Learning Center, technology integration, and 5E cycle for inquiry. Teachers actively participated in investigations with science content related to the emphasized strands and content indicated previously.

School Year Activities

There were several components of the program that kept teachers engaged with the science content through the school year. A core component of the school year activities involved the teachers developing and implementing a unit based on the pedagogical strategies covered during the summer workshop. During the school year, teachers regularly logged on to the NSTA Learning Center, an online professional learning site that provided targeted learning modules related to course content. In addition program leaders from ITTIP provided individual support through ongoing electronic communication as well as individual school visits and classroom observations.

Culminating Event

The culminating event occurred in May of 2014 at Longwood University. This event brought together all of the participating teachers. Each teacher presented the unit that was developed through the grant and shared the results of integrating the unit into classroom practice.

Participant Profile

Seventeen teachers from six schools participated in the program. Table 1 provides a demographic breakdown of teacher participants. Fifteen out of 17 participants responded to the end-of-program survey (a response rate of 88%).

Table 1. Demographics Profile of SCIEnCE K-5 Participants

Schools Represented	**# of Participants**
Amelia County Elementary	5
Burkeville Elementary	1
Buckingham Elementary	4
Crewe Primary School	2
Cumberland County Elementary	2
Lakeview Elementary	1

Grade Level

K	3
1	1
2	4
3	5
4	1
5	1
Years of Experience	
1 to 2	0
3 to 5	2
6 to 10	6
11 to 20	4
21or more	3

Findings

Below is a presentation of the findings from this evaluation effort. The findings have been organized into the following categories:

- Impact on Pedagogical Content Knowledge
- Changes in Practice
- Impact on Students
- Overall Program Perceptions

Impact on Pedagogical Content Knowledge

One of the core goals of the SCIEnCE K-5 professional development program was to improve the science pedagogical content knowledge of participating teachers. The section below discussed the observed impact on both the scientific content knowledge as well as on teachers' growth in the understanding of science pedagogy.

To assess the extent to which the program impacted teachers' science content knowledge participants were asked to indicate the level of agreement with a series of items that related directly to the science standards covered in the summer workshop. These survey items were administered twice: once at the end of the summer 2013 workshop and then again in the spring of 2014, at the end of the program. Table 2 presents the results from the post workshop survey in summer of 2013. Table 3 presents the results of the end-of-program survey. Table 4 presents the mean scores for each item at each time point, as well as the change in mean from summer 2013 to spring 2014.

Table 2. Teacher Perceptions of the Effectiveness of the SCIEnCE K-5 program on Content Knowledge – Post Summer Institute.

The SCIEnCE program . . .	Strongly Disagree	Disagree	Agree	Strongly Agree
...has given me a better understanding of the empirical nature of scientific knowledge.	0.0% (0)	0.0% (0)	58.8% (10)	41.2% (7)
...has made me more knowledgeable about the production of scientific knowledge through observation and inference.	0.0% (0)	0.0% (0)	35.3% (6)	64.7% (11)
...has made me more aware of the differences between scientific law and scientific theory.	0.0% (0)	0.0% (0)	88.2% (15)	11.8% (2)
...has made me more aware of the subjective nature of scientific knowledge.	0.0% (0)	0.0% (0)	52.9% (9)	47.1% (8)
...has helped me to understand ways in which scientists plan and carry out investigations.	0.0% (0)	0.0% (0)	64.7% (11)	35.3% (6)
...has helped me understand the importance of analyzing and interpreting scientific data.	0.0% (0)	0.0% (0)	70.6% (12)	29.4% (5)
...has increased my understanding of the basic nature of matter.	0.0% (0)	0.0% (0)	64.7% (11)	35.3% (6)
...has increased my understanding of changes in matter.	0.0% (0)	0.0% (0)	58.8% (10)	41.2% (7)
…has increased my understanding of linear motion.	0.0% (0)	6.3% (1)	68.8% (11)	25.0% (4)
…has increased my understanding of projectile motion.	0.0% (0)	0.0% (0)	64.7% (11)	35.3% (6)
...has increased my understanding of the states and forms of energy.	0.0% (0)	0.0% (0)	76.5% (13)	23.5% (4)
...has increased my understanding of the ways in which energy is transferred.	0.0% (0)	0.0% (0)	58.8% (10)	41.2% (7)
...has helped me understand calculations related to the transfer of energy.	0.0% (0)	12.5% (2)	68.8% (11)	18.8% (3)

Table 3. Teacher Perceptions of the Effectiveness of the SCIEnCE K-5 program on Content Knowledge – End-of-Program.

The SCIEnCE program . . .	Strongly Disagree	Disagree	Agree	Strongly Agree
...has given me a better understanding of the empirical nature of scientific knowledge.	0.0% (0)	6.7% (1)	86.7% (13)	6.7% (1)
...has made me more knowledgeable about the production of scientific knowledge through observation and inference.	0.0% (0)	0.0% (0)	86.7% (13)	13.3% (2)
...has made me more aware of the differences between scientific law and scientific theory.	6.7% (1)	33.3% (5)	60.0% (9)	0.0% (0)
...has made me more aware of the subjective nature of scientific knowledge.	6.7% (1)	6.7% (1)	80.0% (12)	6.7% (1)
...has helped me to understand ways in which scientists plan and carry out investigations.	0.0% (0)	6.7% (1)	86.7% (13)	6.7% (1)
...has helped me understand the importance of analyzing and interpreting scientific data.	0.0% (0)	6.7% (1)	93.3% (14)	0.0% (0)
...has increased my understanding of the basic	0.0% (0)	6.7% (1)	93.3% (14)	0.0% (0)

nature of matter.				
...has increased my understanding of changes in matter.	0.0% (0)	6.7% (1)	86.7% (13)	6.7% (1)
…has increased my understanding of linear motion.	0.0% (0)	6.7% (1)	86.7% (13)	6.7% (1)
…has increased my understanding of projectile motion.	0.0% (0)	6.7% (1)	93.3% (14)	0.0% (0)
...has increased my understanding of the states and forms of energy.	0.0% (0)	6.7% (1)	86.7% (13)	6.7% (1)
...has increased my understanding of the ways in which energy is transferred.	0.0% (0)	20.0% (3)	73.3% (11)	6.7% (1)
...has helped me understand calculations related to the transfer of energy.	0.0% (0)	53.3% (8)	40.0% (6)	6.7% (1)

Table 4. Teacher Perceptions of the Effectiveness of the SCIEnCE K-5 program on Content Knowledge – Mean change

The SCIEnCE program . . .	Summer 2013 Post Workshop Mean n=17	Spring 2014 Post Program Mean n=15	Change in Mean
...has given me a better understanding of the empirical nature of scientific knowledge.	3.41	2.94	-.047
...has made me more knowledgeable about the production of scientific knowledge through observation and inference.	3.65	3.06	-.059
...has made me more aware of the differences between scientific law and scientific theory.	3.12	2.50	-0.62
...has made me more aware of the subjective nature of scientific knowledge.	3.47	2.81	-0.66
...has helped me to understand ways in which scientists plan and carry out investigations.	3.35	2.94	-0.41
...has helped me understand the importance of analyzing and interpreting scientific data.	3.29	2.88	-0.41
...has increased my understanding of the basic nature of matter.	3.35	2.88	-0.47
...has increased my understanding of changes in matter.	3.41	2.94	-0.47
…has increased my understanding of linear motion.	3.19	2.94	-0.25
…has increased my understanding of projectile motion.	3.35	2.88	-0.47
...has increased my understanding of the states and forms of energy.	3.24	2.94	-0.30
...has increased my understanding of the ways in which energy is transferred.	3.41	2.81	-0.60
...has helped me understand calculations related to the transfer of energy.	3.06	2.50	-0.56

There are several key findings from this data.

- Overall, the survey items from the two time points indicate that there was agreement among participants that the program improved their knowledge and understanding of the majority of targeted science content.
- There is some range in teachers' perceptions of knowledge growth across items. For example, on both pre and post surveys, the highest scores went to the item about "the production of scientific knowledge," while the teachers' understanding of the "calculations related to the transfer of energy" received the lowest level of agreement.
- There was some drop off on the level of agreement across the two time periods, suggesting that teachers' perceptions of their knowledge growth was highest directly after the workshop, and that their sense of their knowledge growth faded somewhat through the school year.

Qualitative data from the focus group support the data from the surveys. In the focus group, when asked about the key concepts that were learned, the teachers discussed the nature of science. For example one teacher stated, "We talked about the nature of science as well, I remember that was a big thing, because a lot of us hadn't heard of it, but it is actually in our SOLs." Within the focus group there was also recognition of the value of the pedagogical focus of the workshop. Many teachers indicated that they appreciated the "hand-on" nature of the workshop activities. For example, one teacher stated, "I really liked building a rollercoaster. That gave a good example. You start with a problem and then we had to meet in our groups to design this, problem solve, think critically, and think like a student. What would a student be thinking during this time? Because we were kind of starting fresh ourselves and had not really done a lot of that kind of hands on learning as much." Along the same lines another teacher stated that the most significant aspect of the program "was when we talked about designing the lesson plan," and that in regards to PBL "at the beginning of last summer I kind of knew what it was but I didn't really. But now seeing it and being in the group and learning how to actually design the lesson, it made it a lot easier and I understand it more."

NSTA Learning Center Data

A key component of the SCIEnCE K-5 professional development model was the use of the NSTA Learning Center to support the ongoing growth of teachers through the school year. The Learning Center allowed teachers to engage in a wide range of personal learning activities, as well as opportunities to find and share resources. When teachers engaged with the site, they were awarded activity points and, at certain times, badges for the completion of particular activities. Overall the participating teachers involved in the SCIEnCE K-5 program earned 30,075 points. The average

number of points earned per teacher was 1583, with a maximum of 4310 and a minimum of 380. The teachers also earned a total of 105 badges. The average per teacher was 5.3, with a max of 9 and a minimum of 2.

Changes in Practice

Another goal of the SCIEnCE K-5 program was to impact the pedagogical practice of the teacher participants. To assess change in practice, a retrospective self-report pretest/posttests (Lam & Bengo, 2003) was used. This instrument asked teachers to indicate the likelihood of engaging in particular pedagogical strategies both "prior to" and "after" participation in the SCIEnCE professional development. The strategies asked about included Inquiry-based Learning, Understanding by Design, Nature of Science, the 5e instructional model, and technology integration. Table 5 presents the frequencies of responses, the pre and post means, and the results of paired sample t-tests for statistical significance.

Table 5. Teacher Reported Change in Practice Related to the SCIEnCE K-5 Program – End-of-Program.

	Not at all likely	Somewhat likely	Likely	Very likely	*M*	*t*(14)	*p*
What is the likelihood that you would develop lessons that use inquiry-based learning?							
PRIOR TO your participation in the SCIEnCE program.	26.7% (4)	53.3% (8)	20.0% (3)	0.0% (0)	1.9	-3.761	.002*
AFTER your participation in the SCIEnCE program.	0.0% (0)	40.0% (6)	33.3% (5)	26.7% (4)	2.9		
What is the likelihood that you would develop lessons using Understanding by Design principles?							
PRIOR TO your participation in the SCIEnCE program.	40.0% (6)	53.3% (8)	6.7% (1)	0.0% (0)	1.7	-4.675	.000*
AFTER your participation in the SCIEnCE program.	6.7% (1)	40.0% (6)	26.7% (4)	26.7% (4)	2.7		
What is the likelihood that you would develop lessons using the Nature of Science?							
PRIOR TO your participation in the SCIEnCE program.	46.7% (7)	40.0% (6)	6.7% (1)	6.7% (1)	1.7	-3.500	.004*
AFTER your participation in the SCIEnCE program.	0.0% (0)	53.3% (8)	26.7% (4)	20.0% (3)	2.7		
What is the likelihood that you would develop lessons using the 5e instructional model?							
PRIOR TO your participation in the SCIEnCE program.	46.7% (7)	40.0% (6)	13.3% (2)	0.0% (0)	1.7	-4.516	.000*
AFTER your participation in	20.0%	20.0%	46.7%	13.3%	2.5		

the SCIEnCE program.	(3)	(3)	(7)	(2)			
What is the likelihood that you would develop lessons that integrate technology?							
PRIOR TO your participation in the SCIEnCE program.	6.7% (1)	20.0% (3)	60.0% (9)	13.3% (2)	2.8	-3.500	.004*
AFTER your participation in the SCIEnCE program.	0.0% (0)	6.7% (1)	60.0% (9)	33.3% (5)	3.3		

* significant at the <.05 level.

This data suggest that teacher participants were much more likely to incorporate the targeted instructional strategies after their participation in the SCIEnCE K-5 professional development program. Results of paired *t*-tests indicate that the change in teacher behavior is statistically significant for all pedagogical methods.

These findings are supported by the qualitative data collected through the focus groups and open-ended survey questions. All of the teachers in the focus groups discussed how the units and lessons developed through the workshop were integrated into their teaching. However, teachers also mentioned that the integration of the new techniques was difficult. One teacher stated that didn't do as much "as I would have liked to, I think I will more next year after I have gotten my feet wet." However, there was also a resolve among the teachers that these strategies were valuable and worth pursuing. For example one teacher stated, "I definitely think I would continue with the problem based learning with different lessons."

Impact on Students

Although student level data was not collected, teachers were asked during the focus group to report on their perceptions of the impact of the targeted pedagogical practices on student motivation, engagement, and achievement. Overall teachers indicated that their students were "more focused and more involved," and that Inquiry-based learning activities helped students to connect classroom activities with a real world purpose and to realize that "this makes sense." Another teacher mentioned that because of the project-based nature of the instructional techniques, students were taking more ownership for their work and were more interested in doing a good job. She stated, when "they take ownership, it empowers them more, so they have a stake in it." Teachers also suggested that "if it is used properly," and appropriate guidance is given to students, then PBL will help students to think better and achieve more highly on standardized testing. The focus group data suggest that students were interacting well with SCIEnCE techniques, and if the teachers' beliefs are correct, there will be a positive impact on academic achievement.

Overall Program Perceptions

A number of questions on the teacher surveys and the focus groups were used to gauge participants' perceptions of the relevance and effectiveness of the SCIEnCE K-5 professional development program. This section is broken out to present the findings related to the various program components.

Effectiveness of Summer Institute

On the post-summer institute survey, teachers were asked to rate the effectiveness of each lesson presented from "ineffective" to "very effective." A summary of participant responses is reported in Table 6.

Table 6. Perceived Effectiveness of SCIEnCE K-5 Program Lessons – Post-Summer Institute.

	Ineffective	Somewhat ineffective	Effective	Very effective
The lesson on the Nature of Science?	0.0% (0)	11.8% (2)	47.1% (8)	41.2% (7)
The lesson on 5E Lesson Design?	0.0% (0)	11.8% (2)	58.8% (10)	29.4% (5)
The lesson on States of Matter?	5.9% (1)	0.0% (0)	52.9% (9)	41.2% (7)
The lesson on NSTA Learning Center?	0.0% (0)	35.3% (6)	29.4% (5)	35.3% (6)
The lesson on Classification of Matter?	0.0% (0)	0.0% (0)	47.1% (8)	52.9% (9)
The lesson on Motion (linear)?	0.0% (0)	11.8% (2)	58.8% (10)	29.4% (5)
The lesson on Problem Based Assessment?	0.0% (0)	11.8% (2)	64.7% (11)	23.5% (4)
The lesson on Projectile Motion?	0.0% (0)	11.8% (2)	35.3% (6)	52.9% (9)
The lesson on Energy?	0.0% (0)	18.8% (3)	43.8% (7)	37.5% (6)
The lesson on NGSS?	12.5% (2)	25.0% (4)	56.3% (9)	6.3% (1)
The lesson on Technology Integration?	0.0% (0)	0.0% (0)	64.7% (11)	35.3% (6)
The lesson on Understanding by Design?	0.0% (0)	11.8% (2)	70.6% (12)	17.6% (3)
The lesson on Unit Plan Development?	0.0% (0)	17.6% (3)	58.8% (10)	23.5% (4)
The lesson on Sound?	5.9% (1)	11.8% (2)	41.2% (7)	41.2% (7)
The lesson on Light?	5.9% (1)	11.8% (2)	52.9% (9)	29.4% (5)

Whereas most lessons were rated as "effective" by a majority of the participants, three were rated "very effective": the lesson on classification of matter, the lesson on projectile motion, and the lesson on sound. Conversely, the lesson on the NSTA Learning Center was rated as "somewhat ineffective" by approximately a third of the participants, whereas the remaining participants rated the same lesson as "effective" or "very effective."

One important idea that emerged from the focus group was the teachers' concerns about the relevance of the lessons to the elementary classroom. One teacher stated that some of the content was "very advanced." However, many of the teachers also saw value in being exposed the content. For example, one teacher stated, "I think it helped me to see that once the kids understand it, eventually when they get there they will understand it better." Along the same lines another teachers stated, "at first I was like 'this is way over my head,' but now looking back I am seeing that it did help."

Perception of the NSTA Learning Center

The NSTA Learning Center was a key component to the continuing impact of the SCIEnCE K-5 program on participating teachers' content knowledge and instruction. For this reason, three survey questions were added to the end-of-program survey that focused explicitly on the NSTA Learning Center. A majority (73.3%) of participating teachers indicated that they only used the web-based resources a few times, while three teachers never used the resources, and only one used the NSTA Learning Center once a month. Two-thirds of the participants indicated that the Learning Center was either "ineffective" or "somewhat ineffective" as a professional learning tool, and no participants responded that it was "very effective." In regards to difficulty of use, 46.7% of participants indicated that the web site was either "very difficult" or "somewhat difficult" to use, while the remainder indicated that the web site was "somewhat easy" to use.

Qualitative data suggest that while the NSTA resources contained some useful information, the resources were difficult to navigate and use. A focus group participant remarked, "I like the NSTA, I think they have good content and I'd like to continue it. I think I learned a lot from it." However, others mentioned that the site was hard to navigate, and that "sometimes it was just easier to access something from Google." Several of the teachers were also concerned that the level of the content was more appropriate for middle and high school teachers. One teacher stated, "I actually shared it with an 8th grade science teacher and I feel like she used it more. I feel like for high school or middle school students, the website is a lot more useful, because they can pull from it, they can actually do stuff on it." Another participant reported on their survey that "the NSTA portion was the least useful part of the program for me. It was a little confusing to navigate the website and the sci-packs seemed like they would be useful for science teachers in upper grades but were not relevant to lower elementary."

Overall Program Perceptions

Teacher perceptions of the SCIEnCE K-5 program were largely positive, although 20% of participants did respond that the program did not meet their expectations. Despite this fact, all participants indicated that they would recommend this professional development program to other teachers that they knew, even if 26.7% would recommend with some reservations. Almost all of the participants recognized the hands-on portions of the program as one of its best aspects, and that the instruction and materials would be useful when brought back to their own classrooms. Consensus from the focus group was that this program would make them more effective teachers, and the support at the program level was very strong. One participant noted that her school was considering dropping out of the program, but that with very focused attention from program staff, they were able to continue developing their goals and continue participation.

Suggestions for Improvement

Teacher participants were also asked for suggestions for improvement. These suggestions focused largely on two specific areas of the program: elementary level focus and NSTA resources. Several teachers reported that the content of the workshop was confusing and not well suited for K-5 classrooms, although several teachers did suggest that they were able to see how this content fit into larger contexts. Suggestions included more focus on topics specific to elementary SOLs and specific training for how to introduce Inquiry-based Learning to younger students. Participants also indicated the NSTA resources as an area for improvement. Most suggestions revolved around improving the usability of the website, but some participants also suggested that materials could be more well developed for elementary school use and that the resources could be explained in greater depth.

Conclusions and Recommendations

The findings from this evaluation suggest that the SCIEnCE professional development program is having a positive impact on teacher pedagogical content knowledge and teacher practice. There is also some anecdotal evidence that these strategies are having a positive effect on student engagement and achievement. Overall, the participating teachers rated the program as an effective and relevant professional development experience.

The findings from the evaluation also lead to several recommendations for future program development and evaluative work.

- ***Assessing the content relevance of the program.*** Many teachers commented on the content level of the science content and strategies. In certain cases, teachers felt that the materials were

not usable at the lower grade levels, while other teachers saw value in knowing what upper grade students were moving toward. This reaction from the teachers suggests that it would be valuable to evaluate the level of the content in relation to participating teacher grade level. Program leaders could shift content to better align with the curriculum of the participating teachers' grade levels. Alternatively, the program could provide support for adapting more advanced content to lower grade levels.

- ***Review of the effectiveness of the NSTA Learning Center***. The data from the evaluation pointed to some concerns among teachers related to the NSTA Learning Center. While there seem to be some teachers that embraced the resources, many seemed frustrated in attempts to use it. This suggests that if the NSTA Learning Center is used again, more time should be spent establishing the value of the resource and helping teachers navigate it.
- ***School year follow-up to ensure retention of pedagogical content knowledge.*** The data on teacher pedagogical content knowledge showed a drop of in self-reported knowledge gain between the end of the summer institute and the end of the program. This suggests that the program leaders may want to assess school year activities to ensure that they are reinforcing program content.
- ***Determining ways to assess impact on students***. Ultimately the goal of any teacher professional development is improved student outcomes. However, determining the impact on students in programs like this is difficult because of the range of grade levels and participating schools and school divisions. Developing a common assessment that is valid and reliable across this range of settings and populations is challenging. Nonetheless, it is important to develop program and evaluation strategies that allow for a deeper understanding of student impact. Future work should go into assessing the impact of these strategies across a broad spectrum of contexts.

Appendices

Appendix A: SCIEnCE K-5 Professional Development Survey (*Post-Workshop and Post-Program*)

Post-Workshop Survey Introduction: This survey is part of an external evaluation of the SCIEnCE professional development to help measure the extent to which the program meets its stated goals. The focus of this survey is the summer 2013 workshop. Additional information will be collected through the 2013-2014 school year as you participate in additional program activities and apply the knowledge gained to your classroom practice. The survey results will be kept anonymous and used only for the purposes of program evaluation. Your feedback on the form and quality of this professional development is very important. The survey should take approximately 10 minutes to complete. Thank you in advance for your participation!

Post-Program Survey Introduction: This survey is part of an external evaluation of the SCIEnCE professional development program to help measure the extent to which the program has met its stated goals. The survey results will be kept anonymous and used only for the purposes of program evaluation. Your feedback on the form and quality of this professional development is very important. If at any time you cannot or do not feel like answering a question you may skip it and move to the next one. The survey should take approximately 10 minutes to complete. Thank you in advance for your participation!

What is the name of your school?

What grade level do you teach?
K
1
2
3
4
5
Other

How many years have you been teaching?
1 to 2
3 to 5
6 to 10
11 to 20
21or more

Content Knowledge
Indicate the degree to which you AGREE or DISAGREE with the following statements about what you have learned in the SCIEnCE program. [Scale: 1 = Disagree strongly, 2 = Disagree; 3 = Agree; 4 = Agree Strongly]. The SCIEnCE program . . .

- has given me a better understanding of the empirical nature of scientific knowledge.
- ...has made me more knowledgeable about the production of scientific knowledge through observation and inference.

- ...has made me more aware of the differences between scientific law and scientific theory.
- ...has made me more aware of the subjective nature of scientific knowledge.
- ...has helped me to understand ways in which scientists plan and carry out investigations.
- ...has helped me understand the importance of analyzing and interpreting scientific data.
- ...has increased my understanding of the basic nature of matter.
- ...has increased my understanding of changes in matter.
- …has increased my understanding of linear motion.
- …has increased my understanding of projectile motion.
- ...has increased my understanding of the states and forms of energy.
- ...has increased my understanding of the ways in which energy is transferred.
- ...has helped me understand calculations related to the transfer of energy.

Change in Practice
Post-Workshop Survey Prompt: The following questions assess potential changes in your professional practice. Consider the likelihood that you would engage in the following professional activities both PRIOR TO and AFTER your participation in the SCIEnCE week-long summer program.
Post-Program Survey Prompt: The following questions assess potential changes in your professional practice. Consider the likelihood that you would engage in the following professional activities both PRIOR TO and AFTER your participation in the SCIEnCE professional development program.
Scale: 1 = Not at all likely; 2 = Somewhat likely; 3 = Likely; 4 = Very likely]

- What is the likelihood that you would develop lessons that use inquiry-based learning?
  PRIOR TO your participation in the SCIEnCE program.
  AFTER your participation in the SCIEnCE program.
- What is the likelihood that you would develop lessons using Understanding by Design principles?
  PRIOR TO your participation in the SCIEnCE program.
  AFTER your participation in the SCIEnCE program.
- What is the likelihood that you would develop lessons using the Nature of Science?
  PRIOR TO your participation in the SCIEnCE program.
  AFTER your participation in the SCIEnCE program.
- What is the likelihood that you would develop lessons using the 5e instructional model?
  PRIOR TO your participation in the SCIEnCE program.
  AFTER your participation in the SCIEnCE program.
- What is the likelihood that you would develop lessons that integrate technology?
  PRIOR TO your participation in the SCIEnCE program.
  AFTER your participation in the SCIEnCE program.

Lesson Effectiveness (*Post Workshop Only*)
The following questions are designed to assess your perception of the relevance and effectiveness of the SCIEnCE week-long summer program for your understanding and practice.

How EFFECTIVE or INEFFECTIVE were the following elements of the program? [Scale: 1 = Ineffective; 2 = Somewhat effective; 3 = Effective; 4 = Very effective]

- The lesson on the Nature of Science?
- The lesson on 5E Lesson Design?
- The lesson on States of Matter?
- The lesson on NSTA Learning Center?
- The lesson on Classification of Matter?
- The lesson on Motion (linear)?
- The lesson on Problem Based Assessment?
- The lesson on Projectile Motion?
- The lesson on Energy?
- The lesson on NGSS?
- The lesson on Technology Integration?
- The lesson on Understanding by Design?
- The lesson on Unit Plan Development?
- The lesson on Sound?
- The lesson on Light?

How likely are you to use the NSTA Learning Center throughout the next school year? (*Post-Workshop Survey Only*)
Very unlikely
Somewhat likely
Likely
Very likely

How often did you use the NSTA Learning Center throughout the school year? (*Post-Program Only*)
Never
Only a few times
At least once a month
Every week
Every day

How effective do you think the NSTA Learning Center is as a professional learning tool?
Ineffective
Somewhat effective
Effective
Very effective

Choose the sentence that best describes your experience of navigating through the NSTA web site:
Navigating through the NSTA web site was very difficult.
Navigating through the NSTA web site was somewhat difficult.
Navigating through the NSTA web site was somewhat easy.
Navigating through the NSTA web site was very easy.

To what extent did this program meet your expectations?
This program did not meet my expectations
This program met my expectations
This program exceeded my expectations

Would you recommend the SCIEnCE program to other teachers that you know?
I would not recommend this program
I would recommend this program with reservations
I would recommend this program
I would highly recommend this program

What were the best parts of the SCIEnCE program?

How would you suggest improving the program?

Appendix B: Teacher Focus Group/Interview Protocol

1. **Introductions**
    a. District, school
    b. Grade level

2. **Activities**
    a. Last summer's workshop - What do you remember doing?
    b. NSTA learning Center – Did you use it? Was it helpful?
    c. What other school year follow up has there been as a part of this program?
        i. Observations / visits / online?

3. **What were the main things you learned in this class?**
    a. Content – Science, Nature of Science, Scientific Investigation
    b. Pedagogical – Instructional Practices, Problem-based, IBL, Interdisciplinary, UbD, Technology

4. **Since you have taken the class, have you had opportunities to integrate the knowledge you have gained into your practice?**
    a. Examples?

5. **What products were expected?**

6. **Do you feel like this has made you a more effective teacher?**

7. **How have the students responded to the strategies you learned through this program?**
    a. Is it helping them grasp the concepts?
    b. Are they interested? Are they motivated?
    c. Do you think the strategies you learned through this training are going to have an impact on student math achievement?

8. **Has your participation in the program led you to collaborate with teachers inside and outside of your school and division?**

9. **How do you feel about the platform for professional development? Face-to-face class and follow up? NSTA tool?**

10. **What do you see as the strengths of this course?**

11. **How do you think it could have been improved?**

Appendix C: Evaluation Matrix

GOAL 1: Develop and implement high-quality professional development activities through integration of UbD, IBL, Problem-Based Assessments and 5e instructional models to improve teacher's knowledge of physical science concepts and the NoS.			
Evaluation Questions	**Data Collection Activities**	**Data Collection Instruments**	**Data Collection Schedule**
What is effect of the SCIEnCE K-5 weeklong professional development on the content knowledge and pedagogical knowledge of participants? What is the effect of the individualized National Science Teachers Association Learning Center courses on the content knowledge and self-efficacy for science pedagogy of participants? What are participants' perceptions of the relevance and effectiveness of the SCIEnCE K-5 professional development?	• Administer PD pre and post assessments • Administer PD inquiry assessment • Administer pre and post PD impact assessment • Administer program post assessment • Conduct focus group • Administer end of program post assessment • Conduct focus group	• NSTA content and pedagogical skill assessment • Concord Inquiry Assessment • Locally developed teacher self-report program-impact assessment • NSTA content and teacher efficacy assessment • Focus group protocol • Locally-developed teacher self-report program satisfaction • Focus group protocol	• Summer 2013 • Summer 2013 • Summer 2013 • Fall 2013 • Spring 2014 • Spring 2014 • Spring 2014

GOAL 2: Develop and model exemplars integrating IBL, UbD, and NoS for improving physical science achievement and reducing achievement gaps in subgroups of students with disabilities.			
Evaluation Questions	**Data Collection Activities**	**Data Collection Instruments**	**Data Collection Schedule**
To what extent are teachers implementing the exemplars and	• Administer end of program post assessment • Conduct classroom	• Locally-developed post test of teacher self-report of	• Spring 2014 • Fall/Spring 2013-

integrating the content and pedagogical practices gleaned from the SCIEnCE K-5 workshops into their teaching? What evidence is there that the knowledge and skills gained through the SCIEnCE K-5 professional development is having an impact on student achievement and achievement gaps between student sub-groups?	observations • Unit plan analysis • Conduct focus group • Administer end of program post assessment • Conduct focus group • Collect school level standardized achievement data	integration • Trainer-developed classroom observation instrument • Unit plan rubric • Focus group protocol • Locally-developed teacher self-report on student impact • Focus group protocol • State tests	2014 • Spring 2014 • Spring 2014 • Spring 2014 • Spring 2014 • Summer 2014

GOAL 3: Facilitate collaborative online learning community of teachers to develop, share, and implement units of instruction and support the teachers through classroom observation and feedback.			
Evaluation Questions	**Data Collection Activities**	**Data Collection Instruments**	**Data Collection Schedule**
What are participants' perceptions of the effectiveness of the SCIEnCE K-5 online learning community and classroom observation and feedback for facilitating the application of exemplars, content, and pedagogical knowledge learned through the SCIEnCE K-5 program into their practice?	• Administer end of program post assessment • Conduct focus group	• Locally-developed post-test of teacher program satisfaction • Focus group protocol	• Summer 2013/Spring 2014 • Spring 2014