Collaboration for SUCCESS in Science:
Science Understanding through a Collaborative Commitment to Enduring Student Success

Li-Ling Yang*[1], Maria Lawrence*[2]

*[1]Roger Williams University, USA, *[2]Rhode Island College, USA

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Abstract

This paper discusses the implementation of lesson study as a research model in a professional development project with elementary school and middle school teachers to increase teachers' use of instructional approaches to science inquiry and students' science practices and knowledge.

Introduction

Contemporary reform in science, technology, engineering, and mathematics or STEM education in the United States has been a topic of considerable attention over the past nearly 70 years. The National Science Foundation (NSF) became the federal agency responsible for making funds available for research and education in the United States. The NSF therefore has been funding STEM education reform for decades. The funding has produced curriculum projects and supported professional development for teachers. It was during the 1990s that statewide systemic reforms and local change reforms were initiated with the release of National Science Education Standards (1996). The trajectory of the reformation in STEM education has been clear and consistent through the present – improve STEM education and advance STEM education through meaningful partnerships between scientists and K-12 education.

National studies reflect the need for teacher professional development in science education as documented by Horizon Research, Inc., among other researchers and evaluation entities, involved in the systemic reformation of elementary science efforts of the 1990s to the present. A 2002 Horizon Research, Inc. report stated that "fewer than 3 in 10 elementary teachers reported feeling well prepared to teach the sciences, 77 percent indicated that they were very well qualified to teach reading/language arts (Fulp, 2002). The same report reflects how underrepresented science learning is in elementary schools with science receiving substantially less instructional time compared to other content.

Development of Project SUCCESS

Project SUCCESS (Science Understanding through a Collaborative Commitment to Enduring Student Success) is a collaboration of two higher education institutions and an educational collaborative, in partnership with two public school districts to improve elementary school and middle school science teaching and science learning. Within the state where the project was implemented, there are four regional education collaborative organizations. The state legislature sought to establish the non-profit collaborative system to "maximize educational effectiveness" among districts situated within these collaborative regions. Project SUCCESS was conceptualized in January 2010 by the northern regional collaborative with the involvement of eight northern school district administrators, teachers, and education consultants. The initial proposal for funding of the Project SUCCESS was sought through the collaborative. The proposal was identified to be funded pending modifications to the scope of the project. Changes were made that reflected the provided feedback, and the National Science Foundation Math-Science Partnership (NSF MSP) grant was awarded to the Project SUCCESS in the spring of 2010.

The NSF-MSP grants are made available to projects with several key outcomes as project goals.

> "The MSP program seeks to improve K-12 student achievement through a sharp focus on three inter-related issues:
> •Ensuring that all students have access to, are prepared for, and are encouraged to participate and succeed in challenging and advanced STEM courses;
> •Enhancing the quality, quantity and diversity of the K-12 STEM teacher workforce; and

•Developing evidence-based outcomes that contribute to our understanding of how students effectively learn the knowledge, skills and ways of thinking inherent in mathematics, computer science, engineering, and/or the natural sciences."
[Source: http://www.nsf.gov/pubs/2012/nsf12518/nsf12518.htm#pgm_desc_txt]

The overarching goal of SUCCESS is to increase instructional coherence by aligning curriculum, instruction, and assessment to each other and to the state standards with a desired outcome of improved student science learning. The core project objectives are to improve teachers' science practices in the classroom with learners and to develop teacher learning communities and leadership through the use of a cohort model and Lesson Study (LS). Project SUCCESS teacher professional development employs a blended professional development strategy that consists of multiday workshops followed by ongoing LS during the school year. LS, a teacher professional development approach originated in Japan, is an established form of action research that engages teachers in a peer-shared reflection on learning (Lewis, 2002). A typical LS cycle consisted of the following stages: selecting a goal, identifying the content topic, designing the unit of study, creating the research lesson, research lesson presentation and observation, and distribution of the unit of study and research lesson (Kolenda, 2007). This iterative process can be completed as many times as desired or needed to develop exemplary lessons.

Research has reported many positive impacts of LS on teaching and learning at all levels of schooling. For example, a study by Mutch-Jones, Puttick, and Minner (2012) found that middle school teams of science and special education teachers who participated in LS improved their instruction in inclusive classrooms. These teachers "were able to generate more accommodations for students with learning disabilities, and they increased their ability to set an instructional context and adapt an instructional plan to meet science learning goals for all students in an inclusive classroom" (p. 1012). Kolenda (2007) also reported that LS helps to "address the isolationism in which teachers work by promoting greater staff collaboration," identify student misconceptions and build strategies to address them into the research lesson, make "data-based" decisions to "improve teaching and learning," and use "positive peer pressure among colleagues" to create "an inherent demand for staff improvement." Kolenda further added the following benefits of using LS as a professional development approach:

1. "Since teachers are directly in charge of this process and its outcomes, they have a sense of empowerment and feel valued;"
2. Teachers teaming up with "varied content expertise" and different years of experience in teaching profession gain "a broader and deeper understanding of the content material;"
3. "It [LS] encourages a thoughtful and thorough examination of student work and an analysis of their learning;"
4. "Through extensive planning sessions, it [LS] promotes a more frugal curriculum that concentrates on fewer topics to a greater depth;"
5. "Research lessons are designed to integrate science process skills with content so that the skills are taught in context thus increasing student achievement levels." (p. 31)

This paper presents findings to date in this ongoing project as a qualitative case study analysis using illustrative case stories of participating classroom teachers. The study analyzes how the professional development experiences of teachers in Project SUCCESS has thus far impacted their science pedagogy, attitudes toward teaching science, students' learning of science, and teachers' response to the use of lesson study as a professional development model.

Methods

Selection of School Districts

Project SUCCESS identified two school districts, District 1 and District 2, to be the high needs school district partners. The criteria employed to make this determination are twofold. First, a review of the 2008-2009 District Summary reports for New England Common Assessment Program (NECAP) science scores for the districts that comprise the regional collaborative reveal these two districts as having significant need based on the percentage of students that attained "proficient" at 16% and 12% respectively (Rhode Island Department of Elementary and Secondary Education [RIDE], 2013). Second, a culturally and linguistically diverse population of students characterizes both districts. District 1 is an urban ring school district, and District 2 is an urban school district. Each district serves communities with economic needs, as indicated by the percent of free and reduced lunch, cultural and linguistic diversity, as well as considerable percentages of special needs learners (see Table 1).

Teacher Participants

Project participants consisted of at least one teacher from each building in both districts and were recruited through self-selection or the recommendation of the district/building administrators. The first cohort of project participants, 23 elementary school and middle school teachers (10 from District 1 and 13 from District 2), was recruited in summer of 2010 and participated in the first two years of project activities. 19 Cohort 1 teachers continued through the third-year of project activities and served as mentors to the second cohort. Among the returning Cohort 1 teachers, 13 were from District 2 and six from District 1. The second cohort of 17 elementary school teachers (16 District 2 teachers and one District 1 teacher) was recruited to begin in fall of 2012.

Project Activities and Data Collected

Project timelines and activities are summarized in Table 2. Data from the professional development activities were collected during each of three distinct PD periods of the project. The last project data will be collected during fall of 2013.

A survey (Appendix 1) was distributed to both cohorts of teachers to collect baseline data at the outset of the project in June 2011 for Cohort 1 and November 2012 for Cohort 2. Following two LS workshops, both cohorts voluntarily responded to a workshop feedback form (Appendix 2). In addition, a project feedback form (Appendix 3) was distributed to Cohort 1 teachers and principals in May 2012, respectively. A similar project feedback form was distributed to four teams of mix-cohort teachers who completed LS sequence in early June 2013. Participants were asked to provide commentary about the PD components.

A final project feedback form will be administered to current teams as each team completes two lesson study lessons before the end of fall 2013. An administer feedback form will also be distributed to the school principals and the district curriculum coordinators in the fall of 2013. The findings of this survey will be reported in a follow-up study.

Lesson Study Process

During the second PD period, 23 Cohort 1 teachers formed five LS teams with two teams of District 2 teachers, one team of District 1 teachers, and two teams of mixed district teachers. Each team is consisted of three to five teachers. 36 teacher participants formed eight mixed cohort LS teams (i.e. teams consisting of both cohorts) during the third PD period. Each team consisted of three to six teachers. Teachers selected lessons from their respective science curricula for the research lessons.

Team teachers completed two cycles of the Lesson Study process. A lesson plan template (see Appendix 4) was provided to teams to use for planning the lesson. Teachers and/or district administrators ensured that substitute teachers were provided to facilitate the time for the discussion of the lesson study with the team. The lesson planning phase was not observed by the investigators. Teachers' completed lesson study lesson plans were given to the investigators before or on the day of the lesson study.

Data Analysis

The impact of the project's professional development on the teaching and learning of science is being assessed through a qualitative analysis of the teacher and principal feedback forms, student work samples from lesson studies, lesson plans, and researchers' observation notes. The approval to observe and document lessons was obtained from the school district administration and the project participants.

Results

Demographics of Participating Districts

Four elementary schools (Grades K-5) and two middle schools (Grades 6-8) in District 1 and ten elementary schools (Grades K-6) in District 2 participated in Project SUCCESS.
The regional collaborative, institutions of higher education (IHE) and district administrators engaged in comprehensive needs assessment activities on the districts' science curriculum, instruction and assessment systems and current teacher practices in science. It was found that neither district has a local assessment or assessment system in place. Also, District 2 uses materials rich, kit-based science curricula consistent with the state's science education standards. District 1 approved a science curriculum aligned with National Science Education Standards (1996) in March 2002, and the district is in the process of reviewing science curriculum and professional development for its elementary schools that will align with the state's science education standards.

Demographics of Project SUCCESS Teacher Participants

Initial Teacher Survey

Respondents to the initial teacher survey (n=14 Cohort 1; n=25 Cohort 2) ranged in professional teaching experience from five to 25 years for Cohort 1 and one to 30 years for Cohort 2. Average years of teaching experience for Cohort 1 is 15.6 years, while it is 13.7 years for Cohort 2. All grades levels from Kindergarten through six were represented in both cohorts; however, most Cohort 1 teachers teach third grade, and most Cohort 2 teachers teach fourth grade. Half of Cohort 1 teachers indicated that their last professional development in science was more than 4 years ago or not applicable, while almost all Cohort 2 teachers responded the same. All responding teachers reported having common planning time in their schedules, and on average they agree they are supported in their teaching of science and recognize that a range of strategies are necessary for students' success. The data also expresses the concerns teachers have for appropriate resources, clear district level standards and expectations, an aligned and articulated curriculum, and guidance for how to teach science. Both cohorts of teachers also indicated in the survey that they rarely got a chance to observe or be observed by other teachers.

Lesson Study Workshop Feedback

Twenty-four Cohort 1 and 2 teachers voluntarily responded to a feedback form for two lesson study workshops, one held on March 15, 2013 (n=13) and the other on April 5, 2013 (n=11). The workshops served to review the nature of science and science practices and introduce the purpose and process of LS to cohort two teachers, while reviewing LS for cohort one teachers. The feedback form required teachers to check their responses on a scale from one to five with strongly disagree equal to one and strongly agree equal to five. The average scale response was calculated for each workshop respondent (median average = 4.5). The responses from the LS workshop feedback survey illustrate teachers' overall satisfaction with the workshop usefulness and potential to positively impact their instruction of science.

> "[What worked today was] determ[ining] groups and topics for lesson study and actually watching and learning how lesson study is conducted." (LS workshop feedback form, 3/15/2013)
>
> "[What worked today was] team meeting and information given in [the] presentation." (LS workshop feedback form, 4/5/2013)

These comments from LS workshop participants along with the feedback scores reveal that teachers valued the LS workshops and the shared planning among colleagues.

Two LS workshop respondents shared that they would have benefited if specific attention was given to the state test (NECAP) and the science content standards. When asked what would improve the workshop, one respondent wrote:

> "understanding the standard
>
> unpacking the standard
>
> how to help students be successful on the NECAP
>
> becoming more confident science teachers"

Five LS workshop respondents stated that "more time to plan" in the LS teams would have been an improvement for them.

LS Case Stories

Case stories are the stories associated with teachers and team research lessons. This section presents findings from case stories within the project to date. Pseudonyms are used in the case stories.

Four out of 23 Cohort 1 teachers and one of 15 principals returned completed project feedback forms in June 2012. One teacher from each of the two mix-cohort teams provided feedback in May 2013. Since the 2013 survey is still ongoing, this section only focuses on the findings from the 2012 survey that the four teachers and the one principal responded to. These four teachers are Polly, Cindy, Katie, and Emily, and they teach sixth, second, first, and third grade, respectively.

The project impacts as well as the challenges that the teachers encountered while practicing inquiry science teaching over the two years of Lesson Study implementation are discussed below.

1. Shifts in instructional methods/approaches

Polly indicated that "The workshops have made a big impact on my teaching style." She "use[d] to teach science experiments directly from the text and follow the steps exactly with the students." She has changed or shifted from a cookbook or prescriptive approach to teaching science to a more inquiry-based one and started acknowledging student agency in their learning. She has "learned to give less information up front and allow students the chance to work together to figure things out." The shifting responsibility to the learner means that she is able to trust that students can and do learn science using hands-on science inquiry. Learner independence is necessary in order to accurately assess students' abilities to authentically engage in the processes and practices of science.

Teachers also found the LS process beneficial. Polly added that the LS "practice taught me to try new ideas." She acknowledged immediate results from making changes in her science instruction by stating that "I actually enjoy teaching labs better now," as a result of using the professional development workshop experiences and engaging in the LS cycle. She appreciates the opportunity for change and is invigorated by and likes the changes in teaching science. Cindy, on the other hand, utilized that experience to make changes in her instruction with her students. She created "a science center using the same lesson" that she observed during the LS and "adapted to" her second graders. Cindy asserted that LS "allowed me to think more clearly and refine my teaching goals as well as how to more efficiently to teach content."

The elementary school principal who returned the survey observed a teacher teach after participating in Project SUCCESSES professional development. He describes how the teacher made shifts in her instructional methods or approaches to better engage students in the following feedback he provided.

> The teacher at my school definitely bought into and implemented more inquiry activities in her instruction. I had a chance to visit some of [the] science lessons and could see the types of activities, questions, and discussions were absolutely consistent with the goals of the program. Science notebooks were being used and along with the other changes were definitely increasing the student engagement and understanding.

This principal's feedback documents the importance of administrative leadership to express active interest in and support teachers' professional growth and to verify that teachers actually improve teaching and learning through engaging in PD.

2. Appreciation of the role of science practices for learning science content

Cindy acknowledged that the workshops that she attended have helped her become "a more focused teacher of science" after she "learned more about the scientific process skills and science notebooks. The changes that she made in her science teaching have resulted in her professional satisfaction or efficacy. Similarly, Katie asserted how giving instructional attention to science processes affords her the opportunity to probe students' thinking about and understanding of content.

> I have integrated inquiry more often during students' science experiences. I have focused more on the development of students' process skills. When assessing, I consider students ability to use steps of the inquiry process, cooperate with peers, and communicate their results. I ask students higher-order questions. For example, I ask them to explain why they think something happened or how they would design an experiment to test it. I encourage students to ask their own questions about science topics and provide experiences that relate to their areas of curiosity and interest.—Katie

The above statement shows that Katie starts focusing on students' development of various process skills, including questioning, prediction, communication, and observation, which is evident in the samples of her student work. The analysis significance of the student work samples will be discussed in the next section.

Emily has embraced inquiry as a process of practices for conducting science investigations. She has done "a lot more posting of information, a lot more sharing out of information from student to student." It is evident that she is modifying her practice to develop communication skills among her students.

3. Building a collaborative learning community to support each other's science teaching

The project goal of building a collaborative learning community is advanced through the LS cycle. Emily acknowledged that the LS process "was interesting and very helpful." She reflected on her experience of collaborating with her team members from other schools by stating that:

> First having the time to sit with my team (from 3 other schools) and really work on the lesson plan together and throw out what has worked in the past and what has failed and then watching how the first lesson went-revising, what didn't go smoothly or took too much time, or not enough time, was incredibly helpful. It was definitely harder on the first teacher, to perform and then have to go back and work out the kinks! But, it really opened our eyes I feel!

4. Challenges encountered

When prompted for topics that they would like to further explore in the future workshops, teachers pointed out the following areas: use of science notebooks and assessment of/for learning. They are interested in developing *practiced science literacy* and assessing students' learning through science notebooks.

Both Katie and Emily expressed the same need for more support for how to view classroom science instruction and assessment in relation to the state standardized assessment and the

Common Core standards. Katie pointed out that she "would like to know more about the new science frameworks and their impact on instruction and testing." Likewise, Emily stated that "I'd like more information on how to align NECAP information to my teaching so that these topics are investigated fully so the children do better on the tests."

Emily anticipates changes and challenges for how she will move forward within her professional community.

> I wish science was still introduced in the lower grades to give the students some prior knowledge when they get to me… I wish I had more time to cover more and do a thorough job of covering the topics.… I feel still very frustrated because there is little consistency throughout the schools with the curriculum and units.

Emily describes the disconnect between what she is being told to do by the district, and how she is being supported in order to accomplish her instruction of science – time restraints, lack of resources and lack of consistency, specifically in elementary grades. There is greater pressure on higher elementary grades in the district with no demand for science in the lower grades (K-2).

Analysis of Team Lesson Study Lessons

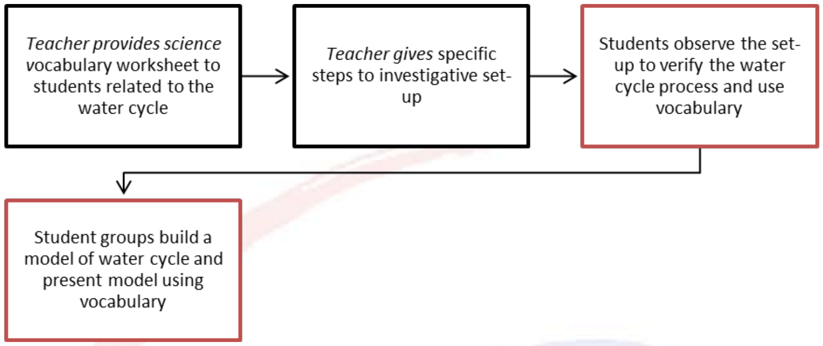
This section shares the comparative analysis of LS lessons conducted by two Cohort 1 teams, Team A and Team B, in the spring of 2012. The investigators identified any changes in teachers' instruction and students' learning performances during the second implemented LS lesson following the first lesson observation. The analysis of the other teams' LS lessons is ongoing and will be reported in a follow-up study.

- Team A: The Water Cycle

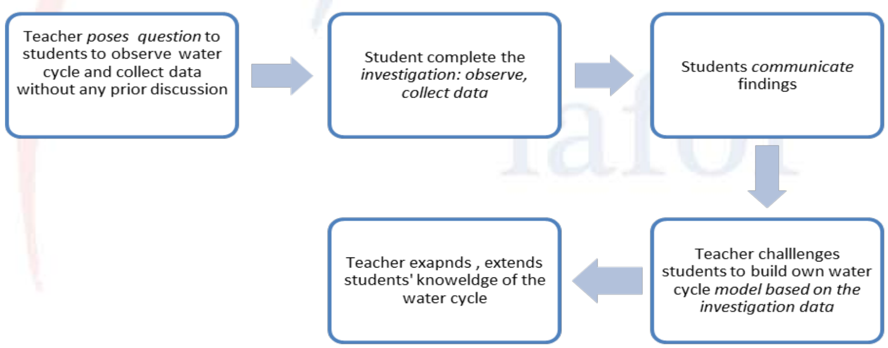
Team A consisted of five fifth- and six-grade teachers from District 1 in Spring 2012. They conducted their first LS at an elementary school's fifth-grade class and their second LS at a middle school's six-grade class. Team A teachers taught a lesson prior to the observed lesson to introduce students to the basic water cycle concepts. The lesson observed focused on students' exhibiting their knowledge about the processes of the water cycle gained from the prior lesson.

Team A teachers modified the instruction from the first to the second implementation of the research lesson by emphasizing a more learner-centered approach and students use of the science process skills, such as questioning, prediction, communication and planning investigations. Students were asked to make and communicate their meanings from their observations and an interpretation of the observational data. The shifts in instructional emphasis are illustrated by the story lines of the research lesson.

Storyline of 1st Implementation of Team A's Water Cycle Research Lesson



Storyline of 2nd Implementation of Team A's Water Cycle Research Lesson



While comparing the two LS lesson plans by Team A, a significant change the team made in the second lesson was that they were able to let students "research the water cycle through inquiry." Previously, they introduced the vocabulary in the beginning of the first observed lesson. The observation data from the first implementation of the research lesson study (March 3, 2012) also consisted of students recalling vocabulary learned from a lesson done one to two days prior to the observation of the research lesson. Students were then told they would recreate the water cycle using the available materials. When the team reinvented the lesson for the second observation, they intended to allow students to "set up [the] water cycle bag [model] without explaining vocabulary." This change would require students to make meaning from observing the closed water system.

The debriefing of the first implementation encouraged the teachers to focus on conceptual understanding while students assumed increased responsibility for representing their thinking and engaging in science practices based on their observations of a water system investigation.

Observer notes (May 6, 2012) include students communicating in small groups with peers about their knowledge of the water cycle, the design for the expression of those ideas, the selection of materials, the construction of the model, the presentation of the model, and what the model conveyed about the water cycle from their prior investigation. While students communicated with each other and the teacher, the teacher was observed recording the accepted science vocabulary on the board as language was raised by students.

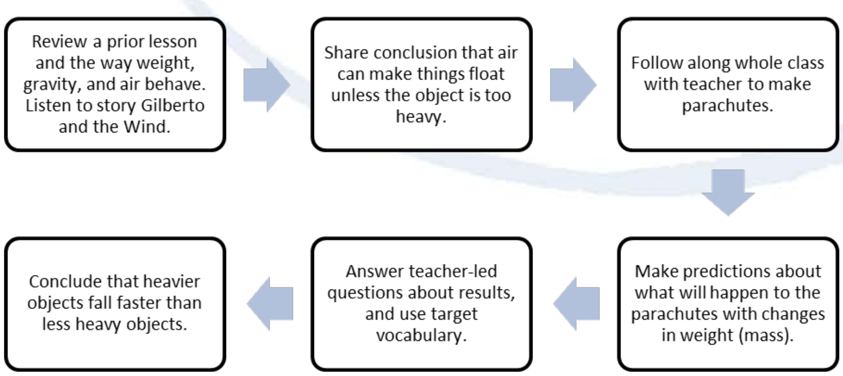
As students presented their models, the teacher used probing and challenging questions to stimulate whole class discussion. For example one group presented a model that included a mountain and a body of water. When asked by the classroom teacher why the group included a mountain, the students responded “water will run off the mountain”. The teacher recorded the term “runoff” affirming the students’ contextual use of the science term. The observed instructional shift from the first implementation toward the research lesson’s second implementation provided a richer authentic development of students’ science knowledge and science process skills.

Table 3, Analysis of Team A’s Lesson Study, summarizes the students’ performances as a result of the differences in first and second implementation of the lesson. The center column reflects the analysis of the first implementation of the research lesson followed by the observed planned changes during the second implementation of the research lesson.

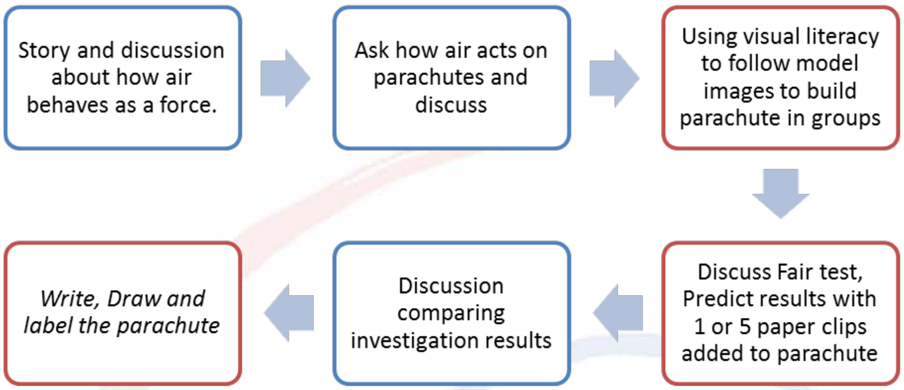
- Team B: Parachutes

Team B consisted of three first- and second-grade teachers from both districts. Both implementations of their research lesson were conducted in first-grade classes in spring of 2012. Data from the analysis of Team B teachers’ LS reveals a greater emphasis on process skills to access science content and focus on first and second grade students’ explanation of their ideas using evidence.

Storyline of Team B’s 1st Implementation of the Parachute Research Lesson



Storyline of Team B's 2nd Implementation of the Parachute Research Lesson



The changes in this research lesson shifted students' focus to science process skills inclusive of the investigation design. While there was evidence in the first implementation that students came to the conclusion that air is a resisting force to gravity, in the second implementation of the lesson, greater emphasis was given to the design of the investigation and the comparison between the two trials of releasing the parachute with different masses attached to come to a conclusion based on the investigation evidence. The notebook entries in the first implementation of LS lesson revealed how students made unstructured drawings to reflect the investigation. Students drew images that included classroom scenes (e.g., tables and chairs) and parachutes. In the second implementation of the research lesson, students had visual as well as verbal scaffolds. By requesting a detailed, labeled drawing of the parachute, students were required to think about how the parachute was constructed, and how that construction related to how the parachute functioned or worked. A sample student drawing from the second implementation is depicted in Images one and two below. The drawing has analysis significance, because it reflects the science investigation as a literacy event with clear literacy practices (Rush, 2003).

Image 1

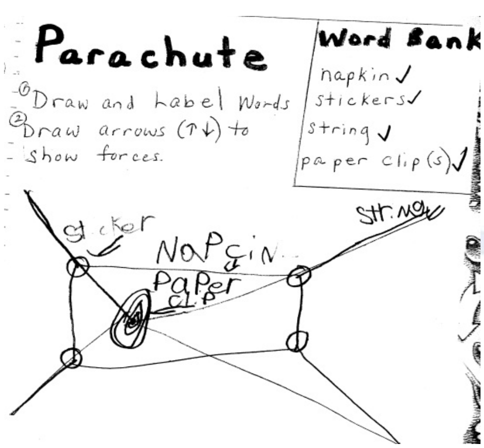
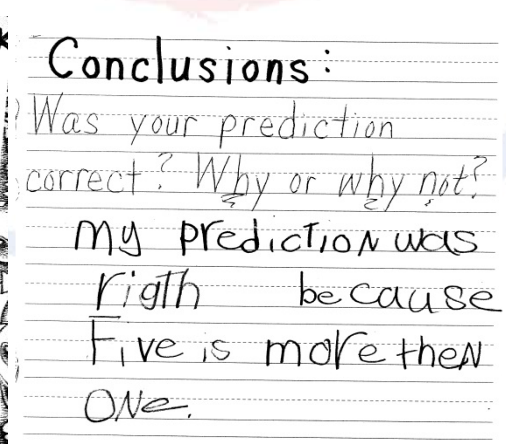


Image 2



This labeled drawing in Image 1 communicates how the materials were used for reference when writing, showing, or telling others about the investigation and the investigation results. The teacher scaffolds the practice of science literacy by providing a word bank of the materials. In Image 2, the same student shares a conclusion that revisits the pre-investigation prediction.
What makes this entry significant is the teacher's demand for an explanation. By asking the student to revisit the prediction, and explain the reason for the correctness or incorrectness of the prediction, the student is guided to make a claim based on the observational data and prior knowledge. Table 4, Analysis of Team B's Lesson Study, summarizes the students' performances as a result of the differences in first and second implementation of the lesson.

Despite teachers' greater emphasis on inquiry in science teaching and learning, their unfamiliarity of science process skills, especially hypothesizing, inferring, and predicting, was observed in each teams' lesson study lessons. This creates a challenge in teachers' capacity in correctly identifying the process skills that their students will need to use and adapting their instruction with the existing science curriculum materials.

Conclusions

This paper sought to present the activities and findings of SUCCESS, an ongoing three-year science education professional development (PD) partnership project with teachers in grades Kindergarten through six in two urban districts in New England in the United States. This is an ongoing project, however, based on the LS data that is available to date, it is possible to assert that this PD model and activities have positively impacted teachers' understanding of the nature of science inquiry practices and the importance of teaching science practices when teaching science content in grades K-6. This claim is supported by these findings thus far, which were presented in this paper:

• The sample case story analyses illustrate teachers' adoption of instructional strategies that utilize science practices to create diverse, developmentally appropriate learning opportunities for students consistent with state science education standards.
• Teacher feedback indicated that self-selected LS teams ensured teacher agency and leadership within the PD model to work in a variety of team configurations with regard to science content, grade levels, schools, and districts.
• Students' products and performances demonstrate discernible learner growth toward standards-based outcomes as a result of Project SUCCESS's impact on teachers' implementation of science curriculum.

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Table 1. Percentages of students who are ELLs, receive special services, or are eligible for free/reduced lunch in each district

District	ELL	Special Services	Free/Reduced Lunch
District 1	1%	18%	40%
District 2	12%	15%	75%

Table 2: Project Timeline and Activities

July 1, 2010 to June 30, 2011	July 1, 2011 to June 30, 2012	September 2, 2012 to May 31, 2013
• Conducted orientation and planning meetings with the regional school districts collaborative personnel and district level leadership.. • Completed a two-day Leadership Institute to review the goals and activities of the project and the project's scope... • Held two-day inquiry PD workshops. District 2 teachers were present in largest number making it necessary to schedule District 1's Cohort 1 teacher PD in fall 2011.	• Completed inquiry PD workshops for District 1 teachers.. • Completed Cohort 1 Lesson Study professional development sessions and workshops on Science Practices and Processes. • Scheduled and conducted ten Cohort 1 LS sessions. • Engaged in the on-going development of a project website for participants (https://sites.google.com/a/nric-pd.org/project-success/home).	• Scheduled and conducted project orientation with cohort1 and 2 teachers. • Scheduled and conducted inquiry PD workshops with cohort 2 teachers. • Scheduled and conducted LS workshop and planning sessions with teacher participants. • Planned and scheduled, then conducted eight mixed cohort LS sessions. Eight more LS sessions will be conducted in fall 2013. • Planned science content PD on data analysis through graphing with hands-on investigations in physical science and life science for both cohorts 1 and 2 for summer 2013.

Table 3: Analysis of Team A's Lesson Study, Water Cycle		
Column 1	**Column 2: Analysis**	**Column 3**
In the First Implementation of the research lesson, students…	As a result of the analysis and debriefing of the 1st implementation, teachers reached consensus on the following changes intended for the second implementation:	In the Second Implementation of the modified Research Lesson, students…
Were given the vocabulary as a means of explaining the water process at the beginning of the observed lesson.	Do not name or provide vocabulary associated with the water cycle at the beginning of the lesson.	Were not given specific science vocabulary before the lesson.
Used a worksheet to record vocabulary and definitions, e.g., evaporation and condensation, prior to students' investigation.	Use questions to guide students to share observation_of water in a closed system. Use formative assessment of students' responses.	Were encouraged to focus on describing their observations from the investigation. Used vocabulary they believe was associated with the processes of the water cycle. Some terms used by students were lay terms and some terms were science vocabulary. Students received a handout with explanations of the water cycle that corresponded with a labeled image of a land-water model of the water process after they presented their water cycle models.
Constructed physical models following a discussion of their observations made in a prior-day investigation that provided evidence of the water cycle process.	Provide materials and asked students to build a land-water model that reflects their understanding of how water behaves.	Constructed physical models that reflect their prior knowledge of the water cycle without any prior instruction/discussion of water cycle process.

Table 4: Analysis of Team B's Research Lesson Study Lesson

Column 1	**Column 2: Analysis**	**Column 3**
In the First Implementation of the Research Lesson, students…	As a result of the analysis and debriefing of the 1st implementation, teachers reached consensus on the following changes intended for the second implementation:	In the Second Implementation of the Research Lesson, students…
Review a prior lesson and the way weight, gravity, and air behave. Listen to the story "Gilberto and the Wind" by Marie Hall Ets (1978), a story about wind pushing on common objects.	Question students about their experiences with air/wind.	Listen to "Gilberto and the Wind" story about the wind pushing on things common to students' daily experiences as they share their stories.
Share conclusion that air can make things float unless the object is too heavy.	Review prior investigation with focus on force as push/pull and air can apply a force to objects.	Share thinking and observations about air interacting with objects.
Follow along whole class as teacher shows how to make parachutes individually.	Direct students to construct parachutes.	Follow visual model to construct physical model in pairs independently.
Make predictions about what will happen to the parachutes with changes in weight (1 to 5 paper clips attached).	Use process skill of prediction including rationale/explanation.	Discuss how air will make parachute behave with various numbers of paper clips.
Answer teacher-led questions about results and use target vocabulary.	Introduce variables, fair test by changing the amount of weight on the parachute and the reason for timing the descent.	Predict, compare, observe, and communicate findings from parachute with one clip attached and with five clips attached.
	Communication of investigation findings using illustration and writing.	Write and draw results, label drawing, explain results using evidence.

Appendix 1

Initial Teacher Survey

1. By the end of this school year, how many years will you have been teaching altogether? _______________

2. Do you have common planning time for yourself or at your grade level? Yes/No

3. How often do you have planning time? __________________

4. How often do you have the following types of interactions with other teachers?

   Select 1-4 in response to a, b, c, d below.
   1. Daily or almost daily
   2. 1-3 times per week
   3. 2 or 3 times per month
   4. Never or almost never

   a) Discussions about how to teach a particular concept
   b) Working on preparing instructional materials
   c) Visits to another teacher's classroom to observe his/her teaching
   d) Informal observations of my classroom by another teacher

5. Provide your opinion about each of the following statements using the 1-5 scale below.
   1. Strongly Agree
   2. Agree
   3. No Opinion
   4. Disagree
   5. Strongly Disagree

   a) Students learn science best with students of similar abilities.
   b) I feel supported to try new ideas in teaching science.
   c) Teachers in this school have a shared/common vision for science teaching and learning.
   d) I have time during the school day/week to work with peers on science curriculum.
   e) I enjoy teaching science.

6. Please rate the importance of each of the following strategies in teaching science using the 1-5 scale below.
   1. Extremely Important
   2. Very Important
   3. Important
   4. Somewhat Important
   5. Not Very Important

a) Students writing descriptions of their reasoning
b) Investigative activities that include data collection and analysis
c) Whole-class discussions during which the teacher talks less than the students
d) Presentation of new information that is deliberately based on students' prior knowledge and conceptions
e) Using computers and/or other instructional technology to support deep conceptual understanding
f) Students gathering information to answer their own questions
g) Having students work in groups, receiving one grade per group
h) Using a variety of assessment techniques, e.g. multiple choice tests, portfolios, projects, etc.
i) Use of science standards (RI Science GSEs, National Science Education Standards, and Benchmarks for Science Literacy)

6. What grade level(s) are you currently teaching? (circle responses)
   a) Pre-K b) K c) 1 d) 2 e) 3 d) 4 e) 5 f) 6

7. How often do you teach science:
   a) every day b) 2-3 times weekly c) twice monthly or less d) not at all

8. What science content did you teach this year? (select all that apply)
   a) LIFE b) EARTH & SPACE c) PHYSICAL SCIENCE d) SCIENCE PROCESS

9. When was your last professional development in science?
   a) 1-2 years ago b) 3-4 years ago c) more than 4 years ago d) not applicable

10. Describe what you need in order to teach science.

Resources: TIMMS & Horizon Research, Inc.

Appendix 2

LS Workshop Feedback Form

Please share your feedback from today's professional development. Thank you.

Response Scale

1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5= strongly agree

Select the best response for each indicator below.	1	2	3	4	5
The workshop content was useful.					
The workshop presenters were prepared.					
The workshop was informative and useful.					
The PD topics addressed my curriculum concerns.					
The experiences from the workshop will positively impact my teaching of science.					
The refreshments/food and environment were adequate.					

What worked for you today?

What could have improved the workshop experience for you?

Appendix 3

Project Success Teacher Participants Feedback on Professional Development Workshops and Lesson Studies

Part I: Workshops

Workshop Dates	Workshop Content
June 24 and 27, 2011 (Pawtucket) November 3 and 10, 2011 (North Providence)	• Comparison of various hands-on approaches (building tops activity) • Process Skills (6 short activities to explore different process skills) • Questioning (Ice Balloon activity)

Workshop Dates	Workshop Content
December 1 and 8, 2011- Both districts	• Introduction of the Project SUCCESS website: Building an online learning community • Different View of formative assessment (formative assessment cycle) • Science Notebooks: structure & entries • Notebooks & NECAP- the alignment • Introduce the Lesson Study process

Workshop Dates	Workshop Content
January 19, 2012- Both districts	• How to assess students' development of science process skills • Lesson study planning

1. How have the workshops you attended impacted your science teaching? Describe the changes that you have made as a result of your workshop experiences. [Use as much space as you need for your answer.]

2. Did the workshops address your needs in science teaching? What other topics that you would like to explore in the future workshops? [Use as much space as you need for your answer.]

Part II: Lesson Study

3. The lesson study cycle is composed of four phases: goal-setting and planning, lesson implementation, follow-up discussion after the first lesson implementation, and refining and re-teaching the lesson. Reflecting on your participation in this process, what are the benefits and challenges that you have experienced? [Use as much space as you need for your answer.]

4. How has the lesson study process impacted your science teaching? Describe the changes that you have made as a result of your lesson study experiences. If possible, please provide sample student work in either electronic or hard copy (e.g., science notebook entries including written entries and labeled diagrams; completed worksheets; pictures of students' product) [Use as much space as you need for your answer.]

5. What suggestions do you have to improve the second round of lesson study? [Use as much space as you need for your answer.]

Appendix 4

LS Lesson Plan Template[1]

GROUP ___: ___ GRADE SCIENCE LESSON

Date lesson will be taught:
Time lesson will begin:
Teacher Name:
Classroom #:
School name:
School address:

School telephone #:
Directions at the school (entrance and where to go):

Special instructions for Lesson Study Team:

GROUP ___: ___ GRADE SCIENCE LESSON

Date:

Grade:

Period and Location:
Instructor:

I. Background information

A. Goal of the Lesson Study Group:

B. Narrative Overview of Background Information:

C. RI GSE

II. Unit Information

A. Name of the unit:

B. Goal(s) of the unit:

C. How this lesson is related to the unit:

D. Instructional sequence for the unit:

III. Lesson Information & Pedagogy

A. Name of the study lesson:

B. Objective/s of the study lesson:

C. How this study lesson is related to the lesson study goal? What is the gap?

D. Process of the study lesson:

Steps of the lesson: learning activities and key questions (and time allocation)	Observer Notes
Student activities/ expected student reactions or responses	**Observer Notes**
Teacher's response to student reactions / Things to remember	**Observer Notes**
Align Objective/s with Method(s) of Assessment	**Observer notes**

E. Evaluation
F. Appendix

[1] Modified from the Sample Study Lesson Plan Format by the Lesson Study Research Group. http://www.tc.columbia.edu/lessonstudy/doc/Sample_Lesson_Plan_Format.pdf

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