ISEP Interdisciplinary Science and Engineering Partnership

Annual Report to NSF

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Interdisciplinary Science and Engineering Partnership (ISEP) with Buffalo Public Schools

Year 4: 2014 – 2015

Section 1: Activities and Findings

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1. Introduction and Summary: Activities and Findings

This Activities and Findings report from the fourth year of the NSF MSP supported expansion of the ISEP program focuses work related to the four research questions being investigated in ISEP.

- What are science teachers' conceptions of interdisciplinary science inquiry? How do their conceptions change through intensive summer research and ongoing professional developments?
- How do science teachers translate interdisciplinary science inquiry experiences and understanding gained in university research laboratories into their classroom inquiry instructional practices, i.e. how do science teachers develop interdisciplinary science inquiry PCK?
- How do professional learning communities (PLC's) support teacher development of interdisciplinary science inquiry PCK?
- What are the processes of STEM students developing understanding of interdisciplinary science inquiry and abilities to communicating science to middle and high school science teachers and students?

As ISEP has developed from a pilot study in 2005-2010, five major activities have been identified as central to the ISEP mission as described in the Strategic Plan:

i. ***School based Wrap Around Support***: the introduction of STEM Ph.D. graduate assistants and undergraduate service learning students to support science, technology, English as a New Language (ENL, formerly English as Second Language (ESL) and special education teachers in twelve schools in the Buffalo City School District (aka Buffalo Public Schools, BPS),

ii. ***Teacher Professional Development***: the development of school based focus areas for STEM education in each school and recruitment and placement of teachers from all twelve schools in summer interdisciplinary research,

iii. ***Professional Learning Communities (PLC***): the development of networks that focus on middle and high school teachers working on content development and alignment across the STEM fields, with special focus on linking feeder middle schools to high schools, inclusion of parents into the PLC, defining the roles and participation of ISEP faculty and graduate students,

iv. ***Research on Teachers and STEM Graduate and Undergraduate Students***: Development, validation and implementation of tools for data collection, collection of baseline data and research into key questions outlined in the 5 year strategic plan and

v. ***Support for summer activities (research/camps) for middle and high school students and support for field trips for students during academic year***

The reports of activities will focus on the MSP five key features: Partnership Driven, Teacher Quality, Quantity and Diversity, Challenging Courses and Curricula, Evidence-Based Design and Outcomes and Institutional Change and Sustainability.

Separate files are submitted for the Sections 2 through 5, the Management Report, Financial Report, Evaluator's Report and Partnership Response, and Implementation Plan for 2015-2016.

Highlights from the fourth year of the NSF support for ISEP include:

- ***placement of 78 teachers in summer professional development (PD) in 2014***, including 55 teachers in research opportunities, 10 ESL teachers working on translation of STEM curricula , and 11 teachers in the BSC Course,
- ***application and placement of 101 teachers for summer PD in 2015***, including 68 teachers in research opportunities, 15 teachers in the ESL translation project and 18 in the BSC course
- ***research results reported in three PhD. dissertations*** (Erica Smith, Michelle Eades-Baird and B. Chowdhary, and two published papers, detailed in the research section of this portion of the report (section 6 below).
- ***development of a focused implementation plan*** and documentation of implementation by consulting with ISEP teachers, resulting in reporting of substantive classroom implementation in academic year 2014-2015,
- ***development of a strategic plan for ISEP sustainability*** following the end of NSF MSP support in a series of grant submissions to supplement and expand ISEP work, including New York State funding, NSF, US Dept of Education and private foundations, building toward integration of ISEP collaboration with higher ed, corporate partners for STEM PD and support into the BPS budget,
- ***development of a focused dissemination plan for other teacher in Buffalo Schools with*** funding awarded for the a BPS/ISEP application to New York State Education Department MSP that brings ISEP work into the academic year PD for all 7/8th science teachers,
- ***initiation of the development of an ecosystem based Theory of Action for ISEP,***
- further development of a STEM/ENL initiative to translate 8th/9th grade Living Environment (NYS Regents Biology course) into languages of importance to Buffalo's growing Immigrant/Refugee population, including oral and written translation into Arabic, Burmese, Somali and Bhutanese,
- development of a novel GIS Summer teacher and student camp to teach programming and mapping for GIS analysis using smartphones,
- development and implementation of a computer science initiative at the middle school level,
- development of subject based PLC's and expansion of the Parent PLC to include parents from each ISEP School (See Section 6 below)
- as a result of collaboration in research teams in 2014-2015, and the PLCs, highly focused STEM teaching teams expanded in 2014 and 2015 in ***both*** K-8 and high schools building on last year's efforts in K-8 schools,
- ISEP sponsored public events, including the Student Science Summit (see narrative below in PLC report), school based STEM or Science Nights and co-sponsorship of BPS Science Week March 13-20,
- Social media and ISEP websites (isep.buffalo.edu) developed to communicate with stakeholders, and report results of implementation from poster sessions to materials made available for download from website,
- award of additional funds from Praxair to expand corporate commitment to ISEP ***and***
- extensive recruiting based on parent PLC input for opportunities for summer high school student research and middle school science camps are added for summer 2015.

The issues that have complicated ISEP progress in year 4 include:

- The forced resignation of BPS Superintendent Dr. Pamela Brown and transition to an interim Superintendent, Donald Ogilvie was difficult but Mr. Ogilvie was quickly engaged as a strong leader and enthusiastic supporter of ISEP. Mr. Oglivie announced his retirement for June 30, 2015, and a short term interim superintendent has been appointed expecting the results of a search for a permanent appointment of a new full time superintendent this summer. This means that ISEP, since the expansion in 2011 with NSF funding, will have worked with three superintendents, two long term interim superintendents and two short term interim superintendents. Each new change requires our work to educate them about ISEP and their role and responsibilities.

- Leadership and action in Buffalo Schools has been complicated by a Board of Education that is split along racial lines, with some members introducing political and ideological evaluation of BPS leadership. This has complicated ISEP work with schools and partners, often being pitted against NY State Ed School Turnaround initiatives. Regular presentations were made to the Buffalo Board of Education, despite the split over leadership, all members have been educated on ISEP programs and outcomes in the schools.
- Understanding of ISEP mission, goals and operation has increased throughout the district and principal leadership has made up for some of the political issues. This is reflected in the continuing growth of teacher applications to ISEP for summer PD.
- Summer student placement in STEM middle school camps at BSC and UB and summer high school research, below expectations in both years 1 and 2 has grown substantially in years 3 and 4. Efforts to increase participation for 2014 were organized with extensive help from the Parent PLC.
- Last year, we reported that the NY State Education Department (NYSED) had not been involved with ISEP directly to discuss opportunities to align with other Race to the Top funded STEM PD efforts. However, as noted above, ISEP partnered with BPS leadership, in particular, Ms. Kelly Baudo, in the implementation of a NYSED MSP application which was funded. Further, extensive discussions with NYS Ed Regents for the 8th Judicial district, Mr. Robert Bennett (who stepped down after 4 five year terms), and Dr. Catherine Collins, a former BPS School Board member familiar with ISEP Pilot Project, are ongoing for longer term substantial support. More on this is discussed in the Sustainability Plan.

Besides UB's participation in hosting many of the summer research opportunities for teachers, and participation (see Management Report) of Buffalo Public Schools leadership in collaborating on management of the ISEP program, other Core and Supporting partners made significant commitments in the past year that should be highlighted.

- ***Buffalo State College (core partner) (see BSC report, Appendix 1, Part 1, following)*** offered a combined (2014) summer teacher PD course, taught by coPI Prof. Dan MacIsaac and Prof. Clark Greene of Technology Education. 11 teachers completed the course and are prepared for summer research in 2015. Further, BSC provided the summer middle school camp for students. BSC also provided exceptional collaborative support in the development of a computer science PD initiative, with existing CS collaborations between BSC, UB and the local CSTA chapter creating the environment to propose a specific initiative between CS and Career and Technical Educators (CTE, aka Technology) in BPS (see below)
- ***Buffalo Museum of Science (core partner (see BMS report, Appendix 1, Part 2)*** continued their support for informal science opportunities, summer enrichment, quarterly Family Science Nights, along with the curricular support and after school programs for School 59. The Museum of Science strongly supported the Parent PLC with Museum memberships for all participants. Many events are held regularly at the Museum, such as the ISEP Student Science Summit (see PLC report below) and planning to optimize the major exhibitions are complemented by the completed renovation of space to make more hands on workstations for use daily by School 59, which is adjacent/connected to the museum, along with other hosted field trips by ISEP schools. Further BMS Director of Education Karen Wallace has led the planning for submission of an ISEP application to the AISL program for this coming fall. Again, more on this in the Sustainability Plan.

- ***Roswell Park Cancer Institute (supporting partner)*** expanded their commitment to teacher PD beyond what was envisioned in the proposal to three to four teachers, plus a planned expansion of high school student research opportunities for ISEP students.
- ***Hauptman Woodward Institute (HWI) (supporting partner)*** obtained major NSF STC funding for research into X-Ray Lasers for crystallography, and included funds for four summer teachers stipends for HWI collaboration in the grant. Teachers were placed at HWI in summer 2014 as part of this additional funding, but NSF site review of the STC recommended a refocus away from K-12 and undergraduate education, so these positions were eliminated for 2015. Former HWI director Dr. William Duax was able to provide mentoring from graduate students and senior participants to both high school and middle school students with ISEP funding, and hosted two of the teachers in 2014. This summer (2015) Dr. Duax will support one ISEP teacher and continue to host his summer research program for middle and high school students.
- ***Praxair Technology Center (Corporate supporting partner)*** hosted four teachers in 2014, two physics teachers and two middle school teachers, who developed unique laboratory based work (Schlieren camera for transparent gas phase fluid dynamic measurements and engineering design programs in middle school). Praxair will host five teachers with partial support of finances for 2015. Praxair Technology Center also received Praxair Global financial support as a Community Engagement Award to sponsor the ISEP Student Science Summit in 2014.
- ***Life Technologies (Corporate supporting partner)*** hosted one teacher in 2014, and will continue that project with the same teacher in 2015
- ***Medaille College (supporting partner)*** has had several major changes in personnel and financing, and has not contributed to ISEP this year. We await changes in leadership to learn the impact on ISEP and our partnership with Medaille, which is also a higher ed partner at Riverside High School, an ISEP school.
- ***WNY Service Learning Coalition (supporting partner)*** helped recruit Daemen College, Niagara University and Canisius College. We anticipate potential partnerships with SUNY Fredonia and Erie County Community College and Jamestown Community College, described in the narrative below.
- ***District Parent Coordinating Council (DPCC, supporting partner)*** provided new opportunities in communication to district parents by participating in our first External Advisory Committee meeting in 2014 and continued support in 2015.

2. ISEP Programmatic Highlights

Following the participation of Professor Gardella and Ms. Kelly Baudo of BPS in the December 3, 2013 Workshop on STEM-C opportunities, ISEP submitted a $500,000 three year supplement request for development and expansion of computer science initiatives, which was declined. However, our recruitment of seven faculty from UB Computer Science and Engineering and BSC Computer and Information Science and Mathematics expanded Google funded summer workshops on Exploring CS and CS Principles. These workshops and research opportunities for teachers in robotics, big data, and programming have allowed the development of a focused pilot project in adapting Exploring CS for middle school students (grades 5 and 6). We placed five teachers (3 high school, 2 middle school) in last summer's research and workshops. The pilot middle school course was developed at School 93, Southside Elementary during AY 2014-2015. BPS CIO Sanjay Gilani and staff member William Russo mobilized extensive support to coordinate with Director of Career and Technical Education, Kathy Heinle and Science Supervisor Kelly Baudo and ISEP leadership, BSC and UB faculty as we continue to develop a CS initiative that might compete for STEM-C funding in 2016.

On June 10, 2015, the ISEP Steering Committee convened the second annual review of ISEP by the External Advisory Committee. The committee participated in a presentation of the current status and meetings were arranged with all core and selected supporting partners. Special attention was paid to a review of the proposed sustainability plan and the status of the ISEP Theory of Action developed from the Conceptual Model. The External Advisory and Steering committees summarized their findings in a summary analysis and reported to the Director and to the Core Partners. Specific suggestions to delineate a component of sustainability around the Corporate partners, and refinements of the approach to the Theory of Action to an Ecosystem structured model following Bronfenbrenner's approach (Bronfenbrenner, 1977, 1986, 1994, Zhao, Frank, 2003, Gunn, Goelman, 2011)

The coming year will focus on the Theory of Action, Sustainability Plan, Teacher implementation and Dissemination of ISEP classroom materials to BPS and NYState teachers. The ISEP website has been the focus for this effort. The External Advisory review analysis is shown in Appendix 2 of Part 1, following the Buffalo State College Report and the Implementation Matrix.

3. Programmatic Results and Sustainability Planning

a. **Development of a common implementation plan with and for teachers**

A targeted goal for year 4 was the development of documentation of teacher implementation of their work from the summer. We began by consulting with ISEP Coordinating teachers in the PLC. The coordinating teachers recommended two standard rubrics well known to middle and high school teachers, for reporting on lesson plans. We required all returning applicants to provide their lesson plans via these rubrics, along with notes and handouts. This resulted in extensive reporting of substantive classroom implementation in academic year 2014-2015. We are just beginning to catalogue these results after placement of the 101 teachers for summer 2015. The development of implementation plans feeds into the dissemination of best practices in ISEP.

b. **Development of a focused dissemination plan for other teachers**

funding awarded for the a BPS/ISEP application to New York State Education Department MSP that brings ISEP work into the academic year PD for all 7/8th science teachers,

Our plan for dissemination is has three components: access to ISEP developments for other BPS teachers through our isep.buffalo.edu website and specific NY State Ed PD sessions, documentation of ISEP developments as lesson plans for teachers in New York State via the NYLearns.org website. NYLearns is a NY State curriculum management and standards-based system for teachers and the broader scholastic community. We plan to begin uploading to NYLearns once we begin to standardize the input from teachers. Finally, ISEP Director Gardella has been working with the College Board in NY City to collaborate using their national online services for teachers as a means to provide ISEP classroom contents, laboratory and field work and lesson plans from teacher developments.

c. Initiation of the development of an ecosystem based Theory of Action for ISEP

As noted above, the development of an Ecosystem model for describing and documenting the theory of action is underway, using general organizational thought brought by Bronfenbrenner (Bronfenbrenner 1977, 1986, 1994, Gunn, Goelman, 2011) and recent work on an Ecosystem model by Zhao and Frank on technology K-12 education (Zhao, Frank, 2003). This involves the following three initial hypotheses about student outcomes and the result of work in ISEP:

1. Development of interdisciplinary classroom materials will increase student interest and performance by providing links between science and technology classes, real world applications and college and career opportunities.
2. Teachers' increased understanding of interdisciplinary science results in innovative classroom materials for early engagement in middle school with inquiry based hands on experimental work will sustain student interest in STEM in high school.
3. Parent involvement in STEM curricula and careers will help engage students and support teachers.

Mapping these hypotheses into the three dimensional ecosystem models such as shown in Figure 1.1a will involve efforts to define the web of intersections of actions of partners and programs and translate the ISEP conceptual framework (Figure 1.1b) of ISEP into this Theory of Action. (see below Section 7 Research)

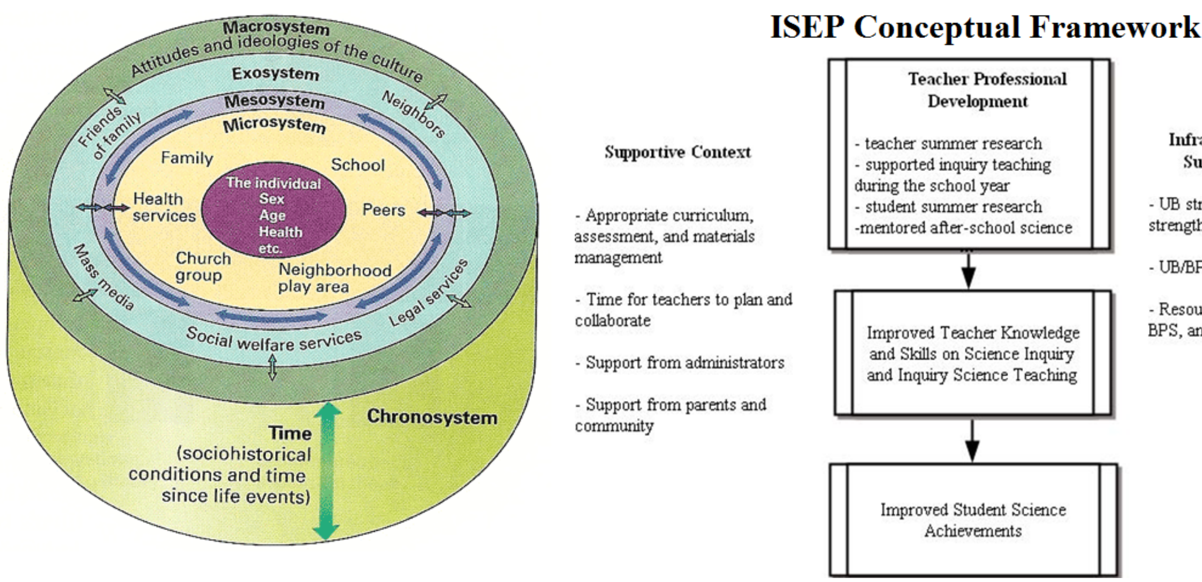

Figure 1.1. a: (left) General descriptive ecosystem model of Bronfenbrenner b: (right) ISEP Conceptual Framework

d. Development of a strategic plan for ISEP sustainability

With the help of ISEP Steering Committee Chair UB President Satish Tripathi and Interim Superintendent Donald Ogilvie we began developing a strategy for future support of ISEP (extension and expansion) in late summer 2014. While initially focused on a submission of a new STEM-C Partnership application in 2016 and enhancement of NY State support, the phase-out of the STEM-C Partnership option began a more serious conversation with President Tripathi, Buffalo Schools leadership, New York State Education Department leadership and ISEP leadership.

ISEP leadership developed a two-step sustainability plan, with the first step a multiyear transition to permanent funding and the second step, permanent funding as part of the budgets of the core partners. We presented this to the External Advisory Committee on June 10th. With detailed feedback (see Appendix 2 of Part 1, Notes from ISEP Executive Session of External Advisory Board Meeting, June 10, 2015) we are moving forward with both steps toward ISEP sustainability.

As noted, longer term goal of sustainability planning is to develop the ISEP model of STEM teacher professional development and wrap around support activities into the budgets of the core (and some supporting) partners. This would lead to a sustainable ISEP program that would be present in ***every school*** in the Buffalo Public Schools and be translated, including a transitional funding plan, to other urban and rural high needs schools. Well-funded suburban schools would be able to support ISEP programs as part of their internal budgets.

In particular, the Buffalo Public Schools, UB, Buffalo State and Museum of Science, as core partners would commit to an ongoing internally funded program following the ISEP model of collaboration. Important corporate partners and research partners would also be engaged as part of the long term sustainable funding of such a program. This approach is founded on the definition of a core partner in NSF Math Science Partnerships, Core Partners agree to Institutional Change as part of Sustainability.

> *"Core partner organizations share responsibility and accountability for the MSP project. Core partner organizations* ***are required*** *to identify the institutional change(s) that will occur and provide evidence of their commitment to undergo the institutional change necessary to sustain the work of the partnership beyond the funding period. This is what distinguishes Core Partner organizations from supporting partner organizations."*

Besides institutional changes in practice as a result of the ISEP program, an institutional commitment to building the program into the regular budget of both higher education partners and the Buffalo Public Schools would demonstrate true sustainability and significant institutional change. One of the current Buffalo Public Schools Board of Education members, Larry Quinn, said it best "the long term success of ISEP depends on it being part of the normal BPS budget".

In the first step of the sustainability plan, we are developing a funding request from UB's President to New York State for substantial multimillion dollar support of a level and timeframe similar to the initial MSP (5 years, $10M). This would continue a base operation for extension of the existing program and expansion to more BPS schools. The goal of the first step funding would be to refine and expand the ISEP model to more middle and high schools in Buffalo. With ***current*** NY State Ed MSP funding (see management plan Section 2) dissemination is underway to all 7/8th grade science teachers and selected special ed and technology teachers.

For this first "transition" step the primary funding request would be to New York State. This makes sense given that the Buffalo Public Schools are funded primarily by New York State, as one of New York's "Big Five" school districts. The five city school districts with populations over 125,000 people are New York City, Yonkers, Rochester, Syracuse and Buffalo. The cities of the Big Five districts do not collect school taxes or millage funding, they are primarily funded by New York State through direct funding, programmatic grants and other support mechanisms, including pass through of federal Department of Education funding. For the Big 5 Districts, the local City municipal budget is expected to directly support the district budget. For Buffalo, in particular, State support, including pass through funding from federal sources, constitutes 83 percent of the 2015-2016 budget, with the City of Buffalo providing 8.3 percent, Erie County, through sales taxes, supporting 5 percent of the budget. ***Thus, working with New York State for primary funding of ISEP is consistent with the overall approach to sustainability, since NY State would have to approve funding components of BPS budget for ISEP in the longer term.***

ISEP Director Gardella with President Tripathi began with an introductory meeting with NY State Education Regent (and Chancellor Emeritus) Robert Bennett in August 2014, followed by a series of meetings between Gardella and Bennett, a plan for the focus of the request was developed. In March 2015, Dr. Catherine Collins was appointed in Mr. Bennett's place. Dr. Collins, a longtime education leader in Buffalo, is a former member of the BPS Board of Education and had worked with ISEP Director Gardella during the pilot phase of ISEP in 2006-2010. She is planning to attend the NSF Site Visit scheduled for July 7/8th and follow up with work to help continue to define a request for major NY State funding for ISEP.

Within the first transition step is a complementary approach to the base New York State funding that includes targeted grant applications to NSF, the US Department of Education and private foundations combined with increased emphasis on funding and participation from additional corporate partners. Table 1.1 includes a list of potential NSF, US Department of Education and private foundation funding programs that are being pursued and/or targeted for applications in 2015/16. Descriptions of innovative present and new ISEP components that would be funded by these programs are also provided. Yellow highlighted rows indicate grant applications to be submitted in fall 2015. The remaining target dates are in 2016. The planned work includes monthly organizational meetings in each potential NSF grant listed.

An early point of institutional commitment of UB is the integration of ISEP within a new "Community of Excellence" internally funded interdisciplinary research and education program at UB, in the "Genome, Environment and Microbiome (GEM)". Profs Norma Nowak and Jennifer Surtees have integrated funding for ISEP summer teacher PD and grad student support into the GEM base budget supported by the UB Provost. A second major new Institute, "Research and Education in eNergy, Environment and Water " (RENEW) has also been established and ISEP Director Gardella has been conversations with the Director of RENEW about a K-12 component to the outreach and public policy component of the research and education plan.

Table 1.1 Grant Opportunities for ISEP Sustainability in Near Term

Source	Name	ISEP Project Component	Topic of Grant	Potential PIs
New York State	Core Funding for ISEP	Interdisciplinary PD for Teachers, Grad Assistant Support, Wrap Around Services for Teachers and Students	Extension and Expansion of ISEP to broader base of Buffalo Public Schools	Gardella, Liu, Baudo, MacIsaac, Wallace, others as appropriate
National Science Foundation (NSF)	STEM-C	Computer Science and Engineering Teacher Prof. Development	Implementation for middle and transition to high school	Ziarek, Alphonce, Banerjee, ISEP Leadership Team
NSF	NRT-IGE	Grad Assistant participation in high needs middle and high school	Communication of Common Core and NGSS based on state of the art Interdisciplinary Research	Gardella, Liu, MacIsaac, Baudo, etc.
NSF	ITEST	GIS Workshop	Geotechnology Experiences for Students and Teachers (GTEST)	Bian, Gardella, Liu, Sodano
NSF	AISL	Informal STEM learning for summer and STEM Ecosystem Development	Summer STEM Camps for Disabled and Disadvantaged Students as part of STEM Ecosystem	Wallace, Gardella, Lange, Cradle Beach, Museum
NSF	EHR Core Research (ECR) Fundamental Research in Science, Technology, Engineering and Mathematics (STEM) Education	STEM Teacher PD and Material Development for English as New Language Students	Rapid integration of Immigrant and Refugee ENL students in STEM education	Gardella, Liu, MacIsaac, others as appropriate
NSF	Teacher Leader Initiative (EAGER)	Coordinating Teacher/Master Teacher leadership	Faculty mentoring for Teacher PD and leadership	Gardella, Huff, Liu, MacIsaac
US Department of Education	Math Science Partnership	Interdisciplinary PD for Teachers,	Teacher improvement, PD, expansion to other districts in NY	NY State Education Department
STEM Funders	STEM Ecosystem	Partnership Development	Aligning STEM Eco-system theory of action to practice	Gardella, Liu, Baudo, MacIsaac, Wallace, Huff

4. School Based Wrap-Around Support for Implementation in Year 4

a. Graduate and Service-Learning Undergraduate Students: Recruitment, Placement and Training

In year 4 of the program, support for the number of STEM Ph.D. graduate assistants continued at 12 full time grad assistants to find a sustainable balance from funding. This aligned with the original support plan in the proposal, giving a full time graduate assistant to each school, committed to 16-20 hours/week with support from over 70 service learning students, comprising paid part time masters students and both paid and credit bearing course and internships for undergraduates. The graduate assistants in the schools work with teachers, classes and the principal, and meet at Common Planning time to facilitate all teachers participating in wrap around support, including science, technology, mathematics and special education

The participation of undergraduates in service-learning continued from UB, BSC and Canisius College. Our collaboration with Medaille for service learning declined due to changes at the school resulting from financial pressures. Our collaboration with Medaille college continued with joint ISEP sponsorship of Medaille's STEM summer middle and high school camp program for 2014. No such camp is expected in 2015 again due to changes in personnel due to financial constraints. Daemen and Niagara did not provide service learning students but intend to recruit for 2015-16.

The combination of students from UB, Buffalo State,and Canisius continued to increase in numbers of service learning support students to nearly 85 in Spring 2015 semester. This allowed for every school to be staffed in-class and after-school with students. Selected graduate assistants who were new to the program and undergraduate students participated in extensive training through the UB service-learning course, which included content on mentoring, K-12 education, introduction to the Buffalo Public Schools and other topics. Research studies and evaluation results related to student involvement were significant in guiding preparation for the student work. Please see section 4.

b. In-class and After School programs

With the placement of graduate and undergraduate students in schools, new opportunities were developed for in-class and additional after-school programs were developed. At least three to four teachers in each school had access to in class help. The impact of the students on the classes is presently being assessed. After school science and engineering programs are now present in all but three ISEP schools.

c. Informal Science Activities

ISEP continued leadership and participation in the BPS STEM Experience, expanding from the one weekB BPS STEM week developed with leadership from SUNY Trustee Eunice Lewin to year round events on STEM education in Buffalo Schools(http://www.research.buffalo.edu/ovpr/stemmonth/), culminating in BPS STEM week, March 13-18th . The STEM Experience was again announced by Mayor Byron Brown of the City of Buffalo at a press conference, and opened and closed with ISEP showcase events including the Science Summit and teacher and student presentations at ISEP middle and high schools. On March 13th, the ISEP Parent PLC again organized the 2nd Annual ISEP Student Science Summit at core partner Buffalo Museum of Science. Each ISEP school prepared a research team and competed in presentations to judges. Nearly 300 people came to the event, including parents, teachers, students and community leadership. Later that day, the annual Tech Savvy program hosted and funded by UB School of Engineering and Applied Sciences, ISEP and Praxair funds (http://www.eng.buffalo.edu/techsavvy/). Tech Savvy is a hands on STEM program focused on middle school female students and their parents. ISEP Director Professor Gardella spoke on STEM jobs to parents. In addition to these opening events, BPS students participated in larger numbers at the annual Science Exploration Day at UB on March 18th, where 25 tours, presentations and lectures attract nearly 1200 middle and high school students, sponsored by UB and NY NSTA chapter (STANYS). A number of schools organized science nights for parents.

The ability for schools to schedule field trips continues to be a significant activity which has been expanded in year 4. The Museum of Science hosted several trips around major exhibitions. Tifft Nature Preserve, a recovered Brownfield managed by the Museum was a popular outdoor choice, and was integrated into a formal classroom activity to map invasive species developed through the GIS camp. The program leadership has continued to negotiate effective discounts to maximize participation of students at middle and high schools. Also, field trips to UB laboratories and to HWI and new Medical facilities opening in the Downtown Medical Campus are popular. Field trips expanded in popularity, well aligned with interdisciplinary STEM experiences. A total of 51 field trips (17 high school field trips and 34 middle school) were funded by ISEP this past year, compared to 25 total field trips last year. Major increases occurred for middle school trips with emphases on the Buffalo Museum of Science, UB and field trips to nature preserves, geological sites, wildlife refuges, Tifft Nature Preserve (overseen by the Museum of Science) and the Buffalo Zoo.

d. **Summer support for STEM Camps and summer research for ISEP BPS students**

With support from the Parent PLC, recruitment has been brisk for summer camps for middle school students. With ISEP support, we developed and continued our partnership with Cradle Beach for summer informal STEM activities at their summer camp and for ISEP students within the camp. Cradle Beach is a historic camp (it was established in 1888 as a local "Fresh Air" camp) for disadvantaged and disabled children in WNY. Most recently, strategic plans for camp enhancement have focused on leveraging their wooded campsite location along the Lake Erie Beachfront for summer STEM activities. This is an ideal collaboration with ISEP to provide continuous STEM experience for students in the summer, since many students in ISEP schools attend Cradle Beach. We also continue the BSC summer program, which may be merged with Cradle Beach. ISEP BSC faculty member, Dr. Cathy Lange, an expert in informal science, is working with Museum of Science Director of Education and ISEP collaborator Karen Wallace to craft hands on STEM activities for Cradle Beach participants.

Professor David Watson's NSF grant includes funding for summer high school research and he continues to coordinate recruitment of ISEP students for that program. Our participation in these opportunities had been lower than expected in years 1 and 2 but efforts to increase recruiting resulted in extensive interest, application and participation of students for summer 2014 and continued increase in applications for summer 2015.

e. Further development of a STEM/ENL initiative

ISEP initiated a formal teacher PD based STEM/ENL program in 2014 10 ESL teachers and 2 science teachers (see Table 1.3) working to develop translations of curriculum and pacing guides for 8th/9th grade Living Environment (NYS Regents Biology course) into languages of importance to Buffalo's growing Immigrant/Refugee population, including oral and written translation into Arabic, Burmese, Somali and Bhutanese. These translations are found at https://www.joomag.com/en/newsstand/living-environment-translated/M0634930001412743925. 2015 will find teachers developing Pictionary type materials that can support ENL students who do not read their language but speak it.

f. development of a novel GIS Summer teacher and student camp

ISEP developed a pilot project in 2014 in a research workshop format to teach programming and mapping for GIS analysis using smartphones and involved teachers with middle and high school students. The program is continuing in 2015. An ITEST proposal was submitted and declined, but gave very useful constructive criticism and will be pursued as part of the Sustainability plan in 2016.

g. Summary impact

The increased recruitment, placement and retention of graduate assistants, undergraduates and corporate partner staffing for wrap-around service support allowed the development of new opportunities and programs in-class and after school. Additional Informal Science activities in the evenings and in collaboration with the Buffalo Museum of Science were also made possible. These outcomes are ***partnership driven*** as UB, Buffalo State, the Museum of Science collaborated in planning with the BPS, as core partners, and supporting partners Praxair and WNY SLC have been engaged in recruitment of participants. Buffalo State faculty members have been engaged in training programs for the mentoring and in-school orientation. The work of these students allows for teacher implementation of ***challenging courses and curricula*** providing a means to overcome the limitations of large class sizes and limited funding to implement laboratory, field, inquiry based experimental work and new class content that aligns across middle and high school. Using ***evidence based design and outcomes*** is the basis for the wrap around support, but extensive research work focused on these students serves as the work of one of the science education graduate assistants, Brooke Grant, directed by Professor Xiufeng Liu (Co-PI, head of the research team). Her current work is discussed below. Finally, the alignment of the ISEP program within other on-campus curricula at UB and Buffalo State, notably for the institutional work to expand service learning along with a serious plan to reach a goal of internal funding commitments from core partners to fund ISEP in the future contributes to both ***institutional change and sustainability.*** Thus, four of the five key features are central to this area of the ISEP program.

5. Summer Teacher Professional Development year 3, Summer 2014 & plans for year 4, Summer 2015

a. Interdisciplinary Research Placements and Results for Summer 2014

Table 1.2 shows the assignments, subjects and numbers of teachers summarized for each school for summer 2014. The organization of the teacher placements into these interdisciplinary subject "clusters" has continued this year (Table 1.3) with increases compared to 2013.

Each teacher is asked to develop and co-sign a Memorandum of Understanding documenting the assignment and detailing the specific responsibilities for the teacher and placement host (faculty members). For the research assignments teachers were asked to meet with their placement host and draft a one-page attachment to the MOU that detailed the research project, teacher schedule, supplies needed and implementation plan for the teacher's classroom projects. The development of the teacher placement has created the opportunity to develop middle/high school collaborations and teacher collaborations in nine different areas. This planning process has been important to identify placements but also to identify faculty who are committed to the ISEP program. More than enough faculty volunteered to host teachers from our meetings at the Department level. The Buffalo State Course provides a transition program to identify partner faculty, develop procedures for recruitment of teachers and for applications and MOUs. We expect the placement process to continue following the strategic plan for the subsequent years of ISEP.

Table 1.3 shows a summary of teacher research participation by Interdisciplinary research areas, including courses affected and the UB resources that supported these efforts (Departments, Programs, Research Centers, Supporting Partners and Strategic Strength areas from UB 2020 Strategic Plans.

Specific placements have been completed for the summer 2015 through review of detailed teacher proposals. ***100 applicants submitted proposals and were placed for participation!*** This is accomplished by a committee staffed by members of the Executive Committee, chaired by Co-PI MacIsaac. Eighteen teachers have been selected for the Buffalo State College course, and five are recommended for the new Exploring CS workshop as part of their research program with the remainder being placed in research positions at the present time. 15 ESL teachers have applied and matched with two science teacher leaders in the ENL translation project.

These outcomes of the development teacher recruitment and placement are ***partnership driven*** as UB, Buffalo State and the BPS leadership collaborated in planning, as core partners, and supporting partners Praxair, Roswell Park Cancer Institute and Hauptman Woodward Research Institute have been engaged in aligning proposed ideas to placements in their laboratories. ISEP teacher professional development is responsive to the key theme of ***Teacher Quality, Quantity and Diversity.*** These major professional development opportunities, as aligned with school based themes may build loyalty and collaboration in the school. Examination of this hypothesis must be evaluated in ISEP. The work of the PD must allow for teacher implementation of ***challenging courses and curricula*** to implement laboratory, field, inquiry based experimental work and new class content that aligns across middle and high school. Using ***evidence based design and outcomes*** is the basis for professional development, but extensive research work focused on this planning is the work of the research team, directed by Professor Xiufeng Liu (coPI). His current work following ISEP teachers is discussed below. Finally, embedding and aligning the research opportunities within other on-campus curricula at UB and Buffalo State, contributes to both ***institutional change and sustainability.*** Thus, all five key features are central to this area of the ISEP program.

Table 1.2: Summary of **2014** teacher summer assignments organized by school.

School Name	Course areas represented	# of Teachers	Type of Participation
K-8 Schools			
Harriet Ross Tubman School 31	7/8th Grade Living Env, Special Ed, Literacy, 4th grade	9	6 Research placements, Botany/Genetics, Engineering Design, 2 BSC Course, I engineering design support
Charles Drew Sci Magnet School 59	7/8th Grade Living Environment	2	Crystallography Chemistry/Museum
Lorraine Academy School 72	4th Grade, 7/8th Grade Curriculum Writing 1-8	3	3 Research Placements, 2 Hauptman Woodward Genetics, Anat/Phys
Southside Elementary School 93	4-8th Grade	14	6 Research placements, Environmental, Computer Science, 6 BSC course, 2 on ESL Team
Native American Magnet School 19	5, 7/8th Living Environment 6th grade Social Studies ESL Team	8	3 Research Placements, Anat/Phys, Env. Science, Social Studies/Native American Studies, 5 on ESL Team
Combined 5-12			
MST Prep School School 197	Eight Grade Sci, Research Living Env, Special Ed, Earth Science, Chemistry	7	6 Research Placements, Env Team, Earth Sci, Chemistry, Computer Science, Anat/Phys 1 web support for team
High Schools			
East High School 307	Living Env, Chemistry Anat/Physio	2	2 assignments in cancer genetics at Roswell Park
Bennett High School 200	Living Env, Earth Science	7	7 Research Placements, Pharm, Extreme Events, Genetics
South Park High School 206	Living Env, Chemistry Special Ed	3	3 Research Placements, Environment, Materials Science
Riverside Institute of Technology School 205	Anat/Physio, Physics, Living Environment, English as Second Language, Special Ed.	12	7 Research Placements Praxair, Anat/Physio/Env, Genetics 2 BSC Course 3 ESL Team
Burgard High School 301	Physics, Earth Science	2	2 Research Placements Physics/Materials, Extreme Events
Hutchinson Central Technical High School 304	Living Enviroment, Chemistry, Physics	8	8 Research Placements Genetics, Engineering Design, Chemistry, Computer Sci

Table 1.3: 2014 Teacher Research Placement Summary

55 teachers in research, 10 ESL teachers, 2 support and 11 teachers in BSC Course (78 total)

Subject Area	Course areas represented	Number of Teachers	UB2020 Strategic Areas and Faculty Departments
Environmental Science and Engineering	Chemistry, Earth Science, Living Environment (Bio), Middle Schools	11	ERIE IGERT, Chemistry, Geology, Geography
Genetics	Living Environment, Middle School	11	Biological Sciences, Pharmacology and Toxicology Hauptman Woodward Institute
Anatomy and Physiology	Living Environment, Medical Careers, Middle Schools	6	Physiology and Anatomy and Pathology (Basic Medical Sciences)
Cancer Research	Living Environment, Middle Schools	2	Roswell Park Cancer Institute,
Interdisciplinary Chemistry, Physics and Materials Science	Living Environment, Chemistry Middle School	9	Chemistry, Physics, Pharmaceutical Sciences
Extreme Events	Earth Science	4	Civil Structural and Environmental Engineering
Computer Science/Engineering	Engineering	5	Computer Science
Engineering Design	Physics, Technology, Engineering	7	Physics, Praxair
English as Second Language Translation	Middle School, Living Environment	2* 10 ESL	Special emphasis with international student support

6. Professional Learning Communities (PLC's)

a. Initial Conceptions: Partnership Driven

The developmental goals of the ISEP Professional Learning Communities (PLCs) include a partnership driven structure designed to foster collaboration between all of the various ISEP partners. Building from the more traditional conceptions of PLCs (DuFour & Eaker, 1998, DuFour, Eaker and DuFour, 2005, Fullan 2001), ISEP has expanded the PLC to include additional participants. The primary role of PLC's has been to cultivate mentoring partnerships between middle and high school teachers, additionally, to include parents and students; UB and BSC STEM and Education faculty; UB and BSC undergraduate and graduate students and volunteer STEM professionals. Thus, a clear understanding of parent involvement and parent participation was considered in PLCs, (along with other areas), following the Epstein models for parent participation (Epstein, 1986, 1987, 2001, 2006).

Utilizing this expanded PLC model has yielded broader impacts, as its scope extends beyond the more traditional teacher based PLC model. This expanded PLC model reaches beyond master teachers mentoring other teachers to include graduate and undergraduate students who mentor middle and high school students; teachers who mentor graduate students in pedagogical methods; graduate students who mentor teachers in science content; and university faculty and volunteer STEM professionals who mentor BPS teacher and students, as well as STEM professionals from Praxair Corporation, Roswell Park and Hauptman Woodward and Life Technologies. Teachers involved in the 2014 summer research actively recruited fellow teachers in their school buildings to get involved in ISEP during the school year via after school science programs and developing science summit student teams to compete in the 2015 Summit. Additionally the veteran ISEP teachers actively recruited teachers to submit research proposals for the summer 2015 research opportunity, resulting in a record number of applicants.

A significant broader impact of this expanded model has included a concerted effort to increase parent participation in the direction of the program, to foster an understanding and interest in the children's science education. The targeted schools enroll a majority of minority and low-income students, providing a means to broaden the participation of under-represented students in STEM fields. This structure and implementation aims to not only foster teacher quality, quantity and diversity; it is also designed to also create an inclusive learning community for parents and other community partners. Mentoring at all levels will continue to focus on increasing interest in STEM fields. Results will be disseminated throughout the district via well-organized science teachers network; regionally and statewide using NYLearns.org; through the ISEP website; and through presentations at regional and national meetings. The PLC structure and implementation as well as the learning outcomes achieved are fostering an environment for institutional change and sustainability.

b. Evidence- Based Design and Outcomes

In two previous ISEP pilot projects (detailed in the grant proposal), professional learning communities (PLC's) were established at School #19 and Seneca MST (including BPS students and teachers, community volunteers, UB graduate and undergraduate students and UB faculty). The PLC's also included STEM employees from Praxair, participating in labs on blood typing and other subjects and helping students to prepare for a Science Olympiad. The PLC's at School #19 involved UB Honors undergraduates and graduate students who mentored BPS students. Teacher Heather Maciejewski played a leadership role and was mentored by UB faculty at the Center of Excellence in Bioinformatics, utilizing her new knowledge to enrich environmental sciences/engineering curricula. In addition, fifth and sixth grade teachers, Mary Ellement and Kathleen Cercone (who were not science specialists) are now fully participating in the ISEP.

c. Partnership Driven, Challenging Course and Curricula, Institutional Change and Sustainability

During the 2014 summer professional development program, UB graduate fellows were paired with BPS teachers with closely aligned research interests to develop inquiry teaching and learning activities for the 2014-15 school year. University STEM faculty were linked with graduate students and BPS physical science and technology teachers, utilizing interdisciplinary research to enhance middle and high science curricula. **Additionally, a cohort of ISEP ESL teachers worked closely with UB undergraduate and graduate students on a major translation project that included translating science terms for living environment classes.**

During the 2014-15 school years, parent involvement solidified. This highly engaged community was instrumental in creating intuitional change in several key areas. In addition to the two Parent driven programs that were created last year; the STEM Social Justices Conference and the ISEP Student Science Summit, a third event was created; the Parent Retreat.

- **ISEP Parent Summer Retreat: August 16, 2014**

The purpose of the parent retreat was to offer parents an opportunity to learn more about what their students were learning in the ISEP classroom as well as future potential career opportunities. ISEP teachers engaged parents in actual lab activities. ISEP Corporate Partner, Dr. Larry Megan, from Praxair, presented on the STEM Pipeline, Core Partner, and Karen Wallace from the Buffalo Museum of Science presented on Informal Science Education.

- **The ISEP Parent PLC STEM and Social Justice Conference, January,17, 2015**

ISEP Second Annual Parent PLC Social Justice Conference: Social Justice and Public Health, Issues and Advocacy

This conference included Keynote Speaker New York State Assemblywoman Crystal Peoples Stokes, (a graduate of ISEP Schools Harriett Ross Tubman School 31 and Bennett High), Stephanie Wheeler, special education teacher from The Parent Network of WNY, Raj Rajnarayanan, Assistant Professor, Pharmacology and Toxicology, University at Buffalo and Maria Marti, ISEP Parent Advocate.

- **The ISEP Student Science Summit, March14, 2015:**

The purpose of the ISEP Science Summit was to provide an opportunity for parents to see how ISEP was being implemented and to showcase ISEP teachers and students research**.** The event provide an excellent opportunity for parents, teachers, doctoral students, BPS students, BPS administrators and other communality members to take pride in and acknowledge the immense amount work and effort the BPS teachers, UB graduate students and BPS students had dedicated to implementation and presentation of inquiry based science.

Building on the success of last year's Summit, this year's Summit included more student participation and in some instances two teams from a school. A judging rubric was created by the ISEP doctoral students, as well as the addition of a poster presentation as part of the competition. Table 1.4 shows that each of the 12 ISEP schools had teams that participated in the Summit competition. The Summit culminated in an awards ceremony where one middle school and one high school were awarded first place trophies. All the students who participated where awarded certificates of recognition for their participation.

This event was conceived by the ISEP parent based PLC and implemented by the ISEP doctoral students, ISEP teachers and ISEP students from all of the 12 ISEP participating schools. The event was hosted by ISEP core partner, The Buffalo Museum of Science and sponsored by corporate partner, Praxair. Our Science Summit judges included Dr. Clark Greene, Buffalo State College, Dr. Kathleen Falconer, Buffalo State College, Dr. Norma Nowak, University at Buffalo, Dr. Mwita Phelps, corporate partner, Life Technologies and Dr. Larry

Table 1.4 ISEP Student Science Summit

School	Teacher/s	Graduate / Undergraduate Students	Presentation Description
Bennett High School #200	Gina O'Kussick	**Peter Bloomingdale** (PhD Student)	**Team 1:** Predicting the Biological Effect of Drinking Carbamazepine Contaminated Water
Burgard Vocational High School #301	Sarah Kzsanak Bruce Allen	**Katherine Niessen** (PhD Student)	**Team 1:** They Live Among Us: An Introduction to Microbiology
Charles Drew Science Magnet #59	Stephanie Finn Robin Foster	**Robin Foster** (PhD Student)	**Team 1:** Spaghetti Spans: Building Bridges to Learn about Engineering
East High School # 307	Patrick McQuaid Jill Roach	**Amy Zielinski** (PhD Student) **Leslie Rosner** (PhD Student)	**Team 1:** Effect of vitamin D on cancer cell growth
Harriet Ross Tubman Academy # 31	Steven Indalecio	**Jonathan Pleban** (PhD Student) **Antara Majumdar** (UG) **Sushmita Gelda** (UG)	**Team 1:** Science Literacy in a Global Context **Team 2:** Variables with Fast Plants
Hutchinson Central Technical HS #304	Jill Jakubowicz	**Suyog Pol** (PhD Student)	**Team 1:** PCR techniques applied in water pathogen enterococcus detection.
Lorraine Academy #72	Reva Gilbert	**Michael Gross** (PhD Student)	**Team1:** Introduction to Cancer Biology
MST Preparatory School at Seneca #197	Michelle Zimmerman Tammy Schwab	**Heather Rudolph** (PhD Student)	**Team 1:** Growing Biofilms **Team2:** Electroplating of Silver and Copper
Native American Magnet (NAMS) #19	Heather Gerber Bonnie General-Vazquez	**Angelina Montes** (PhD Student)	**Team 1:** Analyzing the Heart with EKG: A Comparison of EKG Responses Before and Post-exercise
Riverside Institute of Technology HS #205	Rich Nagler Art Wager Anne Kokolus Amber Glaude Karl Wagner	**Josh Wallace** (PhD Student)	**Team 1:** Vital Signs of the Cardiovascular System **Team 2:** Tools for Assessing Residential Water Quality in Buffalo, NY
Southside Elementary #93	Susan Wade Noah Poczciwinski Carlo Casolini Sarah Gallien	**Michael Stanley Gallisdorfer** (PhD Student)	**Team 1:** Cracking the Code-Computer Science Programming and Robotics at Southside
South Park HS #206	Ann Mychajliw Kathleen Marren Tonya Lewis Dan Hildreth	**Tonya Lewis** (PhD Student)	**Team 1:** Mapping Bird box data using mobile GIS applications at Tifft Nature Preserve **Team 2:** Graphene Oxide Nanostructures for filtration of Copper and Chromium ions from Aqueous systems

Megan, corporate partner, Praxair. There were approximately 300 attendees at the summit including: ISEP parents, grandparents and siblings; Buffalo Pubic School Administrators, ISEP building principals and New York State Assembly member, Crystal Peoples-Stokes. This was truly a collaborative community based event. Additionally, we invited summer program providers to the Summit to inform parents and students about potential summer STEM based opportunities for ISEP students.

d. Outcomes from 2014-2015 PLC's

Parent/Guardian Based- focusing on to how actively partner with your child to keep he/she engaged with ISEP. Additionally, collaborating with BPS teachers, UB/BSC STEM faculty and UB doctoral students on programming designed to help parents understand what interdisciplinary science is and how it will impact their children's educational and future career opportunities. This community meets monthly. The continued growth of the parent PLC has resulted in the formation of a parent executive committee consisting of one representative from each of the 12 ISEP schools. This core group will meet monthly and be responsible for disseminating information to the larger ISEP parent group. We will continue to hold large events where all parents are invited to participate including the annual Parent Retreat, the STEM Social Justice Conference and the ISEP Student Science Summit.

Doctoral, Master and Undergraduate Intern Based- focusing on sharing best practices, collaboration between middle and high schools, creating collaborative learning opportunities for middle and high school students to collaborate on projects and programs that focus on the transition from middle to high school. This community meets monthly.

Coordinating Teacher – focusing on teachers serving in a leadership capacity. The ISEP Coordinating Teaches serves as the ISEP representative in each of the 12 school buildings. They are responsible for disseminating information to colleagues and to the school building leadership about ongoing ISEP programs, projects, and opportunities for teachers and students this community meets monthly

Building Principal- This consists of all of the 12 principals from each of the ISEP school buildings. The principal group's focus is to share best practices, determine ways to maximize and leverage ISEP resources and opportunities for teachers and students, and to collaborate on ISEP projects including the SUNY BPS STEM Experience. This community meets twice a year, fall and spring.

Table 1.5: Overview of Professional Learning Communities 2014-2015

PLCs and Participants	Responsibilities	Issue/Concerns	Outcomes
• Participating BPS teachers in summer research PD • School based STEM PhD. Students schools • STEM faculty • BPS Parents • BPS Building Principals	Meet monthly to exchange ideas, best practices, pedagogical approaches, student engagement, and parent involvement and create and implement programmatic opportunities for students.	Parent access to technology Parents access to transportation	• Initial PLC's were created and implemented • PLC's created opportunities for teachers within school buildings to work together in groups and as a team for upcoming summer 2015 research • STEM Ph.D. students created collaborative opportunities between middle and high school teachers and students • Parent PLC created opportunities for parents to collaborate with BPS teachers, STEM Ph.D. students, STEM faculty, research, corporate and community partners through the creation of the ISEP STEM Social Justice Conference and the ISEP Student Science Summit. • Principal PLC met in June 2015, will meet in fall of 2015.

e. Major Accomplishments

The ongoing development of PLC's representing teachers in specific interdisciplinary research areas will be reestablished again over the summer of 2015 and continue on into the 2015-16 school year.

As a result of parent input, programmatic opportunities were created and implemented during the 2014-2015 school year including:

- Opportunities for parents and students to attend STEM conferences and events.
- Parent involvement and participation in school based and field trip activities with students and teachers.

As a result of input from parents, STEM Ph.D. and undergraduate students, the Science Summit continues to evolve into a highly competitive research opportunity for ISEP students.

As a result of input from BPS teachers, several PLC programmatic opportunities will continue to be developed including:

- More support from STEM faculty and doctoral students with implementation of summer research.
- More collaboration between colleagues' in school building and across the 12 ISEP participating schools.
- More opportunities to co-present with STEM faculty at conferences.
- More opportunities to collaborate with corporate/research partners throughout school year.

The PLC model will incorporate to a greater degree, the use of social media and other digital/virtual platforms as a means of sharing best practices, resources and information among the various professional learning communities.

7. Research Report

The research team consists of Dr. Xiufeng Liu (co-PI), Michelle Eades-Baird, Sara Chudyk, and Yang Yang (doctoral student research assistants). We continued the studies from previous year on teachers' pedagogical content knowledge development on interdisciplinary science inquiry (ISI) and STEM students' development of science communication skills; we also developed two new research areas: one on science teachers' integration of Common Core State Standards English Language and Literacy strategies into ISI, and another on how disciplinary science content background may impact science teachers' development of ISI PCK. The following products have been resulted in:

Published and submitted papers from ISEP Research

A. Conference Presentations:

i. Eades-Baird, Liu, X., & Chowdhary, B. (April, 2015). *Urban Science Teachers' Beliefs, Perceptions and Implementation of CCSS for ELA/Literacy within Interdisciplinary Science Inquiry*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Chicago.

ii. Smith, E., & Liu, X. (April, 2015). *The Impact of Science Teachers' Orientations on their Understanding and Implementation of Interdisciplinary Science Inquiry*). Paper presented at the annual meeting of the National Association for Research in Science Teaching, Chicago.

B. Publication

Chowdhary, B., Liu, X., Yerrick, R., Smith, E., & Grant, B. (2014). Examining science teachers' development of interdisciplinary science inquiry pedagogical knowledge and practices. *Journal of Science Teacher Education, 25*(8), 865-884.

C. Completed Dissertations

i. Chowdhary, B. (May, 2015). *Reflective pedagogical practices in an era of standards based reform: What do teachers do? An examination of science teachers' communities and their contribution to the facilitation of professional growth through authentic reflection*. Unpublished Doctoral of Philosophy dissertation, University at Buffalo.

ii. Eades-Baird, M. (May, 2015). *Exploring urban science teachers' beliefs, perceptions and implementation of common core state standards for ELA within the context of interdisciplinary science inquiry: A mixed methods study*. Unpublished Doctoral of Philosophy dissertation, University at Buffalo.

iii. Grant, B. (May, 2014). *Building capacity within a school-university partnership: An exploration into the perspectives, experiences, and approaches of various stakeholders*. Unpublished Doctoral of Philosophy dissertation, University at Buffalo.

iv. Smith, E. (Aug., 2014). *The development of in-service science teachers' pedagogical content knowledge related to interdisciplinary science inquiry*. Unpublished Doctoral of Philosophy dissertation, University at Buffalo.

D. Submission in Progress

One article on science teachers' development of PCK on ISI will be submitted to *Journal of Research in Science Teaching* and another article on science teachers' integration of literacy strategies in ISI will be submitted to *Science Education*.

E. Previous papers

i. Grant, B., Liu, X., & Gardella, J. "Supporting the Development of Science Communication Skills in STEM University Students: Understanding Their Learning Experiences as They Work in Middle and High School classrooms". International Journal of Science Education - Part B, 2013, http://dx.doi.org/10.1080/21548455.2013.872313.

ii. Grant, B., Liu, X., Yerrick, R., Smith, E., Nargund-Joshi, V., & Chowdhary, B. (in review). STEM Students as Facilitators of Interdisciplinary Science Inquiry Teaching and Learning. School Science and Mathematics. (Presented at the 2013 annual meeting of the NARST - A Worldwide Association for Promoting Science Teaching and Learning through Research, Río Grande, Puerto Rico.)

iii. Chowhary, B., Liu, X., Yerrick, R., Grant, B., Nargund-Joshi, V., & Smith, E. (in review). Examining Science Teachers' Development of Interdisciplinary Science Inquiry Pedagogical Knowledge and Practices. Journal of Science Teacher Education. (Presented at the 2013 annual meeting of the NARST - A Worldwide Association for Promoting Science Teaching and Learning through Research, Río Grande, Puerto Rico.)

iv. Nargund-Joshi, V., Liu, X., Grant, B., Chowdhary, B., & Smith, E. (in review). Understanding Meanings of Interdisciplinary Science Inquiry in an Era of Next Generation Science Standards. Journal of Curriculum Studies. (Presented at the 2013 annual meeting of the NARST - A Worldwide Association for Promoting Science Teaching and Learning through Research, Río Grande, Puerto Rico.)

v. Nargund-Joshi, V., Liu, X., Chowdhary, B., Smith, E., & Grant, B. (in review). Understanding In-service Teachers' Orientation towards Interdisciplinary Science Inquiry. Journal of Research in Science Teaching. (Presented at the 2013 annual meeting of the NARST - A Worldwide Association for Promoting Science Teaching and Learning through Research, Río Grande, Puerto Rico.)

vi. Smith, E., Liu, X., Yerrick, R., Chowdhary, B., Grant, B, & Nargund-Joshi, V. (in review). The Development of Interdisciplinary Science Inquiry Curriculum Knowledge. Science Education. (Presented at the 2013 annual meeting of the NARST - A Worldwide Association for Promoting Science Teaching and Learning through Research, Río Grande, Puerto Rico.)

The next section describes major research activities we implemented from June 1 2014 through May 31 2015 and major findings we have obtained so far.

7.1 Activities

7.1.1 Pedagogical Workshops

Beginning in November, monthly pedagogical professional development workshops relating to several aspects of Interdisciplinary Science Inquiry were led by the ISEP research team. The foci of these PD workshop sessions included: (1) ISI Framework; (2) School-wide implementation of ISI; (3) Common Core State Standards for ELA/Literacy; (4) Engineering Design Within ISI; and (5) Teachers' Classroom Implementation of ISI. The workshops' activities highlighted the teachers' interests in aspects relating to ISI. The sessions provided support for the teachers' implementation of their summer research into their classroom practice. Table 1.6 lists the month, foci, activities and teacher attendance of each of the monthly pedagogical workshops.

Table 1.6 Monthly Pedagogical Workshops

Month	Focus	Major Activities	# of Attendees
November 12	ISI Framework	(1) Review of the ISEP ISI Framework (2) Investigation Activity (3) Group Sharing on Activity (4) Group Activity: Creation of a Best Practices in Implementing ISI Poster (5) Sharing: Gallery Walk (6) Debriefing and Session Evaluation	14

December 10	School-wide ISI Implementation	(1) Teacher Lesson Sharing (2) Progression Report: School-wide Implementation of ISI (3) Group activity: Creation of Poster on Best Practices in School-wide ISI Implementation (4) Sharing: Gallery Walk (5) ISEP Research Team Presentation: Resources for School-Wide Implementation (6) Debriefing and Session Evaluation	17
January 14	Common Core State Standards (CCSS) for ELA/Literacy Within ISI	(1) Teacher Lesson Sharing (2) ISEP Research Team Presentation on CCSS for ELA/Literacy within ISI (3) Teacher Presentations: ESL vocabulary strategies and literature in the science classroom. (4) Group activity: Creation of a Poster on Best Practices in Implementing CCSS for ELA/Literacy within ISI. (5) Sharing: Gallery Walk. (6) Debriefing and Session Evaluation.	15
February 11	Engineering Design in ISI	(1) Teacher Lesson Sharing (2) ISEP Research Team Presentation: Review of Engineering Design and ISI Framework (3) Teacher Presentation: Incorporating Engineering Design into the Science Classroom (4) Group Activity: Best Practices In Implementing Engineering Design (5) Sharing: Gallery Walk. (6) Debriefing and Session Evaluation.	9
March 11	Cancelled due to Student Science Summit on 3/14/15		
April 8	Cancelled due to STEM Week activities at participating schools		
May 13	Teachers' Classroom Implementation of ISIS	(1) Teachers created and presented posters that highlighted their implementation of ISI during the school year.	40

7.1.2: Research on Teachers' Development of ISI Pedagogical Content Knowledge

7.1.2a Pedagogical Content Knowledge Test

In May 2014, a survey was administered to the participating ISEP teachers as a post-test and in July 2014 a same survey was given to new ISEP teachers as a pre-test. This survey was comprised of three parts: demographics information, standardized assessment of the teacher's knowledge of their practice (i.e., PCK) and subject matter, and an assessment of ISI, both knowledge and practice.

The PCK and CK assessments were in chemistry, biology, earth science, physics, middle school science, and elementary school science. The chemistry PCK assessment assessed teachers' knowledge of teaching properties and changes in matter. It was developed by the Assessing the Impact of the MSPs: K-8 Science (AIM) project at Horizon Research, Inc., funded by the National Science Foundation. The biology PCK assessment measured teachers' understanding of the flow of matter and energy for teaching. The earth science PCK assessment measured earth science teachers' understanding of plate tectonics for teaching. The physics PCK assessment tool measured physics and engineering teachers' understanding of force and motion for teaching. The biology, earth science, and physics PCK assessment tools were developed by the Assessing Teacher Learning About Science Teaching (ATLAST) project at Horizon Research, Inc. The middle school science assessment consisted of items from POSTT "Thinking About Science Teaching" (Schuster & Cobern, n.d.) that related to teaching science to grades 5 through 8. The elementary school science PCK assessment consisted of items from POSTT "Thinking About Science Teaching" (Schuster & Cobern, n.d.) that related to teaching science to grades K through 4.

7.1.2b Development of ISI Pedagogical Content Knowledge

The focus of this research was to understand the processes and conditions in which science teachers develop interdisciplinary science inquiry knowledge (ISI) and how that is translated into their pedagogical content knowledge (PCK). Within the framework of PCK in science, this study explored (1) the extent to which the involvement of in-service science teachers in authentic research experiences impacts their PCK of interdisciplinary science inquiry, and (2) the factors that contribute to or constrain the development of interdisciplinary science inquiry PCK.

This research study utilized a mixed methods, explanatory research design to explore the relationships between change in science teachers' PCK and the factors that have impacted that change, or lack thereof. To understand this complex process, both qualitative and quantitative data were collected. Qualitative data collection occurred through observations, interviews, and the analysis of physical artifacts. Quantitative data were collected through a PCK assessment that the participating teachers completed during year 2 of the project. Qualitative data was analyzed using grounded theory. The process of systematic analysis was used to develop plausible relationships between the different factors involved in teacher change in the hope to generate a framework for teacher PD that is applicable to the adoption and implementation of ISI. The PCK scores obtained through the quantitative PCK assessment were analyzed using descriptive statistical analysis. Teachers' PCK scores were related to the qualitative data on their beliefs and perceptions of ISI and their classroom practices.

7.1.3: Research on Teachers' Beliefs and Practices of Incorporating Literacy Practices into ISI Teaching

The main goal of this research study was to gain a better understanding of teacher beliefs regarding the incorporation of literacy skills as described in the Common Core State Standards (CCSS) for ELA within the context of interdisciplinary science inquiry (ISI). This study sought to investigate the following research questions: (1) how do science teachers demonstrate knowledge and values of CCSS for ELA curricula when they conduct ISI? and (2) what relationship, if any, exists between teacher beliefs and perceptions of the CCSS for ELA and its implementation in the science classroom? This research study utilizes a mixed-methods approach to data collection and analysis and is divided into two phases of data collection. During Phase 1 of this research study (Fall 2013 – Early Spring 2014), qualitative data were collected via semi-structured teacher interviews, classroom lesson observations and artifacts, teacher lesson plans and teacher implementation posters and presentations. During Phase 2, (Late Spring 2014 – Spring 2015) qualitative and quantitative data was collected via teacher interviews, classroom observations and a Summer 2014 survey that elicited specific information about teachers' beliefs, perceived values and levels of confidence and knowledge in implementing CCSS for ELA within their science instruction. The survey data was analyzed using descriptive statistical analysis and triangulated with the teachers' interview responses and classroom practices. The data gathered during Phase 2 of the study provided additional insight to possible patterns and relationships that exist between literacy implementation with the teachers' instruction and their beliefs, perceptions and values of literacy skills within the context of ISI.

7.1.4. Research on implementation of Interdisciplinary Science Inquiry by Biology Teachers Compared to Teachers in the Physical Sciences of Earth Science, Chemistry, and Physics

Due to the call to teach modern biology as interdisciplinary and the struggles that biology teachers have in particular to implement interdisciplinary science teaching, the following research questions have been developed:

(1) How does the summer research experience and participation in the monthly project support during the academic year impact the implementation of interdisciplinary science inquiry by biology teachers compared to teachers in the physical sciences of earth science, chemistry, and physics?
(2) How does teacher subject content knowledge and interdisciplinary science knowledge relate to with the implementation of interdisciplinary science inquiry by biology teachers compared to teachers in the physical sciences of earth science, chemistry, and physics?
(3) What challenges do biology teachers encounter in implementing interdisciplinary science inquiry compared to teachers in the physical sciences of earth science, chemistry, and physics?

This study utilized a qualitative approach to explore the implementation of interdisciplinary science inquiry (ISI) among biology teachers compared to earth science, chemistry, and physics teachers. Qualitative data on teacher subject content knowledge and interdisciplinary science pedagogical content knowledge were used to determine if there is a relationship with the implementation of ISI by biology teachers as compared to earth science, chemistry, and physics teachers. Qualitative data was collected in the forms of observations and interviews. Observations of teachers' summer research experiences and classroom lessons were used to determine the amount of implementation of ISI in the science classroom of biology teachers compared to earth science, chemistry, and physics teachers. Interviews were conducted to determine the challenges that biology teachers encounter in implementing ISI compared to earth science, chemistry, and physics teachers.

7.1.5: Research on STEM students' Science Communication Skills

a. Survey

The questionnaire, *Survey of UB STEM Students*, we developed during the first year of the ISEP project, was given to STEM graduate students working for the ISEP project in Dec. 2014, and again in May 2015.

b. Log sheet

All doctoral STEM students completed an online weekly log on their activities engaged in schools during the week in both the fall and spring semesters.

c. School observations

Selected STEM students' activities in schools were also observed during the fall and spring semesters.

7.2. Findings

7.2.1a Results of Pedagogical Content Knowledge Posttest

The results of the standardized assessments (section 2 of survey) in both pre- (July 2013) and posttest (May 2014) are provided in Table 1.7.

Table 1.7

Results of PCK pre- and post assessments

Assessment	N		Total Score	Mean (S.D.)		Range	
	Pre	Post		Pre	Post	Pre	Post
1. Biology (ATLAST Flow of Matter and Energy)	27	16	29	17.7 (6.3)	19.6 (7.1)	7-28	5-29
2. Earth Science (ATLAST Plate Tectonics)	6	6	29	22.2 (1.7)	18.8 (4.8)	19-24	10-23
3. Chemistry (AIM Properties of and Change in Matter)	4	2	30	25.3 (4.2)	27.0 (1.4)	19-28	26-28
4. Physics/Engineering (ATLAST Force and Motion)	8	6	29	19.4 (7.6)	25.2 (3.1)	8-29	17-29
5. Middle School Science (POSTT Assessment of PCK of Inquiry Science Instruction)	13	11	8	3.5 (1.5)	2.9 (1.5)	2-7	0-5
6. Elementary School Science (POSTT Assessment of PCK of Inquiry Science Instruction)	11	6	8	3.5 (1.6)	2.0 (0.9)	1-5	1-3

Paired sample t-tests showed that there was no statistically significant difference between students' pre-test scores and post-test scores on any of the above tests.

7.2.1b Results of pre-test for new teachers in July of 2014

The results of the standardized assessments (section 2 of survey) in second round pre-test (July 2014) for new ISEP teachers are provided in Table 1.8.

Table 1.8
Results of PCK pre-assessment in July 2014

Assessment	N	Total Score	Mean (S.D.)	Range
1. Biology (ATLAST Flow of Matter and Energy)	5	29	17.6 (8.3)	7-27
2. Earth Science (ATLAST Plate Tectonics)	1	30	20 (0.0)	20-20
3. Chemistry (AIM Properties of and Change in Matter)	4	30	23.0 (6.8)	13-28
4. Physics (ATLAST Force and Motion)	3	29	14.3 (6.7)	10-22
5. Middle School Science (POSTT Assessment of PCK of Inquiry Science Instruction)	17	8	3.6 (1.8)	0-6

7.2.1b Development of ISI Pedagogical Content Knowledge – A Grounded Theory

Qualitative results on teachers' development of ISI pedagogical content knowledge were reported in last year's annual report. Based on the findings reported in last year's annual report (for the full study, please refer to Erica Smith's dissertation indicated at the beginning of this section), a grounded theory was developed. Figure 5.1 illustrates the grounded theory, a revised ISEP conceptual framework to the original one included in the proposal on relationship between the professional development model of STIS and the development of in-service science teachers' ISI PCK. This framework proposes a theory for the varying levels of development and implementation in ISI teaching that occurred among ISEP teachers.

Figure 1.2 begins with the core features of the ISEP's professional development model. In comparison to the original conceptual framework, while the summer research experience remained a central component, the student aspects of the framework (i.e. student summer research and mentored afterschool science) were removed and the supporting inquiry aspect was divided into the two programs designed to aid in this process. The two programs included the professional learning communities and the placement of STEM graduate and undergraduate students in the teachers' classrooms.

The remaining aspects of the model serve to clarify the processes involved in translating the ISEP PD experiences into enhanced teacher understanding and implementation of inquiry and inquiry teaching. These aspects are subdivided into three categories: filters, actions, and outcomes.

Filters. The two filters identified were (1) the teachers' beliefs about and background in science and science education and (2) the contextual factors, both contributing and constraining, as perceived by the participating teachers. The initial filter relates to Desimone's (2009) two perspectives of coherence. The pre-existing beliefs held by the teachers or lenses with which they viewed inquiry teaching, their students' abilities, their own abilities, and the structure of courses they taught influenced the level of coherence between the opportunities provided by the project and the teachers' subsequent involvement in all aspects of the project. The second filter had a direct impact on the level or type of implementation that the teachers chose. The placement of this particular filter within the model serves to explain why even though some of the participating teachers, particularly those identified as "wobblers", developed a better understanding of interdisciplinary science inquiry, as defined by the project, did not significantly change their classroom practices.

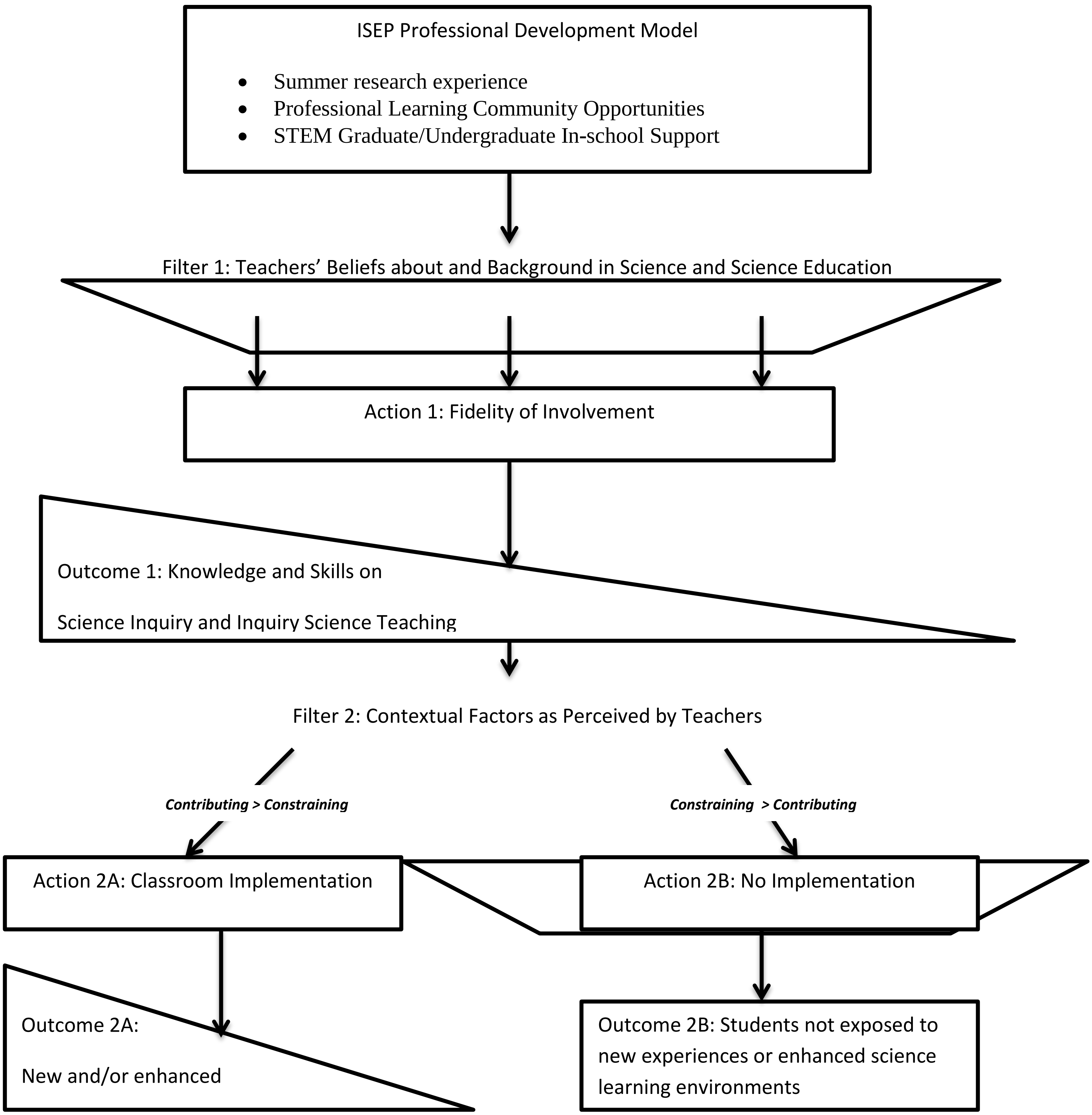

Figure 1.2. Revised ISEP Conceptual Framework – A Grounded Theory

Actions. The two action components of the model relate to the observed enactment of the teachers' understanding of ISI and their summer experiences within their classrooms and their participation throughout each core feature. As the model indicates the filters influenced both actions. These actions, (1) fidelity of involvement and (2) classroom implementation, are adaptations of the construct of fidelity of implementation (FoI). In a review of studies examining the relationship between fidelity of implementation in K-12 curriculum interventions and outcomes, O'Donnell (2008) provided an overview for how this term is defined within K-12 education studies. The definition that best matched both action components of the model was based off of a cross-case analysis study done by Loucks. Loucks' study defined fidelity of implementation as "the extent to which teachers enact innovations in ways that either follow designers' intentions or replicate practices developed elsewhere, or the extent to which the users' current practice matched the developer's 'ideal'" (O'Donnell, 2008, p. 39). In referencing Loucks again, O'Donnell explained this further by stating that FoI could be related to the change that occurred in a teacher's practice (p. 39).

Within the first action, implementation was changed to involvement to encompass how the teachers made use of the three aspects of the ISEP professional development opportunity. Examination of the summer log sheets, PLC attendance records, and the teachers' own acknowledgement of how they interacted with the STEM students indicated that for each of these three aspects of the project there was unequal and often very drastic, particularly in the case of the PLC attendance, enactment of the original intention of the STIS project.

The classroom implementation action was separated into two subcomponents to account for whether or not implementation occurred. As the model indicates when the teachers perceived that the constraining factors were greater than those contributing to implementation, they chose to not implement any aspects of their summer experience. This lack of implementation was identified within the pilot study during the second year of the project and continued for some into the third year as well. This was evidenced in the statements that the teachers made in the interviews, such as "I'm not using anything from the summer because ..." or in the disregard of requests to observe classroom lessons that exemplified aspects of ISI and/or their summer experiences or in the allowed classroom observations where a traditional didactic style of teaching remained dominant. Of those who implemented, the level with which the implementation matched the four aspects of ISI was dependent not only on how much greater the contributing factors exceeded the constraining factors, but also on the first filter identified in the model. Additionally, even though the participating teachers made use of the resources provided for them, classroom implementation of these new materials did not coincide with evidence of a developing PCK. As was often the case, these new resources were modified and implemented in a way that fell into alignment with the teachers' preexisting PCK.

Outcomes. The outcome aspects of the revised model are adaptations of the final two aspects of the original STIS conceptual framework. In the original model, both of the outcomes, teacher knowledge and skills and student achievement, were identified as being improved. The shape of the outcome components in the revised model was used to symbolize that change in both aspects was scaled. The level with which teacher knowledge and skills improved was related to the individual teacher's fidelity of involvement, which in turn was influenced by their beliefs and background.

As mentioned previously, this study only examined the first progression in the original ISEP conceptual framework. Therefore, even though the revised model includes the final outcome of student experiences in science within the confines of this study it could not be determined whether or not there was measurable improvements in student achievement in science. However, this particular outcome was included to account for the utilization of resources by the participating teachers and the experiences provided to their students as a result of that implementation.

7.2.2: Teachers' Beliefs and Practices of Incorporating Literacy into ISI Teaching

The findings from this mixed methods data analysis of the two major foci of the research study can be summarized as the following:

(1) Science teacher beliefs related to science teaching have the greatest Influence on their implementation of the CCSS for ELA.
(2) Science teachers that utilize constructivist pedagogical practices, such as reformed-based teaching, are the most successful at implementing the full spectrum of the CCSS for ELA.
(3) Addressing implementation support during professional development is critical to the successful implementation of the CCSS for ELA and inquiry practices.

7.2.2a Science Teacher Beliefs Related to Science Teaching Have the Greatest Influence on Their Implementation of the CCSS for ELA

This study focused on investigating three major aspects of ISEP science teacher beliefs. These included teachers': (1) approaches, goals and beliefs related to science teaching; (2) perceptions, beliefs, values and self-efficacy related to the CCSS for ELA; and (3) understanding of ISI. After coding each of the 44 observed lessons for the specific CCSS for ELA student portraits and NGSS student practices, the possible relationships between implementation patterns and teachers' interview and survey responses were examined. It was determined that the teachers' beliefs related to the goals and purposes for science teaching was found to highly correlated to how they implemented the CCSS for ELA. Five teaching profiles were created based upon the distinct teacher implementation patterns: "ELA-centered", "In-the-middle", "Exam-focused", "Reformed-based" and "Engineering design". The names given to each of the teaching profiles were based upon teacher implementation patterns, attributes of the teachers' science teaching approaches and the themes that were included in the teachers' descriptions of their goals and purposes for science teaching (see Table 1.9).

ELA-centered. The members of the ELA-centered teaching profile, Danielle and Graham, described their approaches to science teaching as containing elements of literacy and engaging students through their curiosity and using hands-on approaches. Their implementation patterns reflect their approaches by focusing on ELA strategies such as vocabulary mastery and writing. When observing their classroom practices, it was noted that their students were experiencing science through literacy strategies with a focus on science content, but not on the science processes (e.g., problem-based learning, inquiry) or skills (e.g., measuring, observing, analyzing, interpreting).

In-the-middle. Simon, the lone member of the In-the-middle profile, said that he approached science learning from a blending of literacy and science. Although he spent half of his class time on reading comprehension skills of a science text and the other half having his students doing hands-on science, the science students were not experiencing them at the same time. One half of Simon's class participated in a close-read which was highly scaffolded while the other half looked at microscope slides and drew the specimens on a piece

Table 1.9

Teachers' Beliefs About Science Teaching, the CCSS for ELA and ISI and Their Relationship to Classroom Implementation.

Teaching Profile	Teacher Name	Approaches, Goals & Beliefs Related to Science Teaching	Perceptions, Beliefs, Values & Self-efficacy related to the CCSS for ELA	Understanding of ISI	Observed implementation of CCSS for ELA and ISI
ELA-centered	Danielle	Exploring science interactively; hands-on; resources at various reading levels.	Sets broad student learning goals for career and college readiness; high value; literacy is benefit to students, CCSS for ELA is not; "very prepared".	"Hands-on", student engagement and problem-solving.	Heavy science vocabulary focus; no inquiry – teacher-centered science instruction
	Graham	Engaging students' curiosity; using ELA strategies to teach ESL students.	Sets increased expectations for students' reading and vocabulary; high value as literacy is key to success; benefit to students; "very confident".	Inquiry, "multiple points of view" and multi-disciplinary approach.	Heavy science vocabulary and reading focus; no inquiry – teacher-centered science instruction
In-the-middle	Simon	Interweave science and literacy; relationship building with students; develop problem-solving skills; exam preparation.	Focuses on reading and writing -"nothing new"; "no difference" from what already doing; not benefitting students; "adequate" and "need more training".	Interdisciplinary, problem-based learning and "real-world".	Focused 50% on reading; 50% on science – very low inquiry and highly scaffolded.
Exam-focused	Grace	Learning is infinite; collaboration; layer-cake approach to teaching: vocabulary, background then inquiry; external assessment preparation.	Focuses on reading and writing, following directions, writing research reports; high value on literacy, low on implementation of CCSS for ELA; literacy focus benefits students; "I don't feel fully prepared".	Multi-disciplinary and problem-based learning.	Some journal writing, answering questions on labs; low inquiry and highly scaffolded.
	Antonio	"Pass the Regents Exam"; independent thinking & problem solving; approach involves breaking down information for students.	Focuses on reading and writing, following directions and deciphering questions; neutral value; benefit in passing assessments; "greater confidence, less anxiety after professional development"	Multi-disciplinary between teachers.	Direct instruction of science concepts; low inquiry and highly scaffolded.
	Joy	Pass the Regents Exam; "explicit instruction" approach first, "inquiry" later.	Focuses on reading and vocabulary; high value; benefit to students; high confidence.	Student-centered, interdisciplinary and problem-based learning.	Direct instruction of science concepts and teacher-centered; low inquiry and highly scaffolded.
	Juan	All Regents Earth Science concepts; hands-on; improve students' science knowledge	Focuses on reading and writing; high value; benefit to students; high confidence.	Inquiry, student-centered, and cross-disciplinary.	Direct instruction of science concepts and teacher-centered; low inquiry and highly scaffolded.
	Andrew	Critical thinking skills; students build their own knowledge; Regents Exam preparation	Focuses on reading and writing & vocabulary; high value – literacy key to success; benefit to students; "I am reluctant".	Interdisciplinary and "real-world".	Direct instruction of science concepts and teacher-centered; low science inquiry and highly scaffolded.
Reform-based	Bryce	Science skills; "science is a fluid body of knowledge"; students learn 21st century skills	Focuses on reading and "non-traditional literacy" skills such as graphs, formulas and charts; high value, benefit to students; "I don't feel confident at all".	Hands-on, interdisciplinary and student-centered.	Student-centered, student-driven; high science inquiry – low scaffolding.
Engineering design	Hugh	Hands-on; students learn though "success and failure"; "application of science" – how to "design and fix things"	Focuses on making cross-curricular connections; high value; benefit for students' future careers; "As prepared as I could be".	Multidisciplinary between teachers and problem-based learning	Problem-based learning; collaboration between students to design solutions.

of paper. When students were observed doing science-related activities, they were observed to be very low on inquiry (other than following a written procedure to build Science Olympiad projects) and focused on science skills (e.g., observing, building models).

Exam-focused. The five teachers that belong to the Exam-focused profile, Grace, Andrew, Antonio, Joy and Juan, all mentioned that they were externally assessed and focused on exam preparation. The majority of their class time was spent on direct instruction of science content with a smaller amount of class time dedicated to students interacting with science materials. All of these teachers used confirmation and structured inquiry science lab activities. Four of the teachers, Andrew, Antonio, Joy and Juan, have a separate laboratory class period that meets two or three times a week that is separate from their daily science classes. These teachers tend to focus on teacher-directed activities that include direct instruction of science content during their daily classes and have students use science materials only during their separate science laboratory sessions, which are less frequent. Their implementation patterns demonstrate that these teachers within this profile have implemented some "add-on" strategies that focus on reading, writing and science vocabulary, but they do not implement any of the CCSS for ELA strategies that are part of the science inquiry process, located in the intersection of Cheuk's (2013) diagram (see Figure 1.3),.

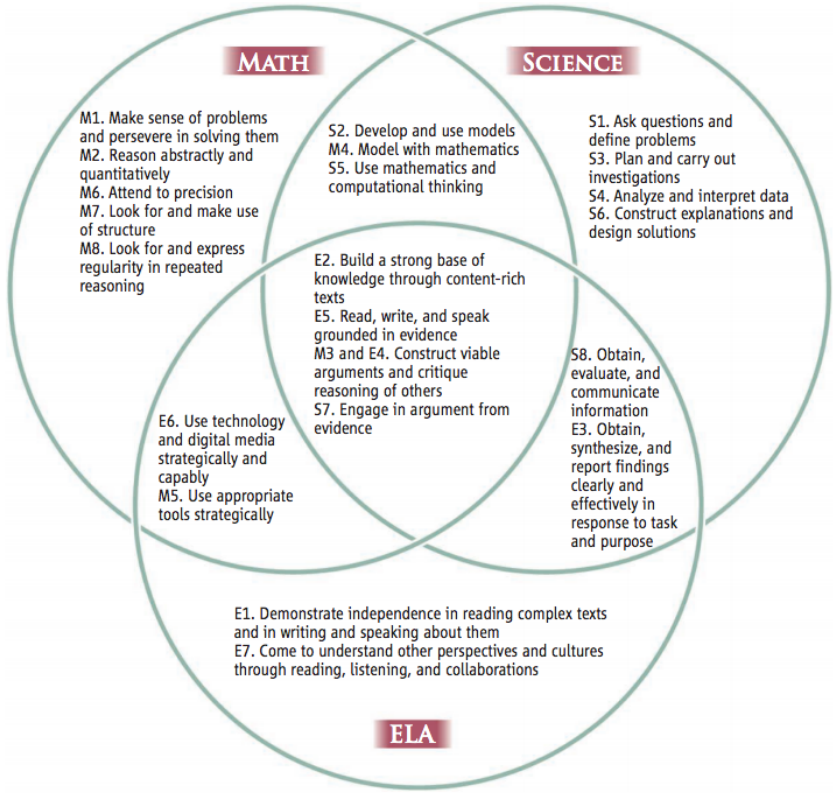

Figure 1.3. Overlap, Relationships and convergences found in the Common Core State Standards for Mathematics (practices), Common Core State Standards for ELA (student portraits), and the NGSS (science and engineering practices). Adapted from Cheuk (2013) and Stage, Asturias, Cheuk, Daro and Hampton (2013).

Reform-based. Bryce, the only member of the reform-based teacher profile, characterized his approach to science teaching as being focused on his students' learning of science skills and 21st century skills (e.g., critical thinking, collaborating, communicating, creating). His classroom practice reflects this and it is through these skills that his students experience the CCSS for ELA. Bryce's approach to science teaching can be described as "reform-based" as defined by the National Science Education Standards as teaching science using:

> collaborative groups and work to engage their students in explaining, clarifying, and justifying what they have learned. The teacher's role in these small and larger group interactions is to listen, encourage broad participation, and judge how to guide discussion – determine ideas to follow, ideas to question, information to provide, and connections to make. In the hands of a skilled teacher, such group work leads students to recognize the expertise that different members of the group add to the endeavor and the greater value of argument. (NRC, 1996, p. 36)

The analysis of Bryce's instruction reveals that his students participate in guided inquiry on a daily basis. As a part of guided inquiry, as well as a product of using a reform-based teaching approach, the students in Bryce's classroom spend their time presenting their findings from their science investigations and defending their conclusions using evidence from these investigations. When the observed lessons were coded and then plotted onto Cheuk's (2013) diagram, the vast majority of the CCSS for ELA and NGSS portraits and practices where met during every lesson. During his interview, Bryce mentioned that he was also incorporating more close reading strategies in addition to what he is doing already in his science classes, although close reading was not observed during any of his lessons.

Engineering design. Hugh, the teacher categorized in the Engineering design teaching profile, described his approach to science teaching as being hands-on and focused on students applying science. He said that his students learn by "success and failure" and hoped that his students would be able to apply what they learned in his CTE class to "design and fix things". His classroom observations focused on the engineering design process whereby students designed and built machines and structures. The coding of the observed lessons revealed that although Hugh's lessons incorporated several of the NGSS practices, they only included one of the CCSS for ELA portraits that attends to students using technology (in this case CAD software). Hugh's instructional style is considered problem-based but not inquiry-based in nature. Because his instruction is not inquiry-based, Hugh's lessons do not meet any of the Standards in the middle overlap area of Cheuk's (2013) diagram.

Examination of other variables. The other variables that were examined to better understand teachers' implementation patterns of the CCSS for ELA included: their understanding of ISI, their understanding of the goals of the CCSS for ELA, their values surrounding the CCSS for ELA and literacy in general, the benefits they felt that their student might gain by focusing on the CCSS for ELA, and their self-efficacy in implementing the CCSS for ELA. These variables were not shown to consistently influence the teachers' implementation of the Standards.

Understanding of ISI. There was no correlation found between teachers' ideas surrounding the concept of ISI and the amount of inquiry-based science nor the types of science activities present within their science lessons. Examining the Year 3 interview responses, it was found that the teachers included the following descriptors in their understandings of ISI: problem-based (50%), multidisciplinary (40%) cross-disciplinary (30%), student-centered (30%), interdisciplinary (20%), and real-world (20%). When compared with their observed teaching practices (see Table 12), no relationship was observed. For example, Hugh, Antonio, Grace and Graham all included the notion of a multi-disciplinary approach to implementing ISI. These teachers were observed to fall into three separate implementation profiles. In a separate example, Simon (In-the-middle) and Bryce (Reform-based) both described ISI as being interdisciplinary, but demonstrated very different implementation patterns. Thus, no consistent patterns were observed between teachers' understanding of ISI and their classroom implementation patterns.

CCSS for ELA. No connection between teachers' understanding of the focus of the CCSS for ELA was noticed for the teachers. The two teachers in the ELA-centered teacher profile group (Danielle and Graham) dedicated the majority of their class time on literacy strategies including close-reads and science vocabulary activities. However, during their interviews, only Graham mentioned vocabulary, reading and writing as being a goal of the CCSS for ELA. Danielle's responses included broad student learning goals such as career and college readiness.

***Values and benefits of the CCSS for ELA**.* During the Year 3 interviews, most teachers (80%) expressed high values when asked about the CCSS for ELA and only two teachers questioned its value (Simon and Antonio). The two teachers who had doubts about students benefitting from the CCSS for ELA (Simon and Juan) still placed a high value on students improving their literacy skills. Further probing during the interviews revealed that Simon and Juan placed this low value specifically on the *implementation* of the CCSS for ELA because they had not witnessed any changes in their students since its introduction. However, there were no patterns observed in their teaching that reflected these feelings: both Simon (In-the-middle) and Juan (Exam-focused) implemented literacy skills into their science teaching, but in different ways.

Self-efficacy. Self-efficacy was not found to be a determinant of the degree of CCSS for ELA implementation. Bryce (Reform-based), who conveyed the lowest amount of confidence, implemented the most CCSS for ELA portraits while Andrew (Exam-focused), who said he was reluctant to teach the Standards, implemented very few CCSS for ELA portraits. The teachers that expressed a high level of confidence with implementing the CCSS for ELA: Danielle (ELA-centered), Graham (ELA-centered), Juan (Exam-focused) and Joy (Exam-focused), implemented the Standards across a range of levels and in different ways. Personal agency beliefs (Ford, 1992) have been demonstrated to have a direct relationship to science teachers' implementation of inquiry-based instructional practices (Haney et al., 2002). This pattern was not observed during the current study.

Contextual factors. A relationship between contextual factors and the implementation of CCSS for ELA was noted within two of the teaching profiles: In-the-middle and Exam-focused. Six teachers belong to these teaching profiles; five (83.3%) of these teachers (Simon, Joy, Andrew, Antonio and Grace) mentioned "assessment", "Regents" or "Exam" when asked about challenges to implementing inquiry into their teaching practice. Three of these teachers cited "time" as the specific constraining factor to implementation as the curricula that were assessed by the exams were demanding and "set". Although the two teaching profiles are different, the one commonality between their classroom implementation patterns is that they are characterized by direct instruction and students' learning experiences are highly scaffolded by the teacher. This finding is consistent with past research on the influence of contextual factors, in particular the influence of assessments on teaching practices (Ajzen, 2002; Ernest, 1988; Lave, 1993; Lederman, 1992; Mansour, 2009; Maxion, 1996).

Conclusion. The relationship between teacher beliefs and instructional practices should not be looked upon as a causative relationship. The findings from this study suggest that there is a strong relationship between the teachers' beliefs and orientations about science teaching and their science teaching practice, in particular their incorporation of inquiry though reform-based teaching practices. It may be possible that the science teachers' practice is influenced by their beliefs, the science teachers' practices influence their beliefs, or that science teachers' beliefs and practices coexist and may reinforce each other. Utilizing Nargund-Joshi and Liu's (2013) orientation continuum, it lends perspective to how teachers' orientations to science teaching impact their teaching practice. As teachers move towards Inquiry and ISI orientations, they are incorporating more CCSS for ELA portraits through the inquiry process. The teachers in this study who fell into the Exam-focused teaching profile also meet the description of Nargund-Joshi and Liu's (2013) Traditional Orientation. These teachers focus on direct instruction and memorization of factual knowledge. When incorporating literacy strategies, they were used as a vehicle for memorization of science vocabulary words but these vocabulary activities are not contextualized within the inquiry process. The two teachers who were categorized as ELA-centered incorporated more of the CCSS for ELA portraits than the Exam-focused teachers. These teachers fit Nargund-Joshi and Liu's (2013) Activity teacher orientation. The teachers taught science through demonstration and skills-based labs, but not through inquiry. The In-the-Middle teaching profile is a bit difficult to define using Nargund-Joshi and Liu's framework as it contains elements of several orientations: Traditional, Activity, Inquiry and ISI. The Reform-based and Engineering Design teaching profiles contain elements of both the Inquiry and ISI teacher orientations. The Engineering design profile is more reminiscent of Magnusson et al.'s (1999) Project-based teaching orientation that also contains elements of inquiry and ISI. Nargund-Joshi and Liu's orientations include Project-based under their Inquiry orientation. There is also an aspect of interdisciplinarity within Hugh's engineering class as it connects to physics, math and ELA. According to Nargund-Joshi and Liu's (2013) model, Bryce's classroom instruction in the Reform-based teaching profile would fall into both the ISI and Inquiry orientations because he focused on developing students' understanding of core science concepts along with science and engineering concepts. He guided his students learning of science concepts and skills through the use of open-inquiry teaching strategies. Due to his daily incorporation of inquiry strategies, Bryce consistently incorporated the vast majority of the CCSS for ELA portraits. In summary, as teachers move along Nargund-Joshi and Liu's continuum of teacher orientations from Traditional to ISI, they incorporate an increased number of the CCSS for ELA portraits.

7.2.2b Science Teachers that Utilize Constructivist Pedagogical Practices, Such as Reformed-based Teaching, are the Most Successful at Implementing the Full Spectrum of the CCSS for ELA

Inquiry and the CCSS for ELA. According to the National Science Educational Standards (NSES),

> Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating results. Inquiry requires identifications of assumptions, use of critical and logical thinking, and consideration of alternative explanations. (NRC, 1996, p.23)

The NRC felt that inquiry was so important that they created an addendum to the NSES, *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning* (NRC, 2000), in which they outlined the five essential features of scientific inquiry:

1. Learners are engaged by scientifically oriented questions.
2. Learners give priority to evidence in responding to questions.
3. Learners formulate explanations from evidence.
4. Learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific knowledge.
5. Learners communicate and justify their proposed explanations.

When these tenets of scientific inquiry are considered while looking at the expectations for the CCSS for ELA, it becomes clear that many of the expectations set forth in the Standards mirror those within the NRC's definitions of scientific inquiry. Revisiting Cheuk's (2013) diagram and highlighting the portraits and practices that align to the NRC's definitions of scientific inquiry, it becomes apparent that 57.1% of the CCSS for ELA portraits are met through the scientific inquiry process. They are located in the region of the diagram where Science and ELA overlap (see Figure 1.4). E1 is also met via the inquiry process and is located in the exclusive ELA region. There is much confusion about the definition of inquiry, as exemplified by the teachers in this study. It was observed that all of the teachers in this study, with the exception of Bryce, were implementing their version of inquiry, but not as it was defined by the NRC. They were found to be implementing inquiry at Banchi and Bell's (2008) Level 1 (Confirmation) and Level 2 (Structured) of their inquiry model. In order to meet the expectations of the NRC's definition of inquiry and those set forth within the CCSS for ELA, science teachers will need to be implementing inquiry at Banchi and Bell's (2008) Level 3, Guided Inquiry.

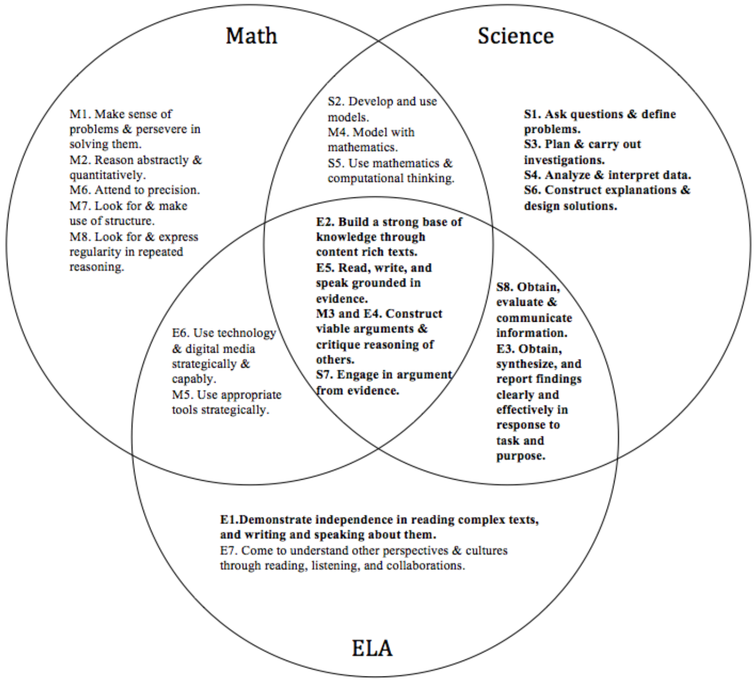

Figure 1.4. Highlighted scientific inquiry practices in the overlap, relationships and convergences found in the Common Core State Standards for Mathematics (practices), Common Core State Standards for ELA (student portraits), and the NGSS (science and engineering practices).

Social constructivism, inquiry and the CCSS for ELA. Rodriguez, in his Social transformative Constructivism theory, promotes the use of science inquiry as a way of promoting social equity within the multicultural classroom. The scientific inquiry process is also supported by the social constructivist theory in which students participate in the social construction of knowledge and active engagement in the learning process. Inquiry-based learning, or co-operative learning as Vygotsky called it, "is an integral part of creating … a social constructivist classroom" (Powell & Kalina, 2009, p. 244). Science teachers who hold social constructivist beliefs about science teaching and who teach via scientific inquiry will be meeting the CCSS for ELA more effectively than their more didactic colleagues. The teacher in this study who was the most successful at meeting the demands of the CCSS for ELA was Bryce (see Figure 5.4). Bryce had a reform-based approach to science teaching and took a social constructivist approach to science instruction. All of the observed lessons in his classroom were taught through the inquiry process. When the observations were coded for the elements of the CCSS for ELA and the NGSS and then highlighted on Cheuk's (2013) diagram, it emphasized the same portraits and practices as shown in Figure 1.5 which emphasizes the Standards mentioned within the NRC's definitions of scientific inquiry.

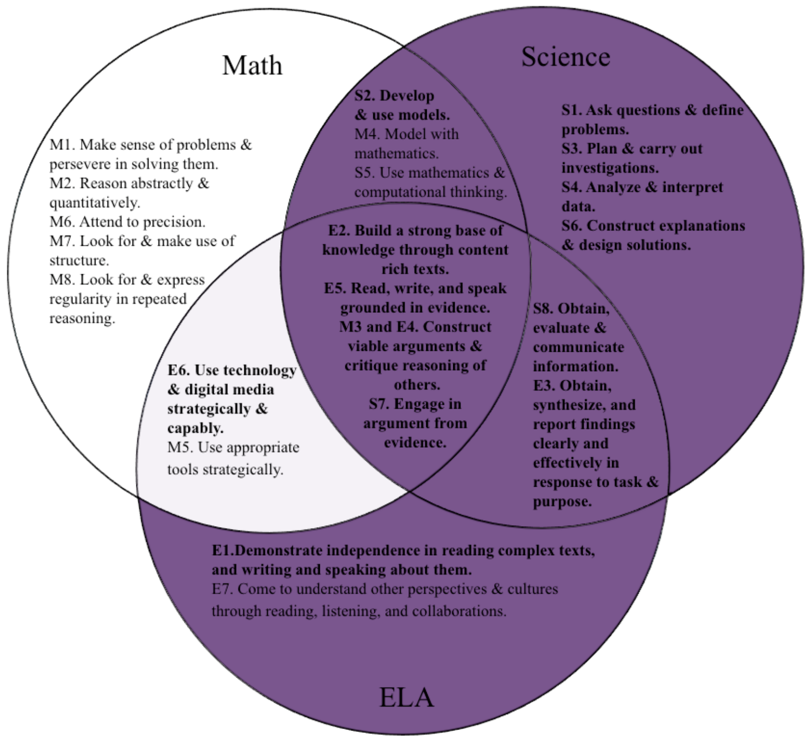

Figure 1.5. Bryce's implementation of the CCSS for ELA and the NGSS.

The other teachers in this study did not meet nearly as many of the CCSS for ELA portraits as they did not approach teaching from a social constructivist perspective. The other two focus teachers, Danielle and Simon, did not employ reform-based instructional strategies within their instruction. Unlike Bryce, their teaching approaches were high didactic and teacher-centered. Since scientific inquiry was not used during Danielle and Simon's lessons, they were unable to meet the CCSS for ELA portraits located within the center of Cheuk's (2013) diagram. Like most of the teachers in this study, Danielle and Simon's implementation of the CCSS for ELA focused on developing students' reading (E2) and vocabulary skills (E1).

Academic language instructional approaches. When asked about how their instructional practices had changed science the introduction of the CCSS for ELA, many of the participants had either (1) said they were "already doing it" as they were already dedicating class time focusing on science vocabulary and reading or (2) stated that they had increased their focus on science vocabulary and had introduced "close reading" of science text and "text-based evidence". These teachers are meeting some of the expectations of the CCSS for ELA by "bandaging on" general literacy techniques, such as those that related to science vocabulary. Shanahan and Shanahan (2012) refer to this type of instruction of literacy strategies as *content area literacy* as they are general study skills that can be used "to help students learn from subject matter specific texts" (p. 8). In contrast, *disciplinary literacy* "emphasizes the unique tools that the experts in a discipline use to engage in the work of that discipline and the description of unique uses [and] implications of literacy use within the various disciplines" (p. 8).

Three focus teachers were asked to describe their approaches to addressing science vocabulary. Danielle and Simon both described their approaches in ways that reflected Shanahan and Shanahan's (2012) definition of content area literacy. Danielle described her approach to science vocabulary in the following interview excerpt:

> I would have students put science terms on colored index cards because I want to use a cross-curricular approach...for example, the pink cards would be verb terms in science, the yellow cards would be nouns and so on and so forth. This way I'm integrating ELA and science and math together. After students put terms on index cards, have students work collaboratively to find words that are related to the science terms to better remember and understand their terms. Students would then create a web underneath the term and put related words around the science word. Areas would also be set-up in the classroom to reinforce those terms and build student vocab and knowledge (Text message, February 2015).

When asked how students would get the definitions to their science vocabulary terms, Danielle said that they would look them up in their textbooks. Simon described his approach as "Identification, discussion, text reading, incorporation into projects, and practice test questions" (Interview, Fall 2014). Bryce's description of his approach to science vocabulary was very different from Danielle and Simon's. He said,

> With the Physics, as much as I can, I like to introduce vocabulary more as an operational definition not necessarily something that's, well formally put on the paper but kids learn the terminology by the way that they measure them in a lab situation and so a good example is speed and when you start to look at the distance covered and the time period that it was measured over and understanding how those, how that distance and how that time period relate to the motion of the object. I find that a much more effective way of introducing the level of speed in having a large distance covered in a very short period of time um that's it. It's a ratio and I have always been a big fan of 'a name is nothing more than a term that allows me to understand what you're saying and you understand what I'm saying.' So whether or not we have that same name in the very beginning, it doesn't really matter to me. We only introduce it or standardize it. Once you come to a point where you have to start sharing notes because the concept is already there and believe it or not half the kids flip the terminology really easy, they don't flip um, conceptual understanding, it takes a lot more time. But if you said that you have been saying this the whole time that you've been talking about velocity and really what we're really talking about is acceleration. They're usually pretty okay with that. (Interview, Fall 2014)

In Bryce's description, he mentions the approach of using operational definitions to define physics vocabulary. In Bryce's classroom, the students and teacher work together to develop definitions based upon students' conceptual understandings of the science terms and how the terms are measured or used within the science inquiry process. This approach to understanding science vocabulary exemplifies Bryce's social constructivist approach to teaching as he and his students participate as a community of learners to generate meaningful definitions based upon his students' conceptual understanding of scientific phenomenon. Bryce's approach is an example of disciplinary literacy as his approach incorporates "the nature of scientific vocabulary and the specialized tools to construct and analyze vocabulary within the sciences" (Shanahan & Shanahan, 2012, p. 9).

Conclusion. Science teachers who are not employing reform-based practices and including inquiry-based approaches at a sufficient level will not be able to meet the majority of the Standards demanded by the CCSS for

ELA without completely changing their approach to science teaching; the majority of the CCSS for ELA can only be met through the inclusion of the scientific inquiry process within science instruction. Although it is vital for all science teachers to address science vocabulary within their instruction, by approaching it from a content area literacy approach, teachers will only be able to meet the expectations of the CCSS for ELA at a minimal level. In contrast, science vocabulary instruction can be approached from a position of scientific inquiry to promote deep conceptual understanding of scientific terminology. In order to incorporate the CCSS for ELA portraits located within the overlap region of Science and ELA, science teachers will need to do more than just bandage on content area literacy approaches to their non-inquiry based instruction; to go beyond a very superficial level of incorporating the CCSS for ELA, science teachers must completely change their instructional approaches to include the inquiry process. Teachers that are not already employing reform-based practices will have to undergo deep, systemic changes in their teaching practice in order to incorporate the CCSS for ELA as it is intended. At the core of this change is the need for strong implementation support both inside and outside of the classroom.

7.2.2c Addressing Implementation Support during Professional Development is Critical to the Successful Implementation of the CCSS for ELA and Inquiry Practices

In order for science teachers to incorporate the CCSS for ELA to its fullest, they will need to do more than simply adding on vocabulary and reading activities within their established teaching practice. Teachers will need to adopt a reform-based approach to science teaching that centers on the inclusion of inquiry-based strategies. This study has demonstrated that teacher beliefs about their approaches, goals and student expectations are central to teachers' styles of instruction. As such, these beliefs about science teaching will need to be addressed within the professional development of science teachers as they work to incorporate all the CCSS for ELA portraits.

Desimone's (2009) model (Figure 1.6) depicts teacher beliefs as both a product of and an influence on the five core features of effective teacher professional development. It also shows that these changes in attitudes and beliefs will lead to changes in instruction. Although this is the adopted model for the ISEP project's professional development, it has not been shown to promote significant change in the participants' incorporation of inquiry practices over the course of this three-year study. The goal of the ISEP project is to provide professional development opportunities for science teachers to help them to incorporate interdisciplinary science inquiry within their teaching practice. At the core of the ISEP project is teachers' summer experiences that may include one of the following: a two-week university physics course, hands-on scientific research, engineering design or curriculum writing. In order to bridge their summer experiences into the classroom, teachers are expected to participate in monthly PLC sessions where the focus is on ISI implementation. Unfortunately, due to a lack in monthly PLC participation, the ISEP teachers may miss this important part of the professional development process and experience difficulty translating their summer experiences into classroom practice.

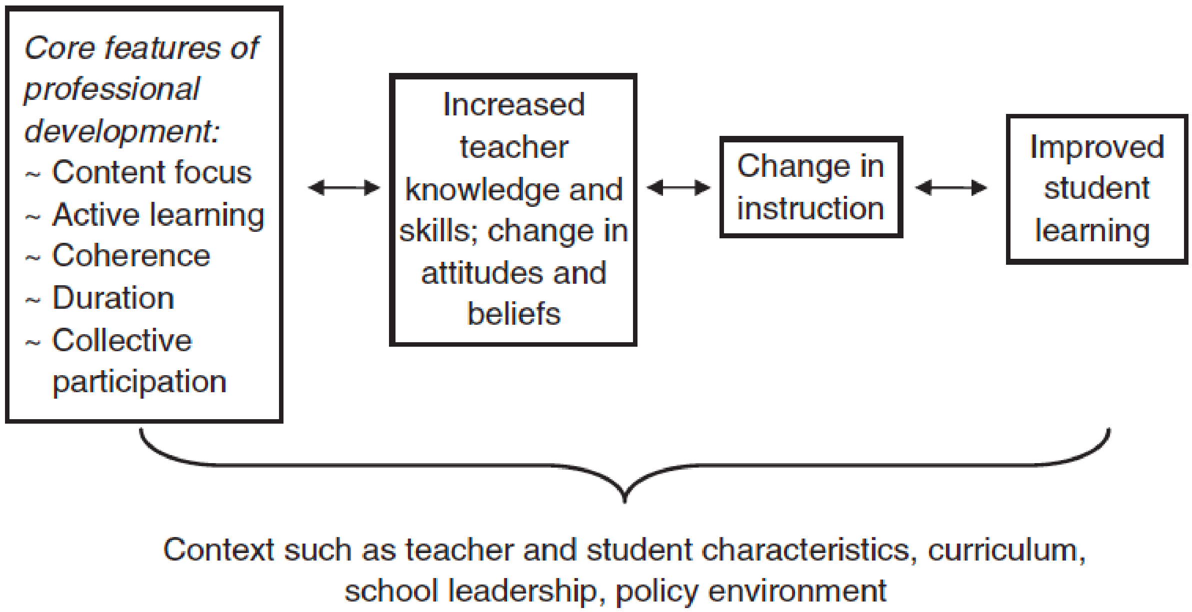

Figure 1.6. The ISEP Adopted Professional Development Model (Desimone, 2009).

Although Desimone's (2009) model highlights all of the necessary components of high-quality teacher professional development, it is very generalized for all areas of teaching. In the case of the ISEP project, it is a professional development opportunity for science teachers and thus, must reflect the unique nature of science teaching. It needs to address the complex process of promoting a dramatic shift from science teachers' current instructional practices and beliefs to an inquiry-based approach. In order for the ISEP teachers to implement ISI and inquiry within their classrooms, they will need long-term support, in-classroom instructional coaching and opportunities in the monthly PLC sessions to engage with other teachers in discussing and critiquing science lessons. The monthly professional development activities should be centered on implementing ISI and inquiry-based teaching. As demonstrated in Luft's (2001) study, changes in teacher beliefs may occur after they implement inquiry-based instructional changes and witness success with their students. In his model (see Figure 1.7), Guskey (2002) also suggested that a change in teacher beliefs occurs primarily after [teachers] gain evidence of improved student learning. These improvements typically result from changes teachers have made in their classroom practices – a new instructional approach, the use of new materials or curricula, or simply a modification in teaching procedures or classroom format. (p. 383)

Due of the unique nature of the ISEP project, the construction of a new professional development model is necessary (see Figure 1.8). Within this new model, the specific features of the ISEP project and the distinct aspects of science teaching are a part of the process. Also, the addition of an implementation support "bridge" between the teachers' summer experience and classroom practice will help teachers to translate their summer experience into inquiry-based teaching practices. The changes in their instructional practices, if demonstrated to improve students' learning and academic performance, may lead to changes in teachers' beliefs and attitudes about inquiry-based science teaching.

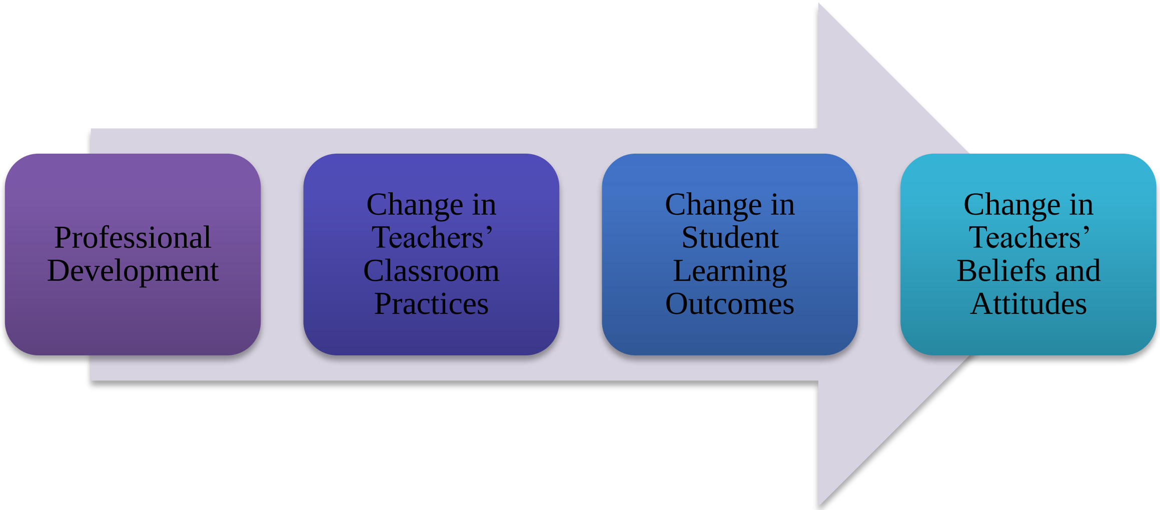

Figure 1.7. A model of teacher change. Adapted from Guskey (2002).

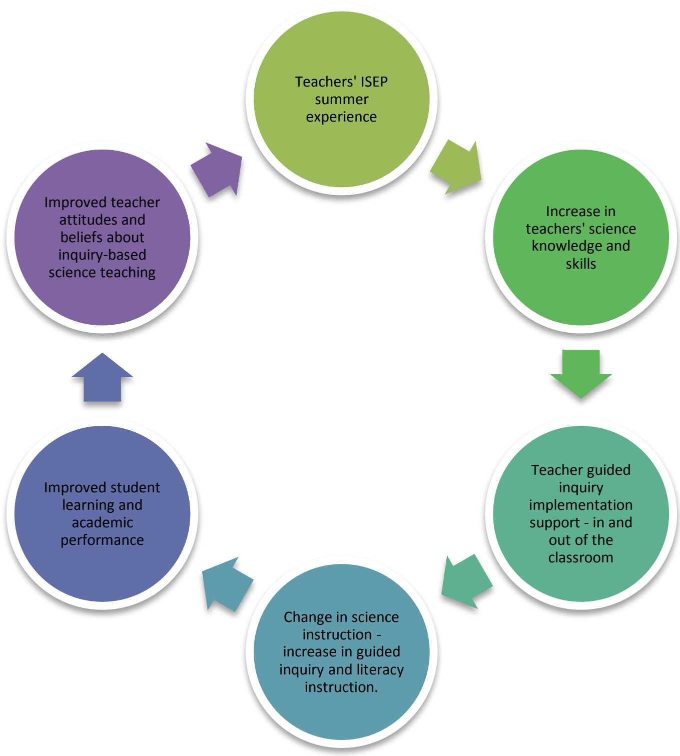

Figure 1.8. Conceptualization of a new ISEP professional development model to promote teachers' implementation of open inquiry instructional practices and changes to their attitudes and beliefs about inquiry-based science teaching.

Conclusion. Research conducted over the last two decades has defined a new paradigm for professional development: one that rejects the ineffective "drive-by" workshop and promotes more effective approaches (Stein, Smith, & Silver, 1999). Such approaches include different types of collaborative, job-embedded professional learning activities (Darling-Hammond & Richardson, 2009). Collaborative professional learning communities include teachers making visits to one another's classrooms and providing feedback about their teaching practice (Hord, 1997) and utilizing instructional coaches that are trained to implement a particular reform and work with the teachers in order to provide support and guidance as they attempt to implement it themselves. Instructional coaches can also model a lesson, provide feedback to the teachers and organize professional learning communities. In addition to the monthly PLC sessions, it is suggested that the new ISEP professional development model includes a job-embedded component whereby instructional support is available to teachers within their school buildings. Given ample training, the existing instructional coaches that are already present within each of the participating ISEP schools could provide this. These instructional coaches could coordinate collaborative activities with teachers during which they could observed each other's implementation of ISI and provide constructive feedback. When needed, these instructional coaches could help teachers plan and implement ISI within their instructional practice.

7.2.3 Implementation of Interdisciplinary Science Inquiry by Biology Teachers Compared to Teachers in the Physical Sciences of Earth Science, Chemistry, and Physics

The preliminary results are based on initial coding of teacher interviews. Overall, there are no particular differences in the implementation of ISI by biology teachers as compared to the physical science teachers of earth science, chemistry, and physics. Most teachers are limiting the implementation of ISI to an after school science club, as they identify the lack of time and the Regents curriculum as major factors that prevent them from implementing ISI, in addition to the low skill set that many students possess. Although teachers may implement some inquiry in class, lab, or an after school club, there seems to a major limitation in making it interdisciplinary. Even though most of the teachers have multiple teacher certifications or have taught different types of science classes, which should allow for easier interdisciplinary science connections to be made, there is a lack of evidence that this interdisciplinary teaching is happening. A summary of results for each teacher is presented on Table 1.10.

Table 1.10 Teacher Implementation of ISI by Subjects

Teacher (Current subject taught)	**Certifications**	**Subjects Taught**	**Implementation of summer research and ISI**
Matt (Physics)	physics	physics (regents, conceptual, medical), chemistry, biology, earth science, environmental science	Have not implemented actual summer research in class, but has a high implementation of ISI
Tom (Physics)	biology, general science, physics	biology, environmental science, physics	Not implementing in class; limits implementation to Science Olympiad after school club
Zack (Chemistry)	biology, chemistry	chemistry, biology	Very limited implementation in class; mostly implements in after school science club
Julie (Chemistry)	chemistry, general science	middle school life science and physical science, chemistry	Implementing summer research in class; implementing inquiry in lab, but seems to lack the interdisciplinary component
Paul (Biology)	biology	biology, chemistry, earth science, environmental science, middle school life science and health	Very limited implementation in biology class; some implementation in environmental science class; implementation mostly limited to after school science club
Jennifer (Biology)	biology, elementary education	biology, environmental science	Limited implementation in lab; implementation mostly limited to after school science club
Michael (Earth science)	earth science, biology, general science, elementary education	earth science, biology	Implementing ISI; implements summer research in the lab during the spring

7.2.4 Findings on STEM students

7.2.4.1 STEM student activities in schools

Tables 1.11 and 1.12 present descriptive statistics.

Table 1.11

Descriptive statistics of STEM student experiences in schools (N = 85) in Fall 2014

Events	**Frequently**	**Infrequently**	**Did not experience**
1. Assisted teachers in teaching lessons	35.29%	29.41%	35.29%
2. Assisted teachers in conducting labs	49.41%	17.65%	32.94%
3. Developed science labs for class use	30.59%	22.35%	47.06%
4. Developed out of school science learning activities	25.88%	17.65%	56.47%
5. Led small group activities/ discussions with students in class	42.35%	23.53%	34.12%
6. Led small group activities/ discussions with students after school or during weekend	9.41%	16.47%	74.12%
7. Demonstrated scientific content, procedures, tools, or techniques to students	49.41%	24.71%	25.88%
8. Helped teachers find relevant resources (e.g., science activities)	43.53%	24.71%	31.76%
9. Presented lessons/lectures to students in class	20.00%	12.94%	67.06%
10. Tutored students after school or during weekends	0.00%	5.88%	94.12%
11. Others	27.06%	2.35%	70.59%

Table 1.11*Descriptive statistics of STEM student experiences in schools (N = 62) in Spring 2015*

Events	**Frequently**	**Infrequently**	**Did not experience**
1. Assisted teachers in teaching lessons	40.48%	23.81%	35.71%
2. Assisted teachers in conducting labs	64.29%	14.29%	21.43%
3. Developed science labs for class use	57.14%	28.57%	14.29%
4. Developed out of school science learning activities	40.48%	23.81%	35.71%
5. Led small group activities/ discussions with students in class	42.86%	30.95%	26.19%
6. Led small group activities/ discussions with students after school or during weekend	9.52%	33.33%	57.14%
7. Demonstrated scientific content, procedures, tools, or techniques to students	59.52%	23.81%	16.67%

8. Helped teachers find relevant resources (e.g., science activities)	71.43%	21.43%	7.14%
9. Presented lessons/lectures to students in class	30.95%	23.81%	45.24%
10. Tutored students after school or during weekends	0.00%	11.90%	88.10%
11. Others	28.57%	4.76%	66.67%

*Others include a number of responses mostly in categories, namely, preparation on lab, working on 2015 ISEP science summit, assisting teachers with posters, and coordinating teacher professional development.

According to the statistics, similar to previous years, the three most frequently happened activities in both terms are assisting teachers in conduction labs (49.4% and 64.3%), demonstrating scientific content, procedures, tools, or techniques to students (49.4% and 59.5%), and helping teachers find relevant resources (e.g., science activities) (43.53% and 71.43%). And the two least experienced activities are leading small group activities/discussions with students after school or during weekend (9.41% and 9.52%), and tutoring students after school or during weekends (0.00% for both).

5.2.4.2 Results of STEM student survey

Section A: Background

According to the descriptive statistics of results of STEM student survey, all 36 respondents were from UB with 23 undergraduates and 13 doctors. Among those 23 undergraduates responded, 16 of them were in service learning. There were 24 respondents in their first year of ISEP, 6 in second year, 5 in their third year, and one reported second year plus two years volunteering work. Five respondents were in UB IGERT program.

Section B: Preparation

Table 1.12
Orientation in preparing schoolwork

Orientation	Frequency
Urban Education	33.3%
Culture and diversity	22.2%
Teamwork/collaboration	33.3%
Science teaching and learning	41.7%
Science communications	19.4%
Mentoring	47.2%
Others	19.4%

*Others include teaching class and educational backgrounds

From Table 1.12, most students had orientation to mentoring and science teaching/learning before their service in the schools (47.2% and 41.7%, respectively), followed by urban education and teamwork/collaboration (33.3% for both). Cultural and diversity and science communication were less focused in their orientation (22.2% and 19.4% respectively).

Section C: Experiences in UB/BPS ISEP project

This section consists of 4 parts: student's experiences in engaging school activities, how do these experiences influence their interest in certain aspects, how do students perceive values of UB/BPS ISEP project, and student's opinion on their experiences in the project. The results are shown in the Table 1.13 below.

Table 1.13

Student experiences on engaging school activities

Activities	Frequency
1. Assisted teachers in teaching lessons	66.7%
2. Assisted teachers in conducting labs	88.9%
3. Developed science labs for class use	36.1%
4. Developed out of school science learning activities	30.6%
5. Led small group activities/ discussions with students in class	88.9%
6. Led small group activities/ discussions with students after school or during weekend	30.6%
7. Demonstrated scientific content, procedures, tools, or techniques to students	77.8%
8. Helped teachers find relevant resources (e.g., science activities)	66.7%
9. Presented lessons/lectures to students in class	38.9%
10. Tutored students after school or during weekends	22.2%
11. Others	16.7%

*Others include preparing materials for labs, mentoring students, creating posters, and assisting for projects.

The three most frequent activities were: assisted teachers in conducting labs (88.9%), led small group activities/discussions with students in class (88.9%), and demonstrated scientific content, procedures, tools, or techniques to students (77.8%), while the three least frequent ones were, led small group activities/ discussions with students after school or during weekend (30.6%), developed out of school science learning activities (30.6%), and tutored students after school or during weekends (22.2%). The results are consistent with the statistics in student log sheets.

Table 1.14

Influence of student's experiences on their interests of certain activities

Statement	Strongly decreased	Decreased	Unchanged	Increased	Strongly increased
1. My interest in conduction research	0.0%	2.8%	38.9%	30.6%	27.8%
2. My interest in teaching at the college/university level	0.0%	2.8%	52.8%	27.8%	16.7%
3. My interest in teaching at K-12 level	8.3%	19.4%	25.0%	36.1%	11.1%
4. My interest in influencing public policy related to STEM education	0.0%		19.4%	44.4%	33.3%

In general, student's experiences in UB/BPS ISEP project positively impact their interests in conducting research, teaching at college/university level, and influencing public policy related to STEM education, but not for their interest in teaching at K-12 level, in which 28% students lost their interest in some degree.

Table 1.15

Reasons of participation in UB/BPS ISEP program

Reasons of Participating in UB/BPS ISEP program	Frequency
1. To gain financial support for my education	38.9%
2. My faculty advisor or another faculty member encouraged me	63.9%
3. Another student(s) encouraged me to participate	19.4%
4. To share my knowledge of science, technology, engineering and /or mathematics	72.2%
5. To work with school-age students	63.9%
6. I was interested in a teaching career	41.7%
7. To have new experiences	61.1%
8. To enhance my C.V. or resume	52.8%
9. To develop my teaching skills	66.7%
10. To develop my teamwork skills	30.6%
11. To develop my science communication skills	58.3%
12. To develop my research skills	33.3%
13. Others	8.3%

*Others include helping students and contributing in Buffalo public schools

The majority of students participated in the project because they wanted to share knowledge of science, technology, engineering and/or mathematics (72.2%), followed by developing their teaching skills (66.7%), working with school-age students (63.9%), encouragement from faculty advisor or another faculty member (63.9%), and to gain new experiences (61.1%).

Student's experiences in the schools can be perceived as a scale consisting of 14 items in a 4-choice rating scale (namely, 1-strongly disagree, 2-disagree, 3-agree, and 4-strongly agree) and the results are analyzed by Rasch modeling. The validity and reliability of this scale is shown in the figures and tables below. The overall person and item reliability are 0.85 and 0.88 respectively.

Figure 1.9

Distribution of the rating scales

```
        CATEGORY PROBABILITIES: MODES - Structure measures at intersections
P      -+------+------+------+------+------+------+------+------+-
R  1.0 +                                                         +
O      |                                                         |
B      |1                                                        |
A      | 11                                                    44|
B   .8 +   111                                               44  +
I      |      1                                            44    |
L      |       11                                        44      |
I      |         1                                      4        |
T   .6 +          11                    33333333       4         +
Y      |            1     22222       33        33   44          |
    .5 +             1 222     222  33            334            +
O      |             2*           **               433           |
F   .4 +           22  11        3  2            44   3          +
       |          2      1      3    22         4      33        |
R      |        22        1   33       2      44         33      |
E      |      22           113          22   4             33    |
S   .2 +    22             331            2*4                33  +
P      | 222             33   11         44 22                 33|
O      |2             333       111   444     222                |
N      |         33333           44***11         22222           |
S   .0 +*********4444444444444444       11111111111111***********+
E      -+------+------+------+------+------+------+------+------+-
       -4     -3     -2     -1      0      1      2      3      4
        PERSON [MINUS] ITEM MEASURE
```

The distribution of the four responses (1-4) shown in the figure above illustrates a well-designed rating scale since the peaks of each response are in order and evenly distributed with no overlap between each other. Thus, the responses of students could be clearly separated based on their various opinions.

About 20% of the students agreed or strongly agreed of almost all items, thus they were over logit 1.5 in the scale and not included in the wright map above. The item's mean is very near to minus one standard deviation of person estimates, which shows that few teachers chose strongly disagree. Furthermore, c2d is the most agreed item since it is at the bottom of the map with 3.4 mean score, which is also aligned with the descriptive statistics. C2k and c2h are the least agreed items with mean score of 2.5. Thus, the UB/BPS ISEP experiences have benefited their ability to teach STEM concepts and methods the most while the experiences have the least effect on presenting their work at a professional conference and explaining STEM research and concepts to public (non-technical) audience.

Figure 1.10

Person-item map of responses

```
            X   |T
            X   |
        XXXXX   |
        XXXXX   |  c2h     c2k
    1          M+
           XX   |S c2g     c2m
            X   |  c2i
           XX   |  c2j
                |
         XXXX   |  c2n
    0       X   +M
            X  S|
            X   |  c2b
            X   |  c2a
           XX   |  c2e
                |S c2c     c2l
   -1           +  c2f
                |
                |  c2d
               T|
         <less>|<frequ>
```

The overall item fit is good as shown in table 9 below, except for item 2 (in fit and outfit ZSTD = -2.30), item 10 (Infit and outfit MNSQ = 1.53 and 1.55, respectively, and infit and outfit ZSTD = 2.10), and item 13 (Infit and outfit MNSQ = 1.85 and 1.96 respectively, and infit and outfit ZSTD = 3.10 and 3.40, respectively).

Table 1.16

Item statements and fit statistics

Item/Statement	s.e.	Infit		Outfit	
		MNSQ	ZSTD	MNSQ	ZSTD
1. Work on a team	0.28	0.62	-1.80	0.62	-1.70
2. Lead a tem	0.27	0.54	-2.30	0.52	-2.30
3. Facilitate group discussions	0.29	0.70	-1.30	0.79	-0.80
4. Teach STEM concepts and methods	0.30	0.97	0.00	0.94	-0.10
5. Develop instructional materials about STEM concepts and methods	0.28	0.91	-0.30	0.88	-0.40
6. Generate others' interest in STEM research and activities	0.29	0.70	-1.40	0.71	-1.10
7. Conduct research as part of a collaborative team	0.26	0.97	0.00	0.98	0.00
8. Conduct independent research	0.26	0.96	-0.10	0.99	0.00
9. Develop a research and/or technology agenda	0.26	0.67	-1.60	0.67	-1.50
10. Write papers and reports about my work	0.26	1.53	2.10	1.55	2.10
11. Present my work at a professional conference	0.26	1.33	1.40	1.27	1.10
12. Explain STEM research and concepts to public (non-technical) audience	0.29	1.33	1.40	1.27	1.10
13. Decide a career in education	0.26	1.85	3.10	1.96	3.40
14. Understand science concepts better	0.27	0.69	-1.40	0.70	-1.30

Section D: Self-Efficacy in communicating science

After validation analysis last year, the scale was further revised. The revised scale has 26 items in the form of rating scale (4 choices, namely, 1-little, 2-some, 3-quite a bit, and 4-a great deal) in this section, which are designed to assess student's self-efficacy in communicating science. Rasch analyses were conducted to evaluate the results rather than simply comparing the means of each item. The validity and reliability evidence is shown in the figures and tables below. The overall person and item reliability are 0.89 and 0.77 respectively.

The distribution of 4 responses (1-4) shown in the figure below also indicates a well-designed rating scale since the peaks of each response are in order and evenly distributed with no overlap between each other. And a good separation is promised by using the scale.

Figure 1.11

Distribution of the rating scales

```
        CATEGORY PROBABILITIES: MODES - Structure measures at intersections
P      -+---------+---------+---------+---------+---------+---------+-
R  1.0 +                                                             +
O      |                                                             |
B      |                                                             |
A      |                                                             |
B   .8 +111                                                        44+
I      |   11                                                    44  |
L      |     111                                              444    |
I      |        11                                          44       |
T   .6 +          1                                       44         +
Y      |           11                         33         4           |
    .5 +             11    22222         33333  33333  44            +
O      |               *222     2222  333            **3             |
F   .4 +            222 11          **2            44   333          +
       |         222      11      33   22         4        33        |
R      |       22           11  33       22     44           333     |
E      |    222               **           22244                33   |
S   .2 + 222               333  11          4422                  333+
P      |2               33       11     444    222                  |
O      |             3333           1***4          2222              |
N      |      3333333          444444   111111         2222222       |
S   .0 +******44444444444444444               1111111111111111*******+
E      -+---------+---------+---------+---------+---------+---------+-
       -3        -2        -1         0         1         2         3
```

Figure 1.12

Person-item map of responses

```
PERSON - MAP - ITEM
       <more>|<rare>
          X  |
         XX M|  d25
          X  |T
 1        X  +
         XX  |  d19
         XX  |  d26
             |S d23    d24
       XXXX  |  d10    d7
         XX  |  d14    d6
          X  |  d16    d22
 0       XX S+M d18    d21    d3     d9
          X  |
             |  d11    d4     d5
             |  d2     d20    d8
             |S d1     d13
          X  |
         XX  |  d15    d17
-1           +  d12
       <less>|<frequ>
```

Table 1.17

Item statements and fit statistics

Item/Statement	s.e.	Infit		Outfit	
		MNSQ	ZSTD	MNSQ	ZSTD
1. Understand middle and high school students' science background knowledge	0.28	0.78	-0.9	0.75	-0.70
2. Understand middle and high school students' interest in science	0.27	0.96	-0.10	1.15	0.50
3. Understand middle and high school students' cognitive abilities	0.25	1.05	0.30	0.95	-0.10
4. Understand middle and high school students' social and cultural backgrounds	0.26	0.90	-0.40	0.87	-0.3
5. Understand middle and high school students' attention span	0.26	0.69	-1.30	0.72	-0.90
6. Decide what science topics are appropriate to students	0.24	0.94	-0.20	0.95	-0.10
7. Decide how much science content is appropriate to students	0.24	1.03	0.20	0.99	0.10
8. Help teachers find relevant resources (e.g., science activities)	0.27	0.73	-1.10	1.94	2.30
9. Develop science labs	0.25	1.36	1.40	1.31	1.10
10. Develop out-of-school science learning activities	0.24	1.06	0.30	1.05	0.30
11. Assist teachers in teaching lessons	0.26	0.89	-0.40	0.95	-0.10
12. Assist teachers in conducting labs	0.29	0.75	-0.90	0.95	0.00
13. Teach science labs to students	0.27	0.58	-	0.52	-

			1.90		1.60
14. Facilitate out-of-school science learning activities	0.24	0.98	0.00	0.89	-0.40
15. Lead small group activities/ discussions with students in class	0.29	0.72	-1.10	1.14	0.50
16. Lead small group activities/discussions with students after school or during weekends	0.25	1.08	0.40	0.99	0.00
17. Demonstrate scientific content, procedures, tools, or techniques to students	0.29	0.53	-2.10	0.63	-1.00
18. Teach lessons or give lectures to students in class	0.25	0.72	-1.30	0.74	-0.90
19. Tutor students after school or during weekends	0.24	1.56	2.20	1.44	1.70
20. Explain a difficult science concept to students	0.27	0.93	-0.20	0.94	-0.10
21. Relate current research to K-12 curriculum	0.01	1.45	1.80	3.32	5.20
22. Explain current research to teachers	0.25	1.12	0.60	1.25	0.90
23. Plan a field trip to museums	0.24	1.23	1.00	1.12	0.50
24. Facilitate student learning in museums	0.24	0.95	-0.10	0.88	-0.40
25. Organize a science family night in school	0.24	1.00	0.10	0.97	0.00
26. Explain science to parents	0.24	0.86	-0.60	0.82	-0.70

The overall item fit is good, except for item 8 (outfit MNSQ = 1.94, ZSTD = 2.30), item 19 (Infit MNSQ = 1.56, ZSTD = 2.20), and item 21 (Outfit MNSQ = 3.32, ZSTD = 5.20).

5.2.4.3 Career orientation toward teaching professions

A more detailed analysis of STEM students' career orientation toward teaching professions is also conducted, as the same as the report of last year. It intends to find if ISEP project has had any effect on STEM students in terms of their interest in teaching at K-12 or college level in 2014. The key findings are presented in Tables 1.18 and 1.19.

Table 1.18
Change in interest in K-12 teaching

		Interest in K-12 teaching					
		Strongly decreased	Decreased	Unchanged	Increased	Strongly increased	Total
Term	2014 Spring	0	1	4	4	3	12
	2014 Fall	3	6	5	9	1	24
Total		3	7	9	13	4	36

Table 1.19
Change in interest in university teaching

		Interest in University teaching					
		Strongly decreased	Decreased	Unchanged	Increased	Strongly increased	Total
Term	2014 Spring	0	0	7	2	3	12
	2014 Fall	0	1	12	8	3	24
Total		0	1	19	10	6	36

From Table 1.18 we see that about 1/3 of the students' (10 out of 36) interest in K-12 teaching decreased after a semester's ISEP experience in school, more students (about 47%, or 17 out of 36) increased their interest in K-12 teaching after a semester's ISEP experience in school. From Table 1.19we see that while most students (19 our 36) did not change their interest in university teaching after a semester in ISEP, 53% (19 out of 36) of students increased their interest in university teaching after one semester of ISEP experience in school.

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Part 1, Activities and Findings, Appendix 1
July 2014-July2015 ISEP Project activity for SUNY Buffalo State College

The Summer Course

PHY594/ TED594: Integrated Physics and Engineering for K-12 Teacher I ran 8-19 July 2014 in the Physics Education Department classrooms at Buffalo State. This summer the instructor of record was Professor Dan MacIsaac of Physics, assisted by Clark Greene of BSC Technology Education. Our final attendance was 11 teachers. These teachers worked six hours a day for two weeks on NGSS style integrated physics and engineering activities, primarily using excerpts from the NSF supported Physics and Everyday Things curriculum (PET, F. Goldberg et al.) focused on energy and mechanics with a multi day major project for use in BPS teachers own classrooms, documented via a course capstone poster presentation. A significant team (five ISEP teachers) was from a single school Southside Elementary and these teachers made particularly good use of follow up support opportunities, booking the follow up expert retired master physics teacher Lowell Sylwester for 20 days during the regular year at SouthSide. Of the remaining teachers, two were from Riverside HS two were from Harriet Ross Tubman (strongly represented the previous summer) and one each from South Park HS and Drew Science Magnet School.

Final summer 2014 course project poster topics included hands-on simple circuits, acid rain activities, ahands-on magnetic field inquiry and engineering design challenges designing a mechanical arm and paper airplanes. All posters, together with a poster describing the course as a whole are available as .PPT files together with a copy of the course syllabus from http://physicsed.buffalostate.edu/courses/14/summer/PHYS594TED594/

ISEP teachers received and evaluated the course quite well, indicating an interest in attending for more time (the five hours/day in Summer 2013 was raised to six hours/day in Summer 2014 and will be again raised to 8 hours/day with optional extra days for outstanding projects in summer 2015). Now that both courses (Integrated Physics and Engineering for Teachers I and II) have been offered twice, paperwork for formal submission of these courses to the BSC College Senate Curriculum Committee is underway (594 is a temporary workshop course number for transient courses; we will seek regular course status in the 2015/16 meetings of the CSCC.

All three course master teacher-instructors returned including Sami Cirpili and Brad Gearhart of BPS and Kathleen Stadler of Lancaster HS. These master teacher instructors were well received and helped with the instruction and course revision paperwork. Stadler and Cirpili were further recognized during 2014 by their appointments to NY State Master Teachers Program in Mathematics and Science – see http://www.suny.edu/masterteacher/ . Gearhart was ineligible for the award. Gearhart further prepared a poster presentation on using student whiteboard discourse to improve conceptual physics learning based upon his work at Riverside HS, and presented that work at multiple venues, including at the National Meeting of the American Association of Physics Teachers in San Diego CA in January 2015. A poster on the TED594/PHY594 course was also presented at that meeting. Draft versions of these posters were presented at the ISEP Poster show in October 2014, and again at the BSC Faculty Staff Research Forum in October 2014.

The Summer Camp

Originally, we had planned to run our own summer science camp for children at Buffalo State, but extreme low enrollment led to collaboration with an existing residential camp for low income student serving ISEP school students called Cradle Beach camp (more famous for their residential programs for disabled students).

Throughout Fall 2013 and Spring 2014, BSC ISEP personnel met repeatedly with Cradle Beach camp staff. Cradle Beach is a nonprofit residential summer camp already serving BPS ISEP students (amongst many others) and we have been working with them to improve their outdoor science, biology, environmental science and astronomy content offerings to their campers. In July and August 2015 we worked with Cradle Beach regular science sessions (5 sessions of 10-7 days each) and hired Buffalo State MSEd graduate students Jennifer Pidgeon, Tyler Mack, and professional staff Michele Parente, who provided regular instruction supplemented with additional instruction by BSC faculty and staff Cathy Lange, Kathleen Falconer and Joe Zawicki. Activities keyed to NGSS standards included "Biologist for a Day" and "Freshwater Ecologist for a Day"-- plants and carnivorous plants, stream macroinvertebrates, terrariums; "Chemist for a Day" – Oobleck, Gak, making ice cream; and finally "Meteorologist for a Day" -- Cloud Observations, temperature, barometric and dew point measurement, and so forth. While restricted in contact hours, these activities were extremely well received and attitudes were surveyed by Dr. Zawicki, as noted in the appended posters.

After follow up reflection and discussion with Cradle Beach, we decided that we would pursue two tracks for the next summer 2015. First we would try and organize an intensive science-camp-within-a-camp experience for ISEP students focusing on much more science to a smaller audience. Second, we would try to improve the overall camp science experience by working with all 60+ camp instructors to improve their general science content knowledge such as by improving their evening astronomy and sun/earth motion knowledge base, improving their ability to recognize plant and animal species etc. In June 2015 we have already conducted an introductory night skies activity for the instructors before the 2015 summer camps started, so hopefully we will inspire naked eye nighttime astronomy using planispheres and Sky Map iOS software by all camp instructors.

Synergistic Work with Other Organizations and Projects

In Spring 2015, Buffalo State ISEP investigators worked with the 100K in 10 project and the NYS Education Department recruiting STEM teachers via on campus recruitment events, and with the NYS Master Teachers program on manufacturing classroom sets of student whiteboards (see last years' report of activity from Gearhart) and instructing Master Teachers and ISEP teachers on their STEM classroom use. ISEP partners included the Western NY Physics Teachers Alliance at http://physicsed.buffalostate.edu/WNYPTA , the WNY Noyce Scholars Project, and the newly created NY State Master Teachers Program in Mathematics and Science, all organizations which hosted or co-hosted presentations of ISEP activity at Buffalo State.

Papers and presentations 2014-15 related to BSC ISEP activity (note several are synergistic with related NSF projects at BSC):

Bresges, A. & MacIsaac, D.L. (2015). EC01: Transatlantic design based and action research in Germany and the US. National Meeting of the American Association of Physics Teachers in San Diego, CA, January 2015. http://www.aapt.org/Conferences/wm2015/session.cfm?type=other

Falconer, K.A., Zawicki, J., Lange, C., & MacIsaac, D.L. (2014). Impact of Informal Science Education at a Residential Summer Camp. Fifteenth Annual Faculty/Staff Research and Creativity Fall Forum, Buffalo State College 30 October 2014.

Gearhart, B.F., MacIsaac, D.L. Falconer, K.A. & Abbott, D.S. (2014). Integrated Physics and Engineering Professional Development for K-12 Teachers. Fifteenth Annual Faculty/Staff Research and Creativity Fall Forum, Buffalo State College 30 October 2014.

Heimburger, J. & MacIsaac, D.L. (2015). PST2D03: Action Research and Design-based Research for Physics Teacher Preparation: A Literature Review. National Meeting of the American Association of Physics Teachers in San Diego, CA, January 2015. http://www.aapt.org/Conferences/wm2015/session.cfm?type=poster

MacIsaac, D.L. (2015) HE: Endangered physics teacher preparation programs (invited panel). National Meeting of the American Association of Physics Teachers in San Diego, CA, January 2015. http://www.aapt.org/Conferences/wm2015/session.cfm?type=other

MacIsaac, D.L., Gearhart, B., Falconer, K.A. & Abbott, D.S. (2015). PST2D05: Lessons from an Integrated Engineering and Physics Summer Course for K-12 Teachers. National Meeting of the American Association of Physics Teachers in San Diego, CA, January 2015. http://www.aapt.org/Conferences/wm2015/session.cfm?type=poster

MacIsaac, D.L., & Falconer, K.A. (2014). An Introduction To Research On Physics Teacher Preparation For Teachers. INVITED presentation to Institut für Physik und ihre Didaktik, Mathematisch-Naturwissenschaftliche Fakultät. Universitat zu Koln, Cologne, Germany, 7 December 2014.

MacIsaac, D.L., Gearhart, B. & Falconer, K.A. (2014). Integrated Physics and Engineering Courses for K-12 Teachers. Fifteenth Annual Faculty/Staff Research and Creativity Fall Forum, Buffalo State College 30 October 2014.

Olsen, J, & MacIsaac, D.L. (2015). EVT04: Physics of SCUBA. National Meeting of the American Association of Physics Teachers in San Diego, CA, January 2015. http://www.aapt.org/Conferences/wm2015/session.cfm?type=event

Pauli, A. & MacIsaac, D.L. (2015). PST2D01: A Table of Specifications for a Physics Teaching PCK Instrument. National Meeting of the American Association of Physics Teachers in San Diego, CA, January 2015. http://www.aapt.org/Conferences/wm2015/session.cfm?type=poster

Vermette, S. & MacIsaac, D.L. (2014). Bengal II: Ascent to the Top of the Atmosphere. Fifteenth Annual Faculty/Staff Research and Creativity Fall Forum, Buffalo State College 30 October 2014.

Append posters on summer BSC ISEP course and Cradle Beach camp, both available from: http://physicsed.buffalostate.edu/pubs/BSCEvents/2014FacStaffCreaSchol/

Append Gearhart poster on whiteboarding from Gearhart 2014: http://physicsed.buffalostate.edu/pubs/AAPTmtgs/AAPT2014Jan/PST2E01WBingConcPhy/

Part 1, Activities and Findings, Appendix 2

July 2014-July2015 ISEP Project activity for Buffalo Museum of Science

The Buffalo Museum of Science, provided support to the Charles R. Drew Science Magnet School through classroom team teaching and differentiated learning for students for all grades, pre-k through eight. Weekly afterschool programming supported sixth and seventh grade students from November 2014 through May 2015 culminating with participation in the regional Solar Sprint Competition. Three teams entered their designed and built solar cars, with a third place finish for one of the teams. They were the only Buffalo Public Schools entered in the competition that was hosted at the Buffalo Museum of Science. Summer Enrichment Scholarships to the Museum's weekly Discovery Camps was offered to thirty students. The Museum also supported the Cradle Beach Summer Camps through programming.

Wrap around support was also offered to the Parent Professional Learning Community through 42 free Museum family memberships to the participating parents from all the ISEP schools. For the second year the Museum played host to the annual ISEP Student Summit in March, 2015. Additional support was provided to the Buffalo Public Schools Science Week with 200 students visiting the Museum for Genome Day. The Museum supports the Teacher Professional Development PLC hosting the monthly workshops and presenting informal science best practices. Field trips to the Museum were attended by 10 schools for a total of 1,432 students and teachers.

Exhibit 1: Implementation Matrix

Goal 1: Improve middle school science teachers' knowledge and skills related to science inquiry through interdisciplinary science research and engineering design with university STEM faculty								
(a)	(b)	(c)	(d)					(e)
Objective	**Activity**	**MSP Key Feature**	**Progress to date (check one)**					**Brief Explanation of Progress**
			Activity carried out as planned	Activity delayed	Activity revised	Activity eliminated	New activity substituted	
Objective 1: To enhance science teachers' ability to demonstrate advanced knowledge and skills in conducting scientific research and engineering design Improve understanding of science and science inquiry teaching.	Activity 1a: Introduction of STEM Ph.D. graduate assistants and undergraduate service learning students to support science, technology and special education teachers in 12 participating BPS schools	• Partnership Driven • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-based design & Outcomes • Institutional Change & Sustainability	✓					
	Activity 1b: All participating schools establish in-class and afterschool programs and informal science activities	• Partnership Driven • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-based design & Outcomes • Institutional Change & Sustainability	✓					All schools established either after-school programs or informal science activities including Science Fun Nights and /or Science –based field trips including trips to UB labs, Tifft Nature Farm and the Buffalo Science Museum. All Schools participated in ISEP Student Science Summit

	Activity 1c: Teacher Professional Development: engage teachers in interdisciplinary science research and engineering design with University STEM faculty	• Partnership Driven • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-based design & Outcomes • Institutional Change & Sustainability			✓			
	Activity 1d: Monthly pedagogical professional learning community meetings with a focus on implementing interdisciplinary science inquiry teaching and learning		✓					
	Activity 1e: External project evaluators administered and analyzed the ISEP Teacher Pre- and Post-Questionnaire to collect demographic, perception data, assess teachers' knowledge and skills in conducting inquiry in science & engineering		✓					

Goal 2: Increase science teacher quantity, quality, diversity, and retention in urban schools.									
Objective 2: Increase the total number of highly-qualified science teachers teaching in the participating schools; hence the diversity of the science teacher population will increase, as well as increased retention for participating science teachers in their urban teaching positions.	Activity 2a: School based Wrap Around Support: the introduction of STEM Ph.D. graduate assistants and undergraduate service learning students to support science, technology and special education teachers in twelve schools in the Buffalo City School District	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes • Institutional Change & Sustainability	✓						

Engage teachers (with a focus on beginning and under-represented teachers) in professional development offerings. Provide support and resources in and after school. Engage teachers in PLC's.	Activity 2b: Teacher Professional Development: development of school based focus areas for STEM education in each school, and recruitment and placement of teachers from all twelve schools in summer interdisciplinary research. Activity 2c: Providing teachers with interdisciplinary science inquiry pedagogical support through monthly professional development workshops	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes • Institutional Change & Sustainability • Partnership Driven • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-based design & Outcomes	✓ ✓					

	Activity 2c: PLC's: Participating teachers will form and sustain professional learning communities with other teachers in their school and district. Utilizing mentoring models with help from university STEM faculty and graduate students; participants will utilize social media, blogs and hold regularly scheduled face to face meetings. Activity 2e: External project evaluators collected and compared baseline. Year 1 and Year 2 teacher, student, and school demographic data	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes • Institutional Change & Sustainability	✓ ✓					Teacher based PLC continued throughout 2014-15 school year. The PLC's focused on ISI and pedagogical content knowledge.

Goal 3: Develop and sustain professional learning communities in urban schools, based on mentoring models, using university STEM faculty and graduate students.									
Objective 3: The ISEP Professional Learning Communities are partnership driven and designed to foster collaboration. The ISEP combines novel mentoring approaches and expanded Professional Learning Communities (PLC's) to build leadership and resources for improving science education in high needs/high potential urban schools. The objective of PLC will be to cultivate mentoring partnerships with middle and high school teachers and students; UB and BSC STEM and Education faculty; UB and BSC undergraduate and graduate students; volunteer STEM professionals; and parents.	Activity 3a: Face to face meetings, virtual communication platforms: blogs, electronic professional communications network. ISEP Partners provide access to their interdisciplinary research programs Parent PLC; DPCC will also help organize school-based parent participation; as well as focus groups that identify best practices for parent participation in science and engineering education. Activity 3b: External project evaluators collected and analyzed data from parents in PLC in 2013-2014	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes • Institutional Change & Sustainability	✓ ✓						Currently all PLC's are being conducted face-to-face. Initial PLC Clusters were created and implemented. PLC Clusters created opportunities for teachers within school buildings to work together in groups and as a team for upcoming summer 2014 research and 2014-15 school year. ISEP Coordinating Teachers created collaborative opportunities between middle and high school teachers via the formation of topic based PLC clusters including a ESL environmental science and GIS. A Principal based PLC was also implemented this year, establishing opportunities for ISEP principals to collaborative and leverage resources. An ISEP corporate/research partner PLC was implemented this year. The focus of this PLC includes examining ways the corporate comminute can play a stronger role in creating sustainable models that yield greater impacts regarding their partnerships with the BPS and the higher education community. Graduate students created collaborative opportunities between middle and high school teachers and students Parent PLC created opportunities for parents to collaborate with STEM faculty and BPS teachers through the ISEP STEM Social Justice Conference the ISEP Student Science Summit and the ISEP Parent Retreat.

Goal 4: Extend interdisciplinary inquiry based science and engineering learning to high school								
Objective 4: Students of participating middle school teachers will continue to experience interdisciplinary science inquiry learning in high school. Students of participating high school teachers will continue experiencing interdisciplinary science inquiry learning in high school and will achieve higher than other students.	Activity 4a: Expansion of the roster of ISEP participating schools, to include more high schools.	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes • Institutional Change & Sustainability	✓					
	Activity 4b: Informal science activities both in and out of class.	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes • Institutional Change & Sustainability	✓					
	Activity 4c: ISEP offerings will also include summer enrichment and university research internships for BPS students starting in Summer 2013.	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes • Institutional Change & Sustainability	✓					Summer opportunities for ISEP middle and high school students during the summer of 2014 included a GIS camp at the UB working BPS teachers, UB doctor students, and faculty; a school based camp at MST organized by ISSEP doctoral students and ISEP coordinating teachers, a middle school camp at the Buffalo Museum of Science, a middle school camp at Cradle Beach; internship opportunities with UB Chemistry faculty for high school students, and a two week research camp at HWI.

Goal 5: Improve student achievement in science, attitude toward science-technology-society, and interest in pursuing advanced science studies								
Objective 5: Students of participating teachers will continue to experience interdisciplinary science inquiry learning in elementary, middle and high school. Participating science teachers will maintain involvement and STEM faculty and students will be actively involved in activities improving k-12 science education; parents will become more involved in school-based in/after-school programs.	Activity 5a: Teachers implement interdisciplinary science inquiry teaching and learning in their classrooms. Activity 5b: STEM Ph.D. graduate assistants & service learning students support teacher implementation of inquiry science teaching Activity 5c: STEM PhD students organize after-school opportunities for students e.g. clubs, tutoring, etc. to pedagogical content knowledge Activity 5e: External evaluators administered ISEP BPS Student Questionnaire to compare BPS students to assess differences in students' interest in science careers	Partnership Driven, Teacher Quality, Quantity & Diversity Challenging Courses & Curricula Evidence-Based Design & Outcomes Partnership Driven, Teacher Quality, Quantity & Diversity Challenging Courses & Curricula Evidence-Based Design & Outcomes Partnership Driven, Teacher Quality, Quantity & Diversity Challenging Courses & Curricula Evidence-Based Design & Outcomes	✓ ✓ ✓ ✓ ✓					

Goal 6: Improve collaboration in student learning among university, school, and parents								
Objective 6: Participating science teachers will maintain involvement and STEM faculty and students will be actively involved in activities improving k-12 science education; parents will become more involved in school-based after-school programs and PLC's. Engage faculty, grad students, undergraduates, UB and BSC STEM faculty, corporate and research partners and parents in PLC's and other programmatic components and leadership structures.	Activity 6a: Engagement of faculty, staff and students, as well as corporate and research partners through informal science activities, both in and out of class.	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes • Institutional Change & Sustainability	✓					ISEP teachers, students, UB doctoral students and faculty collaborated on a summer GIS Camp during the summer of 2014 and will continue in an expanded two week camp this summer, 2015. The middle and high school students were instrumental in assisting teachers becoming more comfortable working with smart phone technology. The collaborative environment continued throughout the school year in after school programs and presentations at the ISEP Student Science Summit in March 2014.
	Activity 6b: Implement The District Parent Coordinating Council into the ISEP program involvement.	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes • Institutional Change & Sustainability	✓					Parent PLC created opportunities for parents to collaborate with STEM faculty and BPS teachers, corporate, research and community partners through STEM Social Justice Conference and ISEP Student Science Summit and the ISEP Parent Summer Retreat. Parents collaborated with STEM faculty, doctoral students, and ISEP Corporate partners in developing a yearlong agenda of pertinent issues the parent group wanted to address including sustained student engagement in STEM and the education to career pipeline.

	Activity 6c: Create active and constructive interactions amongst the parents and teachers through PLCs. Activity 6d: Administered and analyzed parent survey to measure parents' perceptions of the parent PLC and expectations for students' STEM learning in Spring 2013 - Spring 2014	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes • Institutional Change & Sustainability	✓ ✓					Parent based PLC commenced in spring 2013 and continued to meet during 2014-15 school year and will meet during summer the 2015. Additionally, a parent executive committee was formed that includes one parent representative from each of the 12 ISEP schools. This group will meet with more frequency than the lager parent group. The main focus of this group will include the overarching themes of sustained student engagement, engaging ENL (English as a new language) parents and creating more exposure to STEM related career opportunities for ISEP students. Parents partook in a parent retreat that focused on upcoming programmatic events for 2014-15 school year as well as presentations from BPS teachers, UB STEM faculty, doctoral students, and corporate partners as well as discussed strategies regarding how to keep their students engaged in interdisciplinary science and engineering and preparations for higher education and career opportunities.

Section 2: Management Report

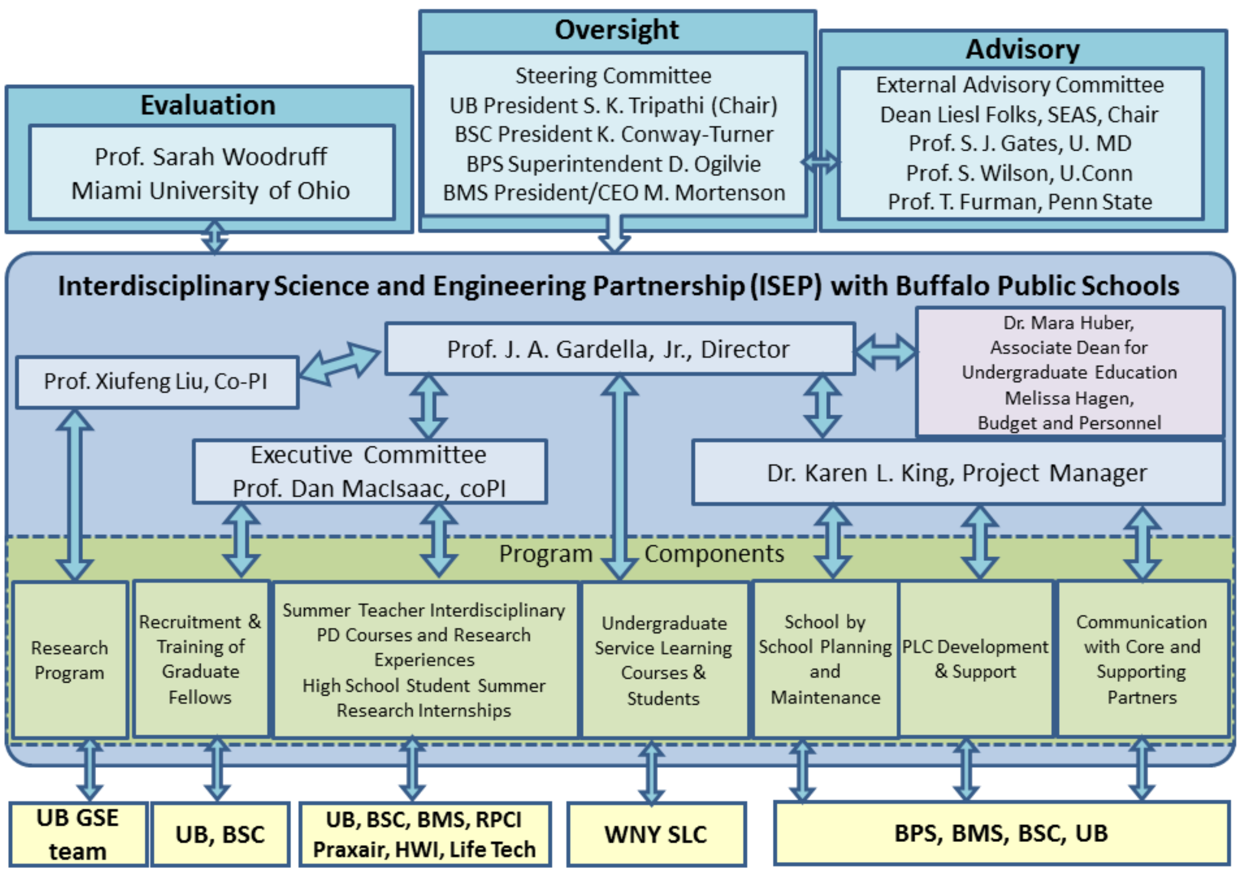
University at Buffalo/ Buffalo Public Schools ISEP

Year 4: 2014 – 2015

Overview

Year 4 was focused on core activities to enhance wrap around support for ***implementation*** of teacher research projects as classroom activities in academic year 2013/2014. The ISEP management team, led by the PIs (Gardella, Liu, Cartwright, MacIsaac and Baudo were supported by Dr. Karen King in management planning and decision making and part time support from Mrs. Melissa Hagen, handling budget, purchasing and personnel. The Executive Committee met once as a whole group for an annual report in December. The only changes in the updated Organizational Chart in Figure 2.1 are the appointment of Dr. Katherine Conway-Turner as new President of Buffalo State College, replacing interim President Howard Cohen, and changes in the Buffalo Public Schools Superintendent, discussed below in Core Partner Management and Coordination under the section entitled "Collaboration with BPS".

Figure2.1: ISEP: Current (2015) Organizational Chart



Core Partner Management and Coordination

Core partner participation in all activities has continued to follow the identifications described in Figure 1. In particular, leadership and faculty from UB and BSC worked together regularly on every aspect of higher education participation, regular meetings with the Buffalo Museum of Science leadership occurred to plan programs as described in the Strategic Plan. While we have had just one full meeting of the Executive Committee, and one meeting of the Steering Committee, core partner leadership communicates effectively through the Project Manager Dr. Karen King, as envisioned in the Strategic Plan. The Project Manager has created email lists for all categories of participants.

ISEP leadership meets twice per semester with Principals, Coordinating Teachers and Graduate Assistants at all twelve schools. Dr. King has established several PLCs, these meetings have created networks of parents, graduate assistants and coordinating teachers and initiated communication between BPS science leadership and principals on ISEP related topics. Her report details subject based PLC's and the Parent PLC as part of the Activities and Findings, Part 1.

Important management activities were both expanded from years 1-3 and new activities were established, according to the strategic plan in year 4. Executive Committee involvement in key components of the recruitment and evaluation of teachers in ISEP was improved in year 4 by subcommittee work to screen teacher summer applications (Prof. Dan MacIsaac, BSC CoPI, Chair), a subcommittee to review and establish summer middle school science camps and summer high school research opportunities for students in ISEP schools chaired by Prof. David Watson. Over the past year, the latter effort has taken a good deal of leadership from Project Manager Dr. Karen King and input from the Parent Professional Learning Community, as discussed in the Activities and Findings.

Table 2.1 summarizes school leadership from year 3-4. Results of the school based theme development are discussed in Activities and Findings.

Collaboration with BPS

A major change from last year's report has been another change in the BPS Superintendent. When we reported last year, Dr. Pamela Brown, Superintendent of BPS was being forced to resign by members of a newly elected majority (from 5-4 supporters of Dr. Brown to 5-4 majority supporting removal of Dr. Brown). A short term interim superintendent was named followed by what was supposed to be a 2 year interim superintendent, Dr. Donald Ogilvie. Dr. Ogilvie immediately, as all previous Superintendents, embraced the ISEP project and helped bring attention to the work. After several months of attempting to build consensus on State required reform efforts, the 5-4 majority lost confidence in Dr. Ogilvie and one board member in the majority even demanded his immediate resignation on a Friday afternoon in April. Dr. Ogilvie soon formally announced that he would return to retirement as of July 1, 2015. An interim superintendent has been named as a national search has been refining the list of interview candidates (including 3 internal candidates) and an appointment of a new Superintendent is expected quickly, perhaps in July. Since the 2011 award of the NSF MSP to ISEP, there have been two Superintendents (Dr. Williams and Dr. Brown), four interim superintendents (Amber Dixon, Dr. Will Kerestes (a candidate in the present search), Dr. Ogilvie and Darren Brown (who will begin July 1st). The appointment of a new Superintendent will be the 7th senior leader with whichi we have had extensive dealings for ISEP. This controversy has been beyond even the most cynical expectation of (in)stability of urban superintendents and has consumed time for the Director and ISEP leadership in developing BPS senior leadership understanding of ISEP research and practice so that they can participate in decision making on ISEP issues.

Thankfully, ISEP Partnership collaboration between the BPS Science Department leadership and ISEP activities continues to be a major focus of Ms. Kelly Baudo, Supervisor of Science. Ms. Baudo continued her exceptional collaboration with ISEP by participating in all planning efforts, and served on the Executive Committee. She met with UB and Buffalo State ISEP leadership at every school-based meeting. Ms. Baudo is very active in the approval chain for all informal science activities such as field trips and other off campus activities. A process of consultation with the Science Department, and development of criteria for alignment of requests to learning goals and standards produced a clearer means for teachers to justify requests for ISEP funding in support of these activities.

Most importantly, the application to NY State Ed for MSP funding for a program to disseminate ISEP middle school interdisciplinary teacher projects to all 7/8th grade BPS science teachers, along with selected technology and special ed teachers was approved. The program began in Fall 2014 and continued in Spring 2015 for 10 sessions on regular school days. Approximately 65 teachers participated in each session. Ms. Baudo's continuing support and vision for ISEP work created this opportunity which helps with our sustainability planning and dissemination.

As the primary point of contact for BPS leadership, and now coPI on the NSF grant, Ms. Baudo will remain the point person for all teacher selection processes and decision-making for summer research and in school activities in collaboration with principals.

A particular responsibility engaging Ms. Baudo along with Principals is ISEP school based leadership transitions. This year saw the several transitions to new Coordinating Teachers at Bennett High and Riverside High, due to transfers of coordinating teachers to another ISEP school, a cycling of Coordinating Teacher at Hutch Tech High School, due to Principal desire to rotate the position and one retirement from Lorraine Academy. As a reminder in our operational plan, School based coordinating teachers serve a 12 month supplemental appointment on ISEP to serve the following responsibilities:

- Point of contact with ALL ISEP leadership (UB, BSC, BPS, Museum, Roswell, etc.)
- Primary oversight of graduate assistants and undergraduate service learning students; training, orientation, classroom placements.
- Coordination of all ISEP associated teachers in the building. Research design, courses, PD alignment with school based goals.
- Point person between principal, UB ISEP leadership and district (Kelly Baudo) on ISEP related research, in class support and professional development.
- Responsible to meet with other coordinating teachers in PLC.
- Distribute summer PD applications, recruit teachers to ISEP,
- Vet and help submit applications for equipment, supplies, field trips.
- Responsible for coordinating with fellow ISEP teachers and doctoral students:
    - after-school science program and or building based science night,
    - full participation in ISEP Student Science Summit, including collaborating with fellow ISEP teachers, doctoral students and other core partners on ISEP grant.

Coordinating teachers are paid a stipend equivalent to 10 weeks full time work. Most work 6-7 weeks in the summer, with additional academic year work completing the commitment.

Supporting Partner Development

Supporting partners for research development, Praxair, Roswell Park Cancer Institute and Hauptman Woodward Institute all hosted teachers in year 3 summer and plan to host teachers for research in year 4. As noted in Activities and Findings, HWI was awarded a major NSF STC grant which included funds for four ISEP teachers in summer research, which was then reconfigured without ISEP participation as an outcome of the annual NSF Site Review. Further, Roswell leadership has worked on developing cancer genetics and cancer biology classroom materials at three schools and directing these to one of the high schools as a themed program.

Coordination with supporting partners for program development, the Western New York Service Learning Coalition and the District Parent Coordinating Council (DPCC) has been excellent.

These outcomes of the Core Partner management and Supporting Partner Development are obviously ***partnership driven.*** Using ***evidence based design and outcomes*** as developed by the Joyce Epstein models of parent involvement, outlined in our ISEP proposal, guiding participation at all levels. Finally, effective collaborations contribute to both ***institutional change and sustainability*** .

Table 2. 1 on the next two pages shows ISEP Schools, Research Themes, Coordinating Teachers & STEM Graduate and Undergraduates. Priority schools under Race to the Top funding (http://www.buffaloschools.org/Turnaround.cfm?subpage=77369) are indicated by the PS designation in the left column under school name. These schools have School Improvement Grants and are subject to various turnaround plan models as dictated by Race to the Top. STEM Graduate Students (Yellow highlights) are presently supporting each of the schools. STEM undergraduates include those taking service learning classes (SL Student), advanced internship credit for continuing work (SL Intern) or paid undergraduate positions for veterans of two or more semesters (Intern). This was the first year where all schools had at least four undergraduates, and a large number of returning undergraduates created some continuity. Riverside High, School 93 and School 19 were popular spots for students interested in working with refugee and immigrant ESL (now English as New Language) students in STEM classes and after school programs.

Table 2.1 ISEP Personnel by School

School Name (Grades Served)	Coordinating Teacher	STEM Themes	STEM Graduate Students	STEM Undergraduates	Other Partner Resources
Native American Magnet 19 (K-8)	Heather Gerber	Environmental Science, Forensics, Anatomy/Physiology	Angelina Montes	Dantiza Cruz (SL Student) Victoria Fallon (SL Student) Michael Fiorica (SL Student) Julia Slezak (SL Student) Joseph J. Gardella (Intern)	Praxair
Harriett Tubman 31 (K-8) PS	Steven Indalecio	Biomedical, Environmental Science	Jon Pleban	Walker Gosrich (SL Student) HalleSauer (SL Student) Antara Majumdar (SL Intern) Sushmita Gelda (SL Intern)	Roswell Park Cancer Institute
Science Magnet 59 (K-8) PS	Stephanie Finn	Biomedical and Environmental Sciences	Robin Foster	Bradley Schurr (SL Student) Ruby Anderson (SL Student) Robert Wechsler (SL Student) Racheal Whiteside (SL Student) Megan Yoerg (SL Student)	Museum of Science
Lorraine Academy 72 (K-8)	Reva Gilbert	Medical Careers Environmental Science	Michael Gross	Danmai Lin (SL Student) Vincent Barnes (Canisius Intern) Benton Swanson (Canisius Intn) Zach Collisson (SL Student) Devon Rennoldson (SL Student)	Hauptmann Woodward Inst. Mercy Hospital
Southside Academy 93 (K-8)	Susan Wade	Environmental Science, Link to South Park High Middle School Computer Science	Michael Gallisdorfer	Sean Kaczmarek (SL Student) Noah Poczciwinski (SL Student) Max Braun (SL Student) Stephanie Kong (SL Intern)	
MST Seneca 197 (Grades 5-12)	Michelle Zimmerman	Environmental Science and Engineering	Heather Rudolph	Tyler Newton (SL Student) Graham Lyon (SL Student) Valerie Goldblatt (Intern)	Praxair
Bennett High 200 (Grades 9-12)PS	Gina O'Kussick	Pharmaceutical Sciences, Environmental, Extreme Events	Peter Bloomingdale (School of Pharmacy and Pharmaceutical Sciences	Makenzie Depetrillo (SL Student) Tristan Reynolds (SL Student) Megan Schmit (SL Student) Michael Derr (Intern)	UB School of Pharmacy and Pharmaceutical Sciences
Burgard 301 (Grades 9-12) PS	Bruce Allen	Auto Technology, Physics	Katherine Niessen	Austin Price (SL Student) Estevan Tineo Mateo (SL Student) Timothy Semon (SL Student) Dylan Burrows (Intern)	Praxair

Riverside Tech 205 (Grades 9-12) PS	Anne Kokolus	Medical Careers	Joshua Wallace Bishwas Thapa (part time)	Fay Creathorn (SL Student) Akunne Kanu (SL Student) Kapila Kappor (SL Student) Daniel Heuskin (SL Student) Caleigh Smith (SL Student) Caroline Sturtz (SL Student) Nida Syed (SL Student) Luke Hoffman (Intern) Anna Jacquinot (Intern) Patricia Johnson (Intern)	Medaille College
South Park 206 (Grades 9-12) PS	Kathleen Marren	Environmental Science and Social Sciences	Tonya Lewis	Emily Belote (SL Student) Mandira Talwar (SL Student) Chris Reinhardt (Intern) Maggie Petrella (Intern) Megan Corcoran (Intern)	
Hutch Tech 304 (Grades 9-12)	Jason Mayle	Engineering, Physics, Biochemistry	Suyog Pol	Alexander Schwartz (SL Student) Tyler Barrett (SL Student) Caleb Walters (Intern) Leatrice Bennett (Intern)	
East High 307 (Grades 9-12) PS	Pat McQuaid	Bioinformatics, Forensics	Amy Zielinski	Dante Iozze (SL Student) Salvatory Izoduha (SL Student) Christine Caito (SL Student) Brentyn Mendel (SL Student)	Roswell Park Cancer Institute

Section 3: Financial Report

Interdisciplinary Science and Engineering Partnership (ISEP) with Buffalo Public Schools

Year 4: 2014 – 2015

3.1 Status

Spreadsheet projections (below) show approximately 11% of UB's portion award will be left at the end of the year (August 31, 2015). Subcontract funding to partners Buffalo Museum of Science and Miami University of Ohio (evaluation) have been expended. Buffalo State College is still evaluating the carry over since the majority of their expenditures are for summer activities.

We are requesting carry over to 2015-2016 for six major categories:

- Faculty support
- Graduate student support
- Undergrad student support
- Supplies

and within the yellow highlighted Participant Support Costs:

- Support for teachers, in the form of travel support
- Support for our student research programs, including stipend support for middle and high school students

3.2 Background related to shortfalls and justification for use of carryover to 2015-2016.

Teacher participation increased as expected in Summer 2014. The success of last year's summer PD for teachers has lead to an even higher increase in participation for Summer 2015 for research facilitated at UB and classroom instruction at Buffalo State College. 100 teachers have been placed and supported compared to the grant projection of 64 each summer and 78 teachers in 2014.

We will continue to focus on expanding the support for Teacher Travel for professional meetings during Y5. We request to carry over these funds to meet upcoming needs.

Student summer research programming was increased in Y4 over Summer 2014 with increased summer research programming for middle and high school students, along with school-year programs including the annual ISEP Science Summit and school-based science clubs. Summer 2015 research opportunities for middle and high school students are anticipated to include the continued, yet expanded, offerings of a GIS camp, Environmental programming at Buffalo's historic Cradle Beach, and UB Professor Dave Watson's mentor programming. A new offering for Summer 2015 includes a parent-initiated workshop focusing on summer science at the Math Science and Technology school, a school serving grades 5-12. A two week summer workshop is being offered for students in August. The active parent participants in our ISEP Parent PLC organized this new summer workshop. With approved carry over funds, we expect to continue programming expansion into the academic year of 2015-2016.

Details of the expenditures are in the spreadsheet in categories utilized in the NSF budget. These are based on our best estimate of costs for summer 2015.

We request that our carry-over be supported by the Program Office, and look forward to any discussions we can have to answer any further questions.

Budget Summary
Year 4 (2014-2015)

Category	Funds Budgeted	Carry Over from Y3	Total Funds Available	Funds Expended	Summer 2015 Committed Funds	Total Expected to Expend	Projected Carryover Funds
Faculty Salaries	$ 48,044.00	$ (480.78)	$ 47,563.22	$ 15,406.61	$ 14,856.86	$ 30,263.47	$ 17,299.75
Staff Salary	$ 4,071.00	$ (61,863.67)	$ (57,792.67)	$ 6,324.12	$ 1,108.08	$ 7,432.20	$ (65,224.87)
Graduate Students	$ 460,735.00	$ (133,945.45)	$ 326,789.55	$ 299,031.92	$ 7,338.61	$ 306,370.53	$ 20,419.02
Undergraduates	$ 74,088.00	$ 157,765.18	$ 231,853.18	$ 2,643.75	$ -	$ 2,643.75	$ 229,209.43
Fringe Benefits	$ 93,972.00	$ (50,218.39)	$ 43,753.61	$ 50,947.66	$ 4,187.40	$ 55,135.06	$ (11,381.45)
Participant Support Costs							
Stipends							
Teachers	$ 282,000.00	$ (132,910.00)	$ 149,090.00	$ 16,358.00	$ 210,000.00	$ 226,358.00	$ (77,268.00)
Middle/High School Students	$ 84,000.00	$ 199,395.00	$ 283,395.00	$ 20,951.00	$ 15,500.00	$ 36,451.00	$ 246,944.00
PT grad assistants	$ 48,000.00	$ 28,006.00	$ 76,006.00	$ 150,019.94	$ 7,000.00	$ 157,019.94	$ (81,013.94)
Parents	$ 1,800.00	$ 3,100.00	$ 4,900.00	$ 11,450.00	$ 1,800.00	$ 13,250.00	$ (8,350.00)
Travel	$ 48,000.00	$ 82,517.68	$ 130,517.68	$ 4,223.73	$ 4,700.00	$ 8,923.73	$ 121,593.95
Supplies	$ 72,000.00	$ 18,945.82	$ 90,945.82	$ 199,116.98	$ 86,000.00	$ 285,116.98	$ (194,171.16)
Supplies	$ 38,400.00	$ 111,362.14	$ 149,762.14	$ -	$ 1,000.00	$ 1,000.00	$ 148,762.14
Tuition	$ 12,876.00	$ (136,964.00)	$ (124,088.00)	$ 40,102.00	$ -	$ 40,102.00	$ (164,190.00)
Travel	$ -	$ (16,027.82)	$ (16,027.82)	$ 2,380.10	$ 12,500.00	$ 14,880.10	$ (30,907.92)
Total UB Direct Costs	$ 1,267,986.00	$ 68,681.71	$ 1,336,667.71	$ 818,955.81	$ 365,990.95	$ 1,184,946.76	$ 151,720.95
							11.35%

Section 4

a: Evaluator's Report
b: Response to Evaluator's Report

Interdisciplinary Science and Engineering Partnership (ISEP) with Buffalo Public Schools

Year 4: 2014 – 2015

Ohio Evaluation & Assessment Center

MATHEMATICS • SCIENCE • EDUCATION

Evaluation of University at Buffalo/Buffalo Public Schools (UB/BPS) Interdisciplinary Science and Engineering Partnership

Annual Report 2014-2015

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Please cite as follows:

Woodruff, S. B., & Li, Y. (2015). *Evaluation of University at Buffalo/Buffalo Public Schools (UB/BPS) Interdisciplinary Science and Engineering Partnership: Annual report 2014-2015.* Oxford, OH: Miami University, Ohio's Evaluation & Assessment Center for Mathematics and Science Education.

Distributed by Ohio's Evaluation & Assessment Center for
Mathematics and Science Education
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Introduction

Ohio's Evaluation & Assessment Center for Mathematics and Science Education (E & A Center) is the project evaluator for the University at Buffalo/Buffalo Public Schools (UB/BPS) Interdisciplinary Science and Engineering Partnership (ISEP) project. The UB/BPS ISEP project is funded through a Mathematics and Science Partnership (MSP) grant from the National Science Foundation (NSF). Dr. Sarah Woodruff, Miami University, is the Principal Investigator for the evaluation, and Ms. Yue Li is the Senior Statistician and Project Manager for the evaluation.

Project Description

The University at Buffalo (UB)/Buffalo Public Schools (BPS) Interdisciplinary Science and Engineering (ISEP) Partnership project is a National Science Foundation (NSF) Mathematics and Science Partnership project working to establish and sustain a comprehensive partnership that targets middle and high school science and technology, with a focus on strengthening teacher professional development (PD) during the critical transition from middle to high school. This project addresses the critical need (documented nationally and locally) for improved student learning in standard areas of science by enhancing science inquiry knowledge and skills, enabling the implementation of interdisciplinary inquiry-based science teaching across all content standards, and supporting the BPS vision for inquiry-based science and engineering curricula.

The ISEP project has six major goals:

- **GOAL 1:** Improve middle school science teachers' knowledge and skills related to science inquiry through interdisciplinary science research and engineering design with university STEM faculty.
- **GOAL 2:** Increase science teacher quantity, quality, diversity, and retention in urban schools.
- **GOAL 3:** Develop and sustain professional learning communities in urban schools, based on mentoring models, with help from university STEM faculty and graduate students.
- **GOAL 4:** Extend interdisciplinary inquiry based science and engineering learning to high school.
- **GOAL 5:** Improve student achievement in science, attitude toward science-technology-society, and interest in pursuing advanced science studies.
- **GOAL 6:** Improve collaboration in student learning among university, school, and parents.

In order to achieve these goals, UB in collaboration with the Buffalo Public Schools, Buffalo State College, and Buffalo Museum of Science are engaged in the following activities:

- Science and technology teacher professional development with a focus on science inquiry content and pedagogical content knowledge through interdisciplinary science and engineering research and workshops led by UB and BSC STEM faculty and students.
- School-based support for teacher implementation of interdisciplinary inquiry-based science instruction by UB STEM graduate students assigned to BPS classrooms and after-school and weekend science clubs designed to expand student inquiry learning opportunities. Additional support comes from service learning students from UB, BSC, and area colleges. ISEP offerings include summer enrichment and university research internships for BPS students.
- Expanded professional learning communities (PLC) with mentoring relationships among UB STEM faculty members, undergraduate and graduate students, and BPS students and parents.

Additionally, the project conducts research on the processes and conditions in which teachers develop interdisciplinary science inquiry knowledge; how this information may be translated into pedagogical content knowledge that ultimately improves students' science learning; and how professional learning communities may support the development of this pedagogical content knowledge. The project also is studying the impact of associated activities on participating STEM graduate students.

Evaluation

Ohio's Evaluation & Assessment Center for Mathematics and Science Education was contracted to conduct summative, external evaluation activities for the UB/BPS ISEP project. Overarching evaluation efforts focus on assessing progress towards project goals and monitoring project implementation at the project, school, and classroom levels. The E & A Center works closely with the internal evaluation and research team, led by Dr. Xiufeng Liu, to provide formative feedback for project improvement.

The E & A Center employs a mixed methods approach with both formative and summative data collection and analysis. The evaluation design utilizes a combination of pre/post, quasi-experimental, as well as causal comparative quantitative measures; and collects relevant qualitative and descriptive data on project participants, their students, and participating schools. The evaluator also utilizes data and findings provided by the internal evaluation team to create annual reports that synthesize findings from all measures. During project Year 4, the evaluation collected and analyzed quantitative data from ISEP participating teachers, students of ISEP and comparison teachers, BPS students who participated in summer workshops, parents of ISEP teachers' students, and UB STEM graduate and undergraduate students.

The external summative evaluation plan submitted with the project's proposal to the NSF was last updated in June 2014 to ensure coordination of ISEP project activities, internal research/evaluation, and the external evaluation. This plan will continue to be modified in response to emerging needs or changes in project plans. Table 1 shows an updated timeline of annual evaluation activities.

Table 1. *E & A Center Annual Evaluation Activities and Timeline, 2014 - 2016*

Evaluation Activity	**Jul - Sept**	**Oct – Dec**	**Jan - Mar**	**Apr - Jun**
Administer Teacher Questionnaire	**X (pre)**			**X (post)**
Analyze pre/post Teacher Questionnaire	**X**			
Administer BPS Student Questionnaire		**X (pre)**		**X (post)**
Analyze pre/post BPS Student Questionnaire Data	**X**			
Administer STEM Student Questionnaire		**X (Sem 1)**		**X (Sem 2)**
Analyze STEM Student Questionnaire Data	**X (Sem 2)**		**X (Sem 1)**	
Administer Teacher CK/PCK instrument (ISEP Research Team)	**X (pre/post)**			
Test Teacher CK/PCK instrument	**X**			
Administer Parent PLC instrument	**X**	**X**	**X**	**X**
Analyze Parent PLC instrument				**X**
Collect School/Teacher-level Data				**X**
Administer Student Summer Experience Questionnaire	**X**			

Analyze Student Summer Experience Questionnaire		x		

During Year 4 of the project, the E & A Center and ISEP Project Team communicated via email, conference calls, and face-to-face meetings to discuss the progress of the evaluation and project. External evaluation activities conducted this year include: (a) researching/testing evaluation instruments; (b) administering online instruments for teacher participants and UB STEM students; (c) administering paper instruments for student participants; (d) collecting school-level demographic data; (e) analyzing data from project instruments; and (f) preparing and submitting the Year 4 annual evaluation report.

Participants

Participants in the evaluation of the ISEP project include Buffalo Public School, elementary, middle, and high school teachers from the 12 participating ISEP schools, their students in Grades 4 through 12, parents of the teachers' students, as well as University at Buffalo and Buffalo State College STEM faculty, undergraduate students, and graduate students. Other key informants include BPS district and building administrators, ISEP project personnel, and non-participating BPS elementary, middle, and high school teachers and their students.

Instruments

UB/BPS ISEP Teacher Questionnaire (Summer 2014)

The *UB/BPS ISEP Teacher Questionnaire* was developed with permission from instruments previously used in NSF and USDOE MSP projects and in DRK12 projects.[1] In Summer 2014, the questionnaire was used to collect data from two groups of teachers: 1) teachers who had participated in ISEP since Summer 2012 or Summer 2013, and 2) teachers who began participating in ISEP in Summer 2014 and completed the questionnaire before their participation in project activities. Summer 2014 Teacher Questionnaire data serves as post-questionnaire data for the first group and as pre-questionnaire data for the second group.

The teacher questionnaire is composed of 157 items for Teacher Group 1 as a post-questionnaire and 212 items for Group 2 as pre-questionnaire. The Group 1 Teacher Questionnaire has 6 sections. The Demographic section contained 20 items asking for comprehensive demographics, including teachers' professional development history. Items in this section were modified with permission from RMC Research (2009). The remaining 5 sections were exactly the same as the Summer 2012 and Summer 2013 version, except that the last section was changed in Summer 2014 from "Attitudes and Beliefs

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[1] Lederman, N. G. (2006). Syntax of Nature of Science within inquiry and science instruction. In L. B. Flick and N. G. Lederman (Eds.), *Scientific inquiry and Nature of Science* (pp. 301-317). Netherlands: Springer.
National Research Council. (2000). *Inquiry and the National Science Education Standards: A guide for teaching and learning.* Washington, DC: The National Academies Press.
Liang, L. L., Chen, S. Chen, X., Kaya, O. N., Adams, A. D., Macklin, M., & Ebenezer, J. (2008). Assessing preservice elementary teachers' views on the nature of scientific knowledge: A dual-response instrument. *Asia-Pacific Forum on Science Learning and Teaching, 9*(1), 1-19.
National Science Teachers Association (2000). *The Nature of Science—A position statement of NSTA*. Washington, DC.
McGinnis, J. R., Kramer, S., Shama, G., Graeber, A. O., Parker, C. A., & Watanabe, T. (2002). Undergraduates' attitudes and beliefs about subject matter and pedagogy measured periodically in a reform-based mathematics and science teacher preparation program. *Journal of Research in Science Teaching, 39*(3), 713-737.
Yasar, S., Baker, D., Robinson-Kurpius, S., Krause, S., & Roberts, C. (2006). Development of a survey to assess K-12 teachers' perceptions of engineers and familiarity with teaching design, engineering, and technology. *Journal of Engineering Education*, 205-216.
National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: The National Academies Press.
RMC Research. (2009). *Needs Assessment Survey for evaluation of the Nebraska Mathematics and Science Partnership projects.* Denver, CO: Author.

about Teaching Science and Mathematics" to "Attitudes and Beliefs about Teaching Science." Ten items regarding attitudes and beliefs regarding teaching mathematics were excluded from this section for two reasons. First, the majority of teachers responding to this questionnaire did not teach mathematics; therefore, the number of responses to this set of items was much smaller than the overall number of responses. Secondly, factor analysis using Summer 2012 and Summer 2013 data showed that these items did not group together as one integrated factor; therefore, the underlining constructs represented by these items were not clearly defined.

Compared to the Group 1 Teacher Questionnaire, this instrument for Group 2 Teachers was composed of 7 sections with 28 demographic items and one additional section at the end regarding teachers' use of literacy in science teaching. This last section contained 15 items on a 5-point Likert-type scale, with responses ranging from *strongly disagree* (1) to *strongly agree* (5), asking about participants' knowledge, value and practice of Common Core State Standards (CCSS) for ELA. Items in this section were developed by the ISEP research team.

A full description of this instrument, factor analysis, and reliability results can be found in the *Evaluation of University at Buffalo/Buffalo Public Schools (UB/BPS) Interdisciplinary Science and Engineering Partnership: Annual Report 2012-2013* (Woodruff & Li, 2013). This questionnaire can be found in Appendix A.

UB/BPS ISEP Teacher Pedagogical Content Assessment (PCK) Assessment (July 2013 [pre] and May/July 2014 [post])

The ISEP research team used the following 7 instruments to collect pre and post data on teacher pedagogical content knowledge and knowledge of interdisciplinary science inquiry teaching:[2]

- *Elementary School Pedagogical Content Knowledge (PCK) Assessment (General Science)* consists of 8 multiple-choice questions regarding classroom science teaching vignettes and 4 open-ended questions about Interdisciplinary Science Inquiry teaching. It was developed by the ISEP research team and the evaluation team using a modified version of Schuster and Cobern's POSTT,[3] with permission, based on input from inservice teachers, results of observations of teaching, and science curriculum standards.
- *Middle School PCK Assessment (General Science)* consists of 8 multiple-choice questions regarding classroom science teaching vignettes and 4 open-ended questions about Interdisciplinary Science Inquiry teaching. It was developed by the ISEP research team and the evaluation team using a modified version of Schuster and Cobern's POSTT, with permission. It was based on input from in-service teachers, results of observations of teaching, and science curriculum standards.
- *Biology PCK Assessment* consists of 29 multiple-choice items from ATLAST Flow of Matter and Energy[4] and 4 open-ended questions about Interdisciplinary Science Inquiry teaching developed by the ISEP research team.
- *Chemistry PCK Assessment* consists of 30 items from AIM Teacher Assessment Form M4: Properties of and Changes in Matter[5] and 4 open-ended questions about Interdisciplinary Science Inquiry teaching developed by the ISEP research team.

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[2] The *Biology, Chemistry, Earth Science, Engineering/Physics, and Physics PCK Assessments* were used, with permission, from the Assessing Teacher Learning About Science Teaching (ATLAST) project at Horizon Research, Inc. ATLAST is funded by the National Science Foundation under grant number DUE-0335328.
[3] Schuster, D. & Cobern, W. W. (2007). *The pedagogy of science teaching test (POSTT).* Western Michigan University, Mallison Institute for Science Education: Kalamazoo, MI.
[4] Horizon Research, Inc. (2011). *ATLAST Flow of Matter and Energy.* Chapel Hill, NC: Author.
[5] Horizon Research, Inc. (2011). *AIM Teacher Assessment, Form M4: Properties of and Changes in Matter*. Chapel Hill, NC: Author.

- *Earth Science PCK Assessment* consists of 30 items from ATLAST Plate Tectonics[6] and 4 open-ended questions about Interdisciplinary Science Inquiry teaching developed by the ISEP research team.
- *Engineering & Physics PCK Assessment* consists of 29 items from ATLAST Force and Motion[7] and 4 open-ended questions about Interdisciplinary Science Inquiry teaching developed by the ISEP research team.

All instruments used or modified for use in the ISEP project were used with permission.

UB/BPS ISEP Student Questionnaire (Fall 2013, Spring 2014 and Fall 2014)

The *UB/BPS ISEP Student Questionnaire* was developed by the E & A Center, with input from the ISEP Research Team, from instruments previously used in NSF as well as USDOE MSP and DRK12 projects evaluated by the E & A Center. This questionnaire collected data from elementary, middle, and high school students of ISEP participant and comparison teachers in Fall 2013 (pre for 2013-2014), Spring 2014 (post for 2013-2014), and Fall 2014 (pre for 2014-2015). This instrument has two versions, one for elementary and middle school students (Grades 5-8, ES/MS) and the other for high school students (Grades 9-12, HS). A full description of this instrument, factor analysis, and reliability results can be found in the *Evaluation of University at Buffalo/Buffalo Public Schools (UB/BPS) Interdisciplinary Science and Engineering Partnership: Annual Report 2013-2014* (Woodruff & Li, 2014). Table 2 shows the internal consistency reliability results for Fall 2013 and Spring 2014 data. Overall, Cronbach's alpha values showed that the four attitudinal subscales had high reliabilities and the two content knowledge assessments were moderately reliable. Both ES/MS and HS Fall 2014 versions of this instrument can be found in Appendix B.

Table 2. *Reliability of UB/BPS ISEP Student Questionnaire Subscale, Fall 2013 and Spring 2014*

		Fall 2013		Spring 2014	
Subscale	**# of Items**	***n***	**Cronbach's Alpha**	***n***	**Cronbach's Alpha**
My opinion about science	12	746	.783	665	.779
What teachers do in classrooms	12	759	.845	655	.864
What students do in classrooms	12	726	.849	652	.875
Parental/adult support at home	7	784	.787	672	.819
Content Knowledge for Elementary and Middle School	20	500	.622	414	.694
Content Knowledge for High School	20	342	.578	271	.686

UB/BPS ISEP STEM Student Questionnaire (Spring 2014 and Fall 2014)

The *UB/BPS ISEP STEM Student Questionnaire* collected data from UB STEM graduate and undergraduate students who participated in project activities in Spring 2014 and Fall 2014. The instrument was developed by Dr. Liu, internal evaluator and researcher for the ISEP project, and was administered online

[6] Horizon Research, Inc. (2011). *ATLAST Plate Tectonics*. Chapel Hill, NC: Author.
[7] Horizon Research, Inc. (2011). *ATLAST Force and Motion.* Chapel Hill, NC: Author.

to new and returning UB STEM students by the E & A Center in Spring and Fall 2014 using Qualtrics®. The current version of *UB/BPS ISEP STEM Student Questionnaire* contains the following sections and can be found in Appendix C.

Section A contains 1 multiple-choice item asking about students' preparedness for aspects of project activities in schools. Section B contains 1 multiple-choice item asking about students' self-reported experiences in schools. Section C contains 1 multiple-choice item, 14 items on a 4-point Likert-type scale, with responses ranging from *strongly disagree* (1) to *strongly agree* (4), and four items on a 5-point Likert-type scale, with responses ranging from *strongly decreased* (1) to *strongly increased* (5), asking about students' perceived value of project experiences. Section D contains 20 items on a 5-point rating scale, with responses ranging from *nothing* (1) to *a great deal* (5), asking about students' self-efficacy in communicating science. Section E contains 8 items requesting students' comprehensive demographics, experiential history, and career plan data.

UB/BPS MSP ISEP Student Summer Experience Questionnaire (Summer 2013 and Summer 2014)

The *UB/BPS MSP ISEP Student Summer Experience Questionnaire* collected data from students who attended summer experiences funded by ISEP in Summer 2013 and Summer 2014. The instrument was developed by the E & A Center with input from the ISEP project team. It contained 12 demographic items; 12 items on a 5-point rating scale, with responses ranging from *almost never* (1) to *very often* (5), asking about students' summer research experience; 15 items on a 5-point rating scale, with responses ranging from *no gain* (1) to *very large gain* (5), asking how students had benefited from this experience;[8] and 14 items on a 5-point Likert-type scale, with responses ranging from *strongly disagree* (1) to *strongly agree* (5), asking students' future career plans. The *UB/BPS MSP ISEP Student Summer Experience Questionnaire* can be found in Appendix D.

UB/BPS MSP ISEP Parent-Based PLC Questionnaire (Spring 2014 – Spring 2015)

The *UB/BPS MSP ISEP Parent-Based PLC Questionnaire* collected data from parents of students who were enrolled in the 12 ISEP participating schools from Spring 2014 through Spring 2015. The instrument was developed by the E & A Center with input from the ISEP project team. It contained 3 demographic items, 4 yes/no items, and 5 open-response items asking parents' perceptions of the parent-based PLC and expectations for their children's science education. The *UB/BPS MSP ISEP Parent-Based PLC Questionnaire* can be found in the *Evaluation of University at Buffalo/Buffalo Public Schools (UB/BPS) Interdisciplinary Science and Engineering Partnership: Annual Report 2013-2014* (Woodruff & Li, 2014), Appendix E.

Data Collection

School-Level Enrollment and Report Card Data

School-level enrollment and report card data for each of the 12 ISEP partner schools were collected for the 2010-2011 and 2011-2012 school years from the New York State Education Department (NYSED) Website (http://data.nysed.gov/lists.php?type=school) and were reported in the *Evaluation of University*

[8] Items on this subscale are adapted with permission from SURE III Survey (2010), Dr. David Lopatto, Grinnell College, with support of the Howard Hughes Medical Institute.

at Buffalo/Buffalo Public Schools (UB/BPS) Interdisciplinary Science and Engineering Partnership: Annual Report 2013-2014 (Woodruff & Li, 2014).

Since the 2012-2013 school year, NYSED changed the school report card system and made the school, teacher, and student data more publicly accessible. In Spring 2015, school-level enrollment and report card data for the 2012-2013 and 2013-2014 school years were collected from the New York State Education Department (NYSED) Website (http://data.nysed.gov/) in order to follow the project's progress toward its goals. Data that were not available from the State school report cards or through the publically accessible BPS website database were requested from the BPS central office, annually, since in June 2012 but have not yet been delivered.

UB/BPS ISEP Teacher Questionnaire

Two online versions of the *UB/BPS ISEP Teacher Questionnaire* (one for each teacher group) were administered by Ohio's Evaluation and Assessment Center using Qualtrics®. The link to the instrument was sent on June 11, 2014 (with an invitation to participate in the questionnaire) to the teacher groups participating in the ISEP summer institute, and the questionnaires remained active online until July 25, 2014. Of the 100 teachers who participated in Summer 2012, Summer 2013, and/or Summer 2014 PD activities, 24 responded to this questionnaire (12 returning teachers and 12 new ISEP teachers). The overall response rate was approximately 24%. Table 3 shows the response rate for each teacher group.

Table 3. *Response Rate by Teacher Group, UB/BPS ISEP Teacher Questionnaire, Summer 2014*

Group	Number of Teachers Involved in ISEP*	Number of Responses Received	Response Rate
Participated since Su2012 or Su2013	57	12	21%
New to ISEP in Su2014	43	12	28%
Total	**100**	**24**	**24%**

* Email invitations were sent out based on an early draft of Summer 2014 ISEP Research placement plan. Therefore, actual numbers of teachers involved in ISEP might be slightly different.

UB/BPS ISEP Teacher PCK Assessment (Summer 2013 and Summer 2014)

The *UB/BPS ISEP Teacher PCK Assessment* instruments were administered in hard copy by the ISEP research team to teachers in July 2013 during their orientation sessions for Summer 2013 PD (pre) and in May or July 2014 (post).

UB/BPS ISEP Student Questionnaire (Fall 2013, Spring 2014, Fall 2014)

Hard copies of the *UB/BPS ISEP Student Questionnaire* were administered to students of ISEP participant and comparison teachers, at the 12 ISEP partner schools, in Fall 2013, Spring 2014, and Fall 2014. Fall 2013 data served as pre-data for the 2013-2014 school year; Spring 2014 data served as post-data for the 2013-2014 school year. Fall 2014 data served as pre-data for the 2014-2015 school year. Spring 2015 data were being collected at the time of this report. Of the 69 teachers who received this instrument (50 ISEP and 19 comparison teachers) in Fall 2013, 43 returned completed student instruments (34 ISEP and 9 comparison teachers, n_{student} = 892). Of the 67 teachers who received this instrument (50 ISEP and 17 comparison teachers) in Spring 2014, 39 returned completed student instruments (32 ISEP and 7 comparison teachers, n_{student} = 764). Of the 55 teachers who received this instrument (45 ISEP and 10 comparison teachers) in Fall 2014, 33 returned completed student instruments (29 ISEP and 4 comparison teachers, n_{student} = 717).The response rates were 62% in Fall 2013, 58% in Spring 2014, and 60% in Fall 2014, based on the number of teachers who were contacted.

UB/BPS ISEP STEM Student Questionnaire (Spring 2014 and Fall 2014)

The *UB/BPS ISEP STEM Student Questionnaire* was administered online by the E & A Center to new and returning UB STEM students at the end of Spring 2014 and Fall 2014 using Qualtrics®. Twelve STEM students completed this questionnaire in Spring 2014 and 24 completed it in Fall 2014.

UB/BPS MSP ISEP Student Summer Experience Questionnaire (Summer 2013 and Summer 2014)

The *UB/BPS MSP ISEP Student Summer Experience Questionnaire* was administered by ISEP project personnel to students who participated in ISEP summer experiences in Summer 2013 at one site and in Summer 2014 at four sites. Table 4 shows the number of responses from each site each year. Fourteen students participated in both Summer 2013 and Summer 2014 activities at the Riverside site.

Table 4. *Number of Responses by Site, UB/BPS MSP ISEP Student Summer Experience Questionnaire, Summer 2013 and Summer 2014*

Site	Summer 2013	Summer 2014	Total
Riverside	42	33	75
Cradle Beach	0	61	61
GIS	0	11	11
UB Chemistry	0	7	7
Total	**42**	**112**	**154**

UB/BPS MSP ISEP Parent-Based PLC Questionnaire (Spring 2013-Spring 2014)

The *UB/BPS MSP ISEP Parent-Based PLC Questionnaire* was administered by ISEP project personnel to parents who participated in parent-based PLC sessions between June 2014 and May 2015. Based on communication between the evaluator and ISEP project personnel, the parent group met monthly during the 2014-2015 school year. On average, 10-20 parents attended each monthly meeting. Two larger events were hosted by the ISEP project during this school year, an ISEP Parent PLC Retreat on August 16, 2014 and the ISEP Second Annual Parent PLC Social Justice Conference on January 17, 2015. Approximately 40-50 parents attended each event. However, only a small number of parents completed the questionnaire during these meetings or events. ISEP project personnel indicated that there is a need to revise the current questionnaire. Instead of asking parents' perceptions of the parent-based PLC and expectations for their children's science education, the purpose of this instrument will shift to measure the impact of PLC sessions on parents and their students at this stage of the project. The evaluator and ISEP project personnel will revise this instrument together and administer it in upcoming parent-based PLC meetings.

Data Analysis

School-Level Enrollment and Report Card Data

Descriptive statistics (e.g., frequencies and percentages) were used to report year-to-year changes between baseline (2010-2011) and the most up-to-date school-level data (2013-2014).

UB/BPS ISEP Teacher Questionnaire

Wilcoxon signed-rank tests were conducted to compare teachers' responses to the *UB/BPS ISEP Teacher Questionnaire* between Summer 2012 or Summer 2013 (pre) and Summer 2014 (post) for those teachers who responded to this questionnaire at both time points. Baseline findings from the *UB/BPS ISEP Teacher*

Questionnaire for those teachers who were new to ISEP since Summer 2014 are not reported in this report.

As shown in Table 5, of the 12 returning teachers who responded the questionnaire in Summer 2014: 4 responded to the questionnaire all three summers; 4 responded in Summer 2012 and Summer 2014; 1 participated in Summer 2012 but only responded to the survey in Summer 2013; 2 began to participate in ISEP in Summer 2013; and 1 did not complete the questionnaire in Summer 2012 nor Summer 2013. Therefore, 8 of the 11 matched teachers responded to the pre-questionnaire in Summer 2012 and 3 responded in Summer 2013. Pre-post comparisons were conducted using the earliest available pre-responses and Summer 2014 as post-responses to capture the maximum project impact.

Table 5. *Number of ISEP Teacher Responses, UB/BPS ISEP Teacher Questionnaire, Summer 2012, Summer 2013, and Summer 2014*

	Responding to Survey in Summer 2012		**Responding to Survey in Summer 2013**		**Responding to Survey in Summer 2014**	
70 Participated in ISEP Since Summer 2012	**Yes**	**46**	**Yes**	**17**	**Yes**	**4**
					No	13
			No	29	**Yes**	**4**
					No	25
	No	24	**Yes**	**3**	**Yes**	**1**
					No	2
			No	21	**Yes**	**1**
					No	20
17 Participated in ISEP Since Summer 2013			**Yes**	**8**	**Yes**	**2**
					No	6
			No	9	**Yes**	**0**
					No	0
43 Participated in ISEP Since Summer 2014					**Yes**	**12**
					No	31

Factor analysis and reliability testing results using data collected in Summer 2012 and Summer 2013 suggested that these data were not ready to be reported at the latent variable level. That is, no factor or subscale scores were generated either from the raw scores nor using Item Response Theory (the Rasch Model) at this stage. The next round of factor analysis will be conducted using Summer 2012, Summer 2013, and Summer 2014 data. Latent variables will be constructed and inferential statistical analyses will be conducted based on the next round of factor analysis results to test the impact of the ISEP project. For now, all analyses of teacher questionnaire data were conducted at the item level.

UB/BPS ISEP Teacher PCK Assessment (Summer 2013 and Summer 2014)

Table 6 shows the number of responses received in each year and the number of pre and post matched responses to teacher PCK assessments administered by the project. Findings from the *Summer 2013 and Summer 2014 UB/BPS ISEP Teacher PCK Assessment* data will be reported by the ISEP research team.

Table 6. *Number of ISEP Teacher Responses by Content Subject, UB/BPS ISEP Teacher PCK Assessment, Summer 2013 and Summer 2014*

Instrument	# of Items	# of Respondents 2013 (pre)	# of Respondents 2014 (post)	Pre-Post Matched
Biology	29	27	21	20
Chemistry	30	4	6	3
Earth Science	30	6	7	5
Engineering/Physics	29	8	9	7
Elementary School Science	8	11	6	6
Middle School Science	8	13	28	11
Total		**69**	**77**	**52**

Due to small sample sizes for each content assessment, the E & A Center could not perform full item analysis. However, item difficulty was examined for each instrument using 2013-2014 pre- and post-data. The four high school subjects, i.e., Biology, Chemistry, Earth Science, and Engineering & Physics, all had easy to moderate overall difficulty levels with a reasonably wide range of item difficulty levels. For example, the overall percentage of correct responses for the *Biology Teacher PCK Assessment* was 61% for the pre-assessment, with a 22% correct rate for the hardest item and 89% for the easiest. The overall percentage of correct responses increased to 66% for the post-assessment, with a 19% correct rate for the hardest item and 90% for the easiest. However, the *Elementary* and the *Middle School Science Teacher PCK Assessments* were more difficult than were the high school assessments. Overall, the percentage of correct responses for the *Elementary School Science Teacher PCK Assessment* was 26% for the pre- and 25% for the post-test. Of the 8 items, 5 pre-assessment and 4 post-assessment items had lower than 20% item difficulty levels, which means less than 20% of teachers were able to answer these items correctly even after the ISEP intervention. One item had no correct responses on the pre- or post-assessment. The *Middle School Science Teacher PCK Assessment* was in a similar but less extreme situation. This indicates a need to reexamine the way elementary and middle school assessments were scored and how the PD addressed these PCK issues. Complete findings of this analysis can be found in Appendix E, Tables E1 through E6.

UB/BPS ISEP Student Questionnaire (Fall 2013 and Spring 2014)

Ideally, ANOVA analysis should be conducted to compare post-responses of students of ISEP participant teachers and non-ISEP peers, using students' pre-responses as a covariate variable to control initial perception differences. However, only 9 elementary school and 8 high school students of comparison teachers could be matched from pre- to post-questionnaires during 2013-2014. The extremely imbalanced sample sizes do not allow ANOVA tests between ISEP and comparison groups. Instead, paired-samples *t*-tests were conducted to compare students' responses to the *UB/BPS ISEP Student Questionnaire* before (Fall 2013) and after (Spring 2014) their teachers' participation in ISEP activities for elementary, middle, and high school students, separately. When sample sizes allowed, independent-samples *t*-tests were conducted to compare ISEP students' responses to the *UB/BPS ISEP Student Questionnaire* to the response of students of comparison teachers in Spring 2014 (post).

Factor analysis and reliability testing results using data collected in Spring 2013 suggested that these data were not ready to be reported at the latent variable level. That is, no factor or subscale scores were generated either from the raw scores or using Item Response Theory (the Rasch Model) at this stage. For now, all analyses of student questionnaire data were conducted at the item level.

UB/BPS ISEP STEM Student Questionnaire (Spring 2014 and Fall 2014)

Descriptive statistics (e.g., frequencies and percentages) were used to report findings from the *UB/BPS ISEP STEM Student Questionnaire*. Independent-samples *t*-tests were used to conduct comparisons at the item level between responses of STEM undergraduate and STEM graduate students. Due to small sample sizes, non-parametric tests (i.e., Mann-Whitney *U*-test) were used to conduct comparisons at the item level between responses of STEM graduate students who participated in the ISEP project for more than 1 year and those who were new to the project. Data collected in Spring 2015 will be reported in the next annual evaluation report.

UB/BPS MSP ISEP Student Summer Experience Questionnaire (Summer 2013 and Summer 2014)

Descriptive statistics (e.g., frequencies and percentages) were used to report findings from the *UB/BPS MSP ISEP Student Summer Experience Questionnaire*. Independent-samples *t*-tests were used to conduct comparisons at the item level between the responses of Summer 2013 and Summer 2014 student participants. Wilcoxson signed-rank tests were conducted to compare the 14 matched students' responses post-Summer 2013 and post-Summer 2014 experiences at the Riverside site.

A significance level of $p < .05$ was chosen for all inferential statistical tests.

Findings

School-Level Enrollment and Report Card Data (2010-2011 to 2013-2014)

School-level data were collected and analyzed to compare aggregate teacher information, student demographics, and middle/high school student performance data for each ISEP partner school in 2010-2011, 2011-2012, 2012-2013, and 2013-2014.

Since aggregated information exclusively for science teachers is not available on the New York State School Report Card or other publicly available data sources, information were reported for all teachers in the building. From 2010-2011 to 2013-2014, the percentage of teachers teaching without an appropriate license/certificate decreased at 5 of the 12 ISEP partner schools; the percentage of teachers with a Master's plus 30 hours or doctorate degree increased at 6 schools; the percentage of core courses not taught by highly qualified teachers decreased at 6 schools; 5 schools had all core courses taught by highly qualified teachers; the turnover rate of teachers with fewer than 5 years of experience decreased at 8 schools and remained the same at 1 other school; and the turnover rate for all teachers decreased at 7 schools (Appendix F, Table F1).

Between 2010-2011 and 2013-2014, the percentage of White students decreased across the state of New York, across the BPS District, and at 6 of the 12 ISEP partner schools. The percentage of students eligible for free or reduced lunch increased at the state level, remained relatively constant at the district level and in the 12 ISEP partner schools, although all ISEP partner schools had much higher percentages of students eligible for free or reduced lunch than the state average (Appendix F, Tables F2 and F3).

For the 7 ISEP partner high schools, 5 had graduation rates lower than the BPS District average and only 1 was higher than the New York State average in 2013-2014. There were no obvious patterns of change regarding graduation rates for students in racial/ethnical or gender subgroups (Appendix F, Table F3).

In 2013-2014, 1 middle school and 2 high schools showed relatively large decreases in the percentage of students meeting or exceeding New York State Standards in Grade 8 Science, Regents Earth Science, and/or Regents Chemistry (Appendix F, Tables F2 and F3).

UB/BPS ISEP Teacher Questionnaire Data, Summer 2013 and Summer 2014

Demographics

Eleven teachers responded to the *UB/BPS ISEP Teacher Questionnaire* in Summer 2012 or Summer 2013 before starting ISEP summer activities and again in Summer 2014 at the end of the 2013-2014 school year. Together, 719 students were taught by these teachers in science classes during the 2013-2014 school year. Demographic frequencies were calculated as shown in Tables 7 to 12. Table 7 shows that 82% of these matched teacher respondents were White and 55% were female.

Table 7. *Respondents' Race and Gender, Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012/Summer 2013*

Race/Ethnicity	Female	Male	Total
Asian	1	0	1 (9%)
Multi-racial	0	1	1 (9%)
White	5	4	9 (82%)
Total (%)	**6 (55%)**	**5 (45%)**	**11 (100%)**

Table 8 shows that all ISEP teachers were teaching science during the 2013-2014 school year and 45% were special education teachers. As shown in Table 9, 73% of teachers were certified to teach science.

Table 8. *Respondents' Position/Subject Taught During 2013-2014, Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2014*

Taught During 2013-2014	*N*	Percent
Science	11	100%
Mathematics	3	27%
Special Education Teacher	5	45%

Note. Teachers could choose more than one subject.

Table 9. *Respondents' Teaching Credential, Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012/Summer 2013*

Teaching Credential	*N*	Percent
Certified to Teach Science	8	73%
Certified to Teach Mathematics	3	27%
Hold Special Education Certificate	5	45%

Note. Not all teachers responded to this item.

Most teachers reported that they had more than 14 years of K-12 teaching experience and had been teaching in their current schools for 10 years (Table 10). Most ISEP teachers taught at the high school level and taught Living Environment, Earth Science, or Environmental Science in 2013-2014 (Table 11).

Table 10. *Respondents' Teaching Experience, Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012/Summer 2013*

Years of Experience	*n*	*M*	*SD*	Minimum	Median	Maximum
Teaching in a K-12 school	11	14	5	6	14	24
Teaching in K-12 Math	6	9	4	2	10	12
Teaching in K-12 Science	10	13	5	6	12	24
Teaching in Current School	11	10	3	5	10	13

Table 11. *Subject Area Taught by Respondents, Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2014*

Courses Taught During 2013-2014	*n*	Percent
3rd Grade Science	1	9%
6th Grade Science	1	9%
7th Grade Physical Science	1	9%
8th Grade Life Science	1	9%
Regents Living Environment	7	64%
Regents Earth Science	4	36%
Regents Chemistry	1	9%
High School Biology and Lab	1	9%
High School Environmental Science	2	18%
High School AP Biology	1	9%
Anatomy Physiology	1	9%
7th and 8th Grade Social Studies	1	9%

Note. Teachers could choose more than one subject.

Most teachers also reported moderate to high levels of participation in ISEP professional development activities focused on content or pedagogy in 2013-2014. In addition, teachers reported that they had participated in an average of 45 hours of professional development activities outside of PD courses or activities with UB and/or BSC in 2013-2014, as shown in Table 12.

Table 12. *Amount of PD Hours in 2013-2014, Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2014*

UB/BSC ISEP PD Hours on…	*n*	*M*	*SD*	Minimum	Median	Maximum	Sum
Content	8	99	166	3	35	500	795
Assessment	4	46	41	2	40	100	182
Curriculum	8	102	169	6	21	500	818
Pedagogy	7	86	183	4	10	500	600
Non-UB/BSC PD Hours	10	45	32	0	45	100	446

Science Preparation and Professional Development Needs

Table 13 shows ISEP teachers' self-reported preparedness for science instruction. Teachers indicated that they were significantly better prepared to teach students who have a learning disability impacting science learning and to teach interdisciplinary science inquiry. In addition, although not statistically significant, teachers reported better preparedness for inquiry science instruction on 13 other items, including managing a class of students using hands-on or laboratory activities, leading a class using investigative strategies, taking into account students' prior conceptions when planning instruction, knowing major unifying concepts of all sciences and how these concepts relate to other disciplines, and teaching science to students from a variety of cultural backgrounds.

Table 13. *Respondents' Preparedness for Science Instruction, Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012/Summer 2013 and Summer 2014*

Q30. Please indicate how well prepared you feel to do each of the following.	Time	*n*	*M*	*SD*	Wilcoxon Signed Rank Test *p*
a. Provide science instruction that meets appropriate standards (district, state, or national).	Pre	9	3.33	0.71	.655
	Post	9	3.22	0.83	
b. Teach scientific inquiry.	Pre	9	2.89	0.93	.414
	Post	9	3.11	0.93	
c. Manage a class of students who are using hands-on or laboratory activities.	Pre	9	2.78	0.83	.059
	Post	9	3.33	0.87	
d. Lead a class of students using investigative strategies.	Pre	9	2.44	0.88	.053
	Post	9	3.22	0.83	
e. Take into account students' prior conceptions about natural phenomena when planning instruction.	Pre	9	2.33	0.87	.098
	Post	9	3.22	0.83	
f. Align standards, curriculum, instruction, and assessment to enhance student science learning.	Pre	9	3.00	0.71	.655
	Post	9	3.11	0.78	
g. Sequence (articulation of) science instruction to meet instructional goals across grade levels and courses.	Pre	9	2.78	1.09	.861
	Post	9	2.78	1.09	
h. Select and/or adapt instructional materials to implement	Pre	9	2.67	1.00	.107

your written curriculum.	Post	9	3.33	0.71	
i. Know the major unifying concepts of all sciences and how these concepts relate to other disciplines.	Pre	9	2.44	0.88	.096
	Post	9	3.00	0.87	
j. Understand how students differ in their approaches to learning and create instructional opportunities that are adapted to diverse learners.	Pre	9	2.78	0.67	.206
	Post	9	3.22	0.83	
k. Teach science to students from a variety of cultural backgrounds.	Pre	8	2.63	0.92	.096
	Post	8	3.25	0.71	
l. Teach science to students who have limited English proficiency.	Pre	8	2.25	1.04	.157
	Post	8	2.75	1.28	
m. Teach students who have a learning disability which impacts science learning.	Pre	9	2.56	0.88	**.034**
	Post	9	3.22	0.83	
n. Encourage participation of females and minorities in science courses.	Pre	9	3.00	0.50	.180
	Post	9	3.33	0.50	
o. Provide a challenging curriculum for all students you teach.	Pre	9	3.00	1.00	.527
	Post	9	3.22	0.67	
p. Learning the processes involved in reading and how to teach reading in science.	Pre	8	2.88	1.13	1.000
	Post	8	2.88	1.13	

Q30. Please indicate how well prepared you feel to do each of the following.	Time	*n*	*M*	*SD*	Wilcoxon Signed Rank Test *p*
q. Use a variety of assessment strategies (including objective and open-ended formats) to inform practice.	Pre	8	3.00	0.76	1.000
	Post	8	3.00	0.76	
r. Use a variety of technological tools (student response systems, lab interfaces and probes, etc) to enhance student learning.	Pre	8	2.75	0.71	.317
	Post	8	3.00	0.76	
s. Teach interdisciplinary science inquiry.	Pre	7	2.43	0.79	**.025**
	Post	7	3.14	0.69	

Teachers were asked to report on their own needs for professional development prior to and following participation in the ISEP project. Before participating in ISEP activities, teachers indicated higher priority professional development needs related to aspects of science teaching closely aligned with NGSS cross-cutting concepts (i.e., scale, proportion, and quantity) than they did following 1 year of participation in ISEP. On the other hand, teachers reported higher priority professional development needs related to some aspects of inquiry teaching (i.e., abilities needed to do scientific inquiry) and practices of science and engineering (i.e., construct explanations and design solutions) after their participation as shown in Appendix G, Table G1.

Pedagogical Content Knowledge (PCK) Assessment

The ISEP research team used 7 instruments to collect pre and post data on teacher pedagogical content knowledge and knowledge of interdisciplinary science inquiry teaching. Two of these instruments, the *Elementary School PCK Assessment* and *Middle School PCK Assessment,* consisted of 8 multiple-choice questions regarding classroom science teaching vignettes that demonstrate different approaches to inquiry teaching. Response options for these 8 items represent teacher-directed (primarily didactic) to student-directed (primarily open inquiry) approaches. Teachers' assessment scores when these items were scored "right or wrong" based upon the teacher either selecting the most student-directed inquiry approach (the key) or any of the remaining 3 responses are shown in Table 15 for elementary teachers and in Table 16 for middle grades teachers.

In order to explore teachers' growth with respect to implementing inquiry in their classrooms, the external evaluation team re-scored the assessments of 6 matched elementary and 11 matched middle grades teachers on pre- and post-assessments using a 1 to 4 scale. In this scoring scheme, 1 represented the least inquiry-oriented teaching approach and 4 represented the most inquiry-oriented teaching approach. Also shown in Tables 14 and 15 are teachers' pre and post-assessment scores using the 4-point ranking scale with responses representing more student-directed inquiry approaches scoring higher than those that represent more teacher-directed approaches.

Table 14. *Two Views of Change in Elementary Teachers Pedagogical Content Knowledge, Summer 2013 and Summer 2014*

Item	**Year**	***n***	***M***	***SD***	**Mean Difference**	**Wilcoxon Signed-Rank Test *p***
Results of Assessment Scored Right or Wrong						
G1	2013	6	0.00	0.00	-0.17	.317
	2014	6	0.17	0.41		
G2	2013	6	0.00	0.00	-0.33	.157
	2014	6	0.33	0.52		
G3	2013	6	0.33	0.52	0.00	1.000
	2014	6	0.33	0.52		
G4	2013	6	0.33	0.52	0.17	.317
	2014	6	0.17	0.41		
G5	2013	6	0.00	0.00	0.00	1.000
	2014	6	0.00	0.00		
G6	2013	6	0.50	0.55	0.00	1.000
	2014	6	0.50	0.55		
G7	2013	6	0.00	0.00	0.00	1.000
	2014	6	0.00	0.00		
G8	2013	6	0.67	0.52	0.17	.655
	2014	6	0.50	0.55		
Total Correct (Max = 8)	2013	6	1.83	1.17	-0.17	.783
	2014	6	2.00	0.89		
Percentage Correct	2013	6	23%	0.15	-0.02	.783
	2014	6	25%	0.11		
Results of Assessment Scored with a 4-Point Rating Scale						
I1	2013	6	2.33	0.52	0.17	.655
	2014	6	2.17	1.17		
I2	2013	6	2.83	0.41	-0.33	.317
	2014	6	3.17	0.75		
I3	2013	6	2.83	0.98	-0.33	.414
	2014	6	3.17	0.75		
I4	2013	6	2.83	1.17	-0.33	.414
	2014	6	3.17	0.41		
I5	2013	6	2.67	0.82	0.00	1.000
	2014	6	2.67	0.82		
I6	2013	6	3.17	1.17	-0.17	.655
	2014	6	3.33	0.82		

Item	Year	*n*	*M*	*SD*	Mean Difference	Wilcoxon Signed-Rank Test *p*
Results of Assessment Scored with a 4-Point Rating Scale						
I7	2013	6	2.67	0.52	-0.33	.157
	2014	6	3.00	0.00		
I8	2013	6	3.67	0.52	0.17	.655
	2014	6	3.50	0.55		
Total (Max = 32)	2013	6	23.00	4.20	-1.17	.458
	2014	6	24.17	1.94		
Percentage towards most open inquiry	2013	6	72%	0.13	-0.04	.458
	2014	6	76%	0.06		

Table 15. *Two Views of Change in Middle Teachers Pedagogical Content Knowledge, Summer 2013 and Summer 2014*

Item	Year	*n*	*M*	*SD*	Mean Difference	*t*	*df*	*p*
Results of Assessment Scored Right or Wrong								
G1	2013	11	0.00	0.00	-0.45	-2.89	10	**.016**
	2014	11	0.45	0.52				
G2	2013	11	0.18	0.40	0.00	0.00	10	1.000
	2014	11	0.18	0.40				
G3	2013	11	0.27	0.47	0.09	0.56	10	.588
	2014	11	0.18	0.40				
G4	2013	11	0.09	0.30	0.00	1.49	10	.167
	2014	11	0.09	0.30				
G5	2013	11	0.45	0.52	0.18			
	2014	11	0.27	0.47				
G6	2013	11	0.45	0.52	-0.18	-1.00	10	.341
	2014	11	0.64	0.50				
G7	2013	11	0.64	0.50	0.00	0.00	10	1.000
	2014	11	0.64	0.50				
G8	2013	11	0.64	0.50	0.18	0.80	10	.441
	2014	11	0.45	0.52				
Total Correct (Max = 8)	2013	11	2.73	1.19	-0.18	-0.36	10	.724
	2014	11	2.91	1.51				
Percentage Correct	2013	11	34%	0.15	-0.02	-0.36	10	.724
	2014	11	36%	0.19				

Item	Year	*n*	*M*	*SD*	Mean Difference	*t*	*df*	*p*
Results of Assessment Scored with a 4-Point Rating Scale								
I1	2013	11	2.45	0.52	-0.73	-3.73	10	**.004**
	2014	11	3.18	0.87				
I2	2013	11	2.73	0.79	0.00	0.00	10	1.000
	2014	11	2.73	0.79				
I3	2013	11	2.73	1.10	-0.09	-0.25	10	.810
	2014	11	2.82	0.87				
I4	2013	11	2.64	0.81	0.00	0.00	10	1.000
	2014	11	2.64	0.81				
I5	2013	11	3.45	0.52	0.18	1.49	10	.167
	2014	11	3.27	0.47				
I6	2013	11	2.91	1.14	-0.45	-1.34	10	.211
	2014	11	3.36	0.92				
I7	2013	11	3.45	0.93	-0.18	-0.52	10	.617
	2014	11	3.64	0.50				
I8	2013	11	3.64	0.50	0.27	1.15	10	.277
	2014	11	3.36	0.67				
Total (Max = 32)	2013	11	24.00	3.19	-1.00	-1.31	10	.219
	2014	11	25.00	2.83				
Percentage towards most open inquiry	2013	11	75%	0.1	-0.03	-1.31	10	.219
	2014	11	78%	0.09				

As shown in Tables 16 and 17 and Figures 1 and 2, the external evaluation team further explored change in teachers' views of implementing classroom inquiry by looking at the frequency of teachers' responses to the PCK assessment items as choices across the inquiry spectrum. As shown in Table 16 and Figure 1, elementary teachers' reports of their inquiry approaches shifted from teacher-directed toward more student-led between the pre- and post-assessment. Similarly to elementary teachers, as shown in Table 17 and Figure 2, pre- and post-assessment of ISEP middle school teachers also demonstrated a shift toward preference for use of student-led inquiry teaching approaches.

Table 16. *ISEP Elementary Teachers' Change in Reported Approaches to Inquiry Instruction, Summer 2013 and 2014*

PCK Item	Year	Teacher-Directed	------------------→		Student-Directed
		1	**2**	**3**	**4**
		Number of Teachers Responding			
I1	2013		4	2	
	2014	2	2	1	1
I2	2013		1	5	
	2014		1	3	2
I3	2013		3	1	2
	2014		1	3	2
I4	2013	1	1	2	2
	2014			5	1
I5	2013	1		5	
	2014	1		5	
I6	2013	1		2	3
	2014		1	2	3
I7	2013		2	4	
	2014			6	
I8	2013			2	4
	2014			3	3
Total	**2013**	**3**	**11**	**23**	**11**
	2014	**3**	**5**	**28**	**12**

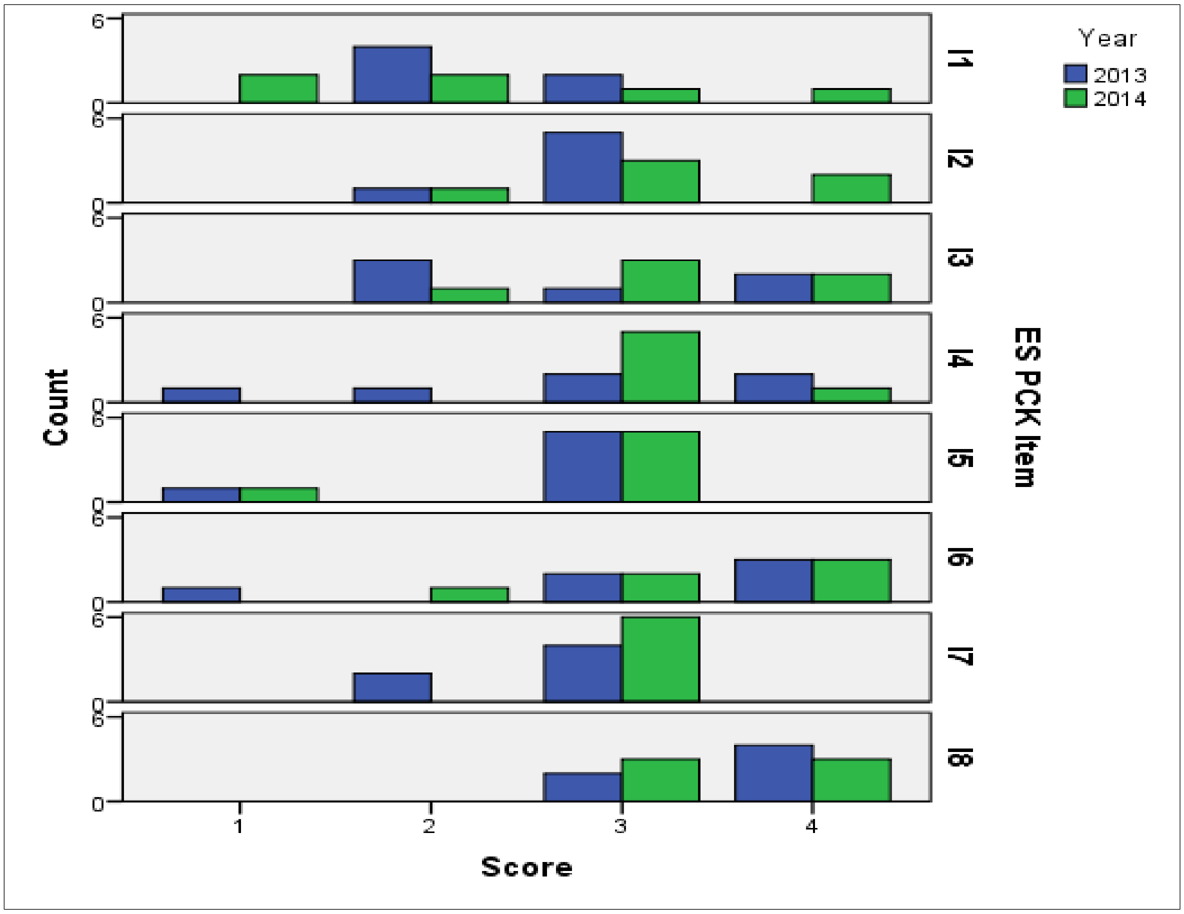


Figure 1. Change in ISEP Elementary Teachers' reports of teaching practices aligned with inquiry, Summer 2013 to Summer 2014.

Table 17. *ISEP Middle School Teachers' Change in Reported Approaches to Inquiry Instruction, Summer 2013 and 2014*

PCK Item	Year	Teacher-Directed	------------------→		Student-Directed
		1	**2**	**3**	**4**
		Number of Teachers Responding			
I1	2013		6	5	
	2014		3	3	5
I2	2013		5	4	2
	2014		5	4	2
I3	2013	2	2	4	3
	2014	1	2	6	2
I4	2013	1	3	6	1
	2014	1	3	6	1
I5	2013			6	5
	2014			8	3
I6	2013	1	4	1	5
	2014		3	1	7
I7	2013	1		3	7
	2014			4	7
I8	2013			4	7
	2014		1	5	5
Total	**2013**	**5**	**20**	**33**	**30**
	2014	**2**	**17**	**37**	**32**

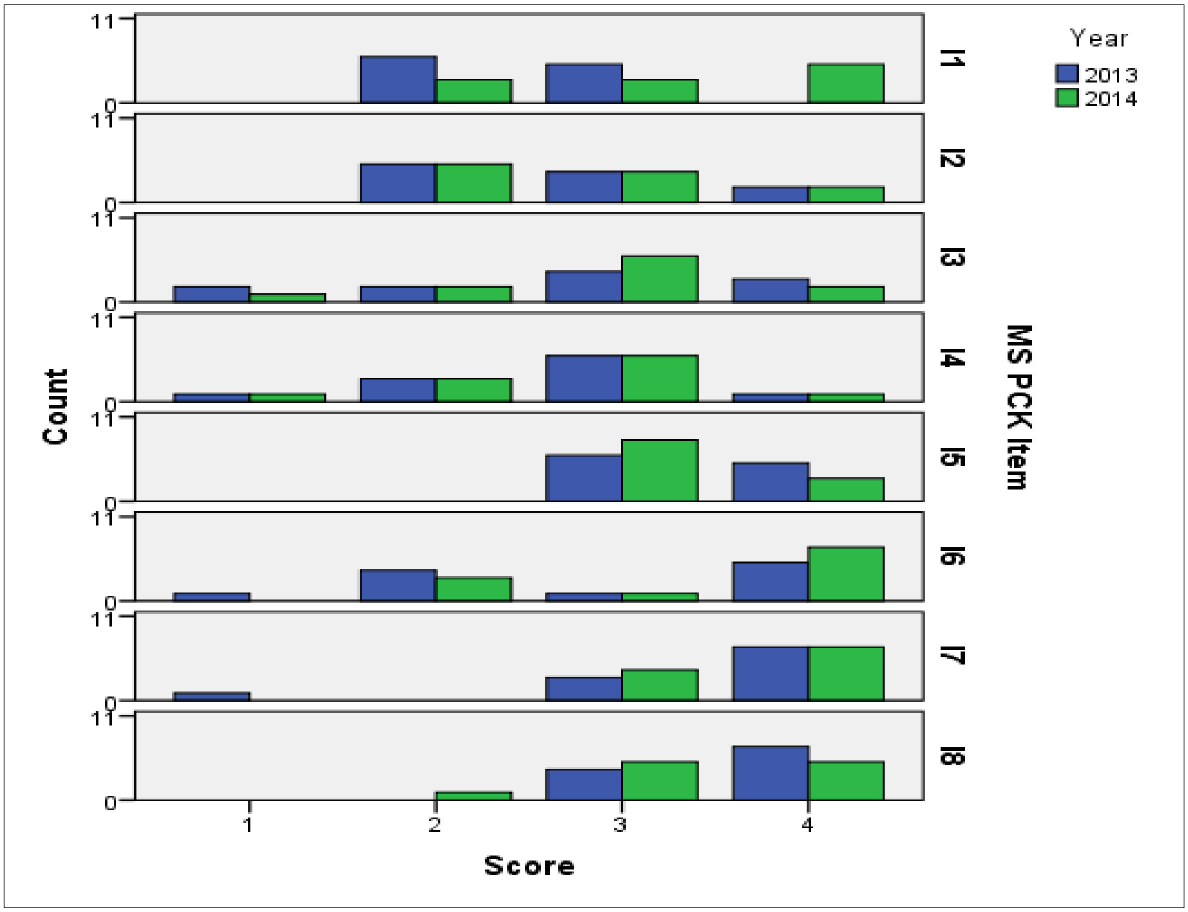


Figure 2. Change in ISEP Middle School Teachers' reports of teaching practices aligned with inquiry, Summer 2013 to Summer 2014.

Science as Inquiry & Understanding the Nature of Science

Table 18 shows teachers' views of inquiry-based science teaching and learning practices. Following 1 or 2 years of participation in ISEP activities, teacher participants agreed significantly more with the accurate understanding that inquiry-based teaching requires the teacher to act as a facilitator or guide of student learning rather than as a disseminator of knowledge. In addition, although not statistically significant, teachers agreed more that inquiry-based learning requires that learners gather data to use as evidence for answering a scientifically-oriented question and that learners manipulate and analyze data to develop evidenced-based explanations, by looking for patterns and drawing conclusions.

Table 18. *Respondents' Views of Inquiry-Based Science Teaching and Learning, Summer 2013 and Summer 2014 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2013 and Summer 2014*

Q32. Views of inquiry-based science teaching and learning.	**Time**	***N***	***M***	***SD***	**Wilcoxon Signed Rank Test *p***
1. Inquiry-based learning requires that learners engage in answering a scientifically-oriented question.	Pre	10	3.60	0.70	.679
	Post	10	3.50	0.85	
2. Inquiry-based learning requires that learners gather (or are given) data to use as evidence for answering a scientifically-oriented question.	Pre	10	3.70	0.48	.083
	Post	10	4.00	0.00	
3. Inquiry-based learning requires that learners manipulate and analyze data to develop evidenced-based explanations, by looking for patterns and drawing conclusions.	Pre	10	3.90	0.32	.083
	Post	10	4.20	0.42	
4. Inquiry-based learning requires that learners connect their explanations with explanations and concepts developed by the scientific community.	Pre	10	3.90	0.32	.157
	Post	10	3.70	0.48	
5. Inquiry-based learning requires that learners communicate, justify, and defend their explanations.	Pre	10	3.90	0.57	.564
	Post	10	4.00	0.00	
6. Inquiry-based learning requires that learners first understand basic, key science concepts prior to engaging in inquiry activities.	Pre	10	3.80	0.42	.655
	Post	10	3.70	0.67	
7. Inquiry-based learning assumes that all science subject matter should be taught through inquiry.	Pre	10	3.20	0.79	.194
	Post	10	2.80	0.92	
8. Inquiry-based learning requires that learners generate and investigate their own questions.	Pre	10	3.40	0.84	.854
	Post	10	3.50	0.97	
9. Inquiry-based learning requires the use of hands-on or kit-based instructional materials.	Pre	10	3.60	0.70	.257
	Post	10	3.30	0.95	
10. Inquiry-based learning requires that learners are engaged in hands-on activities.	Pre	9	3.89	0.33	.102
	Post	9	3.33	0.87	
11. Inquiry, as a process of science, can be taught without attention to specific science content or subject matter.	Pre	9	3.56	0.73	.480
	Post	9	3.33	0.87	
12. Inquiry-based learning assumes that learners build new knowledge and understanding on what they already know.	Pre	9	3.89	0.33	.564
	Post	9	3.78	0.44	

Q32. Views of inquiry-based science teaching and learning.	Time	*N*	*M*	*SD*	Wilcoxon Signed Rank Test *p*
13. Inquiry-based learning assumes that learners formulate new knowledge by modifying and refining their current concepts and by adding new concepts to what they already know.	Pre	9	3.78	0.44	1.000
	Post	9	3.78	0.44	
14. Inquiry-based learning assumes that learning is mediated by the social environment in which learners interact with others.	Pre	9	3.56	0.53	.414
	Post	9	3.78	0.44	
15. Inquiry-based learning requires that learners take control of their own learning.	Pre	9	3.78	0.44	.705
	Post	9	3.67	0.71	
16. Inquiry-based learning assumes that learners develop the ability to apply knowledge to novel situations, and that the transfer of learning is affected by the degree to which learners develop understanding.	Pre	9	3.89	0.33	.564
	Post	9	3.78	0.44	
17. Inquiry-based learning requires more sophisticated materials and equipment than other types of classroom learning.	Pre	9	3.78	0.67	.334
	Post	9	3.33	0.87	
18. Inquiry-based teaching requires that the teacher act as a facilitator or guide of student learning rather than as a disseminator of knowledge.	Pre	9	4.22	0.44	**.046**
	Post	9	3.78	0.67	
19. Inquiry-based teaching focuses more on what the students do, rather than on what the teacher does.	Pre	9	4.11	0.33	.317
	Post	9	3.89	0.78	
20. Inquiry-based teaching requires that the teacher have a strong background in the science content related to the inquiry.	Pre	8	3.75	0.46	.655
	Post	8	3.88	0.64	

Table 19 shows data regarding teachers' understanding of the Nature of Science. Following participation in ISEP activities, teacher participants agreed less with misconceptions that a universal step-by-step scientific method is used by all scientists and that scientific experiments are the only means used to develop scientific knowledge.

Table 19. *Respondents' Understanding of the Nature of Science, Summer 2013 and Summer 2014 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2013 and Summer 2014*

Q33. Understanding the nature of science.	**Time**	***N***	***M***	***SD***	**Wilcoxon Signed Rank Test *p***
1. Science is a systematic way to gain an understanding of the natural world using naturalistic methods and explanations.	Pre	8	3.88	0.35	.180
	Post	8	3.50	0.93	
2. Scientific knowledge is reliable and durable so having confidence in scientific knowledge is reasonable.	Pre	7	4.00	0.00	.157
	Post	7	3.71	0.49	
3. A universal step-by-step scientific method is used by all scientists.	Pre	8	3.38	0.74	.096
	Post	8	2.75	1.04	
4. Scientific experiments are the only means used to develop scientific knowledge.	Pre	9	3.00	0.87	.084
	Post	9	2.33	1.00	
5. Contributions to science are made by people from all cultures around the world.	Pre	9	4.22	0.44	.655
	Post	9	4.33	0.71	
6. Scientific observations and conclusions are influenced by the existing state of scientific knowledge.	Pre	9	3.78	0.44	.705
	Post	9	3.67	0.71	
7. With new evidence and/or interpretation, existing scientific ideas are replaced or supplemented by newer ones.	Pre	9	3.89	0.60	.180
	Post	9	3.56	0.53	
8. Basic scientific research is concerned primarily with practical outcomes related to developing technology.	Pre	9	3.44	0.73	.157
	Post	9	3.00	0.87	
9. The principal product of science is conceptual knowledge about and explanations of the natural world.	Pre	8	3.50	0.76	.395
	Post	8	3.00	1.07	
10. Scientific laws are generalizations or universal relationships about some aspect of the natural world and how it behaves under certain conditions.	Pre	7	3.71	0.49	1.000
	Post	7	3.71	0.49	
11. Scientific theories are inferred explanations of some aspect of the natural world.	Pre	9	3.89	0.33	.129
	Post	9	3.33	1.00	
12. All scientific laws have accompanying explanatory theories.	Pre	9	3.44	0.73	.564
	Post	9	3.33	0.87	
13. Scientific conclusions are to some extent influenced by the social and cultural context of the researcher.	Pre	9	3.89	0.33	.157
	Post	9	3.67	0.50	
14. Scientific observations are to some extent influenced by the observer's experiences and expectations.	Pre	9	3.89	0.33	.157
	Post	9	3.67	0.50	
15. Scientists may make different interpretations based on the same observations.	Pre	9	4.00	0.00	.317
	Post	9	4.22	0.67	

Q33. Understanding the nature of science.	**Time**	***N***	***M***	***SD***	**Wilcoxon Signed Rank Test *p***
16. Scientific theories are subject to on-going testing and revision.	Pre	9	3.89	0.33	.705
	Post	9	3.78	0.97	
17. Scientific laws are theories that have been proven.	Pre	9	3.44	0.73	1.000
	Post	9	3.44	0.73	
18. Cultural values and expectations do not influence scientific research because scientists are trained to conduct unbiased studies.	Pre	9	3.22	0.97	.564
	Post	9	3.11	0.93	
19. Scientists do not use their imagination and creativity because these can interfere with objectivity.	Pre	9	3.00	1.00	.589
	Post	9	2.78	1.09	
20. Scientific knowledge is tentative and may be abandoned or modified in light of new evidence or reconceptualization of prior evidence and knowledge.	Pre	9	3.67	0.71	1.000
	Post	9	3.67	0.50	

The external evaluation further studied teachers' developing understandings of scientific inquiry and nature of science by measuring change in ISEP teachers' views of science inquiry and nature of science following 1 or 2 years of participation in the project. Teachers' responses to SI and NOS items were recoded to account for teachers' informed views and teachers' naïve views. For agreement with all statements that represent accurate conceptions of science inquiry and nature of science, teachers were assigned an "accurate understandings" score; and for agreement with all statements that represent naïve (misconceptions), teachers were assigned a "naïve conceptions" score.

As shown in Figure 3, plotting accurate and naïve understandings created 4 domains that represent the intersection of teachers' views of SI and NOS. Other researchers, most notably Lederman and Lederman,[9] recently have explored how teachers' views of NOS and understandings of SI change from naïve to informed, and have identified a stage in this growth as "transitional or mixed" where teachers demonstrate some accurate understandings while not relinquishing naïve ones. Plotting accurate conceptions scores and naïve conceptions scores helps identify teachers' transitional stage.

Teachers' pre- and post-responses to questionnaire items enquiring about science inquiry and nature of science were compared and are shown in Figures 4 (science inquiry) and 5 (nature of science). Teachers' pre- and post-scores for accurate understandings (y-axis) and naïve understandings (x-axis) were plotted to determine both the relationship between accurate and naïve conceptions and the change in teachers' understandings between 2012 or 2013 and 2014. At the time of this report, these analyses are incomplete but evaluators will continue to explore these important findings for ISEP teachers and provide an interim report of full analyses later this year.

[9] See Lederman, J. S., Lederman, N. G., Bartos, S. A., Bartels, S. L., Meyer, A. A., & Schwartz, R. S. (2014). Meaningful Assessment of Learners' Understandings About Scientific Inquiry – The Views About Scientific Inquiry (VASI) Questionnaire. *Journal of Research in Science Teaching*, 50(1), 65-83.

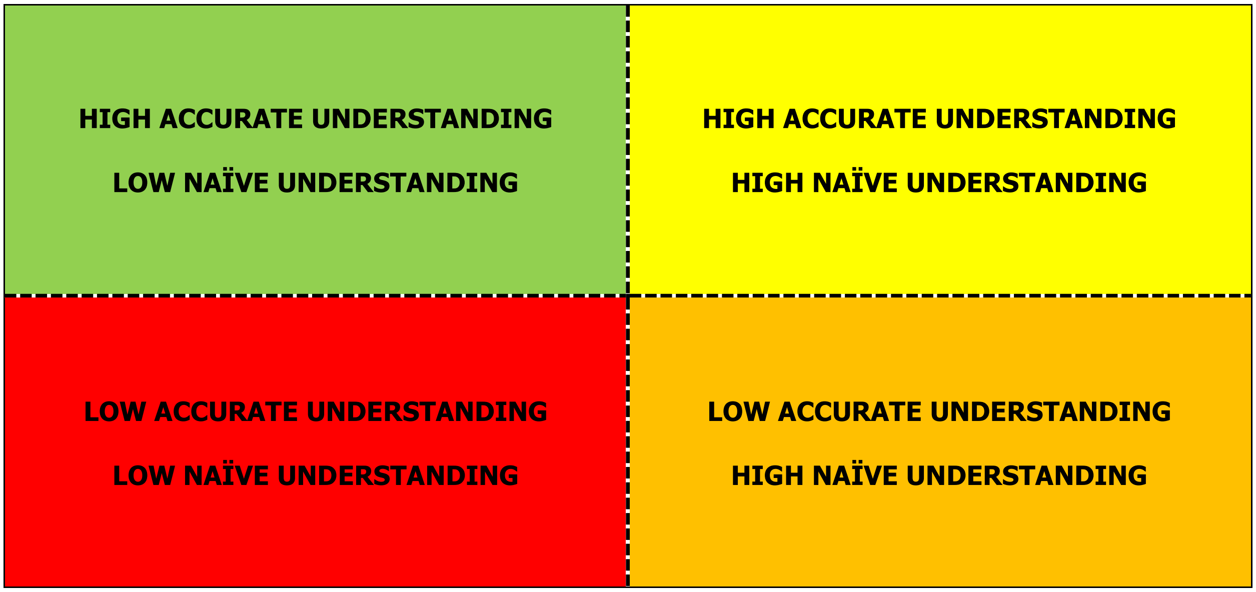


Figure 3. Domains of teachers' understandings of Nature of Science and Science Inquiry.

Change in ISEP teachers' understandings of science inquiry are shown in Figure 4. Though teachers are not identified by their years of participation on this figure, teachers with 1 or 2 years of ISEP participation are represented.[10] Four teachers with 1 year of ISEP experience are shown on Figure 4. Change in these first-year teachers' views of SI are primarily in the direction of greater agreement with accurate conceptions of SI and also greater agreement with naïve conceptions of SI. Six teachers who had been involved with ISEP for 2 years as of Summer 2014 demonstrated less agreement with naïve understandings of science inquiry accompanied by slightly less agreement with statements of accurate understandings.

Change in ISEP teachers' understandings of nature of science are shown in Figure 5. Compared to their understandings of science inquiry, teachers typically began ISEP participation with fewer naïve conceptions of nature of science than of SI, though they demonstrated no better knowledge of accurate NOS understandings. Similar to changes in teachers' views of SI, teachers who had been involved with ISEP for 2 years as of Summer 2014 demonstrated less agreement with naïve understandings of nature of science accompanied by slightly less agreement with statements of accurate understandings. First-year ISEP teachers showed greater agreement with accurate conceptions and with naïve conceptions on their post-questionnaire.

Limited data are available at this time to reach conclusions about these patterns, but evaluators will use additional data collected in Summer 2015 to continue to explore ISEP's impact on participation teachers in this area. Evaluators also will utilize teachers' PCK assessment scores to determine the relationships among teachers' beliefs about SI and NOS and their reported uses of inquiry in the classroom.

[10] It should be noted that more than 1 teacher may be represented by a single dot on these figures due to identical pre- or post-scores.

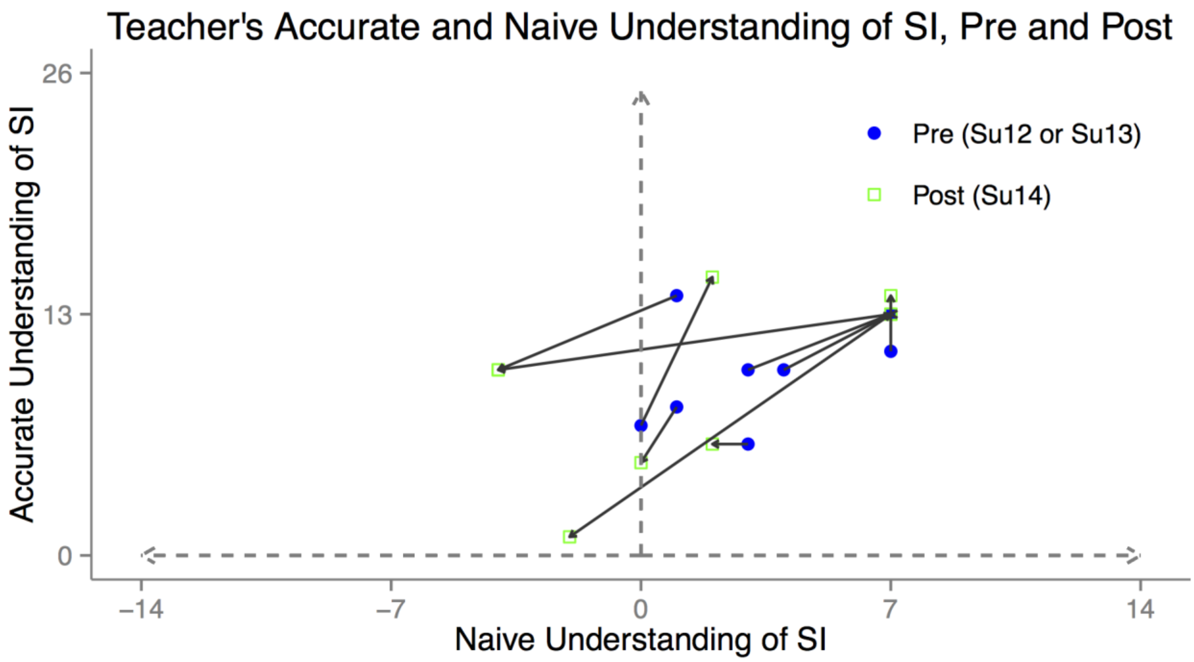


Figure 4. Change in ISEP teachers' understandings of science inquiry following 1 or 2 years of project participation.

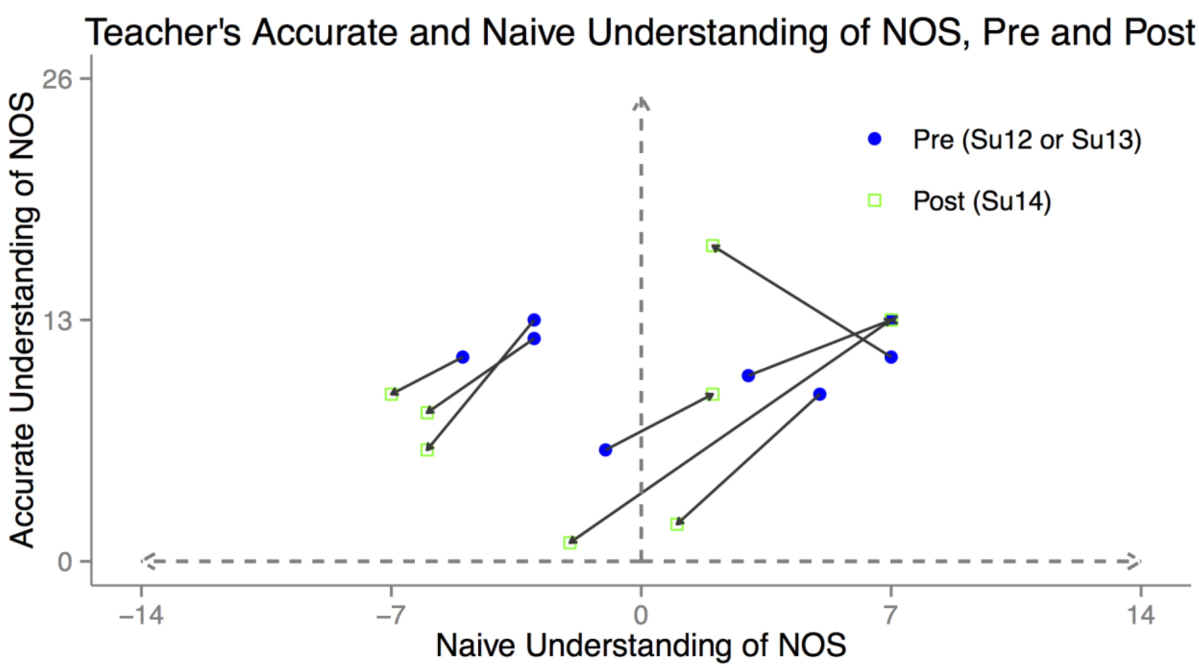


Figure 5. Change in ISEP teachers' understandings of nature of science following 1 or 2 years of project participation.

Design, Engineering, and Technology (DET)

ISEP teachers were asked a number of questions about their familiarity with, beliefs about teaching, and barriers to teaching topics related to design, engineering, and technology prior to and following their participation in ISEP professional development. As shown in Table 20, teachers agreed less that most people feel that female and/or minority students can do well in Design/Engineering/Technology. More than half (56%) of ISEP teachers reported using science kits during science instruction. (See Appendix G, Tables G2 through G9 for full analysis results.)

Table 20. *Teaching DET to Diverse Groups of Students, Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012/Summer 2013 and Summer 2014*

DET 2	**Time**	***n***	***M***	***SD***	**Wilcoxon Signed Rank Test *p***
10. Most people feel that female students can do well in Design/Engineering/Technology.	Pre	9	3.56	1.01	**.046**
	Post	9	3.11	0.78	
11. Most people feel that minority students (African American, Hispanic / Latino, and American Indian) can do well in Design/Engineering/Technology.	Pre	9	3.56	1.01	**.046**
	Post	9	3.11	0.78	

Attitudes and Beliefs about Teaching Science

There were no statistically significant changes in teachers' attitudes and beliefs about teaching science following ISEP PD participation. Full analysis results can be found in Appendix G, Table G10.

UB/BPS ISEP Student Questionnaire Data, Spring 2014

Demographics

In Fall 2013 and Spring 2014, 892 and 764 students responded to the *UB/BPS ISEP Student Questionnaire*, respectively. Among them, 759 students in Fall 2013 and 660 students in Spring 2014 were taught by ISEP teachers, while 133 students in Fall 2013 and 104 students in Spring 2014 were taught by teachers who were not involved in ISEP, but who also taught in the 12 partner schools. After matching student responses in Fall 2013 and in Spring 2014, only 9 elementary and 8 high school students who were taught by control group teachers completed the *Student Questionnaire* in both semesters, as shown in Table 21.

Table 21. *Respondents' Grade Band by Teacher Participation Status, UB/BPS ISEP Student Questionnaire, Fall 2013 and Spring 2014 Matched*

Grade Band	**Control**	**ISEP**	**Total**
ES	9	207	216
MS	0	55	55
HS	8	83	91
Total	**17**	**345**	**362**

Tables 22 to 25 show students' demographic information by their teachers' participation status in ISEP and whether the schools they attended had both ISEP and control teachers who returned student questionnaires for analysis. As shown in Table 22, sample sizes of student groups taught by control teachers were much smaller and not available at every school. This reduced the chance of matching pre-post responses of students' from control group teachers.

Table 22. *Respondents' Grade Band by Teacher and School Participation Status, UB/BPS ISEP Student Questionnaire, Fall 2013 and Spring 2014*

		Number of Students in Fall 2013			Number of Students in Spring 2014		
Grade Band	**Teacher Participation**	**Schools with ISEP OR Control Data**	**Schools with Control AND ISEP Data**	**Total**	**Schools with ISEP OR Control Data**	**Schools with Control AND ISEP Data**	**Total**
ES	Control	0	13	13	0	12	12
	ISEP	260	59	319	268	15	283
	Total	260	72	332	268	27	295
MS	Control	0	0	0	0	0	0
	ISEP	183	0	183	139	0	139
	Total	183	0	183	139	0	139
HS	Control	60	60	120	0	92	92
	ISEP	0	257	257	19	219	238
	Total	60	317	377	19	311	330
Total	**Control**	**60**	**73**	**133**	**0**	**104**	**104**
	ISEP	**443**	**316**	**759**	**426**	**234**	**660**
	Total	**503**	**389**	**892**	**426**	**338**	**764**

Table 23. *Respondents' Gender by Teacher Participation Status, UB/BPS ISEP Student Questionnaire, Fall 2013 and Spring 2014*

Gender	**Fall 2013**			**Spring 2014**		
	Control	**ISEP**	**Total**	**Control**	**ISEP**	**Total**
No Response	2	7	9	0	7	7
Female	61	395	456	53	341	394
Male	70	357	427	51	312	363
Total	133	759	892	104	660	764

Table 24. *Respondents' Race/Ethnicity by Teacher Participation Status, UB/BPS ISEP Student Questionnaire, Fall 2013 and Spring 2014*

Race/Ethnicity	**Fall 2013**			**Spring 2014**		
	Control	**ISEP**	**Total**	**Control**	**ISEP**	**Total**
No Response	2	8	10	0	4	4
American Indian or Alaska Native	2	22	24	1	10	11
Asian	10	55	65	14	51	65
Black or African American	47	279	326	40	201	241
Hispanic/Latino(a)	26	138	164	20	137	157
Multi-Race	8	62	70	7	58	65
Native Hawaiian or Other Pacific Islander	1	1	2	0	1	1
Not Hispanic/Latino(a), race unknown*	4	12	16	3	7	10
White	33	182	215	19	191	210
Total	133	759	892	104	660	764

* Respondents reported ethnicity, but did not report race.

Table 25. *Respondents' Grade by Teacher and School Participation Status, UB/BPS ISEP Student Questionnaire, Fall 2013 and Spring 2014*

Grade	**Fall 2013**			**Spring 2014**		
	Control	**ISEP**	**Total**	**Control**	**ISEP**	**Total**
3	0	11	11	0	0	0
4	0	74	74	0	46	46
5	0	170	170	0	170	170
6	13	64	77	12	67	79
7	0	58	58	0	34	34
8	0	122	122	0	103	103
9	29	64	93	14	62	76
10	62	80	142	18	83	101
11	12	79	91	45	75	120
12	17	37	54	15	20	35
Total	133	759	892	104	660	764

Elementary Grades Students' Attitudes and Perceptions About Science Learning

When comparing pre-post attitudes and opinions of elementary grades students of ISEP participant teachers, students agreed more that they like science in Spring 2014 than they did in Fall 2013. At the end of the school year, students reported that their teachers more frequently encouraged them to ask questions and to explain their ideas to other students. Students also self-reported that they used information and data to support their conclusions, learned from other students, considered different scientific explanations, had a say in deciding what activities they did, used computers or the Internet for science assignments or activities, and developed skills for doing science more frequently at the end of the school year than they did at the beginning of the year. Elementary students also demonstrated a better understanding of the processes and nature of science at the end of the school year (Table 26).

Table 26. *Comparisons of ISEP Students' Pre-Post Responses, UB/BPS ISEP Student Questionnaire, Fall 2013 and Spring 2014, Elementary School Students*

Item	**Time**	***n***	***M***	***SD***	***t***	***Df***	***p***
Q8. Views of Science							
Q8a. I like science.	Fall 2013	201	4.01	0.96	-2.54	200	**.012**
	Spring 2014	201	4.19	0.83			
Q8b. I am good at science.	Fall 2013	191	3.67	0.92	-0.74	190	.458
	Spring 2014	191	3.72	0.85			
Q8c. I would keep on taking science classes even if I did not have to.	Fall 2013	196	3.52	1.28	-1.20	195	.231
	Spring 2014	196	3.64	1.14			
Q8d. I understand most of what goes on in science.	Fall 2013	199	3.81	1.07	-1.38	198	.169
	Spring 2014	199	3.93	0.83			
Q8e. Almost all people use science in their jobs.	Fall 2013	197	3.15	1.06	-1.46	196	.146
	Spring 2014	197	3.29	1.11			
Q8f. Science is useful for solving	Fall 2013	182	3.15	1.16	-1.54	181	.126

everyday problems.	Spring 2014	182	3.28	1.11			
Q8g. Science is a way to study and understand the natural world.	Fall 2013	196	4.20	0.86	-0.79	195	.430
	Spring 2014	196	4.27	0.88			
Q8h. Scientists sometimes disagree about scientific knowledge.	Fall 2013	187	3.56	1.04	-1.09	186	.278
	Spring 2014	187	3.66	0.99			
Q8i. All scientists do not follow the same step-by-step method to do science.	Fall 2013	194	3.39	1.27	-0.93	193	.353
	Spring 2014	194	3.48	1.24			
Q8j. Scientists use their imagination when doing science.	Fall 2013	195	3.22	1.30	1.36	194	.177
	Spring 2014	195	3.07	1.35			
Q8k. Science ideas or hypotheses must be supported by evidence.	Fall 2013	194	3.99	1.00	-1.52	193	.129
	Spring 2014	194	4.12	0.91			
Q8l. Scientific theories can change when new evidence or a new explanation becomes available.	Fall 2013	196	3.93	1.03	-1.23	195	.219
	Spring 2014	196	4.03	0.95			
Q9. In this class, my teacher ...	**Time**	***n***	***M***	***SD***	***t***	***Df***	***p***
Q9a. arranges the classroom so students can have discussion.	Fall 2013	200	3.13	1.37	0.23	199	.821
	Spring 2014	200	3.11	1.44			
Q9b. asks questions that have more than one answer.	Fall 2013	196	3.84	1.03	0.11	195	.912
	Spring 2014	196	3.83	1.05			
Q9c. asks me to give reasons and provide evidence for my answers.	Fall 2013	198	4.46	1.01	-0.67	197	.502
	Spring 2014	198	4.52	0.89			
Q9d. encourages me to ask questions.	Fall 2013	196	3.48	1.23	-3.51	195	**.001**
	Spring 2014	196	3.82	1.07			
Q9e. lets me work at my own pace.	Fall 2013	195	3.50	1.21	0.05	194	.959
	Spring 2014	195	3.50	1.10			
Q9f. encourages me to explain my ideas to other students.	Fall 2013	197	3.39	1.24	-2.29	196	**.023**
	Spring 2014	197	3.61	1.16			
Q9g. encourage me to consider different scientific explanations.	Fall 2013	191	3.47	1.22	-1.46	190	.147
	Spring 2014	191	3.62	1.15			
Q9h. provides time for me to discuss science ideas with other students.	Fall 2013	193	3.59	1.17	-1.90	192	.060
	Spring 2014	193	3.77	1.11			
Q9i. checks that I have completed my assignments.	Fall 2013	197	4.46	1.02	-0.84	196	.401
	Spring 2014	197	4.53	0.88			
Q9j. provides meaningful and challenging assignments.	Fall 2013	194	3.73	1.11	0.34	193	.734
	Spring 2014	194	3.70	0.98			
Q9k. helps me apply my learning to real life.	Fall 2013	195	4.08	1.00	-0.79	194	.431
	Spring 2014	195	4.15	1.06			

Item	Time	n	M	SD	t	df	p
Q9l. expects me to do well.	Fall 2013	202	4.78	0.59	-0.10	201	.918
	Spring 2014	202	4.79	0.57			
Q10. In this class, I ...	**Time**	***n***	***M***	***SD***	***t***	***df***	***p***
Q10a. use information and data to support my conclusions.	Fall 2013	195	3.98	1.05	-2.69	194	**.008**
	Spring 2014	195	4.18	0.94			
Q10b. talk with other students about how to do a science task or about how to interpret the data from an experiment.	Fall 2013	190	3.57	1.13	-0.58	189	.563
	Spring 2014	190	3.63	1.22			
Q10c. learn from other students.	Fall 2013	190	3.17	1.27	-2.23	189	**.027**
	Spring 2014	190	3.41	1.19			
Q10d. consider different scientific explanations.	Fall 2013	185	3.49	1.13	-3.12	184	**.002**
	Spring 2014	185	3.79	1.04			
Q10e. have a say in deciding what activities I do.	Fall 2013	189	2.63	1.47	-1.97	188	**.050**
	Spring 2014	189	2.91	1.45			
Q10f. use a computer or the Internet for science assignments or activities.	Fall 2013	186	2.36	1.42	-3.43	185	**.001**
	Spring 2014	186	2.76	1.36			
Q10g. write about how I solved a science task or about what I am learning.	Fall 2013	187	3.35	1.28	-2.95	186	**.004**
	Spring 2014	187	3.70	1.15			
Q10h. learn that there are different solutions to science tasks.	Fall 2013	185	3.92	0.96	0.66	184	.509
	Spring 2014	185	3.86	1.07			
Q10i. use multiple sources of information to learn.	Fall 2013	187	3.92	1.17	-0.99	186	.322
	Spring 2014	187	4.03	1.06			
Q10j. develop my skills for doing science.	Fall 2013	190	3.89	1.01	-2.17	189	**.031**
	Spring 2014	190	4.09	0.94			
Q10k. learn about how science is important in the real world.	Fall 2013	191	4.03	1.08	-1.65	190	.100
	Spring 2014	191	4.17	1.00			
Q10l. work on science tasks in a group with other students.	Fall 2013	192	3.97	1.09	0.11	191	.910
	Spring 2014	192	3.96	1.06			
Q11. At least one adult in my home, ...	**Time**	***n***	***M***	***SD***	***t***	***df***	***p***
Q11a. makes me do my science homework.	Fall 2013	195	3.99	1.41	-0.47	194	.639
	Spring 2014	195	4.05	1.46			
Q11b. asks about what I am learning in science class.	Fall 2013	195	3.61	1.42	-0.89	194	.375
	Spring 2014	195	3.70	1.33			
Q11c. helps me with my science homework.	Fall 2013	192	3.61	1.39	0.65	191	.515
	Spring 2014	192	3.53	1.50			
Q11d. helps me work on my science	Fall 2013	189	3.66	1.44	0.14	188	.891

projects.	Spring 2014	189	3.65	1.46			
Q11e. expects me to do well in science.	Fall 2013	192	4.70	0.73	1.50	191	.135
	Spring 2014	192	4.60	0.84			
Q11f. expects me to go to college.	Fall 2013	192	4.70	0.80	0.29	191	.771
	Spring 2014	192	4.68	0.80			
Q11g. expects me to have a science-related career.	Fall 2013	193	2.79	1.52	1.25	192	.214
	Spring 2014	193	2.65	1.50			

Note. Q8: 1 = Strongly Disagree, 5 = Strongly Agree; and Q9, Q10, & Q11: 1 = Almost Never, 5 = Very Often.

Responses of elementary grades control and ISEP participant students also were compared using Spring 2014 data. Compared to students taught by ISEP participant teachers, control students had more positive views of science than did ISEP participant students on 3 of 12 items, reported that their teachers used inquiry-based teaching methods more frequently on 3 of 12 items, and self-reported that they used inquiry-based learning practices more frequently on 2 of 12 items. However, since ANCOVA could not be conducted to control the pre-intervention differences between ISEP participant and control groups and the sample sizes of the two groups are significantly different, these findings should be interpreted with caution. Full analysis results can be found in Appendix H, Table H1.

Middle Grades Students' Attitudes and Perceptions About Science Learning

When comparing pre-post attitudes and opinions of middle school ISEP participant teachers' students, students agreed less that they like science and would keep on taking science classes even if they did not have to at the end of the school year than did they at the beginning of the school year. Generally, students reported slightly less positive perceptions of their experiences in science classrooms at the end of the school year than at the beginning. Towards the end of the school year, middle school students reported receiving more parental help with their science homework (Table 27).

There were no control student responses in this grade band.

Table 27. *Comparisons of ISEP Students' Pre-Post Responses, UB/BPS ISEP Student Questionnaire, Fall 2013 and Spring 2014, Middle School Students*

Item	**Time**	***n***	***M***	***SD***	***t***	***df***	***p***
Q8. Views of Science							
Q8a. I like science.	Fall 2013	55	4.02	0.89	3.67	54	**.001**
	Spring 2014	55	3.56	1.12			
Q8b. I am good at science.	Fall 2013	55	3.47	0.81	0.92	54	.359
	Spring 2014	55	3.36	0.87			
Q8c. I would keep on taking science classes even if I did not have to.	Fall 2013	55	3.38	1.10	3.47	54	**.001**
	Spring 2014	55	2.80	1.15			
Q8d. I understand most of what goes on in science.	Fall 2013	55	3.78	0.83	1.99	54	.051
	Spring 2014	55	3.53	0.96			
Q8e. Almost all people use science in their jobs.	Fall 2013	55	3.40	1.12	0.86	54	.393
	Spring 2014	55	3.25	1.13			
Q8f. Science is useful for solving everyday problems.	Fall 2013	54	3.41	0.92	0.75	53	.458
	Spring 2014	54	3.28	1.19			

	Time	*n*	*M*	*SD*	*t*	*df*	*p*
Q8g. Science is a way to study and understand the natural world.	Fall 2013	55	4.38	0.65	0.93	54	.357
	Spring 2014	55	4.24	0.84			
Q8h. Scientists sometimes disagree about scientific knowledge.	Fall 2013	52	3.67	0.90	-0.60	51	.550
	Spring 2014	52	3.79	1.00			
Q8i. All scientists do not follow the same step-by-step method to do science.	Fall 2013	53	3.49	1.23	0.60	52	.549
	Spring 2014	53	3.36	1.09			
Q8j. Scientists use their imagination when doing science.	Fall 2013	53	3.60	1.21	1.20	52	.237
	Spring 2014	53	3.34	1.18			
Q8k. Science ideas or hypotheses must be supported by evidence.	Fall 2013	51	4.39	0.85	1.14	50	.261
	Spring 2014	51	4.22	0.97			
Q8l. Scientific theories can change when new evidence or a new explanation becomes available.	Fall 2013	53	4.19	0.76	-0.83	52	.411
	Spring 2014	53	4.30	0.82			
Q9. In this class, my teacher ...	**Time**	***n***	***M***	***SD***	***t***	***df***	***p***
Q9a. arranges the classroom so students can have discussion.	Fall 2013	55	3.58	1.27	1.78	54	.081
	Spring 2014	55	3.20	1.13			
Q9b. asks questions that have more than one answer.	Fall 2013	53	3.92	0.98	2.20	52	**.033**
	Spring 2014	53	3.58	1.03			
Q9c. asks me to give reasons and provide evidence for my answers.	Fall 2013	54	4.65	0.55	2.42	53	**.019**
	Spring 2014	54	4.30	1.02			
Q9d. encourages me to ask questions.	Fall 2013	54	3.93	1.13	1.49	53	.142
	Spring 2014	54	3.63	1.19			
Q9e. lets me work at my own pace.	Fall 2013	54	3.26	0.96	1.42	53	.163
	Spring 2014	54	2.96	1.20			
Q9f. encourages me to explain my ideas to other students.	Fall 2013	53	3.51	1.05	1.86	52	.068
	Spring 2014	53	3.15	1.29			
Q9g. encourage me to consider different scientific explanations.	Fall 2013	53	3.83	0.83	2.39	52	**.020**
	Spring 2014	53	3.42	1.06			
Q9h. provides time for me to discuss science ideas with other students.	Fall 2013	54	3.83	0.88	3.16	53	**.003**
	Spring 2014	54	3.22	1.18			
Q9i. checks that I have completed my assignments.	Fall 2013	54	4.44	0.84	2.09	53	**.041**
	Spring 2014	54	4.15	1.05			
Q9j. provides meaningful and challenging assignments.	Fall 2013	54	4.11	0.88	2.46	53	**.017**
	Spring 2014	54	3.65	1.14			
Q9k. helps me apply my learning to real life.	Fall 2013	55	4.04	0.86	3.77	54	**< .001**
	Spring 2014	55	3.35	1.11			
Q9l. expects me to do well.	Fall 2013	54	4.83	0.47	1.43	53	.159
	Spring 2014	54	4.65	0.85			
Q10. In this class, I ...	**Time**	***n***	***M***	***SD***	***t***	***df***	***p***
Q10a. use information and data to	Fall 2013	55	4.36	0.62	1.54	54	.129

support my conclusions.	Spring 2014	55	4.13	0.92			
Q10b. talk with other students about how to do a science task or about how to interpret the data from an experiment.	Fall 2013	54	3.76	1.01	0.11	53	.916
	Spring 2014	54	3.74	1.01			
Q10c. learn from other students.	Fall 2013	55	3.42	1.20	1.79	54	.079
	Spring 2014	55	3.07	1.18			
Q10d. consider different scientific explanations.	Fall 2013	54	3.78	1.00	1.59	53	.118
	Spring 2014	54	3.44	1.18			
Q10e. have a say in deciding what activities I do.	Fall 2013	55	2.65	1.11	0.28	54	.777
	Spring 2014	55	2.60	1.13			
Q10f. use a computer or the Internet for science assignments or activities.	Fall 2013	55	2.60	1.18	-2.74	54	**.008**
	Spring 2014	55	3.13	1.36			
Q10g. write about how I solved a science task or about what I am learning.	Fall 2013	54	3.56	1.19	2.95	53	**.005**
	Spring 2014	54	2.94	1.09			
Q10h. learn that there are different solutions to science tasks.	Fall 2013	53	3.87	0.98	1.14	52	.258
	Spring 2014	53	3.66	0.96			
Q10i. use multiple sources of information to learn.	Fall 2013	55	4.02	0.87	1.86	54	.069
	Spring 2014	55	3.69	1.05			
Q10j. develop my skills for doing science.	Fall 2013	54	3.91	0.87	0.77	53	.447
	Spring 2014	54	3.78	0.88			
Q10k. learn about how science is important in the real world.	Fall 2013	54	4.11	1.00	0.97	53	.336
	Spring 2014	54	3.93	1.04			
Q10l. work on science tasks in a group with other students.	Fall 2013	54	4.24	0.73	1.90	53	.062
	Spring 2014	54	3.94	1.02			
Q11. At least one adult in my home, ...	**Time**	***n***	***M***	***SD***	***t***	***df***	***p***
Q11a. makes me do my science homework.	Fall 2013	55	3.85	1.46	-1.46	54	.150
	Spring 2014	55	4.09	1.28			
Q11b. asks about what I am learning in science class.	Fall 2013	55	3.25	1.43	0.40	54	.693
	Spring 2014	55	3.18	1.49			
Q11c. helps me with my science homework.	Fall 2013	55	2.71	1.41	-3.18	54	**.002**
	Spring 2014	55	3.18	1.47			
Q11d. helps me work on my science projects.	Fall 2013	53	3.02	1.55	-1.94	52	.058
	Spring 2014	53	3.38	1.40			
Q11e. expects me to do well in science.	Fall 2013	55	4.51	1.05	-0.85	54	.397
	Spring 2014	55	4.64	0.73			
Q11f. expects me to go to college.	Fall 2013	55	4.76	0.64	0.49	54	.626
	Spring 2014	55	4.71	0.88			
Q11g. expects me to have a science-related career.	Fall 2013	54	2.72	1.52	-0.38	53	.707
	Spring 2014	54	2.80	1.55			

Note. Q8: 1 = Strongly Disagree, 5 = Strongly Agree; and Q9, Q10, & Q11: 1 = Almost Never, 5 = Very Often.

High School Grades Students' Attitudes and Perceptions About Science Learning

As shown in Table 28, there were no statistically significant differences between the pre-post responses of high school students of ISEP teachers on their views of science, teachers' teaching practices, and their learning experiences. However, of the 24 items asking students about their classroom inquiry experiences, students in Spring 2014 responded more positively on 14 of these items than they did in Fall 2013. Further, towards to the end of the school year, students of ISEP teachers reported that they had lower levels of parental expectations for them to do well in science, to go to college, or to have a science related career. This implies that the ISEP project is serving students that are in high-need situations.

Table 28. *Comparisons of ISEP Students' Pre-Post Responses, UB/BPS ISEP Student Questionnaire, Fall 2013 and Spring 2014, High School Students*

Item	Time	*n*	*M*	*SD*	*t*	*df*	*p*
Q8. Views of Science							
Q8a. I like science.	Fall 2013	82	3.52	1.03	0.31	81	.760
	Spring 2014	82	3.49	1.12			
Q8b. I am good at science.	Fall 2013	82	3.50	0.93	0.96	81	.339
	Spring 2014	82	3.41	0.96			
Q8c. I would keep on taking science classes even if I did not have to.	Fall 2013	81	2.94	1.25	0.69	80	.494
	Spring 2014	81	2.85	1.26			
Q8d. I understand most of what goes on in science.	Fall 2013	80	3.51	0.97	-0.12	79	.908
	Spring 2014	80	3.53	0.80			
Q8e. Almost all people use science in their jobs.	Fall 2013	82	3.37	0.96	1.73	81	.088
	Spring 2014	82	3.17	0.99			
Q8f. Science is useful for solving everyday problems.	Fall 2013	79	3.32	0.97	-0.59	78	.556
	Spring 2014	79	3.38	1.02			
Q8g. Science is a way to study and understand the natural world.	Fall 2013	75	3.96	0.86	0.61	74	.544
	Spring 2014	75	3.88	0.96			
Q8h. Scientists sometimes disagree about scientific knowledge.	Fall 2013	73	3.64	0.96	-0.20	72	.838
	Spring 2014	73	3.67	1.03			
Q8i. All scientists do not follow the same step-by-step method to do science.	Fall 2013	77	3.65	1.00	1.00	76	.320
	Spring 2014	77	3.49	1.10			
Q8j. Scientists use their imagination when doing science.	Fall 2013	78	3.18	1.15	0.10	77	.920
	Spring 2014	78	3.17	1.07			
Q8k. Science ideas or hypotheses must be supported by evidence.	Fall 2013	78	3.97	1.07	-1.24	77	.218
	Spring 2014	78	4.15	0.85			
Q8l. Scientific theories can change when new evidence or a new explanation becomes available.	Fall 2013	78	3.96	1.01	-0.92	77	.359
	Spring 2014	78	4.08	0.94			

Q9. In this class, my teacher ...	Time	*n*	*M*	*SD*	*t*	*df*	*p*
Q9a. arranges the classroom so students can have discussion.	Fall 2013	76	3.11	1.22	-1.54	75	.128
	Spring 2014	76	3.32	1.19			
Q9b. asks questions that have more than one answer.	Fall 2013	75	3.59	1.09	0.11	74	.914
	Spring 2014	75	3.57	1.07			
Q9c. asks me to give reasons and provide evidence for my answers.	Fall 2013	75	4.05	1.04	0.72	74	.473
	Spring 2014	75	3.95	0.93			
Q9d. encourages me to ask questions.	Fall 2013	76	3.74	1.22	-1.12	75	.266
	Spring 2014	76	3.87	1.05			
Q9e. lets me work at my own pace.	Fall 2013	76	3.57	1.09	-0.09	75	.926
	Spring 2014	76	3.58	1.02			
Q9f. encourages me to explain my ideas to other students.	Fall 2013	77	3.48	1.19	0.88	76	.383
	Spring 2014	77	3.36	1.15			
Q9g. encourage me to consider different scientific explanations.	Fall 2013	77	3.21	1.13	-1.85	76	.068
	Spring 2014	77	3.49	1.02			
Q9h. provides time for me to discuss science ideas with other students.	Fall 2013	77	3.52	1.17	0.00	76	1.000
	Spring 2014	77	3.52	1.15			
Q9i. checks that I have completed my assignments.	Fall 2013	77	4.01	1.19	0.00	76	1.000
	Spring 2014	77	4.01	1.07			
Q9j. provides meaningful and challenging assignments.	Fall 2013	77	3.77	1.04	0.93	76	.354
	Spring 2014	77	3.65	1.10			
Q9k. helps me apply my learning to real life.	Fall 2013	75	3.68	1.23	-0.92	74	.359
	Spring 2014	75	3.80	1.03			
Q9l. expects me to do well.	Fall 2013	76	4.38	0.94	0.00	75	1.000
	Spring 2014	76	4.38	0.91			
Q10. In this class, I ...	**Time**	***n***	***M***	***SD***	***t***	***df***	***P***
Q10a. use information and data to support my conclusions.	Fall 2013	72	3.74	1.09	-1.95	71	.056
	Spring 2014	72	4.00	0.90			
Q10b. talk with other students about how to do a science task or about how to interpret the data from an experiment.	Fall 2013	72	3.61	1.17	0.54	71	.591
	Spring 2014	72	3.53	1.14			
Q10c. learn from other students.	Fall 2013	73	3.47	1.18	-1.11	72	.272
	Spring 2014	73	3.62	1.05			
Q10d. consider different scientific explanations.	Fall 2013	71	3.39	1.18	-1.48	70	.144
	Spring 2014	71	3.61	1.02			
Q10e. have a say in deciding what activities I do.	Fall 2013	71	2.97	1.34	-0.65	70	.518
	Spring 2014	71	3.07	1.22			
Q10f. use a computer or the Internet for science assignments or activities.	Fall 2013	70	2.90	1.25	0.37	69	.716
	Spring 2014	70	2.83	1.31			
Q10g. write about how I solved a science task or about what I am learning.	Fall 2013	73	3.21	1.12	-1.34	72	.184
	Spring 2014	73	3.42	1.21			

Q10h. learn that there are different solutions to science tasks.	Fall 2013	72	3.51	1.10	-0.82	71	.413
	Spring 2014	72	3.64	1.09			
Q10i. use multiple sources of information to learn.	Fall 2013	72	3.58	1.12	-0.29	71	.772
	Spring 2014	72	3.63	1.03			
Q10j. develop my skills for doing science.	Fall 2013	71	3.56	1.09	-0.90	70	.369
	Spring 2014	71	3.69	1.19			
Q10k. learn about how science is important in the real world.	Fall 2013	70	3.66	1.06	-1.03	69	.305
	Spring 2014	70	3.77	1.11			
Q10l. work on science tasks in a group with other students.	Fall 2013	73	3.73	1.16	-0.18	72	.857
	Spring 2014	73	3.75	1.23			
Q11. At least one adult in my home, ...	**Time**	***n***	***M***	***SD***	***t***	***df***	***P***
Q11a. makes me do my science homework.	Fall 2013	71	3.21	1.55	0.72	70	.472
	Spring 2014	71	3.07	1.48			
Q11b. asks about what I am learning in science class.	Fall 2013	70	2.91	1.48	0.00	69	1.000
	Spring 2014	70	2.91	1.49			
Q11c. helps me with my science homework.	Fall 2013	71	2.54	1.47	-0.72	70	.474
	Spring 2014	71	2.66	1.47			
Q11d. helps me work on my science projects.	Fall 2013	70	2.93	1.55	1.16	69	.249
	Spring 2014	70	2.71	1.41			
Q11e. expects me to do well in science.	Fall 2013	71	4.39	1.06	2.24	70	**.028**
	Spring 2014	71	4.17	1.17			
Q11f. expects me to go to college.	Fall 2013	70	4.69	0.79	1.99	69	**.050**
	Spring 2014	70	4.47	0.90			
Q11g. expects me to have a science-related career.	Fall 2013	71	2.82	1.55	2.23	70	**.029**
	Spring 2014	71	2.46	1.43			
Q12. I plan to . . .	**Time**	***n***	***M***	***SD***	***t***	***df***	***P***
Q12a. take (or have taken) only the science courses I am required to take in high school.	Fall 2013	71	3.39	1.22	0.23	70	.815
	Spring 2014	71	3.35	1.24			
Q12b. take (or have taken) the most challenging science courses offered in my high school.	Fall 2013	67	3.12	1.16	0.46	66	.645
	Spring 2014	67	3.04	1.25			
Q12c. take (or have taken) 4 years of science courses in high school.	Fall 2013	70	3.59	1.29	1.50	69	.139
	Spring 2014	70	3.36	1.24			
Q12d. pursue a science-related career.	Fall 2013	70	2.83	1.33	-0.90	69	.369
	Spring 2014	70	2.94	1.34			
Q12e. go to a 2- or 4-year college.	Fall 2013	66	3.97	1.19	-1.11	65	.272
	Spring 2014	66	4.14	1.09			
Q12f. take science courses in college.	Fall 2013	65	3.35	1.35	-0.61	64	.544
	Spring 2014	65	3.45	1.35			

Q12g. major in a science field in college.	Fall 2013	69	2.81	1.26	-0.38	68	.704
	Spring 2014	69	2.86	1.30			
Q12h. major in an engineering field in college.	Fall 2013	68	2.62	1.29	-1.04	67	.300
	Spring 2014	68	2.78	1.20			
Q12i. major in a science or engineering technical field in college.	Fall 2013	69	2.64	1.27	-1.39	68	.169
	Spring 2014	69	2.87	1.29			

Note. Q8 & Q12: 1 = Strongly Disagree, 5 = Strongly Agree; and Q9, Q10, & Q11: 1 = Almost Never, 5 = Very Often.

Responses of high school control and ISEP participant students also were compared using Spring 2014 data. Compared to students taught by ISEP participant teachers, control students had more positive views of science than did ISEP participant students on 3 of 12 items. However, since ANCOVA could not be conducted to control pre-intervention differences between ISEP participant and control groups and sample sizes for the two groups are very different, these findings should to be interpreted with caution. Full analysis results can be found in Appendix H, Table H2.

Elementary, Middle, and High School Grades Students' Content Knowledge Assessment

There were no statistically significant differences between the pre- and post-intervention content knowledge assessment scores of middle and high school students of ISEP teachers. The only statistical significant difference was found in elementary grades data. Elementary ISEP students improved their correct response rate on a question about heat and temperature from 41% in Fall 2013 to 51% in Spring 2014. Elementary students demonstrated improved content knowledge on 6 assessment items; middle school students' content knowledge improved on 7 items; and, high school students' performance improved on 5 items. Full analysis results can be found in Appendix I, Tables I1 through I3.

UB/BPS ISEP STEM Student Questionnaire Data, Spring 2014 and Fall 2014

As shown in Table 29, 23 STEM undergraduate students and 13 STEM graduate students (all doctoral students) who participated in the ISEP project in Spring and Fall 2014 responded to the *UB/BPS ISEP STEM Student Questionnaire*. Among them, 5 STEM undergraduate and 7 STEM graduate students indicated that they were returning participants to the ISEP project.

Table 29. *Respondents' Student Status by Years of Participation, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

Number of Years in ISEP	**Spring 2014**		
	STEM Undergraduate	**STEM Graduate**	**Total**
This is my first year.	9	1	10
This is my second year.	0	0	0
This is my third year.	0	2	2
Total	**9**	**3**	**12**
	Fall 2014		
This is my first year.	9	5	14
This is my second year.	4	3	7
This is my third year.	1	2	3
Total	**14**	**10**	**24**
	Both Semesters		
This is my first year.	18	6	24
This is my second year.	4	3	7
This is my third year.	1	4	5
Total	**23**	**13**	**36**

Comparisons of STEM Undergraduate Students and STEM Graduate Students

STEM undergraduate and graduate students' responses were compared using Spring and Fall 2014 data. Table 30 shows their roles in the ISEP project in Spring and Fall 2014.

Table 30. *Respondents' Role in ISEP by Student Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

Role in ISEP	**STEM Undergraduate**	**STEM Graduate**	**Total**
Service learning student	16	0	16
Undergraduate intern	7	0	7
Graduate student	0	13	13
Total	23	13	36

As shown in Table 31, most STEM undergraduate students indicated that they tutored K–12 students in STEM (70%) and/or worked with K–12 students outside of the classroom (52%) before participating in the ISEP project. Most STEM graduate students indicated that they were teaching or laboratory assistants for undergraduate or graduate courses (77%) and/or worked or volunteered for social, environmental, or political projects/organizations (54%) prior to joining the ISEP project.

Table 31. *Respondents' Experience Prior to the UB/BPS ISEP Project by Student Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

E7. Experience before participating in the UB/BPS ISEP Project	STEM Undergraduate (%)	STEM Graduate (%)	Total (%)
Worked as an elementary, a middle, or a high school classroom substitute teacher	1 (4%)	3 (23%)	4 (11%)
Volunteered in an elementary, middle, or high school classroom	9 (39%)	5 (38%)	14 (39%)
Tutored K–12 students in STEM	16 (70%)	3 (23%)	19 (53%)
Tutored undergraduate students in STEM	5 (22%)	3 (23%)	8 (22%)
Volunteered or worked with K–12 students outside of a classroom setting	12 (52%)	4 (31%)	16 (44%)
Taught at a college or university (2- or 4-year)	0 (0%)	2 (15%)	2 (6%)
Was a teaching or laboratory assistant for undergraduate or graduate courses	2 (9%)	10 (77%)	12 (33%)
Worked or volunteered at a science/technology museum, nature center, aquarium, zoo, or similar institution open to the public	3 (13%)	2 (15%)	5 (14%)
Worked or volunteered for social, environmental, or political projects/organizations	10 (43%)	7 (54%)	17 (47%)
Published a STEM-related research paper or presented a STEM-related paper or poster at a professional conference	5 (22%)	5 (38%)	10 (28%)
Wrote about or presented STEM content to a non-scientific audience	5 (22%)	4 (31%)	9 (25%)
Participated in an IGERT project	0 (0%)	4 (31%)	4 (11%)

Note. Respondents could choose more than one option.

Table 32 shows STEM undergraduate and graduate students' career plans and goals. STEM undergraduate students would like to become researchers at a government laboratory or research institution (57%) and/or pursue college or university faculty positions with both teaching and research responsibilities (43%). STEM graduate students would like to become researchers at a government laboratory or research institution (69%) and/or researchers/developers in industry/business (62%).

Table 32. *Respondents' Career Goals by Student Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

E8. Career Goals	**STEM Undergraduate (%)**	**STEM Graduate (%)**	**Total (%)**
College or university faculty position with both teaching and research responsibilities	10 (43%)	4 (31%)	14 (39%)
College or university faculty position with primarily teaching responsibilities (greater emphasis on teaching than research)	2 (9%)	6 (46%)	8 (22%)
College or university faculty position with primarily research responsibilities (greater emphasis on research than teaching)	2 (9%)	2 (15%)	4 (11%)
College or university faculty position preparing K–12 teachers in science or mathematics education	2 (9%)	2 (15%)	4 (11%)
Researcher at a government laboratory or research institution	13 (57%)	9 (69%)	22 (61%)
Researcher/developer in industry/business	6 (26%)	8 (62%)	14 (39%)
Non-research position in the government or nonprofit sectors	3 (13%)	2 (15%)	5 (14%)
K–12 science or mathematics teacher	5 (22%)	2 (15%)	7 (19%)
K–12 administrator (e.g., school, district, State-level educational administration)	1 (4%)	2 (15%)	3 (8%)
I am unsure at this time	5 (22%)	3 (23%)	8 (22%)
Other (PA, Pediatrician, Policy Maker)	3 (13%)	0 (0%)	3 (8%)

Note. Respondents could choose more than one option.

Of all orientations available to students prior to working in BPS schools, most STEM undergraduate students indicated that they attended orientations in urban education (52%) and/or in mentoring (57%) (Table 33). About half of the graduate students (54%) reported that they attended orientation in science teaching and learning.

Table 33. *Respondents' Preparation for Working in Schools by Student Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

A. Preparation for working in schools	STEM Undergraduate (%)	STEM Graduate (%)	Total (%)
Orientation in urban education	12 (52%)	0 (0%)	12 (33%)
Orientation in culture and diversity	6 (26%)	2 (15%)	8 (22%)
Orientation in teamwork/collaboration	7 (30%)	5 (38%)	12 (33%)
Orientation in science teaching and learning	8 (35%)	7 (54%)	15 (42%)
Orientation in science communications	3 (13%)	4 (31%)	7 (19%)
Orientation in mentoring	13 (57%)	4 (31%)	17 (47%)
Other	3 (13%)	4 (31%)	7 (19%)

Note. Respondents could choose more than one option.

As shown in Table 34, both STEM undergraduate and graduate students indicated that their major responsibilities in schools included assisting teachers in teaching lessons and conducting labs, leading small group activities/discussions in class, and demonstrating scientific content, procedures, tools, or techniques. In addition, the majority of graduate students indicated that they assisted teachers in teaching lessons (77%), developed science labs for class use (75%), developed out-of-school science learning activities (62%), led small group activities/discussions with students after school (54%), helped teachers find resources (92%), and presented lessons/lectures to students in class (54%).

Table 34. *Respondents' Experience in Schools by Student Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

B. Experiences in schools	STEM Undergraduate (%)	STEM Graduate (%)	Total (%)
Assisted teachers in teaching lessons	14 (61%)	10 (77%)	24 (67%)
Assisted teachers in conducting labs	19 (83%)	13 (100%)	32 (89%)
Developed science labs for class use	2 (9%)	11 (85%)	13 (36%)
Developed out-of-school science learning activities	3 (13%)	8 (62%)	11 (31%)
Led small group activities/discussions with students in class	20 (87%)	12 (92%)	32 (89%)
Led small group activities/discussions with students after school or during weekend	4 (17%)	7 (54%)	11 (31%)
Demonstrated scientific content, procedures, tools, or techniques to students	15 (65%)	13 (100%)	28 (78%)

B. Experiences in schools	STEM Undergraduate (%)	STEM Graduate (%)	Total (%)
Helped teachers find relevant resources (e.g., science activities)	12 (52%)	12 (92%)	24 (67%)
Presented lessons/lectures to students in class	7 (30%)	7 (54%)	14 (39%)
Tutored students after school or during weekends	6 (26%)	2 (15%)	8 (22%)
Other	3 (13%)	3 (23%)	6 (17%)

Note. Respondents could choose more than one option.

When reflecting on reasons for participating in the ISEP project, a majority of students from both groups reported that faculty encouragement, sharing STEM knowledge, having new experiences, and developing teaching skills and science communication skills were important reasons for their participation. Most STEM undergraduate students also indicated that working with school-age students also was a reason for participating in this project; while STEM graduate students indicated that financial support for education and enhancing their CVs were reasons for participating (Table 35).

Table 35. *Respondents' Reasons for Participating in UB/BPS ISEP Project by Student Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

C1. Reasons for participating in UB/BPS ISEP	STEM Undergraduate (%)	STEM Graduate (%)	Total (%)
To gain financial support for my education	2 (9%)	12 (92%)	14 (39%)
My faculty advisor or another faculty member encouraged me	14 (61%)	9 (69%)	23 (64%)
Another student(s) encouraged me to participate	2 (9%)	5 (38%)	7 (19%)
To share my knowledge of science, technology, engineering and/or mathematics	17 (74%)	9 (69%)	26 (72%)
To work with school-age students	17 (74%)	6 (46%)	23 (64%)
I was interested in a teaching career	9 (39%)	6 (46%)	15 (42%)
To have new experiences	14 (61%)	8 (62%)	22 (61%)
To enhance my C.V. or resume	10 (43%)	9 (69%)	19 (53%)
To develop my teaching skills	15 (65%)	9 (69%)	24 (67%)
To develop my teamwork skills	8 (35%)	3 (23%)	11 (31%)
To develop my science communication skills	13 (57%)	8 (62%)	21 (58%)
To develop my research skills	10 (43%)	2 (15%)	12 (33%)
Other	2 (9%)	1 (8%)	3 (8%)

Note. Respondents could choose more than one option.

Table 36 shows differences between STEM undergraduate and graduate students' responses about the benefits of participating in the ISEP project. Compared to STEM graduate students, undergraduate students reported a higher level of agreement that the ISEP project improved their ability to write papers and reports about their work, as well as to present at professional conferences.

Table 36. *Respondents' Perceived Benefit in Participating in UB/BPS ISEP Project by Student Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

C2. My UB/BPS ISEP Experiences Have Benefited My Ability to...	**Student Status**	***n***	***M***	***SD***	**T**	***df***	***p***
C2a. Work on a Team	STEM Undergraduate	23	3.09	0.67	-0.64	34	.525
	STEM Graduate	13	3.23	0.60			
C2b. Lead a team	STEM Undergraduate	23	3.00	0.74	-0.61	34	.543
	STEM Graduate	13	3.15	0.69			
C2c. Facilitate group discussions	STEM Undergraduate	23	3.30	0.63	0.71	34	.480
	STEM Graduate	13	3.15	0.55			
C2d. Teach STEM concepts and methods	STEM Undergraduate	23	3.39	0.58	-0.33	34	.743
	STEM Graduate	13	3.46	0.66			
C2e. Develop instructional materials about STEM concepts and methods	STEM Undergraduate	23	3.04	0.82	-1.56	34	.127
	STEM Graduate	13	3.46	0.66			
C2f. Generate others' interest in STEM research and activities	STEM Undergraduate	23	3.22	0.52	-1.36	34	.184
	STEM Graduate	13	3.46	0.52			
C2g. Conduct research as part of a collaborative team	STEM Undergraduate	23	2.61	0.94	-0.18	33	.856
	STEM Graduate	12	2.67	0.78			
C2h. Conduct independent research	STEM Undergraduate	23	2.61	0.89	1.20	34	.237
	STEM Graduate	13	2.23	0.93			
C2i. Develop a research and/or technology agenda	STEM Undergraduate	23	2.52	0.95	-1.31	34	.200
	STEM Graduate	13	2.92	0.76			
C2j. Write papers and reports about my work	STEM Undergraduate	23	3.09	0.90	3.23	34	**.003**
	STEM Graduate	13	2.15	0.69			
C2k. Present my work at a professional conference	STEM Undergraduate	23	2.70	1.11	2.31	33	**.027**
	STEM Graduate	13	2.08	0.49			
C2l. Explain STEM research and concepts to public (non-technical) audience	STEM Undergraduate	23	3.09	0.90	-1.58	34	.123
	STEM Graduate	13	3.54	0.66			
C2m. Decide a career in education	STEM Undergraduate	23	2.57	1.04	-0.18	34	.860
	STEM Graduate	13	2.62	0.65			
C2n. Understand science concepts better	STEM Undergraduate	23	3.00	0.74	1.19	34	.241
	STEM Graduate	13	2.69	0.75			

Note. Items in this table were on a 4-point Likert-type scale with responses ranging from *strongly disagree* (1) to *strongly agree* (4).

Table 37 shows there were no statistically significant differences in the results of participating in the ISEP reported by STEM undergraduate and graduate students. Congruent with past findings, undergraduate students reported more interest in teaching at the K-12 level than did graduate students.

Table 37. *Respondents' Perceived Effects of Participating in UB/BPS ISEP Project by Student Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

C3. As a result of my UB/BPS ISEP experiences…	Student Status	*n*	*M*	*SD*	t	*df*	*p*
C3a. My interest in conducting research	STEM Undergraduate	23	3.91	0.90	0.72	34	.477
	STEM Graduate	13	3.69	0.85			
C3b. My interest in teaching at the college/university level	STEM Undergraduate	23	3.52	0.85	-0.60	34	.550
	STEM Graduate	13	3.69	0.75			
C3c. My interest in teaching at the K–12 level	STEM Undergraduate	23	3.39	1.20	1.18	34	.246
	STEM Graduate	13	2.92	1.04			
C3d. My interest in influencing public policy related to STEM education	STEM Undergraduate	22	4.14	0.77	-0.07	33	.947
	STEM Graduate	13	4.15	0.69			

Note. Items in this table were on a 5-point Likert-type scale with responses ranging from *strongly decreased* (1) to *strongly increased* (5).

Students also reported their levels of self-efficacy in communicating science, as shown in Table 38. Compared to STEM undergraduate students, STEM graduate students reported that they were more effective at developing science labs and out-of-school science learning activities, assisting teachers in conducting labs, teaching science labs to students, and demonstrating scientific content, procedures, tools, or techniques to students. Undergraduate students reported higher confidence than did graduate students in tutoring other students.

Table 38. *Respondents' Self-Efficacy in Communicating Science by Student Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

D. How much I can do in order to…	Student Status	*n*	*M*	*SD*	t	*df*	*p*
D1. Understand middle and high school students' science background knowledge	STEM Undergrad	23	3.30	0.63	-0.76	34	.453
	STEM Graduate	13	3.46	0.52			
D2. Understand middle and high school students' interest in science	STEM Undergrad	23	3.26	0.69	-0.22	34	.830
	STEM Graduate	13	3.31	0.48			
D3. Understand middle and high school students' cognitive abilities	STEM Undergrad	23	3.09	0.79	-0.57	34	.574
	STEM Graduate	13	3.23	0.60			
D4. Understand middle and high school students' social and cultural backgrounds	STEM Undergrad	23	3.09	0.79	-1.52	34	.137
	STEM Graduate	13	3.46	0.52			
D5. Understand middle and high school students' attention span	STEM Undergrad	23	3.13	0.69	-1.15	34	.256
	STEM Graduate	13	3.38	0.51			
D6. Decide what science topics are appropriate to students	STEM Undergrad	23	2.87	0.76	-0.97	34	.339
	STEM Graduate	13	3.15	0.99			
D7. Decide how much science content is appropriate to students	STEM Undergrad	23	2.87	0.76	-0.44	34	.661
	STEM Graduate	13	3.00	1.00			

D. How much I can do in order to…	Student Status	*n*	*M*	*SD*	t	*df*	*p*
D8. Help teachers find relevant resources (e.g., science activities)	STEM Undergrad	23	3.13	0.81	-1.84	34	.075
	STEM Graduate	13	3.62	0.65			
D9. Develop science labs	STEM Undergrad	23	2.83	1.03	-3.13	34	**.004**
	STEM Graduate	13	3.69	0.63			
D10. Develop out-of-school science learning activities	STEM Undergrad	23	2.65	0.88	-2.08	34	**.045**
	STEM Graduate	13	3.31	0.95			
D11. Assist teachers in teaching lessons	STEM Undergrad	23	3.17	0.83	-0.78	34	.438
	STEM Graduate	13	3.38	0.65			
D12. Assist teachers in conducting labs	STEM Undergrad	23	3.30	0.76	-2.32	34	**.027**
	STEM Graduate	13	3.77	0.44			
D13. Teach science labs to students	STEM Undergrad	23	3.13	0.87	-2.14	34	**.039**
	STEM Graduate	13	3.69	0.48			
D14. Facilitate out-of-school science learning activities	STEM Undergrad	23	2.87	1.01	-0.79	34	.433
	STEM Graduate	13	3.15	1.07			
D15. Lead small group activities/discussions with students in class	STEM Undergrad	23	3.35	0.65	-1.19	34	.243
	STEM Graduate	13	3.62	0.65			
D16. Lead small group activities/discussions with students after school or during weekends	STEM Undergrad	23	3.09	0.85	0.53	34	.598
	STEM Graduate	13	2.92	0.95			
D17. Demonstrate scientific content, procedures, tools, or techniques to students	STEM Undergrad	23	3.22	0.67	-3.60	34	**.001**
	STEM Graduate	13	3.85	0.38			
D18. Teach lessons or give lectures to students in class	STEM Undergrad	23	3.00	0.95	-1.04	34	.306
	STEM Graduate	13	3.31	0.63			
D19. Tutor students after school or during weekends	STEM Undergrad	23	2.96	1.07	1.78	34	.085
	STEM Graduate	13	2.31	1.03			
D20. Explain a difficult science concept to students	STEM Undergrad	22	3.23	0.92	-0.65	33	.519
	STEM Graduate	13	3.38	0.51			
D21. Relate current research to K-12 curriculum	STEM Undergrad	23	3.17	0.89	0.56	34	.580
	STEM Graduate	13	3.00	0.91			
D22. Explain current research to teachers	STEM Undergrad	23	2.91	0.95	-1.34	34	.190
	STEM Graduate	13	3.31	0.63			
D23. Plan a field trip to museums	STEM Undergrad	23	2.61	1.20	-1.77	34	.086
	STEM Graduate	13	3.31	1.03			
D24. Facilitate student learning in museums	STEM Undergrad	23	2.65	1.11	-1.29	34	.207
	STEM Graduate	13	3.15	1.14			
D25. Organize a science family night in school	STEM Undergrad	23	2.52	1.04	0.15	34	.878
	STEM Graduate	13	2.46	1.27			
D26. Explain science to parents	STEM Undergrad	23	2.74	0.96	-0.31	34	.760
	STEM Graduate	13	2.85	1.07			

Note. Items in this table were on a 5-point rating scale with responses ranging from *nothing* (1) to *a great deal* (5).

Comparisons of First-Year and Returning STEM Graduate Students

Of the 13 responses received from STEM graduate students who participated in the UB/BPS ISEP project in Spring and Fall 2014, 6 were in their first year with the project and 7 were returning students. Their responses were compared to see if new and veteran participants of this project held different perceptions about their career goals, preparation for the project, experiences in schools, benefits of the project, and self-efficacy in communicating science. Since no unique identifiers were collected from the respondents, no pre-post matched comparisons could be conducted to measure changes in perceptions of these returning students. Due to small sample sizes, Mann-Whitney *U*-tests were used to conduct comparisons at the item level between the responses of STEM graduate students who participated in the ISEP project for more than 1 year and those who were new to the project in Spring or Fall 2014.

Compared to first-year STEM graduate student participants, veteran participants reported less interest in pursuing careers as researchers/developers in industry/business and more interest in pursuing college or university faculty positions with primarily teaching responsibilities (Table 39).

Table 39. *Respondents' Career Goals by Participation Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

E8. Career Goals	**First Year in ISEP (%)**	**Not First Year in ISEP (%)**	**Total (%)**
College or university faculty position with both teaching and research responsibilities	2 (33%)	2 (29%)	4 (31%)
College or university faculty position with primarily teaching responsibilities (greater emphasis on teaching than research)	2 (33%)	4 (57%)	6 (46%)
College or university faculty position with primarily research responsibilities (greater emphasis on research than teaching)	0 (0%)	2 (29%)	2 (15%)
College or university faculty position preparing K–12 teachers in science or mathematics education	0 (0%)	2 (29%)	2 (15%)
Researcher at a government laboratory or research institution	4 (67%)	5 (71%)	9 (69%)
Researcher/developer in industry/business	5 (83%)	3 (43%)	8 (62%)
Non-research position in the government or nonprofit sectors	0 (0%)	2 (29%)	2 (15%)
K–12 science or mathematics teacher	0 (0%)	2 (29%)	2 (15%)
K–12 administrator (e.g., school, district, State-level educational administration)	0 (0%)	2 (29%)	2 (15%)
I am unsure at this time	0 (0%)	3 (43%)	3 (23%)

Note. Respondents could choose more than one option.

As shown in Table 40, veteran graduate student participants indicated that they participated in more orientations than did first-year participants.

Table 40. *Respondents' Preparation for Working in Schools by Participation Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

A. Preparation for working in schools	First Year in ISEP (%)	Not First Year in ISEP (%)	Total (%)
Orientation in urban education	0 (0%)	0 (0%)	0 (0%)
Orientation in culture and diversity	0 (0%)	2 (29%)	2 (15%)
Orientation in teamwork/collaboration	1 (17%)	4 (57%)	5 (38%)
Orientation in science teaching and learning	2 (33%)	5 (71%)	7 (54%)
Orientation in science communications	1 (17%)	3 (43%)	4 (31%)
Orientation in mentoring	0 (0%)	4 (57%)	4 (31%)
Other	2 (33%)	2 (29%)	4 (31%)

Note. Respondents could choose more than one option.

As shown in Table 41, both first-year and veteran graduate student participants indicated that their activities in schools were highly integrated and comprehensive. In addition, more returning graduate students indicated that they assisted teachers in teaching lessons and presented lessons/lectures to students in class.

Table 41. *Respondents' Experience in Schools by Participation Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

B. Experiences in schools	First Year in ISEP (%)	Not First Year in ISEP (%)	Total (%)
Assisted teachers in teaching lessons	3 (50%)	7 (100%)	10 (77%)
Assisted teachers in conducting labs	6 (100%)	7 (100%)	13 (100%)
Developed science labs for class use	4 (67%)	7 (100%)	11 (85%)
Developed out-of-school science learning activities	3 (50%)	5 (71%)	8 (62%)
Led small group activities/discussions with students in class	5 (83%)	7 (100%)	12 (92%)
Led small group activities/discussions with students after school or during weekend	2 (33%)	5 (71%)	7 (54%)
Demonstrated scientific content, procedures, tools, or techniques to students	6 (100%)	7 (100%)	13 (100%)
Helped teachers find relevant resources (e.g., science activities)	5 (83%)	7 (100%)	12 (92%)
Presented lessons/lectures to students in class	2 (33%)	5 (71%)	7 (54%)
Tutored students after school or during weekends	1 (17%)	1 (14%)	2 (15%)
Other	1 (17%)	2 (29%)	3 (23%)

Note. Respondents could choose more than one option.

When reflecting on reasons for participating in the ISEP project, new and returning graduate student participants listed many of the same reasons for participating in this project (Table 42). More returning participants than new participants listed working with school-age students as one of the reasons for participating in ISEP, while more first-year ISEP participant students listed faculty encouragement as one of the reasons.

Table 42. *Respondents' Reasons for Participating in UB/BPS ISEP Project by Participation Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

C1. Reasons for participating in UB/BPS ISEP	First Year in ISEP (%)	Not First Year in ISEP (%)	Total (%)
To gain financial support for my education	5 (83%)	7 (100%)	12 (92%)
My faculty advisor or another faculty member encouraged me	5 (83%)	4 (57%)	9 (69%)
Another student(s) encouraged me to participate	2 (33%)	3 (43%)	5 (38%)
To share my knowledge of science, technology, engineering and/or mathematics	3 (50%)	6 (86%)	9 (69%)
To work with school-age students	1 (17%)	5 (71%)	6 (46%)
I was interested in a teaching career	2 (33%)	4 (57%)	6 (46%)
To have new experiences	3 (50%)	5 (71%)	8 (62%)
To enhance my C.V. or resume	4 (67%)	5 (71%)	9 (69%)
To develop my teaching skills	4 (67%)	5 (71%)	9 (69%)
To develop my teamwork skills	1 (17%)	2 (29%)	3 (23%)
To develop my science communication skills	3 (50%)	5 (71%)	8 (62%)
To develop my research skills	0 (0%)	2 (29%)	2 (15%)
Other	0 (0%)	1 (14%)	1 (8%)

Note. Respondents could choose more than one option.

Table 43 shows that veteran ISEP graduate students agreed more often that ISEP experiences had benefited their ability to write papers and reports about their works than did first-year ISEP participants.

Table 43. *Respondents' Perceived Benefit in Participating in UB/BPS ISEP Project by Participation Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

C2. My UB/BPS ISEP Experiences Have Benefited My Ability to…	Experience in ISEP	*n*	*M*	*SD*	Mann-Whitney *U*-Test *p*
C2a. Work on a Team	First Year in ISEP	6	3.17	0.75	.804
	Not First Year in ISEP	7	3.29	0.49	
C2b. Lead a team	First Year in ISEP	6	2.83	0.75	.133
	Not First Year in ISEP	7	3.43	0.53	
C2c. Facilitate group discussions	First Year in ISEP	6	3.00	0.63	.379
	Not First Year in ISEP	7	3.29	0.49	
C2d. Teach STEM concepts and methods	First Year in ISEP	6	3.17	0.75	.148
	Not First Year in ISEP	7	3.71	0.49	
C2e. Develop instructional materials about STEM concepts and methods	First Year in ISEP	6	3.33	0.82	.630
	Not First Year in ISEP	7	3.57	0.53	
C2f. Generate others' interest in STEM research and activities	First Year in ISEP	6	3.50	0.55	.805
	Not First Year in ISEP	7	3.43	0.53	

C2. My UB/BPS ISEP Experiences Have Benefited My Ability to…	**Experience in ISEP**	***n***	***M***	***SD***	**Mann-Whitney *U*-Test *p***
C2g. Conduct research as part of a collaborative team	First Year in ISEP	5	2.60	0.89	.723
	Not First Year in ISEP	7	2.71	0.76	
C2h. Conduct independent research	First Year in ISEP	6	2.00	1.10	.253
	Not First Year in ISEP	7	2.43	0.79	
C2i. Develop a research and/or technology agenda	First Year in ISEP	6	2.67	0.82	.249
	Not First Year in ISEP	7	3.14	0.69	
C2j. Write papers and reports about my work	First Year in ISEP	6	1.67	0.52	**.018**
	Not First Year in ISEP	7	2.57	0.53	
C2k. Present my work at a professional conference	First Year in ISEP	6	1.83	0.41	.100
	Not First Year in ISEP	7	2.29	0.49	
C2l. Explain STEM research and concepts to public (non-technical) audience	First Year in ISEP	6	3.17	0.75	.056
	Not First Year in ISEP	7	3.86	0.38	
C2m. Decide a career in education	First Year in ISEP	6	2.50	0.55	.633
	Not First Year in ISEP	7	2.71	0.76	
C2n. Understand science concepts better	First Year in ISEP	6	2.33	0.52	.120
	Not First Year in ISEP	7	3.00	0.82	

Note. Items in this table were on a 4-point Likert-type scale with responses ranging from *strongly disagree* (1) to *strongly agree* (4).

Table 44 shows that there were no statistically significant differences between the responses of first-year and veteran graduate students about their interest in teaching and research as a result of participating in the UB/BPS ISEP project.

Table 44. *Respondents' Perceived Effects of Participating in UB/BPS ISEP Project by Participation Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

C3. As a result of my UB/BPS ISEP experiences…	**Experience in ISEP**	***n***	***M***	***SD***	**Mann-Whitney *U*-Test *p***
C3a. My interest in conducting research	First Year in ISEP	6	3.33	0.52	.208
	Not First Year in ISEP	7	4.00	1.00	
C3b. My interest in teaching at the college/university level	First Year in ISEP	6	3.83	0.75	.485
	Not First Year in ISEP	7	3.57	0.79	
C3c. My interest in teaching at the K–12 level	First Year in ISEP	6	2.67	1.21	.453
	Not First Year in ISEP	7	3.14	0.90	
C3d. My interest in influencing public policy related to STEM education	First Year in ISEP	6	4.17	0.75	.937
	Not First Year in ISEP	7	4.14	0.69	

Note. Items in this table were on a 5-point Likert-type scale with responses ranging from *strongly decreased* (1) to *strongly increased* (5).

Table 45 shows that there were no statistically significant differences in first-year and veteran graduate students' responses about their levels of self-efficacy in communicating science, though more experienced students reported higher levels of self-efficacy on 17 of 26 items than did first-year students.

Table 45. *Respondents' Self-Efficacy in Communicating Science by Participation Status, UB/BPS ISEP STEM Student Questionnaire, Spring 2014 and Fall 2014*

D. How much I can do in order to…	**Experience in ISEP**	***n***	***M***	***SD***	**Mann-Whitney *U*-Test *p***
D1. Understand middle and high school students' science background knowledge	First Year in ISEP	6	3.33	0.52	.409
	Not First Year in ISEP	7	3.57	0.53	
D2. Understand middle and high school students' interest in science	First Year in ISEP	6	3.17	0.41	.327
	Not First Year in ISEP	7	3.43	0.53	
D3. Understand middle and high school students' cognitive abilities	First Year in ISEP	6	3.00	0.63	.213
	Not First Year in ISEP	7	3.43	0.53	
D4. Understand middle and high school students' social and cultural backgrounds	First Year in ISEP	6	3.33	0.52	.409
	Not First Year in ISEP	7	3.57	0.53	
D5. Understand middle and high school students' attention span	First Year in ISEP	6	3.33	0.52	.735
	Not First Year in ISEP	7	3.43	0.53	
D6. Decide what science topics are appropriate to students	First Year in ISEP	6	2.83	1.17	.320
	Not First Year in ISEP	7	3.43	0.79	
D7. Decide how much science content is appropriate to students	First Year in ISEP	6	2.50	1.05	.099
	Not First Year in ISEP	7	3.43	0.79	
D8. Help teachers find relevant resources (e.g., science activities)	First Year in ISEP	6	3.67	0.52	1.000
	Not First Year in ISEP	7	3.57	0.79	
D9. Develop science labs	First Year in ISEP	6	3.67	0.52	.561
	Not First Year in ISEP	7	3.71	0.76	
D10. Develop out-of-school science learning activities	First Year in ISEP	6	3.17	0.75	.305
	Not First Year in ISEP	7	3.43	1.13	
D11. Assist teachers in teaching lessons	First Year in ISEP	6	3.17	0.75	.302
	Not First Year in ISEP	7	3.57	0.53	
D12. Assist teachers in conducting labs	First Year in ISEP	6	3.83	0.41	.626
	Not First Year in ISEP	7	3.71	0.49	
D13. Teach science labs to students	First Year in ISEP	6	3.67	0.52	.859
	Not First Year in ISEP	7	3.71	0.49	
D14. Facilitate out-of-school science learning activities	First Year in ISEP	6	2.83	0.98	.240
	Not First Year in ISEP	7	3.43	1.13	
D15. Lead small group activities/discussions with students in class	First Year in ISEP	6	3.67	0.52	1.000
	Not First Year in ISEP	7	3.57	0.79	
D16. Lead small group activities/discussions with students after school or during weekends	First Year in ISEP	6	2.83	0.98	.653
	Not First Year in ISEP	7	3.00	1.00	
D17. Demonstrate scientific content, procedures, tools, or techniques to students	First Year in ISEP	6	3.83	0.41	.909
	Not First Year in ISEP	7	3.86	0.38	
D18. Teach lessons or give lectures to students in class	First Year in ISEP	6	3.33	0.52	1.000
	Not First Year in ISEP	7	3.29	0.76	

D. How much I can do in order to…	Experience in ISEP	*n*	*M*	*SD*	Mann-Whitney *U*-Test *p*
D19. Tutor students after school or during weekends	First Year in ISEP	6	2.17	1.17	.602
	Not First Year in ISEP	7	2.43	0.98	
D20. Explain a difficult science concept to students	First Year in ISEP	6	3.50	0.55	.447
	Not First Year in ISEP	7	3.29	0.49	
D21. Relate current research to K-12 curriculum	First Year in ISEP	6	2.50	1.05	.079
	Not First Year in ISEP	7	3.43	0.53	
D22. Explain current research to teachers	First Year in ISEP	6	3.33	0.52	1.000
	Not First Year in ISEP	7	3.29	0.76	
D23. Plan a field trip to museums	First Year in ISEP	6	3.33	0.82	.744
	Not First Year in ISEP	7	3.29	1.25	
D24. Facilitate student learning in museums	First Year in ISEP	6	3.17	0.75	.531
	Not First Year in ISEP	7	3.14	1.46	
D25. Organize a science family night in school	First Year in ISEP	6	2.00	1.10	.267
	Not First Year in ISEP	7	2.86	1.35	
D26. Explain science to parents	First Year in ISEP	6	2.67	1.03	.501
	Not First Year in ISEP	7	3.00	1.15	

Note. Items in this table occurred on a 5-point rating scale with responses ranging from *nothing* (1) to *a great deal* (5).

UB/BPS MSP ISEP Student Summer Experience Questionnaire (Summer 2013 and Summer 2014)

In Summer 2013, 42 students participated in an ISEP-sponsored summer experience at the Riverside site. In Summer 2014, 112 students participated in summer experiences at Riverside, Cradle Beach, GIS, and the UB Chemistry sites. Tables 46 to 52 show students' demographic information and their future career plans.

Table 46. *Respondents' Grade, UB/BPS ISEP Student Summer Experience Questionnaire, Summer 2013 and Summer 2014*

Grade	Summer 13	Summer 14	Total
No Response	3	16	19
3	0	1	1
4	0	14	14
5	0	9	9
6	0	6	6
7	0	5	5
8	0	6	6
9	3	11	14
10	11	15	26

Grade	Summer 13	Summer 14	Total
11	20	13	33
12	5	16	21
Total	42	112	154

Table 47 shows participant students' gender and race/ethnicity composition. Both summers had high percentages of non-White and female student participants.

Table 47. *Respondents' Gender by Race/Ethnicity, UB/BPS ISEP Student Summer Experience Questionnaire, Summer 2013 and Summer 2014*

Year	Race/Ethnicity	No Response	Female	Male	Total
Summer 13	Asian	0	12	9	21
	African American or Black	0	10	5	15
	Hispanic	0	4	1	5
	Multi-racial	0	0	1	1
	Total	0	26	16	42
Summer 14	Unknown	2	0	1	3
	Asian	0	11	9	20
	African American or Black	0	22	15	37
	Hispanic	0	4	2	6
	Multi-racial	0	9	2	11
	White	0	18	17	35
	Total	2	64	46	112
Total	Unknown	2	0	1	3
	Asian	0	23	18	41
	African American or Black	0	32	20	52
	Hispanic	0	8	3	11
	Multi-racial	0	9	3	12
	White	0	18	17	35
	Total	2	90	62	154

Students participating in Summer 2013 were from Riverside Institute of Technology High School, while in Summer 2014, participant students were from 11 of the 12 ISEP participating schools (Table 48).

Table 48. *Respondents' School, UB/BPS ISEP Student Summer Experience Questionnaire, Summer 2013 and Summer 2014*

School	Summer 13	Summer 14	Total
No Response	0	1	1
Bennett HS	0	4	4
Harriett Ross Tubman Academy #31	0	2	2
Hutchinson Central Technical HS	0	11	11
Lorraine Academy #72	0	20	20

School	Summer 13	Summer 14	Total
Maritime Charter	0	1	1
MST Preparatory School at Seneca	0	2	2
Native American Magnet School #19	0	4	4
Oracle Charter School	0	1	1
Riverside Institute of Technology HS	42	36	78
South Park HS	0	3	3
Southside Elementary	0	27	27
Total	42	112	154

Table 49 shows that the majority of students had no prior summer informal science experiences.

Table 49. *Respondents' Prior Summer Experience, UB/BPS ISEP Student Summer Experience Questionnaire, Summer 2013 and Summer 2014*

Prior to this summer experience; did you participate in any other similar summer experiences?	Summer 13	Summer 14	Total
No Response	1 (2%)	3 (3%)	4 (3%)
No, I did not have any prior summer experiences	27 (64%)	68 (61%)	95 (62%)
Yes, I did have one prior summer experience	12 (29%)	26 (23%)	38 (25%)
Yes, I did have more than one prior summer experience	2 (5%)	15 (13%)	17 (11%)
Total	42 (100%)	112 (100%)	154 (100%)

Table 50 shows that following their Summer 2013 experiences, 17% of students (7 of 42) changed their future education plans from undecided or not going to college to getting a college degree in a science-related field, or in a non-science-related field.

Table 50. *Respondents' Career before and after Participating in Summer Experience, UB/BPS ISEP Student Summer Experience Questionnaire, Summer 2013*

Summer 2013	After Summer Experience					
Before Summer Experience	No Response	I still have not decided whether to go to college	I now plan to go to college	I now plan to get a college degree in a science-related field	I now plan to get a college degree in a non-science-related field	Total
I had not decided whether to go to college	1	3	**4**	**1**	**1**	10
I had planned not to go to college	0	1	**2**	0	0	3
I had planned to get a college degree in a science-related field	2	0	2	14	0	18
I had planned to get a college degree in a non-science-related field	1	0	2	0	8	11
Total	4	4	10	15	9	42

Table 51 shows that following their Summer 2014 experiences, 6% of students (7 of 112) changed their future education plans from not going to college or undecided to getting a college degree in a science or non-science/engineering-related field. In addition, 5% of students (6 of 112) changed their planned college major from a non-science/engineering-related field or undecided to studying in a science- or engineering-related field in college.

Table 51. *Respondents' Career before and after Participating in Summer Experience, UB/BPS ISEP Student Summer Experience Questionnaire, Summer 2014*

Summer 2014	**After Summer Experience**							
Before Summer Experience	**No Response**	**I still have not decided whether to go to college.**	**I still do not plan to go to college.**	**I now plan to go college**	**I now plan to go to college and study a science- or engineering-related field.**	**I now plan to go to college and study a non-science- or engineering-related field.**	**I still plan to go to college and am still undecided about what I will study.**	**Total**
No Response	3	2	0	0	0	0	2	7
I had not decided whether to go to college.	0	11	0	**4**	0	0	**1**	16
I had planned not to go to college.	0	2	2	**1**	0	**1**	0	6
I had planned to go to college and study a science- or engineering-related field.	2	0	0	2	23	1	0	28
I had planned to go to college and study a non-science- or engineering-related field.	1	2	0	0	**4**	7	2	16
I had planned to go to college but did not know what I wanted to study.	1	1	0	4	**2**	1	30	39
Total	7	18	2	11	29	10	35	112

As shown in Table 52, during their summer experiences, students not only worked with other high school students, but also worked with college students, their teachers, and college faculty, as well as individually.

Table 52. *Respondents' Summer Experience Environment, UB/BPS ISEP Student Summer Experience Questionnaire, Summer 2013 and Summer 2014*

How would you describe your summer experience environment?	Summer 13	Summer 14	Total
I worked individually	10 (24%)	28 (25%)	38 (25%)
I worked with other high school students	27 (64%)	54 (48%)	81 (53%)
I worked with middle school or high school teachers	8 (19%)	26 (23%)	34 (22%)
I worked with college students	17 (40%)	36 (32%)	53 (34%)
I worked with college faculty	11 (26%)	15 (13%)	26 (17%)
I worked with scientists and/or engineers	3 (7%)	11 (10%)	14 (9%)
I worked with other professionals from business or industry	13 (31%)	18 (16%)	31 (20%)

In general, students reported that they were engaged in and benefited from real inquiry-based research experiences both in Summer 2013 and in Summer 2014, as shown in Table 53. When comparing students in Summer 2013 and in Summer 2014 as two independent groups, students in Summer 2013 reported that they used computers or the Internet for activities and wrote about how they solved a science task or about what they learned more frequently than did students in Summer 2014. In addition, more students in Summer 2013 indicated that the summer experience helped them better clarify their career paths than did students in Summer 2014. All students in Summer 2013 were in high school grades, while students in Summer 2014 were spread across elementary, middle, and high school grades. This likely is the reason for these significant differences across years.

Table 53. *Respondents' Summer Experience, UB/BPS ISEP Student Summer Experience Questionnaire, Summer 2013 and Summer 2014, Unmatched*

Item	Time	*n*	*M*	*SD*	*t*	*df*	*p*
13. During my summer experience; I…							
13a. Used information and data to support my conclusions.	Summer 2013	38	3.37	1.28	0.19	133	.849
	Summer 2014	97	3.32	1.36			
13b. talked with others about how to do a science task or about how to interpret the data from an experiment.	Summer 2013	35	3.17	1.27	-0.36	132	.716
	Summer 2014	99	3.26	1.27			
13c. Learned from other students	Summer 2013	40	3.48	1.18	-0.69	138	.490
	Summer 2014	100	3.63	1.20			
13d. Considered different scientific explanations.	Summer 2013	32	3.09	1.15	0.10	119	.917
	Summer 2014	89	3.07	1.25			
13e. Had a say in deciding what activities I did.	Summer 2013	38	3.45	1.35	0.32	130	.753
	Summer 2014	94	3.37	1.19			
13f. Used a computer or the Internet	Summer 2013	40	3.98	1.17	2.24	94	**.027**

for activities.							
	Summer 2014	96	3.44	1.51			
13g. Wrote about how I solved a science task or about what I learned.	Summer 2013	35	3.49	1.29	2.40	126	**.018**
	Summer 2014	93	2.86	1.32			
13h. Learned that there are different solutions to science tasks.	Summer 2013	35	3.54	1.22	0.87	130	.386
	Summer 2014	97	3.31	1.41			
13i. Used multiple sources of information to learn.	Summer 2013	38	3.89	1.03	1.51	90	.135
	Summer 2014	99	3.57	1.39			
13j. Developed my skills for doing science.	Summer 2013	34	3.32	1.25	-0.64	128	.520
	Summer 2014	96	3.49	1.31			
13k. Learned about how science is important in the real world.	Summer 2013	33	3.52	1.28	-0.27	130	.789
	Summer 2014	99	3.59	1.32			
13l. Worked on science tasks in a group with other students	Summer 2013	37	3.46	1.14	0.01	80	.993
	Summer 2014	94	3.46	1.40			
14. I gained…	**Time**	***n***	***M***	***SD***	***t***	***df***	***p***
14a. Clarification of a career path	Summer 2013	37	3.30	1.24	2.21	129	**.029**
	Summer 2014	94	2.72	1.37			
14b. Skill in the interpretation of results	Summer 2013	37	3.46	0.99	1.96	124	.053
	Summer 2014	89	3.01	1.24			
14c. Tolerance for obstacles faced in learning	Summer 2013	36	3.36	1.17	0.59	131	.556
	Summer 2014	97	3.22	1.28			
14d. Readiness for more challenging academic experiences	Summer 2013	39	3.28	1.28	-0.05	132	.956
	Summer 2014	95	3.29	1.19			
14e. Understanding of the research process.	Summer 2013	39	3.23	1.25	-0.64	130	.521
	Summer 2014	93	3.39	1.29			
14f. Ability to apply my learning to real situations and problems.	Summer 2013	39	3.54	1.10	-0.13	134	.894
	Summer 2014	97	3.57	1.14			
14g. Understanding of how researchers work on real problems.	Summer 2013	37	3.54	1.02	0.15	128	.878
	Summer 2014	93	3.51	1.23			
14h. Ability to analyze data and other information.	Summer 2013	38	3.42	1.20	0.52	126	.604
	Summer 2014	90	3.30	1.20			
14i. Experience with research techniques.	Summer 2013	38	3.58	1.08	1.46	129	.147

	Summer 2014	93	3.24	1.27			
14j. Ability to read and understand professional or research literature.	Summer 2013	37	3.46	1.26	1.60	120	.112
	Summer 2014	85	3.05	1.33			
14k. Skill in writing.	Summer 2013	36	3.14	1.31	-0.13	127	.899
	Summer 2014	93	3.17	1.34			
14l. Self-confidence.	Summer 2013	39	3.56	1.10	-0.24	134	.807
	Summer 2014	97	3.62	1.20			
14m. Understanding of how researchers think.	Summer 2013	39	3.38	1.09	0.10	131	.920
	Summer 2014	94	3.36	1.23			
14n. Ability to work independently	Summer 2013	36	3.50	1.21	-0.24	131	.812
	Summer 2014	97	3.56	1.22			
14o. Experience in a learning community	Summer 2013	40	3.70	1.14	-0.12	137	.905
	Summer 2014	99	3.73	1.24			
15. I plan to…	**Time**	***n***	***M***	***SD***	***t***	***df***	***p***
15a. Take (or have taken) only the science courses I am required to take in high school.	Summer 2013	38	3.32	1.19	1.00	142	.319
	Summer 2014	106	3.08	1.30			
15b. Take (or have taken) the most challenging science courses offered in my high school.	Summer 2013	38	3.18	1.27	0.29	141	.770
	Summer 2014	105	3.11	1.26			
15c. Take (or have taken) 4 years of science courses in high school.	Summer 2013	37	3.51	1.22	0.24	139	.813
	Summer 2014	104	3.45	1.40			
15d. Graduate from high school.	Summer 2013	38	4.26	1.18	-0.96	141	.340
	Summer 2014	105	4.47	1.10			
15e. Enter the workforce full-time after high school.	Summer 2013	37	3.30	1.29	0.47	140	.643
	Summer 2014	105	3.17	1.46			
15f. Enter the military after high school.	Summer 2013	38	2.61	1.26	1.59	142	.115
	Summer 2014	106	2.20	1.39			
15g. Go to a 2- or 4-year college.	Summer 2013	38	4.32	1.02	0.85	140	.394
	Summer 2014	104	4.14	1.07			
15h. Take science courses in college.	Summer 2013	38	3.50	1.29	-0.71	140	.480
	Summer 2014	104	3.88	3.25			
15i. Major in a science field in college.	Summer 2013	37	3.14	1.29	-0.80	140	.423
	Summer 2014	105	3.32	1.20			
15j. Major in an engineering field in college.	Summer 2013	37	2.65	1.03	-1.24	139	.217
	Summer 2014	104	2.92	1.20			

15k. Major in a science or engineering technical field in college.	Summer 2013	36	3.11	1.09	0.18	135	.858
	Summer 2014	101	3.07	1.23			
15l. Major in a non-science field, such as business, in college.	Summer 2013	37	3.24	1.12	1.36	139	.175
	Summer 2014	104	2.94	1.16			
15m. Major in education in college in order to become a teacher.	Summer 2013	38	2.76	1.34	1.12	140	.267
	Summer 2014	104	2.50	1.21			
15n. Eventually go to graduate school to earn an advanced degree.	Summer 2013	38	3.95	1.14	-0.02	138	.986
	Summer 2014	102	3.95	1.08			

Fourteen students participated in the summer experience both in 2013 and in 2014 at the Riverside site and responded to the questionnaire at both time points. Wilcoxon Signed Ranks tests were used to examine if these students' perceptions changed across years. As shown in Table 54, students reported that the summer experience helped them gain more tolerance for obstacles faced in learning in Summer 2013 than they did in Summer 2014. In addition, all students strongly agreed that they would graduate from high school after participating in the Summer 2014 experience.

Table 54. *Respondents' Summer Experience, UB/BPS ISEP Student Summer Experience Questionnaire, Summer 2013 and Summer 2014 Matched*

Item	**Time**	***n***	***M***	***SD***	**Wilcoxon Signed Ranks Test *p***
13. During my summer experience; I…					
13a. Used information and data to support my conclusions.	Summer 2013	12	3.50	0.90	.317
	Summer 2014	12	3.67	1.15	
13b. talked with others about how to do a science task or about how to interpret the data from an experiment.	Summer 2013	10	2.90	1.60	.450
	Summer 2014	10	3.30	0.82	
13c. Learned from other students	Summer 2013	13	3.62	1.26	.527
	Summer 2014	13	3.77	0.83	
13d. Considered different scientific explanations.	Summer 2013	8	2.75	1.16	.888
	Summer 2014	8	2.63	0.92	
13e. Had a say in deciding what activities I did.	Summer 2013	12	4.00	1.13	.191
	Summer 2014	12	3.42	0.79	
13f. Used a computer or the Internet for activities.	Summer 2013	13	4.00	1.15	.854
	Summer 2014	13	3.85	1.41	

13g. Wrote about how I solved a science task or about what I learned.	Summer 2013	10	2.90	0.99	.773
	Summer 2014	10	2.80	1.40	
13h. Learned that there are different solutions to science tasks.	Summer 2013	9	3.44	1.42	.670
	Summer 2014	9	3.11	1.54	
13i. Used multiple sources of information to learn.	Summer 2013	13	4.00	1.00	.748
	Summer 2014	13	4.08	1.12	
13j. Developed my skills for doing science.	Summer 2013	8	3.25	1.28	.829
	Summer 2014	8	3.13	1.64	
13k. Learned about how science is important in the real world.	Summer 2013	9	3.00	1.58	.755
	Summer 2014	9	2.78	1.48	
13l. Worked on science tasks in a group with other students	Summer 2013	9	3.56	1.13	.892
	Summer 2014	9	3.44	1.01	
14. I gained…	**Time**	***n***	***M***	***SD***	**Wilcoxon Signed Ranks Test *p***
14a. Clarification of a career path	Summer 2013	12	3.50	1.09	.087
	Summer 2014	12	2.83	1.40	
14b. Skill in the interpretation of results	Summer 2013	11	3.27	0.90	.480
	Summer 2014	11	2.91	0.94	
14c. Tolerance for obstacles faced in learning	Summer 2013	10	3.70	0.95	**.020**
	Summer 2014	10	3.00	1.05	
14d. Readiness for more challenging academic experiences	Summer 2013	12	3.33	1.23	.566
	Summer 2014	12	3.17	1.11	
14e. Understanding of the research process.	Summer 2013	12	3.58	1.31	.952
	Summer 2014	12	3.67	1.23	
14f. Ability to apply my learning to real situations and problems.	Summer 2013	13	3.31	1.18	.405
	Summer 2014	13	3.54	1.05	
14g. Understanding of how researchers work on real problems.	Summer 2013	12	3.25	0.97	.340
	Summer 2014	12	3.58	1.08	
14h. Ability to analyze data and other information.	Summer 2013	11	3.36	1.12	.480
	Summer 2014	11	3.55	0.69	
14i. Experience with research	Summer 2013	13	3.62	1.04	.248

techniques.					
	Summer 2014	13	3.92	0.76	
14j. Ability to read and understand professional or research literature.	Summer 2013	9	3.56	1.33	.752
	Summer 2014	9	3.33	1.32	
14k. Skill in writing.	Summer 2013	11	3.18	1.33	1.000
	Summer 2014	11	3.18	1.08	
14l. Self-confidence.	Summer 2013	11	3.73	0.79	.429
	Summer 2014	11	4.00	1.18	
14m. Understanding of how researchers think.	Summer 2013	13	3.38	1.19	.206
	Summer 2014	13	3.69	1.03	
14n. Ability to work independently	Summer 2013	11	3.82	1.17	.288
	Summer 2014	11	3.36	0.81	
14o. Experience in a learning community	Summer 2013	13	3.46	1.13	.072
	Summer 2014	13	4.23	1.09	
15. I plan to…	**Time**	***n***	***M***	***SD***	**Wilcoxon Signed Ranks Test *p***
15a. Take (or have taken) only the science courses I am required to take in high school.	Summer 2013	12	3.25	1.14	.672
	Summer 2014	12	3.08	1.44	
15b. Take (or have taken) the most challenging science courses offered in my high school.	Summer 2013	12	2.92	1.31	.190
	Summer 2014	12	3.42	0.90	
15c. Take (or have taken) 4 years of science courses in high school.	Summer 2013	11	3.18	1.47	.156
	Summer 2014	11	4.00	1.10	
15d. Graduate from high school.	Summer 2013	12	3.83	1.53	**.026**
	Summer 2014	12	5.00	0.43	
15e. Enter the workforce full-time after high school.	Summer 2013	11	2.91	1.38	.559
	Summer 2014	11	2.73	1.49	
15f. Enter the military after high school.	Summer 2013	12	2.17	1.34	.680
	Summer 2014	12	2.00	1.54	
15g. Go to a 2- or 4-year college.	Summer 2013	12	4.08	1.38	.516
	Summer 2014	12	4.25	0.75	
15h. Take science courses in college.	Summer 2013	12	3.33	1.37	.226
	Summer 2014	12	3.83	1.03	
15i. Major in a science field in college.	Summer 2013	11	2.73	1.35	.058

	Summer 2014	11	3.55	1.13	
15j. Major in an engineering field in college.	Summer 2013	11	2.55	0.93	.719
	Summer 2014	11	2.73	1.42	
15k. Major in a science or engineering technical field in college.	Summer 2013	11	2.82	0.87	.417
	Summer 2014	11	3.18	1.25	
15l. Major in a non-science field, such as business, in college.	Summer 2013	12	3.17	1.27	.391
	Summer 2014	12	3.50	1.00	
15m. Major in education in college in order to become a teacher.	Summer 2013	12	2.83	1.11	.546
	Summer 2014	12	2.58	1.38	
15n. Eventually go to graduate school to earn an advanced degree.	Summer 2013	12	3.75	1.42	.245
	Summer 2014	12	4.25	0.97	

Summary and Recommendations

Summary of Evidence of Progress Toward Project Goals

During Year 4 of the ISEP project, the E & A Center evaluation team turned greater attention to collecting evidence of project progress toward its major goals. It should be noted that due to data collection cycles that align with the academic year, pre- and post-intervention data analyzed for this report were primarily from ISEP's third year of implementation with teachers (Summer 2013 - Spring 2014). Spring 2014 data were collected post-Year 3 from students of ISEP teachers and a well-matched comparison group of students of non-ISEP teachers. Findings also are reported for post-experience data collected from STEM undergraduate and graduate students in Spring and Fall 2014 and from BPS students who attended summer experience activities in Summer 2013 and Summer 2014. Although not reported here, Fall 2014 data also were collected pre-Year 4 from students of ISEP teachers and a well-matched comparison group of students of non-ISEP teachers. Spring 2015 data (post-Year 4) are being collected from ISEP teachers and their BPS students, comparison BPS students, and STEM students at the time of this report. Findings reported herein are intended for the purpose of project improvement upon reflection by the ISEP project team. Data were not available to evaluate progress toward some project goals; those instances are noted. Limitations of the evaluation to respond to some questions are based upon lack of sufficient data from comparison teachers' students to conduct rigorous analyses. Inconsistent responses of ISEP teachers to annual questionnaires also limits the ability of the evaluation to report on impact of the project over time. Findings from the Year 4 evaluation are summarized under each ISEP project goal.

GOAL 1: Improve elementary/middle school science teachers' knowledge and skills related to science inquiry through interdisciplinary science research and engineering design with university STEM faculty.

Three evaluation questions are associated with ISEP project Goal 1:

*Evaluation Question 1: Have elementary/middle school science **teachers' knowledge and skills** improved as the result of conducting interdisciplinary science research and engineering design with university STEM faculty?*

Before participating in ISEP activities, teachers felt well prepared to provide instruction in disciplinary core ideas but indicated higher priority professional development needs related to aspects of science teaching closely aligned with NGSS cross-cutting concepts (i.e., scale, proportion, and quantity) and practices of science and engineering (i.e., ask questions and define problems; develop an understanding of evidence, models, and explanation; and communicate an argument based on evidence). Following one year of participation in ISEP, teachers reported less need for professional development related to interdisciplinary concepts, suggesting that their ISEP experiences had provided opportunities to develop their understanding of interdisciplinary science. On the other hand, teachers reported higher priority professional development needs related to some aspects of inquiry teaching (i.e., abilities needed to do scientific inquiry) and practices of science and engineering (i.e., construct explanations and design solutions) after their first year of participation.

Both before and after ISEP participation, teachers reported high priority professional development needs related to helping their students develop the ability to obtain, evaluate, and communicate information, as well as to analyze and interpret data. These findings suggest that teachers may be developing new, deeper understandings of inquiry teaching and learning; and therefore, they perceived a need to further develop inquiry-based teaching skills.

Regarding development of teachers' knowledge and skills, statistically significant improvements after two years of ISEP participation included better preparedness to teach students who have a learning disability which impacts science learning and to teach interdisciplinary science inquiry. In addition, teachers reported better preparedness for many aspects of inquiry science instruction (i.e., managing students using hands-on or laboratory activities, leading students using investigative strategies, taking into account students' prior conceptions, knowing major unifying concepts and how concepts relate to other disciplines, and teaching science to students from a variety of cultural backgrounds).

Following their participation in ISEP professional development, there were no statistically significant changes in teachers' reported familiarity, beliefs, or attitudes about design, engineering, and technology. However, after participating in ISEP professional development, more ISEP teachers indicated that there was a lack of training and support for teaching design, engineering, and technology in their schools. Yet, most teachers indicated that they were highly enthusiastic about including DET in science teaching, had strong beliefs that DET should be integrated into curricula, and believed it was important to align DET to mathematics and science state and national standards. These findings suggest that DET either was not an explicit focus of teachers' experiences with ISEP or that integration of DET into teachers' experiences did not impact teachers' familiarity with or beliefs about teaching design, engineering, and technology.

Evaluation Question 2: Have elementary/middle school science teachers improved their ***understanding of the Nature of Science and inquiry science teaching****?*

Following one year of participation in ISEP activities, teacher participants demonstrated significantly more accurate understanding that inquiry-based teaching requires the teacher to act as a facilitator or guide of student learning rather than as a disseminator of knowledge. Although not statistically significant, teachers agreed more that inquiry-based learning requires learners to gather data to use as evidence for answering scientifically-oriented questions; and manipulate and analyze data to develop evidenced-based explanations, by looking for patterns and drawing conclusions. In addition, following participation in ISEP activities, teacher participants agreed less with misconceptions that a universal step-by-step scientific method is used by all scientists and that scientific experiments are the only means to develop scientific knowledge.

Although ISEP teachers demonstrated positive views toward inquiry-based teaching and learning prior to their participation in the ISEP project, they revealed a number of common misconceptions regarding classroom scientific inquiry and understanding of the nature of science. Change in ISEP teachers views of scientific inquiry were primarily in the direction of greater agreement with accurate conceptions of scientific inquiry and also greater agreement with naïve conceptions of SI after one year of involvement. Six teachers who had been involved with ISEP for two years as of Summer 2014 demonstrated less agreement with naïve conceptions of science inquiry accompanied by slightly less agreement with statements of accurate understandings.

Compared to their understandings of scientific inquiry, teachers typically began ISEP participation with fewer naïve conceptions of nature of science than of SI, though they demonstrated no better knowledge of accurate NOS understandings. Similar to changes in teachers' views of SI, teachers who had been involved with ISEP for two years as of Summer 2014 demonstrated less agreement with naïve conceptions of nature of science accompanied by slightly less agreement with statements of accurate understandings. First-year ISEP teachers showed greater agreement with accurate conceptions and with naïve conceptions on their post-questionnaires.

Limited data are available at this time to reach conclusions about these patterns, but evaluators will use additional data collected in Summer 2015 to continue to explore ISEP's impact on participating teachers in this area. Evaluators also will utilize teachers' PCK assessment scores to determine the relationships among teachers' beliefs about SI and NOS and their reported uses of inquiry in the classroom.

*Evaluation Question 3: Have elementary/middle school science teachers improved their **competence in conducting inquiry science teaching**?*

Data regarding teachers' competence in conducting inquiry science in their classrooms was collected from their students, as well as from their own self-report. As noted under Evaluation Question 1, teachers reported somewhat lower levels of preparedness to implement inquiry instruction in their classrooms following their first year of participation in ISEP project activities. Despite these self-reported deficiencies, ISEP teachers' students reported more positively on their classroom inquiry learning experiences than did their peers taught by non-ISEP teachers following the teachers' first year of ISEP participation.

At the end of the 2013-2014 school year, both elementary and middle school ISEP science teachers reported more alignment of their own classroom practices with inquiry approaches based on analyses of teacher pedagogical content assessments. On these assessments, teachers shifted their responses from teacher-directed toward more student-led between the pre- and post-assessment.

Elementary grades students of ISEP participant teachers agreed more that they liked science in Spring 2014 than they did in Fall 2013. At the end of the school year, students also reported that their teachers demonstrated some behaviors that characterize inquiry teaching, including teachers more frequently encouraged them to ask questions and to explain their ideas to other students. Students also self-reported that they used information and data to support their conclusions, learned from other students, considered different scientific explanations, had a say in deciding what activities they did, and developed skills for doing science more frequently at the end of the school year than they did at the beginning of the year. Elementary students also demonstrated a better understanding of the processes and nature of science at the end of the school year.

Findings of comparison of ISEP students and non-ISEP peers suggested that control students had somewhat more positive views of science than did ISEP participant students, reported that their teachers used inquiry-based teaching methods and that they used inquiry-based learning practices more frequently than did ISEP students. However, due to significantly different sample sizes of these two student groups, it was not possible to conduct statistical analyses to control for pre-intervention differences between ISEP participant and control groups, so these findings should be interpreted with caution.

When comparing pre-post attitudes and opinions of middle school ISEP participant teachers' students, students agreed less that they liked science at the beginning of the school year. Generally, students reported slightly less positive perceptions of their experiences in science classrooms at the end of the school year than at the beginning. Towards the end of the school year, middle school students reported receiving more parental help with their science homework. There were no control group students who responded the questionnaire in this grade band.

GOAL 2: Increase science teacher quantity, quality, diversity, and retention in urban schools.

Evaluation Question 4: Has the total number of highly-qualified science teachers increased? Has the science teacher population become more diverse? Are highly-qualified science teachers being retained in urban schools?

Data collected prior to their participation in the project indicated that ISEP teachers are primarily experienced teachers, with moderate to high levels of prior participation in professional development experiences. Most teachers were credentialed to teach high school science, so reported adequate pre- and in-service preparation in science content generally.

To respond to questions regarding impact of the project on the Buffalo Public Schools, publically available school-level data were collected and analyzed to compare aggregate teacher information for each ISEP partner school between 2010-2011 and 2013-2014. A limited data set is publically available and data that may respond more directly to evaluation questions should be obtained from the BPS central administration. Since aggregate information exclusively for science teachers is not available on the New York State School Report Card or other publicly available data sources, information was reported for all teachers in the ISEP partner schools. Evaluators will continue to work with ISEP project personnel to collect key data that inform questions about improvement in science teacher quality and diversity and impact at the school and district level.

From 2010-2011 to 2013-2014, the percentage of teachers teaching without an appropriate license/certificate decreased at 5 of the 12 ISEP partner schools; the percentage of teachers with a Master's plus 30 hours or doctorate degree increased at 6 schools; the percentage of core courses <u>not</u> taught by highly qualified teachers decreased at 6 schools; 5 schools had all core courses taught by highly qualified teachers; the turnover rate of teachers with fewer than 5 years of experience decreased at 8 schools and remained the same at 1 other school; and the turnover rate for all teachers decreased at 7 schools.

GOAL 3: Develop and sustain professional learning communities in urban schools, based on mentoring models, with help from university STEM faculty and graduate students.

Evaluation Question 9: Are parents actively involved in project activities that support student learning?

Based on communication between the evaluator and ISEP project personnel, the parent group met monthly during the 2014-2015 school year. On average, 10-20 parents attended each monthly meeting. Two larger events were hosted by the ISEP project during this school year, an ISEP Parent PLC Retreat on August 16, 2014 and the ISEP Second Annual Parent PLC Social Justice Conference on January 17, 2015. Approximately 40-50 parents attended each event. However, only a small number of parents completed the PLC questionnaire during these meetings or events and their feedback was not analyzed in this report.

GOAL 4: Extend interdisciplinary inquiry based science and engineering learning to high school.

Evaluation Question 6: Are high schools with participating students implementing interdisciplinary inquiry in classrooms?

ISEP high school teachers who took both pre- and post-intervention teacher pedagogical content assessments achieved small gains in their PCK knowledge in biology, engineering, and physics after participating in ISEP activities.

There were no statistically significant differences between the pre-post responses of high school students of ISEP teachers on their views of science, teachers' teaching practices, and their learning experiences in 2013-2014. However, of the 24 items asking students about their classroom inquiry experiences, students in Spring 2014 responded more positively on 14 of these items than they did in Fall 2013. Further, towards to the end of the school year, students of ISEP teachers reported that they had lower levels of parental expectation for them to do well in science, to go to college, or to have a science related career. This implies that the ISEP project is serving students that are in high-need situations.

Responses of high school control and ISEP participant students also were compared using Spring 2014 data. Compared to students taught by ISEP participant teachers, control students had somewhat more positive views of science than did ISEP participant students. However, similar to the analyses of elementary students' data, it was not possible to conduct statistical analyses to control for pre-intervention differences between ISEP participant and control groups due to significantly different sample sizes. These findings should be interpreted with caution.

Teacher reports of implementing inquiry in their classrooms have not been disaggregated by grade level in order to explore if high school teachers' reports of implementing inquiry are congruent with students' perceptions. The evaluation team will disaggregate these data to the extent possible (without compromising participant confidentiality) to report differences between levels of implementation of inquiry in elementary, middle, and high school classrooms.

GOAL 5: Improve student achievement in science, attitude toward science-technology-society, and interest in pursuing advanced science studies.

Evaluation Question 7: Are students achieving higher learning standards in science?

In 2013-2014, 1 middle school and 2 high schools showed relatively large decreases in the percentage of students meeting or exceeding New York State Standards in Grade 8 Science, Regents Earth Science, and/or Regents Chemistry (Appendix F, Tables F2 and F3).

As a more proximal measure of students' learning in science, a content assessment was administered in Fall 2013 and Spring 2014 to students of ISEP teachers and to their non-ISEP peers. There were no statistically significant differences between the pre- and post-content knowledge assessment scores of middle and high school students of ISEP teachers. The only statistical significant difference was found in elementary grades data. Elementary ISEP students improved their correct response rate on a question about heat and temperature from 41% in Fall 2013 to 51% in Spring 2014. Elementary students demonstrated improved content knowledge on 6 assessment items; middle school students' content knowledge improved on 7 items; and, high school students' performance improved on 5 items.

Evaluation Question 8: Are students more interested in learning science and pursing advanced studies in science?

When comparing pre-post attitudes and opinions of high school grades students of ISEP participant teachers, students agreed more that they planned to pursue a science-related career, to go to a 2- or 4-year college, to take science courses in college, and to major in a science or engineering field in college after their teachers had participated in ISEP PD.

In Summer 2013, 42 high school students participated in an ISEP-sponsored summer experience at one site. In Summer 2014, 112 elementary to high school grades students participated in summer experiences at four sites. Among them, 14 students participated in a summer experience both in 2013 and in 2014 at the Riverside site and responded to the questionnaire at both time points. All of these students strongly agreed that they would graduate from high school after participating in the Summer 2014 experience.

Following ISEP summer experiences in 2013, 17% of students (7 of 42) changed their future education plans from undecided or not going to college, to getting a college degree in a science-related field, or in a non-science-related field. Following their Summer 2014 experience, 6% of students (7 of 112) changed their future education plans from not going to college or undecided to getting a college degree in a science or non-science/engineering-related field. In addition, 5% of students (6 of 112) changed their planned college major from a non-science/engineering-related field or undecided, to studying in a science- or engineering-related field in college.

GOAL 6: Improve collaboration in student learning among university, school, and parents.

Evaluation Question 10: Are science teachers actively participating in project activities?

On the post-Year 2 survey, most ISEP teachers reported moderate to high levels of participation in ISEP professional development activities focused on content and pedagogy in 2013-2014. Based on information provided by ISEP project personnel, 46 ISEP teachers participated in 160 hours or more of professional development during 2013-2014 school year. In addition, teachers self-reported that they had participated in an average of 45 hours of professional development activities outside of PD courses or activities with UB and/or BSC in 2013-2014.

Evaluation Question 11: Are university STEM faculty and students actively participating in project activities that improve K-12 science education?

STEM students' self-report of involvement in project activities suggested that their commitment to the work of the project is based on some common reasons, including faculty encouragement, sharing STEM knowledge, having new experiences, and developing teaching skills and science communication skills. Most STEM undergraduate students also indicated that working with school-age students was a reason for participating in this project; while STEM graduate students indicated that financial support for education and enhancing their CVs were reasons for participating.

Both STEM undergraduate and graduate students indicated that their major responsibilities in schools included assisting teachers in teaching lessons and conducting labs, leading small group activities/discussions in class, and demonstrating scientific content, procedures, tools, or techniques. In addition, the majority of graduate students indicated that they developed science labs for class use, helped teachers find resources, presented lessons to students in class, and developed and led out-of-school science learning activities.

Complete analyses of STEM student involvement in and learning from participation in ISEP project activities can be found in the report of the ISEP Research Team.

No data have been collected by the external evaluation team to directly assess the participation of faculty in project activities. If available, those data will be collected, analyzed, and incorporated into future evaluation reports.

In addition to the six project goals that are focused primarily on BPS teachers and students, the ISEP project has three additional objectives for the professional development of STEM undergraduate and graduate students. Data collected by the external evaluation team are provided to the ISEP Research Team to assess progress toward these objectives. Findings of the ISEP Research Team regarding this objective are included in the research section of this report. These objectives are:

Objective 1: To develop STEM undergraduate students' and graduate students' understanding of the nature of interdisciplinary science inquiry including engineering research.

Objective 2: To develop STEM undergraduate students' and graduate students' communication skills to promote interdisciplinary science inquiry to middle and high school science teachers and students.

Objective 3: To develop STEM undergraduate students' and graduate students' appreciation of professional learning communities and collaborative skills to actively contribute to the PLCs.

Observations and Recommendations

Based upon findings of the external evaluation, the E & A Center makes the following recommendations for Year 5:

1. After performing analysis of pre/post *UB/BPS ISEP Teacher Questionnaire* 2013-2014 and 2014-2015 data, evaluators will synthesize the results with data on teachers' participation in school-year project professional development workshop sessions provided by the project team. These analyses will

explore the contributions of summer PD experience and school-year follow-up experience to teachers' acquisition of knowledge and skill related to project goals at the individual level, though data will be reported in aggregate. For teachers involved in ISEP multiple years, additional analyses will be conducted to determine if and how teachers' perceptions of preparedness and attitudes toward interdisciplinary science teaching, understandings of the Nature of Science and classroom inquiry, and familiarity with design, engineering and technology changed following participation in ISEP project activities.

2. In order to continue to test the psychometric properties of the *UB/BPS ISEP Teacher* and the *US/BPS ISEP Student Questionnaire,* the E & A Center will repeat the factor analyses and reliability tests using all teacher and student pre/post data up-to-date to determine if the performance of some subscales, particularly on the student instrument, are improved and will make recommendations for modification to the instruments, if necessary. The objective of the evaluation is to establish valid factors for each instrument subscale with the ISEP target populations so that data can be analyzed at the construct level (factor level) and the Rasch model can be used to transform and compare data across project years and participant groups.
3. If valid factors can be established for the lower performing subscales (i.e., Science as Inquiry, Understanding the Nature of Science) of the *UB/BPS ISEP Teacher Questionnaire*, evaluators are interested in exploring how teachers' progressive acquisition of understanding of the Nature of Science and classroom inquiry interact with teachers' misconceptions regarding scientific inquiry and Nature of Science, as components of the teachers' belief system regarding teaching and learning. We would like to explore these aspects of teacher learning in collaboration with the ISEP Research Team.
4. Evaluators will continue to collaborate with project internal evaluation and research teams to test the psychometric properties of the Teacher Pedagogical Content Knowledge and Student Content Knowledge instruments and will report to the project team the validity and reliability of these instruments as they were administered to ISEP teachers and students in 2014-2015. Evaluators proposed to rescore two of the Teacher Pedagogical Content Knowledge Assessment instruments, i.e., the *Elementary School PCK Assessment* and *Middle School PCK Assessment* and the *Middle School PCK Assessment* and *Middle School PCK Assessment*, each consisting of 8 multiple-choice questions regarding classroom science teaching vignettes that demonstrate different approaches to inquiry teaching. Instead of scoring "right or wrong" based upon the teacher either selecting the most student-directed inquiry approach (right) or any of the remaining 3 responses, the new scoring scheme used a 1 to 4 scale with 1 represented the least inquiry-oriented teaching approach and 4 represented the most inquiry-oriented teaching approach. Data collection in 2013-2014 resulted in 6 matched responses to the elementary school assessment and 11 matched responses to the middle school assessment. The external evaluation team will further explore change in teachers' views of implementing classroom inquiry when 2014-2015 assessment data are available.
5. ISEP project personnel indicated that there is a need to revise the current version of the UB/BPS MSP ISEP Parent-Based PLC Questionnaire. Instead of asking parents' perceptions of the parent-based PLC sessions and expectations for their children's science education, the purpose of this instrument will shift to measure the impact of parent-based PLC sessions on parents and their students at this stage of the project. The evaluator and ISEP project personnel will revise this instrument together and administer it in upcoming parent-based PLC meetings.

Appendices

Targeted MSP: The University of Buffalo/Buffalo Public Schools (UB/BPS) Interdisciplinary Science and Engineering Partnership

Teacher Questionnaire, Summer 2014

Dear Participant,

We want to thank you for your participation in the *Targeted MSP: The University of Buffalo/Buffalo Public Schools (UB/BPS) Interdisciplinary Science and Engineering Partnership (ISEP)* project. This online *Teacher Questionnaire* is designed to obtain information about professional development, instructional practice, meeting various student needs, and other topics related to mathematics and science. Please complete this questionnaire by July 15.

The questionnaire takes no more than 20 minutes to complete. Although we have asked for identification information in order to link your responses across the points of data collection, you will never be identified in any reports or summaries of the data. After individual responses are entered into the database, access to your responses is strictly limited. Your participation is completely voluntary; you may refuse to answer certain questions or withdraw from the evaluation at any point. All the questionnaire data will be confidential. Failure to participate will not affect you in any way, but it will weaken the overall study because your important ideas and opinions will not be represented. By clicking to the next page, you indicate your consent to participate in this portion of the evaluation.

If you have questions about the questionnaire or evaluation, please contact me at 513-529-1686. If you have questions about participant rights, please contact the Office for the Advancement of Research and Scholarship at Miami University, 513-529-3600. If you have questions or concerns regarding the UB/BPS ISEP project, please contact Xiufeng Liu, xliu5@buffalo.edu.

Thank you again for your participation.

Sincerely,

Sarah B. Woodruff, Director
Ohio's Evaluation and Assessment Center for Mathematics and Science Education

DEMOGRAPHICS

Dear Teacher,

The following survey contains questions about professional development, instructional practice, meeting various student needs, and other topics related to mathematics and science. The information you provide is critical to the success of the UB/BPS ISEP project in which your are participating. We thank you for your assistance in collecting this information.

Instructions:

Please provide answers that best represent your situation. We request the following identification information so that we can match this questionnaire with one you may be asked to complete in the future. Your responses will be completely confidential. No identifying information will be provided to project personnel. All data will be reported in aggregate. NOTE: Current page won't be saved until you click "Next" button.

*** = Required field**

***1. The first letter of your FIRST name is:**

[ ]

***2. The first letter of your LAST name is:**

[ ]

3. Your date of birth is: *(Format: MM/DD/YYYY)

[ ]

4. What is your gender?

○ Female

○ Male

5. Are you Hispanic/Latino(a)?

○ No, not Hispanic/Latino(a)

○ Yes, Hispanic/Latino(a)

6. Please select race(s) from list below. (*Please check all that apply.*)

☐ American Indian or Alaska Native

☐ Black or African American

☐ White

☐ Asian

☐ Native Hawaiian or other Pacific Islander

7. Please identify the school in which you teach:

- ○ Harriet Ross Tubman Academy #31
- ○ Charles Drew Science Magnet #59
- ○ Lorraine Academy #72
- ○ Southside Elementary #93
- ○ Native American Magnet (NAMS) #19
- ○ East HS #307
- ○ Bennett HS #200
- ○ South Park HS #206
- ○ Riverside Institute of Technology HS #108
- ○ MST Preparatory School at Seneca #197
- ○ Burgard Vocational HS #301
- ○ Hutchinson Central Technical HS #304

8. Approximately how many students were in your science classes in 2013-2014 school year?

9. Of all the students in your science classes in 2013-2014 school year, what are the approximate percentages of:

	Percentage
% American Indian or Alaska Native	
% Black or African American	
% Hispanic or Latino	
% Asian or Native Hawaiian/ Other Pacific Islander	
% White	
% Multiracial	
% Limited English	
% Students with disabilities	
% Poverty (% free/reduced lunch)	
% Male	
% Female	

***10. Did you teach science and/or mathematics in 2013-2014 school year?**

	Yes	No
a. Science	○	○
b. Mathematics	○	○

***11. Are you certified to teach science and/or mathematics?**

	Yes	No
a. Science	○	○
b. Mathematics	○	○

12. Including this year . . .

a. How many years have you taught in a K-12 school? [ ]

b. How many years have you taught mathematics in a K-12 school? [ ]

c. How many years have you taught science in a K-12 school? [ ]

d. How many years have you taught at your current school? [ ]

	Yes	No
*** 13. Are you a special education teacher?**	○	○
*** 14. Are you a career/technical education teacher?**	○	○

15. What grades and/or course(s) did you teach in 2013-2014 school year? *(Please check all that apply.)*

- ☐ Grade 3 Science
- ☐ Grade 4 Science
- ☐ Grade 5 Science
- ☐ Grade 6 Science
- ☐ Grade 7 Physical Science
- ☐ Grade 8 Life Science
- ☐ Grade 3 Mathematics
- ☐ Grade 4 Mathematics
- ☐ Grade 5 Mathematics
- ☐ Grade 6 Mathematics
- ☐ Grade 7 Mathematics
- ☐ Grade 8 Mathematics
- ☐ Regents Living Environment
- ☐ Regents Earth Science
- ☐ Regents Chemistry
- ☐ Regents Physics
- ☐ High School Biology and Lab
- ☐ High School Environmental Science
- ☐ High School AP Biology
- ☐ High School AP Chemistry
- ☐ High School AP Physics
- ☐ High School AP Environmental Science
- ☐ High School IB Biology Jr. & Sr.
- ☐ High School IB Physics Jr. & Sr.
- ☐ High School Advanced Biology
- ☐ High School Advanced General Chemistry
- ☐ High School Organic Chemistry
- ☐ Other (please specify): [ ]

DEMOGRAPHICS (Cont'd)

Instructions:
Please provide answers that best represent your situation. NOTE: Current page won't be saved until you click "Next" button.

16. Please identify the majors of all degrees you have earned.

	Major
BA or BS	
MA, MS or MEd	
PhD or EdD	
Other (describe)	

17. In which of the following field(s) are you certified to teach mathematics? (Please check all that apply.)

	Yes, I am certified
ELEMENTARY	☐
PREK-6, 5-6	☐
MIDDLE GRADES	☐
5-9, 7-8, 7-9	☐
HIGH SCHOOL	☐
7-12	☐

18. If you are certified to teach other field(s) in mathematics not listed above, please specify:

19. In which of the following field(s) are you certified to teach science? (Please check all that apply.)

	Yes, I am certified
ELEMENTARY	☐
PREK-6, 5-6	☐
MIDDLE GRADES	☐
5-9, 7-8, 7-9	☐
HIGH SCHOOL	☐
7-12	☐
Certification Areas:	☐
Biology	☐
Chemistry	☐
Earth Science	☐
General Science	☐
Physics	☐

20. If you are certified to teach other field(s) in science not listed above, please specify:

21. Do you have Special Education Certificate?

○ Yes

○ No

22. Do you have Technology Education Certificate?

○ Yes

○ No

23. Are you presently teaching in an area for which you hold a certificate/license?

○ Yes

○ No

24. Do you meet NCLB requirements for Highly Qualified Teacher status?

(A Highly Qualified Teacher is one who holds at least a bachelor's degree; holds a valid teaching certificate; and demonstrates subject matter competency for the core content area s/he teaches.)

- ○ Yes
- ○ No
- ○ Unsure

25. Are you now or have you previously participated in professional development activities with Univiersity of Buffalo and/or Buffalo State College? *(Please check all that apply.)*

- ☐ Yes, during the 2013-2014 school year.
- ☐ Yes, during the 2012-2013 school year.
- ☐ Yes, during the 2011-2012 school year.
- ☐ No.

DEMOGRAPHICS (Cont'd)

Instructions:
Please provide answers that best represent your situation. NOTE: Current page won't be saved until you click "Next" button.

26. Approximately how many hours of professional development with the University of Buffalo and/or Buffalo State College have you participated in for each of the following foci?

	Number of Hours in 2012-2013 School Year:	Number of Hours in 2013-2014 School Year:
Content-related		
Assessment-related		
Curriculum-related		
Pedagogy-related		

	Number of Hours
27a. In 2012-2013 school year, the number of hours of professional development activities in which you participated NOT with the University of Buffalo or Buffalo State College is:	
27b. In 2013-2014 school year, the number of hours of professional development activities in which you participated NOT with the University of Buffalo or Buffalo State College is:	

Math

MATHEMATICS PREPARATION

Instructions:
Please provide answers that best represent your situation. NOTE: Current page won't be saved until you click "Next" button.

28. How many of the following mathematics undergraduate and/or graduate courses have you taken?

	Number of Undergraduate Courses:	Number of Graduate Courses:
a. College Algebra		
b. Geometry		
c. Statistics		
d. Calculus		
e. Integrated Mathematics		
f. Other (please specify):		

29. Considering your undergraduate or graduate preparation to teach, please indicate how well your degree(s) prepared you for teaching in the following areas.

	Not Adequately Prepared	Somewhat Prepared	Well Prepared	Very Well Prepared	Not Sure
a. Algebra	○	○	○	○	○
b. Algebra II	○	○	○	○	○
c. Geometry	○	○	○	○	○
d. Statistics	○	○	○	○	○
e. Pre-calculus	○	○	○	○	○
f. Calculus	○	○	○	○	○
g. Integrated Mathematics	○	○	○	○	○
h. Middle School Mathematics	○	○	○	○	○
i. Elementary School Mathematics	○	○	○	○	○
j. Other (please specify):	○	○	○	○	○

Science

SCIENCE PREPARATION

Instructions:

Please provide answers that best represent your situation. NOTE: Current page won't be saved until you click "Next" button.

30. How many of the following science and engineering undergraduate and/or graduate courses have you taken?

	Number of Undergraduate Courses:	Number of Graduate Courses:
a. Chemistry		
b. Physics		
c. Life Sciences -- Biology, Zoology		
d. Earth and Space Sciences -- Geology, Astronomy		
e. Physical Sciences (other than Chemistry and Physics)		
f. Engineering		
g. Technology Education		
h. Other (please specify):		

31. Considering your undergraduate or graduate preparation to teach, please indicate how well your degree (s) prepared you for teaching in the following areas.

	Not Adequately Prepared	Somewhat Prepared	Well Prepared	Very Well Prepared	Not Sure
a. Chemistry	○	○	○	○	○
b. Physics	○	○	○	○	○
c. Life Science	○	○	○	○	○
d. Earth and Space Science	○	○	○	○	○
e. Physical Science	○	○	○	○	○
f. Middle School Science	○	○	○	○	○
g. Elementary School Science	○	○	○	○	○
h. Other (please specify):	○	○	○	○	○

32. Please indicate how well prepared you feel to do each of the following.

	Not Adequately Prepared	Somewhat Prepared	Well Prepared	Very Well Prepared	Not Sure
a. Provide science instruction that meets appropriate standards (district, state, or national).	○	○	○	○	○
b. Teach scientific inquiry.	○	○	○	○	○
c. Manage a class of students who are using hands-on or laboratory activities.	○	○	○	○	○
d. Lead a class of students using investigative strategies.	○	○	○	○	○
e. Take into account students' prior conceptions about natural phenomena when planning instruction.	○	○	○	○	○
f. Align standards, curriculum, instruction, and assessment to enhance student science learning.	○	○	○	○	○
g. Sequence (articulation of) science instruction to meet instructional goals across grade levels and courses.	○	○	○	○	○
h. Select and/or adapt instructional materials to implement your written curriculum.	○	○	○	○	○
i. Know the major unifying concepts of all sciences and how these concepts relate to other disciplines.	○	○	○	○	○
j. Understand how students differ in their approaches to learning and create instructional opportunities that are adapted to diverse learners.	○	○	○	○	○
k. Teach science to students from a variety of cultural backgrounds.	○	○	○	○	○
l. Teach science to students who have limited English proficiency.	○	○	○	○	○
m. Teach students who have a learning disability which impacts science learning.	○	○	○	○	○
n. Encourage participation of females and minorities in science courses.	○	○	○	○	○
o. Provide a challenging curriculum for all students you teach.	○	○	○	○	○
p. Learning the processes involved in reading and how to teach reading in science.	○	○	○	○	○
q. Use a variety of assessment strategies (including objective and open-ended formats) to inform practice.	○	○	○	○	○
r. Use a variety of technological tools (student response systems, lab interfaces and probes, etc) to enhance student learning.	○	○	○	○	○
s. Teach interdisciplinary science inquiry.	○	○	○	○	○

33. Within science, many teachers feel better prepared to teach some topics than others, resulting in differing needs for professional development. Please indicate the degree to which these professional development needs are a priority for you at the grade level(s) you teach, whether or not they are currently included in your curriculum. Select the response that indicates your priority for each statement.

	Not a Priority	Low Priority	Moderate Priority	High Priority	Not Sure
1). Help students develop the ability to communicate with others an argument based on evidence.					
2). Help students develop an understanding of scale, proportion, and quantity as these concepts are used to describe the natural world.					
3). Help students develop an understanding of the behavior of organisms.					
4). Help students develop the ability to use mathematics and computational thinking.					
5). Help students develop the ability to construct explanations and design solutions.					
6). Help students develop an understanding of chemical reactions.					
7). Help students develop an understanding of patterns in natural events.					
8). Help students develop an understanding of the interactions of energy and matter.					
9). Help students develop an understanding of form and function.					
10). Help students develop an understanding of the structure and properties of matter.					
11). Help students develop an understanding of the conservation of energy and increase in disorder.					
12). Help students develop the abilities needed to do scientific inquiry.					
13). Help students develop an understanding of the structure of the atom.					
14). Help students develop an understanding of the molecular basis of heredity.					
15). Help students develop an understanding of energy in the earth system.					
16). Help students develop an understanding of the theory of biological evolution.					
17). Help students develop the ability to develop and use valid models.					
18). Help students develop the ability to obtain, evaluate, and communicate information.					
19). Help students develop the ability to ask questions and define problems.					
20). Help students develop an understanding of matter, energy, and organization in living systems.					
21). Help students develop the ability to analyze and interpret data.					
22). Help students develop an understanding of systems, order, and organization.					
23). Help students develop an understanding of evidence, models, and explanation.					
24). Help students develop an understanding of the cell.					
25). Help students develop a scientific understanding of the earth in the solar system.					
26). Help students develop an understanding of the interdependence of organisms.					

27). Help students develop the ability to plan and carry out investigations.	○	○	○	○	○
28). Help students develop an understanding of change, constancy, and measurement.	○	○	○	○	○
29). Help students develop an understanding of geochemical cycles.	○	○	○	○	○
30). Help students develop a scientific understanding of the origins of the earth and the universe.	○	○	○	○	○

Science as Inquiry & Understanding the Nature of Science

Instructions:

Please provide answers that best represent your situation. NOTE: Current page won't be saved until you click "Next" button.

34. Current reform documents in science education call for teaching "science as inquiry." The following statements represent views of inquiry-based teaching and learning. Please indicate your level of agreement with each of these statements regarding inquiry-based science teaching and learning.

	Strongly Disagree	Disagree	Neutral/ Undecided	Agree	Strongly Agree
1. Inquiry-based learning requires that learners engage in answering a scientifically-oriented question.	○	○	○	○	○
2. Inquiry-based learning requires that learners gather (or are given) data to use as evidence for answering a scientifically-oriented question.	○	○	○	○	○
3. Inquiry-based learning requires that learners manipulate and analyze data to develop evidenced-based explanations, by looking for patterns and drawing conclusions.	○	○	○	○	○
4. Inquiry-based learning requires that learners connect their explanations with explanations and concepts developed by the scientific community.	○	○	○	○	○
5. Inquiry-based learning requires that learners communicate, justify, and defend their explanations.	○	○	○	○	○
6. Inquiry-based learning requires that learners first understand basic, key science concepts prior to engaging in inquiry activities.	○	○	○	○	○
7. Inquiry-based learning assumes that all science subject matter should be taught through inquiry.	○	○	○	○	○
8. Inquiry-based learning requires that learners generate and investigate their own questions.	○	○	○	○	○
9. Inquiry-based learning requires the use of hands-on or kit-based instructional materials.	○	○	○	○	○
10. Inquiry-based learning requires that learners are engaged in handson activities.	○	○	○	○	○
11. Inquiry, as a process of science, can be taught without attention to specific science content or subject matter.	○	○	○	○	○
12. Inquiry-based learning assumes that learners build new knowledge and understanding on what they already know.	○	○	○	○	○
13. Inquiry-based learning assumes that learners formulate new knowledge by modifying and refining their current concepts and by adding new concepts to what they already know.	○	○	○	○	○
14. Inquiry-based learning assumes that learning is mediated by the social environment in which learners interact with others.	○	○	○	○	○
15. Inquiry-based learning requires that learners take control of their own learning.	○	○	○	○	○
16. Inquiry-based learning assumes that learners develop the ability to apply knowledge to novel situations, and that the transfer of learning is affected by the degree to which learners develop understanding.	○	○	○	○	○
17. Inquiry-based learning requires more sophisticated materials and equipment than other types of classroom learning.	○	○	○	○	○
18. Inquiry-based teaching requires that the teacher act as a facilitator or guide of student learning rather than as a disseminator of knowledge.	○	○	○	○	○
19. Inquiry-based teaching focuses more on what the students do, rather than on what the teacher does.	○	○	○	○	○
20. Inquiry-based teaching requires that the teacher have a strong background in the science content related to the inquiry.	○	○	○	○	○

35. Current reform documents in science education suggest that understanding the nature of science is critical for developing scientific literacy. The following statements represent views of the nature of science. Please indicate your level of agreement with each of these statements regarding the nature of science.

	Strongly Disagree	Disagree	Neutral/ Undecided	Agree	Strongly Agree
1. Science is a systematic way to gain an understanding of the natural world using naturalistic methods and explanations.	○	○	○	○	○
2. Scientific knowledge is reliable and durable so having confidence in scientific knowledge is reasonable.	○	○	○	○	○
3. A universal step-by-step scientific method is used by all scientists.	○	○	○	○	○
4. Scientific experiments are the only means used to develop scientific knowledge.	○	○	○	○	○
5. Contributions to science are made by people from all cultures around the world.	○	○	○	○	○
6. Scientific observations and conclusions are influenced by the existing state of scientific knowledge.	○	○	○	○	○
7. With new evidence and/or interpretation, existing scientific ideas are replaced or supplemented by newer ones.	○	○	○	○	○
8. Basic scientific research is concerned primarily with practical outcomes related to developing technology.	○	○	○	○	○
9. The principal product of science is conceptual knowledge about and explanations of the natural world.	○	○	○	○	○
10. Scientific laws are generalizations or universal relationships about some aspect of the natural world and how it behaves under certain conditions.	○	○	○	○	○
11. Scientific theories are inferred explanations of some aspect of the natural world.	○	○	○	○	○
12. All scientific laws have accompanying explanatory theories.	○	○	○	○	○
13. Scientific conclusions are to some extent influenced by the social and cultural context of the researcher.	○	○	○	○	○
14. Scientific observations are to some extent influenced by the observer's experiences and expectations.	○	○	○	○	○
15. Scientists may make different interpretations based on the same observations.	○	○	○	○	○
16. Scientific theories are subject to on-going testing and revision.	○	○	○	○	○
17. Scientific laws are theories that have been proven.	○	○	○	○	○
18. Cultural values and expectations do not influence scientific research because scientists are trained to conduct unbiased studies.	○	○	○	○	○
19. Scientists do not use their imagination and creativity because these can interfere with objectivity.	○	○	○	○	○
20. Scientific knowledge is tentative and may be abandoned or modified in light of new evidence or reconceptualization of prior evidence and knowledge.	○	○	○	○	○

Design Engineering and Technology (DET) Survey

Instructions:

The term "technology," as used in the national science standards, implies the design, engineering, and the technological issues related to conceiving, building, maintaining, and disposing of the useful objects and/or processes in the human-built world. Sometimes this term is referred to as "technological education," but, please note that it is separate from the use of computers and educational technology in the classroom. It is also distinctly different from job training or vocational education.

In this questionnaire, we use the term "Design/Engineering/Technology" or DET, synonymously with what the science standards call "technology." Examples of different Design/Engineering/Technology (DET) functions include:
• Building a paper bridge that will support a weight,
• Designing the layout of a new playground,
• Inventing a new device or process,
• Building working models of devices or processes.

NOTE: Current page won't be saved until you click "Next" button.

36. Do you use any science kits during science instruction?

○ Yes

○ No

Section I

37. Please answer the following questions by checking the most appropriate answer.

	Not At All	A Little	Neutral/ Undecided	Somewhat	Very Much
1. How familiar are you with Design/Engineering/Technology as typically demonstrated in the examples given above?	○	○	○	○	○
2. Have you had any specific courses in Design/Engineering/Technology outside of your preservice curriculum?	○	○	○	○	○
3. Did your preservice curriculum include any aspects of Design/Engineering/Technology?	○	○	○	○	○
4. Was your pre-service curriculum effective in supporting your ability to teach Design/Engineering/Technology at the beginning of your career?	○	○	○	○	○
5. How confident do you feel about integrating more Design/Engineering/Technology into your curriculum?	○	○	○	○	○
6. How important should pre-service education be for teaching Design/Engineering/Technology?	○	○	○	○	○
7. Do you use Design/Engineering/Technology activities in the classroom?	○	○	○	○	○
8. Does your school support Design/Engineering/Technology activities?	○	○	○	○	○
9. Do you believe Design/Engineering/Technology should be integrated into the K-12 curriculum?	○	○	○	○	○

To what extent do you agree with the following statements?

	Strongly Disagree	Disagree	Neutral/ Undecided	Agree	Strongly Agree
10. Most people feel that female students can do well in Design/Engineering/Technology.	○	○	○	○	○
11. Most people feel that minority students (African American, Hispanic /Latino, and American Indian) can do well in Design/Engineering/Technology.	○	○	○	○	○

As you teach a science curriculum, it is important to include…

	Not At All Important	A Little Important	Neutral/ Undecided	Somewhat Important	Very Important
12. Planning a project.	○	○	○	○	○
13. Using engineering to develop new technologies.	○	○	○	○	○

I would like to be able to teach my students to understand the…

	Strongly Disagree	Disagree	Neutral/ Undecided	Agree	Strongly Agree
14. Design process.	○	○	○	○	○
15. Use and impact of Design/Engineering/Technology.	○	○	○	○	○
16. Science underlying Design/Engineering/Technology.	○	○	○	○	○
17. Types of problems to which Design/Engineering/Technology should be applied.	○	○	○	○	○
18. Process of communicating technical information.	○	○	○	○	○

My motivation for teaching science is…

	Strongly Disagree	Disagree	Neutral/ Undecided	Agree	Strongly Agree
19. To prepare young people for the world of work.	○	○	○	○	○
20. To promote an enjoyment of learning.	○	○	○	○	○
21. To develop an understanding of the natural and technical world.	○	○	○	○	○
22. To develop scientists, engineers, and technologists for industry.	○	○	○	○	○
23. To promote an understanding of how Design/Engineering/Technology affects society.	○	○	○	○	○

How strong is each of the following a BARRIER in integrating Design/Engineering/Technology in your classroom?

	Not Strong At All	A Little Strong	Neutral/ Undecided	Somewhat Strong	Very Strong
24. Lack of time for teachers to learn about Design/Engineering/Technology.	○	○	○	○	○
25. Lack of teacher knowledge.	○	○	○	○	○
26. Lack of training.	○	○	○	○	○
27. Lack of administration support.	○	○	○	○	○
Other (please specify):	○	○	○	○	○

How much do you know about the …

	Not At All	A Little	Neutral/ Undecided	Somewhat	Very Much
29. National science standards related to Design/Engineering/Technology?	○	○	○	○	○

Section II

Please answer the following questions by checking the most appropriate answer.

	Not At All	A Little	Neutral/ Undecided	Somewhat	Very Much
30. How enthusiastic do you feel about including Design/Engineering/Technology activities in your teaching?	○	○	○	○	○
31. How prepared do you feel to include Design/Engineering/Technology activities in your teaching?	○	○	○	○	○
32. How important is it for you that Design/Engineering/Technology activities are aligned to mathematics state and national standards?	○	○	○	○	○
33. How important is it for you that Design/Engineering/Technology activities are aligned to science state and national standards?	○	○	○	○	○

Attitudes/Beliefs

Attitudes and Beliefs about Teaching Science and Mathematics

Instructions:
Please provide answers that best represent your situation. NOTE: Current page won't be saved until you click "Next" button.

38. Please indicate your level of agreement with each of the following statements.

	Strongly Disagree	Disagree	Neutral/ Undecided	Agree	Strongly Agree
Using technologies (e.g., calculators, computers) in science lessons will improve students' understanding of science.	○	○	○	○	○
Getting the correct answer to a problem in the science classroom is more important than investigating the problem in a scientific manner.	○	○	○	○	○
In Grades K–9, truly understanding science in the science classroom requires special abilities that only some people possess.	○	○	○	○	○
Students should be given regular opportunities to think about what they have learned in the science classroom.	○	○	○	○	○
To understand science, students must solve many problems following examples provided.	○	○	○	○	○
The use of technologies (e.g., calculators, computers) in science is an aid primarily for slow learners.	○	○	○	○	○
Students should have opportunities to experience manipulating materials in the science classroom before teachers introduce scientific vocabulary.	○	○	○	○	○
Science consists of unrelated topics such as biology, chemistry, geology, and physics.	○	○	○	○	○
Calculators should always be available for students in science classes.	○	○	○	○	○
The primary reason for learning science is to provide real-life examples for learning mathematics.	○	○	○	○	○
Small group activity should be a regular part of the science classroom.	○	○	○	○	○
The idea of teaching science scares me.	○	○	○	○	○
The idea of teaching engineering design concepts scares me.	○	○	○	○	○
I prefer to teach engineering design concepts and science emphasizing connections between the two disciplines.	○	○	○	○	○
I feel prepared to teach engineering design concepts and science emphasizing connections between the two disciplines.	○	○	○	○	○

Knowledge, Value and Practice of Common Core State Standards (CCSS) for ELA - Literacy in Science Teaching

Instructions:

Please provide answers that best represent your situation. NOTE: Current page won't be saved until you click "Next" button.

39. Knowledge of CCSA for ELA - Literacy

Please indicate your level of agreement with each of the following statements.

	Strongly Disagree	Disagree	Neutral/ Undecided	Agree	Strongly Agree
I completed at least one class on literacy strategies during my teacher preparation program.	○	○	○	○	○
My school district has provided ample training on CCSS for ELA - Literacy.	○	○	○	○	○
I have comprehensive knowledge of the CCSS for ELA-Literacy that relates to my grade and subject area.	○	○	○	○	○
I understand how CCSS for ELA-Literacy is connected to interdisciplinary science inquiry (ISI)	○	○	○	○	○
I am familiar with many strategies to implement CCSS for ELA-Literacy strategies within my science instruction.	○	○	○	○	○

40. Values of CCSA for ELA - Literacy

Please indicate your level of agreement with each of the following statements.

	Strongly Disagree	Disagree	Neutral/ Undecided	Agree	Strongly Agree
I feel that the CCSS for ELA-Literacy is appropriate for the student population I teach.	○	○	○	○	○
I believe that the CCSS for ELA-Literacy will lead to improved student learning for the majority of the students I teach.	○	○	○	○	○
I think it is important that all teachers implement literacy strategies into their instruction.	○	○	○	○	○
I feel that literacy skills are critical to students' science learning.	○	○	○	○	○
I feel that literacy skills play an important role in the work of scientists.	○	○	○	○	○

41. Integration of CCSA for ELA - Literacy in Science Teaching

Please indicate your level of agreement with each of the following statements.

	Strongly Disagree	Disagree	Neutral/ Undecided	Agree	Strongly Agree
I have made changes to my science teaching practice as a result of the CCSS for ELA-Literacy.	○	○	○	○	○
I dedicate a lot of classroom time on my students' learning and mastery of science vocabulary.	○	○	○	○	○
My science students regularly participate in "close-reading" of science texts.	○	○	○	○	○
My science students regularly interpret graphs and tables containing scientific data.	○	○	○	○	○
My science students regularly present and share their laboratory findings with their peers.	○	○	○	○	○

Citations for UB ISEP Teacher Questionnaire

Some items and subscales in this instrument have been modified and used with permission. The E&A Center would like to acknowledge and thank the following:

FOR INQUIRY TEACHING AND LEARNING QUESTIONS:
Lederman, N. G. (2006). Syntax of nature of science within inquiry and science instruction. In L. B. Flick and N. G. Lederman (Eds.), *Scientific inquiry and nature of science* (pp. 301-317). Netherlands: Springer.

National Research Council. (2000). *Inquiry and the National Science Education Standards: A guide for teaching and learning*. Washington, DC: The National Academies Press.

FOR NATURE OF SCIENCE QUESTIONS :
Liang, L. L., Chen, S. Chen, X., Kaya, O. N., Adams, A. D., Macklin, M., & Ebenezer, J. (2008). Assessing preservice elementary teachers' views on the nature of scientific knowledge: A dual-response instrument. *Asia-Pacific Forum on Science Learning and Teaching*, 9(1), 1-19.

National Science Teachers Association (2000). *The nature of science—A position statement of NSTA*. Washington, DC.

FOR ATTITUDES AND BELIEFS ABOUT TEACHING SCIENCE AND MATHEMATICS QUESTIONS:
McGinnis, J. R., Kramer, S., Shama, G., Graeber, A. O., Parker, C. A., & Watanabe, T. (2002). Undergraduates' attitudes and beliefs about subject matter and pedagogy measured periodically in a reform-based mathematics and science teacher preparation program. *Journal of Research in Science Teaching*, 39(3), 713-737.

FOR DESIGN, ENGINEERING AND TECHNOLOGY SURVEY QUESTIONS:
Yasar, S., Baker, D., Robinson-Kurpius, S., Krause, S., & Roberts, C. (2006). Development of a survey to assess K-12 teachers' perceptions of engineers and familiarity with teaching design, engineering, and technology. *Journal of Engineering Education*, 205- 216.

FOR SCIENCE AND MATHEMATICS PREPARATION QUESTIONS:
National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: The National Academies Press.
RMC Research. (2009). *Needs Assessment Survey for evaluation of the Nebraska Mathematics and Science Partnership projects*. Denver, CO: Author.

If you are satisfied with your responses, please click "Finalize the Questionnaire" button to submit your responses or click "Back" to modify your responses. Note: after the responses are finalized, you cannot make any changes to your responses or access this questionnaire.

Appendix B. UB/BPS ISEP ES/MS and HS Student Questionnaires (Fall 2014)

Dear Student:

Your teacher is participating in a professional development project called the Interdisciplinary Science and Engineering Partnership. This project is designed to help teachers improve how they teach science.

To help us improve this project, we are asking you to complete a questionnaire. The questionnaire has two parts. Part 1 of the questionnaire contains several questions about your experiences with science and your opinions about studying science. There are no right or wrong answers to these questions.

Part 2 of the questionnaire has some science questions. You may not know the answers to all of the science questions but please do your best. You will not be graded on this work and it will take less than 30 minutes to complete. You will be asked to provide some information about yourself so that your responses can be matched to questionnaires you may be asked to complete for this evaluation in the future.

All of your responses will be kept private. To do that, we place all of the data from students into a secure database, and no one will be identified by name in any reports about the project.

Your opinions are important to this evaluation but you get to decide whether to participate. You can choose to answer these questions or not, and you can choose not to answer any question that you do not want to answer. You can stop answering questions at any time. Whether you decide to participate or not, you will not be penalized in any way. We are asking for your help because the information you provide will help improve teaching in your school.

By answering these questions, you are saying that you agree to help us with our study and that we may use the data from your responses. Please ask your teacher if you have questions about how to complete the questionnaire.

Thank you for your help!

Sincerely,

Sarah B. Woodruff, Director
Ohio's Evaluation & Assessment Center for Mathematics and Science Education

Instructions: **Please provide answers that best represent your situation**. Your personal responses will be completely confidential. Identifying information will not be used in any report or paper.

1. The **first letter** of my **FIRST** name is:

Example: My first name is Chris [C] Answer here [ ]

2. The **first letter** of my **LAST** name is:

Example: My last name is Smith [S] Answer here [ ]

3. My **date of birth** is:

Example: [0 6] / [3 0] / [9 1] Answer here [ ] [ ] / [ ] [ ] / [ ] [ ]

Month Day Year Month Day Year

4. I am a: (Please check only one.)

____ Female ____ Male

5. Are you **Hispanic/Latino(a)**? (Choose only one.)

____ No, I am not Hispanic/Latino(a) ____ Yes, I am Hispanic/Latino(a)

6. Please select race(s) from list below. (Choose all that apply.)

____ American Indian or Alaska Native ____ Asian

____ Black or African American ____ Native Hawaiian or Other Pacific Islander

____ White

7. My current **grade level** is: (Please check only one.)

____ 4th ____ 7th ____ 10th

____ 5th ____ 8th ____ 11th

____ 6th ____ 9th ____ 12th

MY OPINION ABOUT SCIENCE

8. Please **circle** the response that best reflects how you feel about science.	**Level of Agreement** Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
a. I like science.	SD	D	U	A	SA
b. I am good at science.	SD	D	U	A	SA
c. I would keep on taking science classes even if I did not have to.	SD	D	U	A	SA
d. I understand most of what goes on in science.	SD	D	U	A	SA
e. Almost all people use science in their jobs.	SD	D	U	A	SA
f. Science is useful for solving everyday problems.	SD	D	U	A	SA
g. Science is a way to study and understand the natural world.	SD	D	U	A	SA
h. Scientists sometimes disagree about scientific knowledge.	SD	D	U	A	SA
i. All scientists do not follow the same step-by-step method to do science.	SD	D	U	A	SA
j. Scientists use their imagination when doing science.	SD	D	U	A	SA
k. Science ideas or hypotheses must be supported by evidence.	SD	D	U	A	SA
l. Scientific theories can change when new evidence or a new explanation becomes available.	SD	D	U	A	SA

WHAT MY TEACHER DOES

Instructions: Please **circle** the response that best reflects how often this happens in your science class.

9. In this class, my teacher ...	**How Often** Almost Never	Seldom	Sometimes	Often	Very Often
a. arranges the classroom so students can have discussion.	AN	Se	So	O	VO
b. asks questions that have more than one answer.	AN	Se	So	O	VO
c. asks me to give reasons and provide evidence for my answers.	AN	Se	So	O	VO
d. encourages me to ask questions.	AN	Se	So	O	VO
e. lets me work at my own pace.	AN	Se	So	O	VO
f. encourages me to explain my ideas to other students.	AN	Se	So	O	VO
g. encourage me to consider different scientific explanations.	AN	Se	So	O	VO
h. provides time for me to discuss science ideas with other students.	AN	Se	So	O	VO
i. checks that I have completed my assignments.	AN	Se	So	O	VO
j. provides meaningful and challenging assignments.	AN	Se	So	O	VO
k. helps me apply my learning to real life.	AN	Se	So	O	VO
l. expects me to do well.	AN	Se	So	O	VO

WHAT I DO

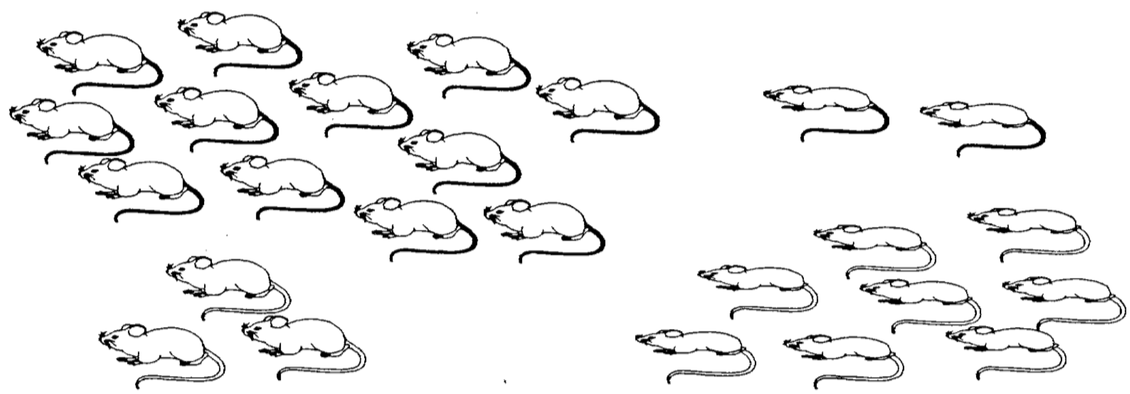
Instructions: Please **circle** the response that best reflects how often this happens in your science class **OR** in your home.

	How Often				
	Almost Never	Seldom	Sometimes	Often	Very Often
10. In this class, I ...					
a. use information and data to support my conclusions.	AN	Se	So	O	VO
b. talk with other students about how to do a science task or about how to interpret the data from an experiment.	AN	Se	So	O	VO
c. learn from other students.	AN	Se	So	O	VO
d. consider different scientific explanations.	AN	Se	So	O	VO
e. have a say in deciding what activities I do.	AN	Se	So	O	VO
f. use a computer or the Internet for science assignments or activities.	AN	Se	So	O	VO
g. write about how I solved a science task or about what I am learning.	AN	Se	So	O	VO
h. learn that there are different solutions to science tasks.	AN	Se	So	O	VO
i. use multiple sources of information to learn.	AN	Se	So	O	VO
j. develop my skills for doing science.	AN	Se	So	O	VO
k. learn about how science is important in the real world.	AN	Se	So	O	VO
l. work on science tasks in a group with other students.	AN	Se	So	O	VO
11. At least one adult in my home, ...					
a. makes me do my science homework.	AN	Se	So	O	VO
b. asks about what I am learning in science class.	AN	Se	So	O	VO
c. helps me with my science homework.	AN	Se	So	O	VO
d. helps me work on my science projects.	AN	Se	So	O	VO
e. expects me to do well in science.	AN	Se	So	O	VO
f. expects me to go to college.	AN	Se	So	O	VO
g. expects me to have a science-related career.	AN	Se	So	O	VO

Part 2: Please read the following science questions carefully and circle the letter of the correct answer. There is only ONE correct answer for each question. You may not have learned all of the science on this assessment but please do your best work and it's okay to guess on any question that you do not know the answer.

Questions 1 and 2 are about the following story and picture:

Farmer Brown was watching the mice that live in his field. He saw that all of them were either fat or thin. Also, all of them had either black tails or white tails. This made him wonder if there might be a link between the size of the mice and the color of their tails. So he captured all of the mice in one part of his field and observed them. Here are the mice that he captured.



1. Do you think there is a link between the size of the mice and the color of their tails?

   A. There appears to be a link.
   B. There appears not to be a link.
   C. I cannot make a reasonable guess.

2. Because

   A. There are some of each kind of mouse.
   B. There were not enough mice captured.
   C. Most of the fat mice have black tails while most of the thin mice have white tails.

3. How would you explain the phases of the moon?

   A. The size of the moon changes.
   B. The shadow of the earth falls on the moon.
   C. The amount of light falling on the moon changes.

4. What's the reason for your answer in Question 3?

   A. The earth comes between the sun and the moon.
   B. The position of the moon, earth and sun changes.
   C. The distance from the sun to the moon changes.

Questions 5 and 6 are about an experiment your teacher asks you to do to test whether a sample of soil and a sample of water heat up at the same rate. To do this, you are given the following materials:

2 heat lamps	1 sample of soil
2 bins	1 sample of water
2 thermometers	1 timer

Your teacher says to heat a sample of soil and a sample of water with heat lamps and measure the temperature of each sample every minute for 8 minutes.

5. What should you do to make sure you do this experiment accurately?

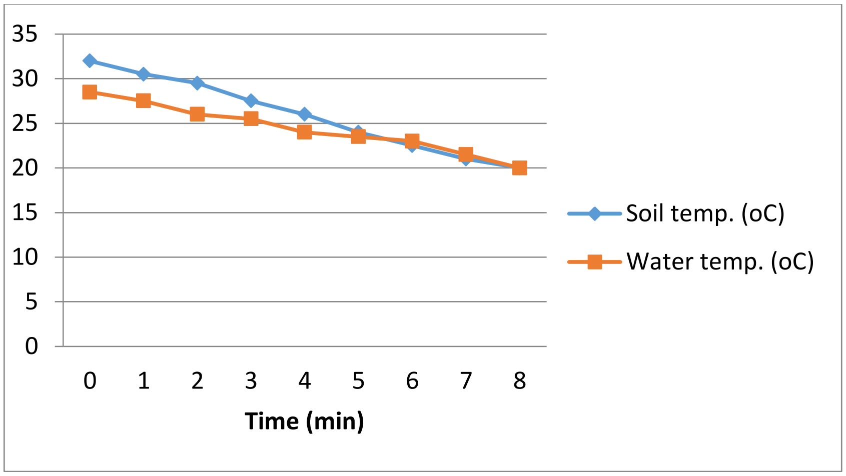
   A. Heat the samples for exactly the same amount of time.
   B. Heat the water sample longer than you heat the soil sample.
   C. Heat the soil sample longer than you heat the water sample.

Your experiment gives you the results shown in this table.

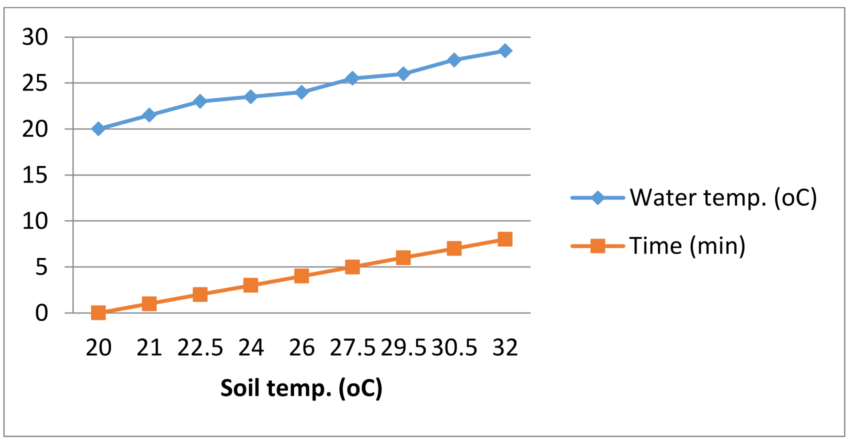
Time (min)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Soil temp. (^{O}C)	**20.0**	**21.0**	**22.5**	**24.0**	**26.0**	**27.5**	**29.5**	**30.5**	**32.0**
Water temp. (^{O}C)	**20.0**	**21.5**	**23.0**	**23.5**	**24.0**	**25.5**	**26.0**	**27.5**	**28.5**

6 . Which graph represents the data from your experiment?

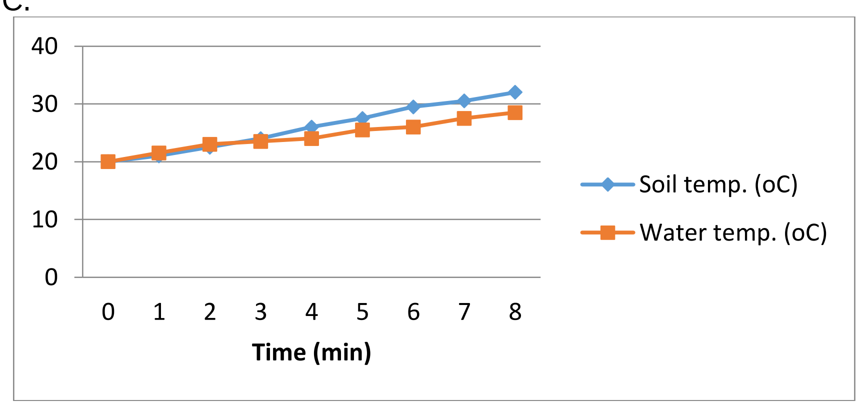
A.



B.

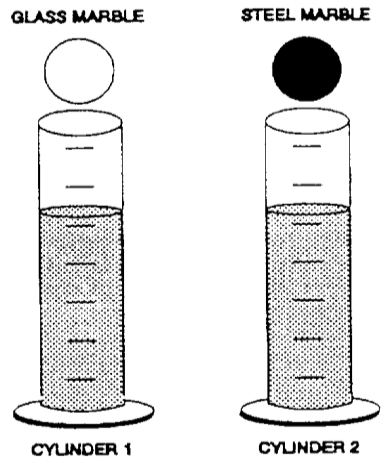


C.



Questions 7 and 8 are about the following information and pictures:

Two cylinders filled to the same level with water. The cylinders are exactly the same size and shape. Also shown are two marbles, one glass and one steel. The marbles are the same size but the steel one is much heavier than the glass one.



7. When you put the glass marble into Cylinder 1 it sinks to the bottom and the water level rises to the 6th mark. If you put the steel marble into Cylinder 2, the water will rise

   A. to the same level as it did in Cylinder 1.
   B. to a higher level than it did in Cylinder 1.
   C. to a lower level than it did in Cylinder 1.

8. Because

   A. The steel marble will sink faster.
   B. The marbles are made of different materials.
   C. The marbles are the same size.

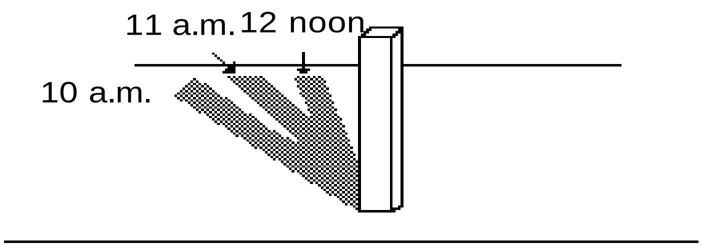
Use the information in this table to answer question 9.

Property	Powder *X*	Powder *Y*
Color	White	White
Melting Point	80°C	120°C
Shape	Crystals	Crystals
Mixed with Water	Dissolves	Dissolves

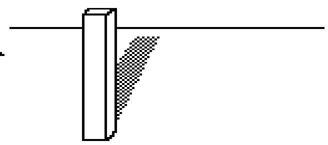
9. According to the information in the table, what should you do to decide whether an unknown powder is Powder X or Powder Y?

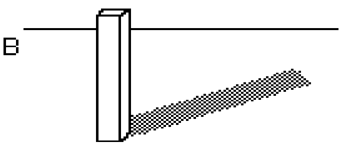
   A. Check the color of the powder.
   B. Measure the melting point of the powder.
   C. Dissolve the powder in water.

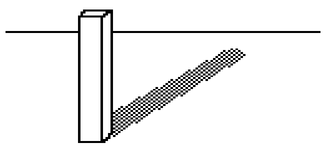
10. You notice that the shadow from a stick you placed in the sunlight changed position during the day. You recorded this information as shown here.



Which of the following shadows would you expect to see at 2 p.m.?

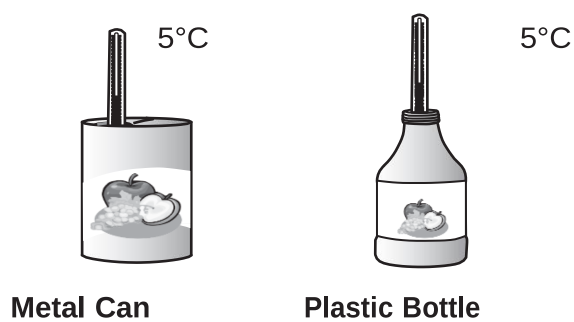
A


B


C


Use the following information and picture to answer Question 11.

Two juice containers are in a cooler. One is plastic and one is metal. The metal can feels colder than the plastic bottle. You place a thermometer in each container. You find that the juices in the bottle and in the can are the same temperature.

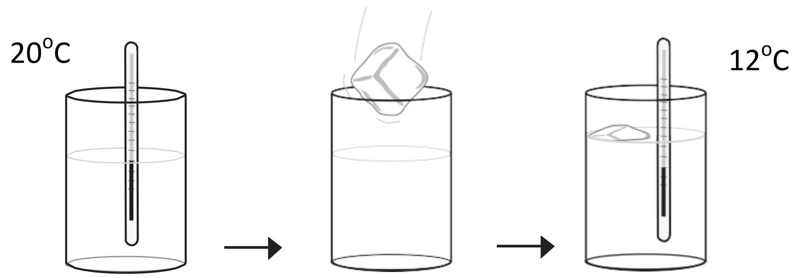


11. Why does the can feel colder than the bottle?

A. The metal can holds colder juice than the plastic bottle.
B. Plastic is a better conductor of thermal energy than metal.
C. Metal is a better conductor of thermal energy than plastic.

Use the following information and picture to answer Question 12.

You have a glass of water as shown. You take an ice cube from the freezer and put the ice cube into the water.



12. Which explains the change that happens?

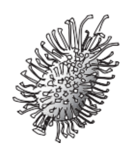
A. The ice cube melts because cold flows out of the ice cube to the water.
B. The ice cube does not melt because cold flows into the ice cube from the water.
C. The ice cube melts because thermal energy transfers to the ice cube from the water.

13. Which seed has structures that allow animals to transport the seed on their fur?

Corn Seed

A. 

Cocklebur

B. 

Maple Seed

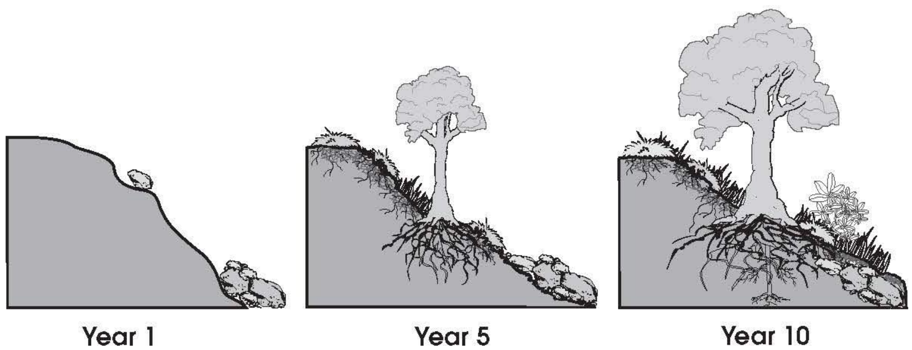
C. 

14. In the forest, one type of tree produces special seeds. These seeds start to grow only after going through a fire. In the fire, the adult trees are destroyed.

    Which resources, needed for growth, are available to the newly growing seeds after the fire?

    A. Sunlight and wind.
    B. Sunlight and space.
    C. Pollen producers and space.

Use the following pictures to answer Question 15.



15. How do these plants slow soil erosion caused by heavy rains on this hillside?

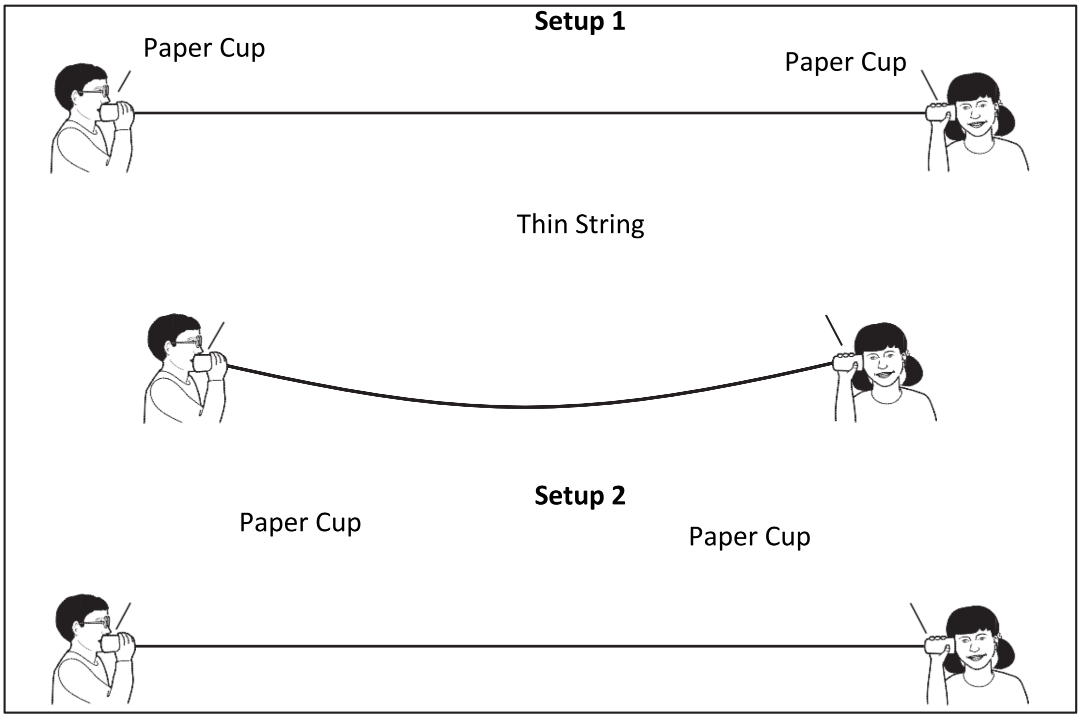
    A. Plants absorb water from the wet soil.
    B. Plant roots hold soil particles together.
    C. Plants decrease moisture evaporation from the soil.

Use the following information and picture to answer Questions 16, 17, and 18.

Model Telephone

Two students want to find out what affects the sounds heard through model telephones. They investigate the materials used and the tightness of the material connecting the cups.

Their first three setups are shown. They use the same length of string or wire in each setup. The boy repeats the same sounds at the same volume for each setup.



They record the results of the three setups in the table below.

Model Telephone Investigation

Setup	Description of Sound Heard
1	Sound is Muffled
2	No Sound is Heard
3	Sound is Clear

16. The two students want classmates to repeat the investigation so that they can compare results. What should the students tell the class so that results may be compared?

    A. They should tell what materials and steps were used in the investigation.
    B. They should tell their conclusions about results from the investigation.
    C. They should tell where they got the idea for making model telephones.

17. Which variable changed between Setup 1 and Setup 2?

    A. The type of cups used.
    B. The tightness of the string.
    C. The thickness of the string.

18. Two other students investigate model telephones made with paper and plastic cups. They find that sound is transmitted better using plastic cups. You and your friend want to make a model telephone that makes the best sound possible. You use the results of both investigations. Which setup should you use?

    A. Plastic cups and tight string.
    B. Plastic cups and tight wire.
    C. Paper cups and tight wire.

19. When you stand outside on a cold winter day, your hands become cold. You rub them together to make them warmer. Which statement explains why rubbing your hands together makes them warmer?

    A. This action produces thermal energy through friction.
    B. This action conducts thermal energy away from your body.
    C. This action captures thermal energy from the environment.

Use the following information and picture to answer Question 20.

20. Nectar is a sweet liquid that some flowering plants produce. A hummingbird drinks nectar from a flower. When a hummingbird drinks nectar, pollen from the flower sticks to the hummingbird's beak. The picture shows a hummingbird drinking nectar from a flower.

Which statement explains the role of a hummingbird in the life cycle of a flowering plant?

    A. A hummingbird carries food to the plant.
    B. A hummingbird helps the plant reproduce.
    C. A hummingbird protects the plant from predators.

Items comprising the *Evaluation of ISEP ES-MS Student Questionnaire* came from various preexisting questionnaires/surveys. Permission(s) to use these items have been granted to Ohio's Evaluation & Assessment Center from each respective author or group of authors. Sources by item are provided below.

Item 1: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 1.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 2: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 1.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 3: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 2.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 4: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 2.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 5: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 1.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 6: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 1.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 7: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 3.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 8: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 3.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 9: Kahle, J. B. & Rogg, S. R. (1997). *Discovery Inquiry Test (DIT).* Oxford, OH: Ohio's Evaluation & Assessment Center for Mathematics and Science Education.

Item 10: Kahle, J. B. & Rogg, S. R. (1997). *Discovery Inquiry Test (DIT).* Oxford, OH: Ohio's Evaluation & Assessment Center for Mathematics and Science Education.

Item 11: Ohio Department of Education. (2007 May). *Ohio Achievement Tests: Grade 5 Science Student Test Booklet.* Columbus, OH: Author.

Item 12: Ohio Department of Education. (2007 May). *Ohio Achievement Tests: Grade 5 Science Student Test Booklet.* Columbus, OH: Author.

Item 13: Ohio Department of Education. (2007 May). *Ohio Achievement Tests: Grade 5 Science Student Test Booklet.* Columbus, OH: Author.

Item 14: Ohio Department of Education. (2010 Spring). *Ohio Achievement Assessments: Grade 5 Science Student Test Booklet.* Columbus, OH: Author.

Item 15: Ohio Department of Education. (2010 Spring). *Ohio Achievement Assessments: Grade 5 Science Student Test Booklet.* Columbus, OH: Author.

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Item 18: Ohio Department of Education. (2007 May). *Ohio Achievement Tests: Grade 5 Science Student Test Booklet.* Columbus, OH: Author.

Item 19: Ohio Department of Education. (2011 Spring). *Ohio Achievement Assessments: Grade 5 Science Student Test Booklet.* Columbus, OH: Author.

Item 20: Ohio Department of Education. (2010 Spring). *Ohio Achievement Assessments: Grade 5 Science Student Test Booklet.* Columbus, OH: Author.

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Part 2 of the questionnaire has some science questions. You may not know the answers to all of the science questions but please do your best. You will not be graded on this work and it will take less than 30 minutes to complete. You will be asked to provide some information about yourself so that your responses can be matched to questionnaires you may be asked to complete for this evaluation in the future.

All of your responses will be kept private. To do that, we place all of the data from students into a secure database, and no one will be identified by name in any reports about the project.

Your opinions are important to this evaluation but you get to decide whether to participate. You can choose to answer these questions or not, and you can choose not to answer any question that you do not want to answer. You can stop answering questions at any time. Whether you decide to participate or not, you will not be penalized in any way. We are asking for your help because the information you provide will help improve teaching in your school.

By answering these questions, you are saying that you agree to help us with our study and that we may use the data from your responses. Please ask your teacher if you have questions about how to complete the questionnaire.

Thank you for your help!

Sincerely,

Sarah B. Woodruff, Director
Ohio's Evaluation & Assessment Center for Mathematics and Science Education

Instructions: **Please provide answers that best represent your situation**. Your personal responses will be completely confidential. Identifying information will not be used in any report or paper.

1. The **first letter** of my **FIRST** name is:
Example: My first name is Chris [C] Answer here [ ]

2. The **first letter** of my **LAST** name is:
Example: My last name is Smith [S] Answer here [ ]

3. My **date of birth** is:
Example: 0 6 / 3 0 / 9 1 Answer here [ ][ ] / [ ][ ] / [ ][ ]
Month Day Year Month Day Year

4. I am a: (Please check only one.)

____ Female ____ Male

5. Are you **Hispanic/Latino(a)**? (Choose only one.)

____ No, I am not Hispanic/Latino(a) ____ Yes, I am Hispanic/Latino(a)

6. Please select **race(s)** from list below. (Choose all that apply.)

____ American Indian or Alaska Native ____ Asian

____ Black or African American ____ Native Hawaiian or Other Pacific Islander

____ White

7. My current **grade level** is: (Please check only one.)

____ 4th ____ 7th ____ 10th

____ 5th ____ 8th ____ 11th

____ 6th ____ 9th ____ 12th

MY OPINION ABOUT SCIENCE

8. Please **circle** the response that best reflects how you feel about science.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
m. I like science.	SD	D	U	A	SA
n. I am good at science.	SD	D	U	A	SA
o. I would keep on taking science classes even if I did not have to.	SD	D	U	A	SA
p. I understand most of what goes on in science.	SD	D	U	A	SA
q. Almost all people use science in their jobs.	SD	D	U	A	SA
r. Science is useful for solving everyday problems.	SD	D	U	A	SA
s. Science is a way to study and understand the natural world.	SD	D	U	A	SA
t. Scientists sometimes disagree about scientific knowledge.	SD	D	U	A	SA
u. All scientists do not follow the same step-by-step method to do science.	SD	D	U	A	SA
v. Scientists use their imagination when doing science.	SD	D	U	A	SA
w. Science ideas or hypotheses must be supported by evidence.	SD	D	U	A	SA
x. Scientific theories can change when new evidence or a new explanation becomes available.	SD	D	U	A	SA

(Level of Agreement)

WHAT MY TEACHER DOES

Instructions: Please **circle** the response that best reflects how often this happens in your science class.

9. In this class, my teacher ...	**How Often**				
	Almost Never	**Seldom**	**Sometimes**	**Often**	**Very Often**
a. arranges the classroom so students can have discussion.	AN	Se	So	O	VO
b. asks questions that have more than one answer.	AN	Se	So	O	VO
c. asks me to give reasons and provide evidence for my answers.	AN	Se	So	O	VO
d. encourages me to ask questions.	AN	Se	So	O	VO
e. lets me work at my own pace.	AN	Se	So	O	VO
f. encourages me to explain my ideas to other students.	AN	Se	So	O	VO
g. encourage me to consider different scientific explanations.	AN	Se	So	O	VO
h. provides time for me to discuss science ideas with other students.	AN	Se	So	O	VO
i. checks that I have completed my assignments.	AN	Se	So	O	VO
j. provides meaningful and challenging assignments.	AN	Se	So	O	VO
k. helps me apply my learning to real life.	AN	Se	So	O	VO
l. expects me to do well.	AN	Se	So	O	VO

WHAT I DO

Instructions: Please **circle** the response that best reflects how often this happens in your science class **OR** in your home.

How Often: Almost Never (AN), Seldom (Se), Sometimes (So), Often (O), Very Often (VO)

	Almost Never	Seldom	Sometimes	Often	Very Often
10. In this class, I ...					
m. use information and data to support my conclusions.	AN	Se	So	O	VO
n. talk with other students about how to do a science task or about how to interpret the data from an experiment.	AN	Se	So	O	VO
o. learn from other students.	AN	Se	So	O	VO
p. consider different scientific explanations.	AN	Se	So	O	VO
q. have a say in deciding what activities I do.	AN	Se	So	O	VO
r. use a computer or the Internet for science assignments or activities.	AN	Se	So	O	VO
s. write about how I solved a science task or about what I am learning.	AN	Se	So	O	VO
t. learn that there are different solutions to science tasks.	AN	Se	So	O	VO
u. use multiple sources of information to learn.	AN	Se	So	O	VO
v. develop my skills for doing science.	AN	Se	So	O	VO
w. learn about how science is important in the real world.	AN	Se	So	O	VO
x. work on science tasks in a group with other students.	AN	Se	So	O	VO
11. At least one adult in my home, ...					
h. makes me do my science homework.	AN	Se	So	O	VO
i. asks about what I am learning in science class.	AN	Se	So	O	VO
j. helps me with my science homework.	AN	Se	So	O	VO
k. helps me work on my science projects.	AN	Se	So	O	VO
l. expects me to do well in science.	AN	Se	So	O	VO
m. expects me to go to college.	AN	Se	So	O	VO
n. expects me to have a science-related career.	AN	Se	So	O	VO

MY OPINION ABOUT MY FUTURE

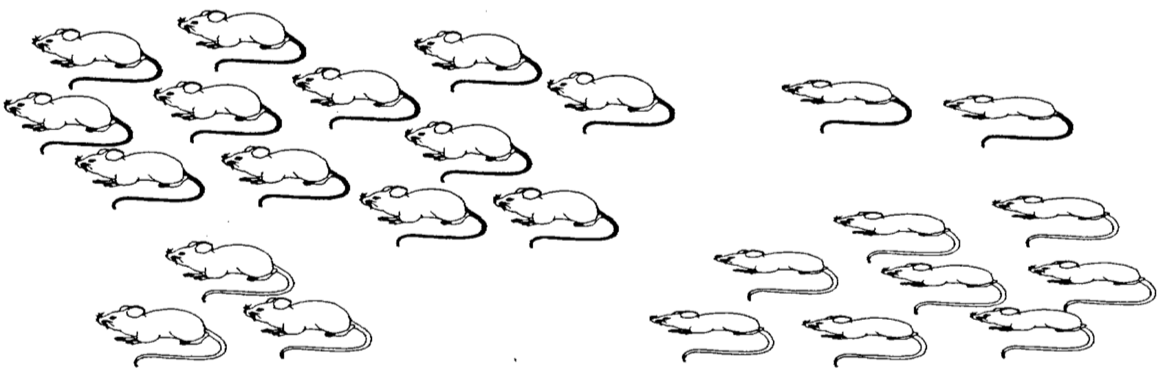
Instructions: Please **circle** the response that best reflects your future plans.

12. I plan to . . .	**Level of Agreement:** **Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
a. take (or have taken) only the science courses I am required to take in high school.	SD	D	U	A	SA
b. take (or have taken) the most challenging science courses offered in my high school.	SD	D	U	A	SA
c. take (or have taken) 4 years of science courses in high school.	SD	D	U	A	SA
d. pursue a science-related career.	SD	D	U	A	SA
e. go to a 2- or 4-year college.	SD	D	U	A	SA
f. take science courses in college.	SD	D	U	A	SA
g. major in a science field in college.	SD	D	U	A	SA
h. major in an engineering field in college.	SD	D	U	A	SA
i. major in a science or engineering technical field in college.	SD	D	U	A	SA

Part 2: Please read the following science questions carefully and circle the letter of the correct answer. There is only ONE correct answer for each question. You may not have learned all of the science on this assessment but please do your best work and it's okay to guess on any question that you do not know the answer.

Questions 1 and 2 are about the following story and picture:

Farmer Brown was observing the mice that live in his field. He discovered that all of them were either fat or thin. Also, all of them had either black tails or white tails. This made him wonder if there might be a link between the size of the mice and the color of their tails. So he captured all of the mice in one part of his field and observed them. Here are the mice that he captured.



1. Do you think there is a link between the size of the mice and the color of their tails?

   A. There appears to be a link.
   B. There appears not to be a link.
   C. I cannot make a reasonable guess.

2. Because

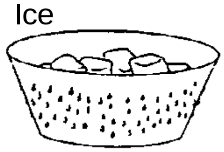
   A. There are some of each kind of mouse.
   B. There may be a genetic link between mouse size and tail color.
   C. There were not enough mice captured.
   D. Most of the fat mice have black tails while most of the thin mice have white tails.

3. An insulated bottle keeps a cold liquid in the bottle cold by

   A. Destroying any heat that enters the bottle.
   B. Keeping cold energy within the bottle.
   C. Trapping dissolved air in the liquid.
   D. Slowing the transfer of heat into the bottle.

4. What is the most likely science explanation for why there are drops of water on the outside

of the metal container in the picture?



A. Water is leaking through the container wall.
B. Water in the air outside the container is cooling and changing from vapor to liquid.
C. Air above the ice inside the container is warming and changing from vapor to liquid.
D. Cold air is carrying water from the inside to the outside of the container.

Question 5 is about an experiment your teacher asks you to do to compare the heating rate of soil to the heating rate of water. To do this, you are given the following materials:

2 heat lamps	1 sample of soil
2 bins	1 sample of water
2 thermometers	1 timer

Your teacher says to heat a sample of soil and a sample of water with heat lamps and measure the temperature of each sample every minute, for 8 minutes.

Your experiment gives you the results shown in this table.

Time (min)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Soil temp. (^{o}C)	**20.0**	**21.0**	**22.5**	**24.0**	**26.0**	**27.5**	**29.5**	**30.5**	**32.0**
Water temp. (^{o}C)	**20.0**	**21.5**	**23.0**	**23.5**	**24.0**	**25.5**	**26.0**	**27.5**	**28.5**

5. At a beach that has white sand, you measure the temperature of the sand and the temperature of the seawater at 9:00 a.m. You find that both have a temperature of 16°C. If it is clear and sunny all morning, what do the data from the experiment predict about the temperature of the white sand compared to the temperature of the seawater at noon?

   A. The temperature of the sand will be higher than the temperature of the seawater.
   B. The temperature of the sand will be lower than the temperature of the seawater.
   C. The temperature of the sand and the temperature of the seawater will be the same.
   D. The temperature of the sand and the temperature of the seawater cannot be predicted.

6. How would you explain the phases of the moon?

   A. The apparent size of the moon changes.
   B. The part of the lighted side of the moon that we see changes.
   C. The shadow of Earth falls on the moon.
   D. The amount of light falling on the moon changes.

7. What's the reason for your answer in Question 6?

A. The distance from Earth to the moon changes.
B. Earth comes between the sun and the moon.
C. The position of the moon, Earth and sun changes.
D. The distance from the sun to the moon changes.

Questions 8 and 9 are about the following information:

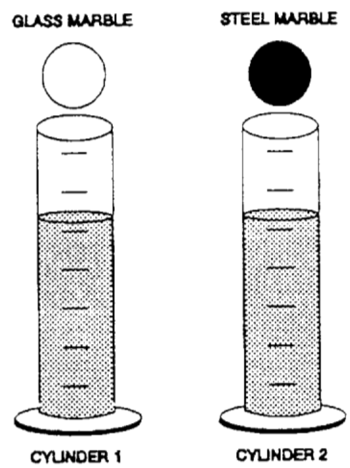
Two cylinders filled to the same level with water. The cylinders are the same size and shape. Also shown are two marbles, one glass and one steel. The marbles are the same size but the steel one is much heavier than the glass one.

8. When you put the glass marble into Cylinder 1, it sinks to the bottom and the water level rises to the 6th mark. If you put the steel marble into Cylinder 2, the water will rise

   A. To the same level as it did in Cylinder 1.
   B. To a higher level than it did in Cylinder 1.
   C. To a lower level than it did in Cylinder 1.
   D. It's not possible to predict the water level.

9. Because

   A. The steel marble will sink faster.
   B. The marbles are made of different materials.
   C. The steel marble is heavier than the glass marble.
   D. The marbles are the same size.



10. Imagine that you could put popcorn kernels into an airtight popcorn popper and measure the mass of the popper with the kernels. After the popcorn has popped, the mass of the popper and the popcorn will be

    A. Less than the original mass because popped corn is less dense than the kernels are.
    B. Equal to the original mass because the container is airtight.
    C. Greater than the original mass because the volume of the popped corn is greater than that of the kernels.
    D. It's impossible to determine without weighing each piece of popcorn.

11. A student has set up an artificial ecosystem for a class project. This ecosystem has producers, first-level consumers, second-level consumers, and third-level consumers. By accident, a chemical enters the ecosystem and kills all of the first-level consumers.

Which group(s) of organisms will most likely survive?

A. Only the producers.
B. Only the second-level consumers.
C. Second-level and third-level consumers.
D. Third-level consumers and producers.

12. Three students added equal volumes of pond water to four beakers (1-4) and placed each beaker in a different constant temperature bath, at 5ºC, 15ºC, 25ºC, and 35ºC. The students then added 6 water fleas to each beaker and recorded the time. After 1 hour, the students removed 3 water fleas from each beaker and immediately observed the water fleas under a microscope. The water fleas' heart rates were recorded as beats per minute. The results of the experiment are shown here.

	BeakerTemp	Time Water Fleas Added	Time Water Fleas Removed	Beats/minute (average of 3 Water Fleas)
Beaker 1	5ºC	2:00 pm	3:00 pm	41
Beaker 2	15ºC	2:10 pm	3:10 pm	119
Beaker 3	25ºC	2:20 pm	3:20 pm	202
Beaker 4	35ºC	2:30 pm	3:30 pm	281

The data obtained in this experiment support which of the following statements?

A. At 45ºC the heart rate of water fleas would be 320 beats/minute.
B. Water fleas swim more slowly at high temperature.
C. Metabolic rate in water fleas is directly proportional to water temperature.
D. The heart rate of water fleas is inversely proportional to water temperature.

13. Due to a loss of habitat, hunting, drought, disease, and inbreeding, the cheetah population has declined in number and is close to extinction. The current cheetah population has very little genetic variation.

Which is a result of the limited genetic variation in the current cheetah population compared to earlier cheetah populations with more variation?

A. Current populations of cheetahs are more resistant to diseases.
B. The survival rate of young cheetahs is increased in current populations.
C. Current populations of cheetahs are less likely to be able to adapt to environmental changes.
D. Current populations of cheetahs are able to interbreed with other species, increasing genetic variation.

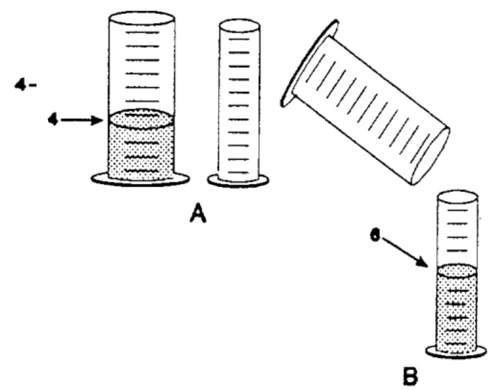
Questions 14 and 15 are about the following information:

To the right are drawings of a wide and a narrow cylinder. The cylinders have equally spaced marks on them. Water is poured into the wide cylinder up to the 4th mark shown in Picture A. This water rises to the 8th mark when poured into the narrow cylinder shown in Picture B.

Both cylinders are emptied and water is poured into the wide cylinder up to the 5th mark.

14. How high would this water rise if it were poured into the empty narrow cylinder?

    A. To about 8.
    B. To about 9.
    C. To about 10.
    D. None of these answers are correct.



15. Because

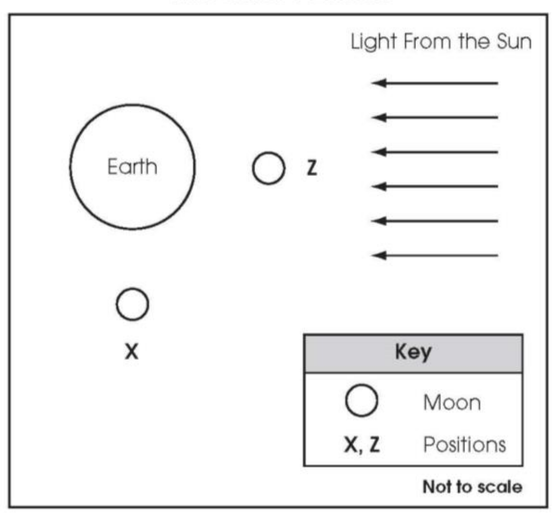
    A. The answer cannot be determined with the information given.
    B. It went up 4 more before, so it will go up 4 more again.
    C. It goes up 2 in the narrow for every 1 in the wide.
    D. It will go up to the same mark as it did before.

16. The diagram models Earth and the moon in two positions of its orbit. The arrows indicate the direction of the light from the sun.

    What phase of the moon will be seen from Earth when the moon is in position X?

    A. Full Moon
    B. New Moon
    C. First Quarter
    D. Last Quarter

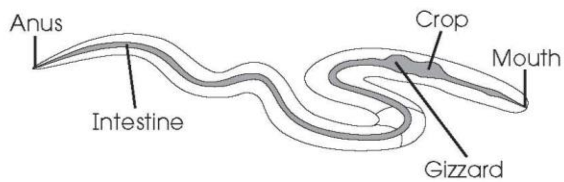
Two Lunar Positions



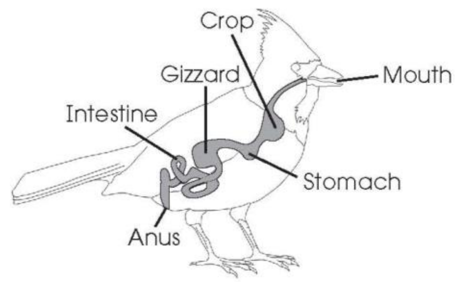
Use the diagrams and information below to answer Question 17.

The diagrams below show the digestive systems of an earthworm and a bird. Earthworms and birds have strong muscular gizzards. The gizzard grinds food into small bits before it passes on to the intestine. Mammals, in contrast, do not have gizzards.

Digestive System of a Worm



Digestive System of a Bird



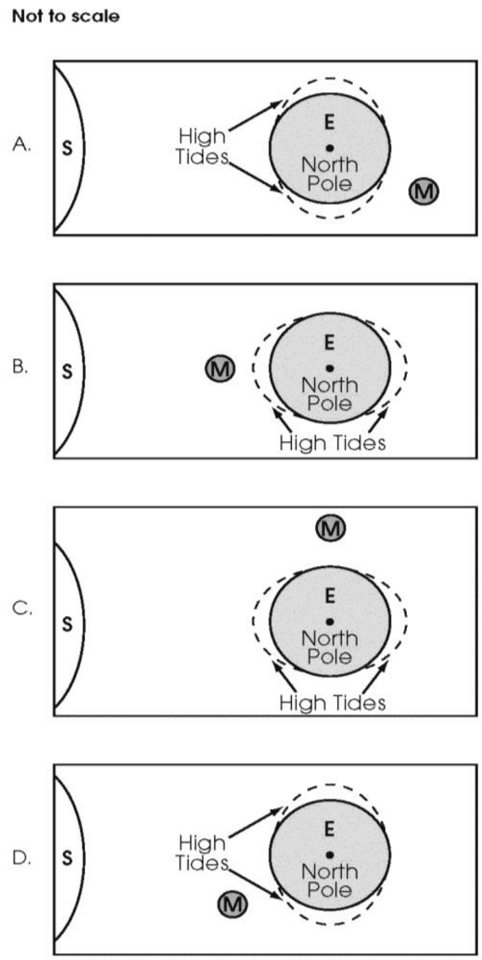
17. Why do earthworms and birds need gizzards but mammals do not?

    A. Earthworms and birds are not equipped to chew food.
    B. Earthworms and birds eat food that is difficult to digest.
    C. Earthworms and birds have intestines that work inefficiently.
    D. Earthworms and birds do not have stomachs to mix moistened food.

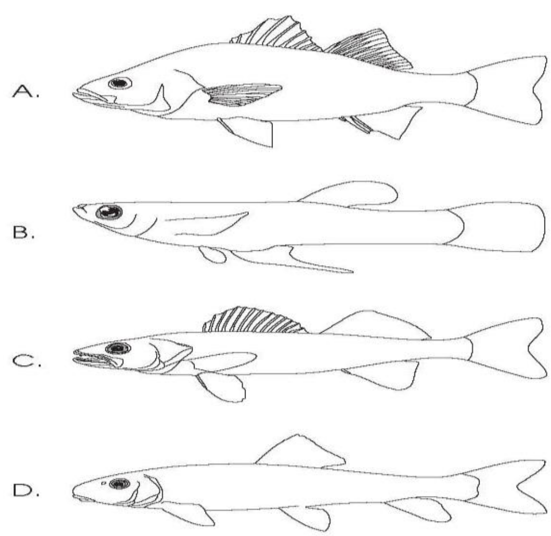
18. You walk from inside an air- conditioned building to stand outside on a sunny, sandy beach. You notice that your face and the bottoms of your feet feel warm. Which statement best describes the thermal energy transfer taking place?

    A. Thermal energy is transferred to your face by radiation, and thermal energy is transferred to the bottoms of your feet by radiation.
    B. Thermal energy is transferred to your face by convection, and thermal energy is transferred to the bottoms of your feet by radiation.
    C. Thermal energy is transferred to your face by radiation, and thermal energy is transferred to the bottoms of your feet by conduction.
    D. Thermal energy is transferred to your face by conduction, and thermal energy is transferred to the bottoms of your feet by conduction

19. The diagrams show the sun, Earth and moon in different positions relative to one another. Which diagram shows the correct arrangement of the sun (S), Earth (E) and moon (M) relative to the location of high tides?



20. The shape of an animal's body is related to where it lives and how it feeds. Which fish has a body shape that is best suited for feeding at the bottom of a lake?



Items comprising the *Evaluation of ISEP HS Student Questionnaire* came from various preexisting questionnaires/surveys. Permission(s) to use these items have been granted to Ohio's Evaluation & Assessment Center from each respective author or group of authors. Sources by item are provided below.

Item 1: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 1.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 2: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 1.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 3: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 3.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 4: Kahle, J. B. & Rogg, S. R. (1997). *Discovery Inquiry Test (DIT).* Oxford, OH: Ohio's Evaluation & Assessment Center for Mathematics and Science Education.

Item 5: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 1.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 6: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 2.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 7: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 2.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 8: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 3.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 9: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 3.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 10: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 2.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 11: Ohio Department of Education (2009 Spring). Ohio Graduation Tests: Science. Columbus, OH: Author.

Item 12: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 3.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 13: Ohio Department of Education (2009 Spring). Ohio Graduation Tests: Science. Columbus, OH: Author.

Item 14: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 1.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 15: Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Form 1.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

Item 16: Ohio Department of Education. (2011 Spring). *Ohio Achievement Assessments: Grade 8 Science Student Test Booklet.* Columbus, OH: Author.

Item 17: Ohio Department of Education. (2007 May). *Ohio Achievement Tests: Grade 8 Science Student Test Booklet.* Columbus, OH: Author.

Item 18: Ohio Department of Education (2009 Spring). *Ohio Graduation Tests: Science.* Columbus, OH: Author.

Item 19: Ohio Department of Education. (2010 Spring). *Ohio Achievement Assessments: Grade 8 Science Student Test Booklet.* Columbus, OH: Author.

Item 20: Ohio Department of Education. (2011 Spring). *Ohio Achievement Assessments: Grade 8 Science Student Test Booklet.* Columbus, OH: Author.

Appendix C. UB/BPS ISEP STEM Student Questionnaire

UB-BPS ISEP
STEM Student Questionnaire
Fall 2014

Default Block

Dear student:

We want to thank you for your participation in the UB/BPS ISEP project. As part of the NSF-required project evaluation, you are being asked to complete this online questionnaire, which includes questions regarding your experience with the UB/BPS ISEP project. Completing this questionnaire will provide important information to the ISEP project and your participation is very much appreciated. Please complete this questionnaire by December 12.

The questionnaire takes no more than 10 minutes to complete. All data you provide are confidential. Your responses will not be shared with anyone. You will never be identified in any reports or summaries of the data. Failure to complete this questionnaire will not affect you in any way, but it will weaken the evaluation because your important ideas and opinions will not be represented. By clicking to the next page, you indicate your consent to participate in this portion of the evaluation.

If you have questions about the questionnaire or the evaluation, please contact me at 513-529-1686. If you have questions or concerns regarding the UB/BPS ISEP project, please contact Xiufeng Liu, xliu5@buffalo.edu, or Joe Gardella, gardella@buffalo.edu.

Thank you again for your participation.

Sincerely,

Sarah B. Woodruff, Director
Ohio's Evaluation and Assessment Center for Mathematics and Science Education

Section A: Preparation

A1. What preparation, if any, did you have for working in schools? (Check all that apply.)

- Orientation in urban education
- Orientation in culture and diversity
- Orientation in teamwork/collaboration
- Orientation in science teaching and learning
- Orientation in science communications
- Orientation in mentoring
- Other (please specify):

Section B: Experiences

B1. Which of the following describes your activities in schools? (Check all that apply.)

- Assisted teachers in teaching lessons
- Assisted teachers in conducting labs
- Developed science labs for class use
- Developed out-of-school science learning activities
- Led small group activities/discussions with students in class
- Led small group activities/discussions with students after school or during weekend
- Demonstrated scientific content, procedures, tools, or techniques to students
- Helped teachers find relevant resources (e.g., science activities)
- Presented lessons/lectures to students in class
- Tutored students after school or during weekends
- Other (please specify):

Section C: Perceived Values of UB/BPS ISEP

C1. Why did you participate in UB/BPS ISEP program? (Check all that apply.)

- To gain financial support for my education
- My faculty advisor or another faculty member encouraged me
- Another student(s) encouraged me to participate
- To share my knowledge of science, technology, engineering and/or mathematics
- To work with school-age students
- I was interested in a teaching career
- To have new experiences
- To enhance my C.V. or resume
- To develop my teaching skills
- To develop my teamwork skills
- To develop my science communication skills
- To develop my research skills
- Other (please specify):

C2. Please indicate your level of agreement or disagreement with the following statements about your UB/BPS ISEP experiences. (Check one response in each row.)

My UB/BPS ISEP Experiences Have Benefited My Ability to

	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●

C3. Please indicate how your UB/BPS ISEP experiences influenced your interest in the following activities. (Check one response in each row.)

As a result of my UB/BPS ISEP Experiences…

	Strongly Decreased	Decreased	Was Unchanged	Increased	Strongly Increased
C3a. My interest in conducting research	●	●	●	●	●
C3b. My interest in teaching at the college/university level	●	●	●	●	●
C3c. My interest in teaching at the K–12 level	●	●	●	●	●
C3d. My interest in influencing public policy related to STEM education	●	●	●	●	●

Section D. Self-Efficacy in Communicating Science

How much can you do in order to...

	Little	Some	Quite A Bit	A Great Deal
D1. Understand middle and high school students' science background knowledge	●	●	●	●
D2. Understand middle and high school students' interest in science	●	●	●	●
D3. Understand middle and high school students' cognitive abilities	●	●	●	●
D4. Understand middle and high school students' social and cultural backgrounds	●	●	●	●
D5. Understand middle and high school students' attention span	●	●	●	●
D6. Decide what science topics are appropriate to students	●	●	●	●
D7. Decide how much science content is appropriate to students	●	●	●	●

D8. Help teachers find relevant resources (e.g., science activities)	●	●	●	●
D9. Develop science labs	●	●	●	●
D10. Develop out-of-school science learning activities	●	●	●	●
D11. Assist teachers in teaching lessons	●	●	●	●
D12. Assist teachers in conducting labs	●	●	●	●
D13. Teach science labs to students	●	●	●	●
D14. Facilitate out-of-school science learning activities	●	●	●	●
D15. Lead small group activities/discussions with students in class	●	●	●	●
D16. Lead small group activities/discussions with students after school or during weekends	●	●	●	●
D17. Demonstrate scientific content, procedures, tools, or techniques to students	●	●	●	●
D18. Teach lessons or give lectures to students in class	●	●	●	●
D19. Tutor students after school or during weekends	●	●	●	●
D20. Explain a difficult science concept to students	●	●	●	●
D21. Relate current research to K-12 curriculum	●	●	●	●
D22. Explain current research to teachers	●	●	●	●
D23. Plan a field trip to museums	●	●	●	●
D24. Facilitate student learning in museums	●	●	●	●
D25. Organize a science family night in school	●	●	●	●
D26. Explain science to parents	●	●	●	●

Section E: Background

E1. At which University/College are you currently enrolled?

- UB
- Buffalo State College
- Canisius College
- Damen College
- Medaille College
- Niagara University
- Other (please specify):

E2. Are you currently a undergraduate or graduate student? Choose one of the following:

- Undergraduate
- Master's
- Doctoral

E3. What is your role in the UB/BPS ISEP program?

- Service learning student
- Undergraduate intern
- Graduate student
- Other (please specify):

E4. How many years have you participated in the UB/BPS ISEP program?

- This is my first year.
- This is my second year.
- This is my third year.
- Other (Please specify):

E5. Are you currently participating in the UB IGERT Project?

- Yes
- No
- Not sure

E6. Which of the following disciplines are most closely aligned with what you are currently studying? (Select up to 2, with 1 being your primary discipline of study.)

	Rank 1	Rank 2
Biological Science	●	●
Chemistry	●	●
Geological and Earth Sciences	●	●
Geography	●	●
Math	●	●
Physics and astronomy	●	●
Engineering:		
Aerospace	●	●
Biomedical	●	●
Chemical	●	●
Civil and structural	●	●
Computer	●	●
Electrical	●	●
Environmental	●	●
Industrial/system	●	●
Mechanical	●	●
Other Engineering (please specify)	●	●
Social Sciences	●	●
Other (please specify):	●	●

E7. Before participating in the UB/BPS ISEP Project, did you have any of the following experiences? (Check all that apply.)

STEM = Science, Technology, Engineering, and/or Mathematics K–
12 = Kindergarten to 12th grade

- Worked as an elementary, a middle, or a high school classroom substitute teacher
- Volunteered in an elementary, middle, or high school classroom
- Tutored K–12 students in STEM
- Tutored undergraduate students in STEM
- Volunteered or worked with K–12 students outside of a classroom setting
- Taught at a college or university (2- or 4-year)
- Was a teaching or laboratory assistant for undergraduate or graduate courses
- Worked or volunteered at a science/technology museum, nature center, aquarium, zoo, or similar institution open to the public
- Worked or volunteered for social, environmental, or political projects/organizations
- Published a STEM-related research paper or presented a STEM-related paper or poster at a professional conference
- Wrote about or presented STEM content to a non-scientific audience
- Participated in an IGERT project
- None of the above

E8. Which of the following best describes your current career goals? (Check all that apply.)

- College or university faculty position with both teaching and research responsibilities
- College or university faculty position with primarily teaching responsibilities (greater emphasis on teaching than research)
- College or university faculty position with primarily research responsibilities (greater emphasis on research than teaching)
- College or university faculty position preparing K–12 teachers in science or mathematics education
- Researcher at a government laboratory or research institution
- Researcher/developer in industry/business
- Non-research position in the government or nonprofit sectors
- K–12 science or mathematics teacher
- K–12 administrator (e.g., school, district, State-level educational administration)
- I am unsure at this time
- Other (please specify):

If you are satisfied with your responses, please click "Submit" button to submit your responses. Note: after the responses are finalized, you cannot make any changes to your responses or access this questionnaire.

Appendix D. UB/BPS MSP ISEP Student Summer Experience Questionnaire

Dear Student:

You are receiving this questionnaire because you are participating in a summer experience funded by the Interdisciplinary Science and Engineering Partnership. One of the goals of this project is to help students become more interested in science and engineering.

To help us improve this project, we are asking you to complete a questionnaire. The questionnaire contains several questions and will take less than 15 minutes to complete. There are no 'right' or 'wrong' responses to these questions. You will be asked to provide some information about yourself so that your responses can be matched to questionnaires you may be asked to complete for this evaluation in the future.

All of your responses will be kept private. To do that, we place all of the data from students into a secure database, and no one will be identified by name in any reports about the project.

Your opinions are important to this evaluation but you get to decide whether to participate. You can choose to answer these questions or not, and you can choose not to answer any question that you do not want to answer. You can stop answering questions at any time. Whether you decide to participate or not, you will not be penalized in any way. We are asking for your help because the information you provide will help improve teaching in your school.

By answering these questions, you are saying that you agree to help us with our study and that we may use the data from your responses. Please ask your instructor if you have questions about how to complete the questionnaire.

Thank you for your help!

Sincerely,

Sarah B. Woodruff, Director
Ohio's Evaluation & Assessment Center for Mathematics and Science Education

Evaluation of ISEP Summer Experience

Student Questionnaire

Summer 2014

Instructions: **Please provide answers that best represent your situation**. Your personal responses will be completely confidential.

1. The **first letter** of my **FIRST** name is:

Example: My first name is Chris [C] Answer here [ ]

2. The **first letter** of my **LAST** name is:

Example: My last name is Smith [S] Answer here [ ]

3. My **date of birth** is:

Example: 0 6 / 3 0 / 9 6 Answer here __ __ / __ __ / __ __

Month Day Year Month Day Year

4. I am a: (Please check only one.)

☐ Female ☐ Male

5. Are you **Hispanic/Latino(a)**? (Please check only one.)

☐ No, I am not Hispanic/Latino(a) ☐ Yes, I am Hispanic/Latino(a)

6. Please select **race(s)** from list below. (Please check all that apply.)

☐ American Indian or Alaska Native ☐ Asian

☐ Black or African American ☐ Native Hawaiian or Other Pacific Islander

☐ White

7. My current **grade level** is: (Please check only one.)

☐ 7th ☐ 9th ☐ 11th

☐ 8th ☐ 10th ☐ 12th

8. Which school do you attend? (Please check only one.)

☐ Harriet Ross Tubman Academy ☐ Bennett HS

☐ Charles Drew Science Magnet ☐ South Park HS

☐ Lorraine Academy ☐ Riverside Institute of Technology HS

☐ Southside Elementary ☐ MST Preparatory School at Seneca

☐ Native American Magnet (NAMS) ☐ Burgard Vocational HS

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Evaluation of ISEP Summer Experience

Student Questionnaire
Summer 2014

☐ East HS ☐ Hutchinson Central Technical HS

☐ Other School (Please specify): ____

9. Prior to this summer experience, did you participate in any other similar summer experiences?

☐ No, I did not have any prior summer experiences like this one.

☐ Yes, I did have one prior summer experience like this one.

☐ Yes, I did have more than one prior summer experience like this one.

The next two questions ask about how your summer experience may have influenced your plans for continuing your education beyond high school. For questions 10 and 11, please choose the **one option** which best matches your opinion and plans for the next few years.

10. **Before** I started my summer experience,

☐ I had not decided whether to go to college.

☐ I had planned **not** to go to college.

☐ I had planned to go to college and study a science- or engineering-related field.

☐ I had planned to go to college and study a non-science- or engineering-related field.

☐ I had planned to go to college but did not know what I wanted to study.

11. **After** having my summer experience,

☐ I still have not decided whether to go to college.

☐ I still do **not** plan to go to college.

☐ I now plan to go college.

☐ I now plan to go to college and study a science- or engineering-related field.

☐ I now plan to go to college and study a non-science- or engineering-related field.

☐ I still plan to go to college and am still undecided about what I will study.

12. How would you describe your summer experience environment? (Please check all that apply.)

☐ I worked individually.

☐ I worked with other middle or high school students.

☐ I worked with middle school or high school teachers.

☐ I worked with college students.

☐ I worked with college faculty.

☐ I worked with scientists and/or engineers.

☐ I worked with other professionals from business or industry.

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Evaluation of ISEP Summer Experience

Student Questionnaire
Summer 2014

MY SUMMER EXPERIENCE

Instructions: Please **circle** the response that best reflects how often this happened during your summer experience. If the question does not apply to your experience, please choose "Not applicable".

13. During my summer experience, I ...	**How Often**					
	Almost Never	**Seldom**	**Sometimes**	**Often**	**Very Often**	**Not Applicable**
a. used information and data to support my conclusions.	AN	SE	SO	O	VO	NA
b. talked with others about how to do a science task or about how to interpret the data from an experiment.	AN	SE	SO	O	VO	NA
c. learned from other students.	AN	SE	SO	O	VO	NA
d. considered different scientific explanations.	AN	SE	SO	O	VO	NA
e. had a say in deciding what activities I did.	AN	SE	SO	O	VO	NA
f. used a computer or the Internet for activities.	AN	SE	SO	O	VO	NA
g. wrote about how I solved a science task or about what I learned.	AN	SE	SO	O	VO	NA
h. learned that there are different solutions to science tasks.	AN	SE	SO	O	VO	NA
i. used multiple sources of information to learn.	AN	SE	SO	O	VO	NA
j. developed my skills for doing science.	AN	SE	SO	O	VO	NA
k. learned about how science is important in the real world.	AN	SE	SO	O	VO	NA
l. worked on science tasks in a group with other students.	AN	SE	SO	O	VO	NA

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Evaluation of ISEP Summer Experience

Student Questionnaire
Summer 2014

BENEFITS OF MY SUMMER EXPERIENCE*

Instructions: Consider the possible benefits you may have gained from your summer experience. Please **circle** the response that best reflects your view of the benefits you gained.

If the question does not apply to your summer experience, please choose "Not applicable".

14. I gained . . .	**Level of Agreement**					
	No Gain	**Small Gain**	**Moderate Gain**	**Large Gain**	**Very Large Gain**	**Not Applicable**
a. Clarification of a career path	NG	SG	MG	LG	VLG	NA
b. Skill in the interpretation of results	NG	SG	MG	LG	VLG	NA
c. Tolerance for obstacles faced in learning	NG	SG	MG	LG	VLG	NA
d. Readiness for more challenging academic experiences	NG	SG	MG	LG	VLG	NA
e. Understanding of the research process	NG	SG	MG	LG	VLG	NA
f. Ability to apply my learning to real situations and problems	NG	SG	MG	LG	VLG	NA
g. Understanding of how researchers work on real problems	NG	SG	MG	LG	VLG	NA
h. Ability to analyze data and other information	NG	SG	MG	LG	VLG	NA
i. Experience with research techniques	NG	SG	MG	LG	VLG	NA
j. Ability to read and understand professional or research literature	NG	SG	MG	LG	VLG	NA
k. Skill in writing	NG	SG	MG	LG	VLG	NA
l. Self-confidence	NG	SG	MG	LG	VLG	NA
m. Understanding of how researchers think	NG	SG	MG	LG	VLG	NA
n. Ability to work independently	NG	SG	MG	LG	VLG	NA

o. Experience in a learning community	NG	SG	MG	LG	VLG	NA

*** Items on this subscale are adapted with permission from SURE III Survey (2010), Dr. David Lopatto, Grinnell College, with support of the Howard Hughes Medical Institute.**

MY OPINION ABOUT MY FUTURE

Instructions: Please **circle** the response that best reflects your future plans.

15. I plan to . . .	**Level of Agreement**				
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
a. take (or have taken) only the science courses I am required to take in high school.	SD	D	U	A	SA
b. take (or have taken) the most challenging science courses offered in my high school.	SD	D	U	A	SA
c. take (or have taken) 4 years of science courses in high school.	SD	D	U	A	SA
d. graduate from high school.	SD	D	U	A	SA
e. enter the workforce full-time after high school.	SD	D	U	A	SA
f. enter the military after high school.	SD	D	U	A	SA
g. go to a 2- or 4-year college.	SD	D	U	A	SA
h. take science courses in college.	SD	D	U	A	SA
i. major in a science field in college.	SD	D	U	A	SA
j. major in an engineering field in college.	SD	D	U	A	SA
k. major in a science or engineering technical field in college.	SD	D	U	A	SA
l. major in a non-science field, such as business, in college.	SD	D	U	A	SA

m. major in education in college in order to become a teacher.	SD	D	U	A	SA
n. eventually go to graduate school to earn an advanced degree.	SD	D	U	A	SA

Appendix E. Findings from UB/BPS ISEP Teacher PCK Assessment (Summer 2013 and Summer 2014)

Table E1. *Item Difficulty, UB/BPS ISEP Teacher PCK Assessment, Biology, Summer 2013 and Summer 2014*

Biology	July 2013 (Pre)			May/July 2014 (Post)			Mean Pre-Post Difference
	n	*M*	*SD*	*n*	*M*	*SD*	
Q1	27	70%	0.47	21	86%	0.36	15%
Q2	27	74%	0.45	21	86%	0.36	12%
Q3	27	48%	0.51	21	67%	0.48	19%
Q4	27	78%	0.42	21	81%	0.40	3%
Q5	27	67%	0.48	21	71%	0.46	5%
Q6	27	81%	0.40	21	86%	0.36	4%
Q7	27	63%	0.49	21	81%	0.40	18%
Q8	27	74%	0.45	21	81%	0.40	7%
Q9	27	78%	0.42	21	86%	0.36	8%
Q10	27	74%	0.45	21	71%	0.46	-3%
Q11	27	78%	0.42	21	81%	0.40	3%
Q12	27	70%	0.47	21	76%	0.44	6%
Q13	27	89%	0.32	21	76%	0.44	-13%
Q14	27	63%	0.49	21	76%	0.44	13%
Q15	27	59%	0.50	21	71%	0.46	12%
Q16	27	81%	0.40	21	90%	0.30	9%
Q17	27	67%	0.48	21	67%	0.48	0%
Q18	27	63%	0.49	21	57%	0.51	-6%
Q19	27	56%	0.51	21	43%	0.51	-13%
Q20	27	52%	0.51	21	48%	0.51	-4%
Q21	27	44%	0.51	21	43%	0.51	-2%
Q22	27	22%	0.42	21	43%	0.51	21%
Q23	27	70%	0.47	21	52%	0.51	-18%
Q24	27	52%	0.51	21	67%	0.48	15%
Q25	27	22%	0.42	21	19%	0.40	-3%
Q26	27	48%	0.51	21	62%	0.50	14%
Q27	27	63%	0.49	21	71%	0.46	8%
Q28	27	33%	0.48	21	43%	0.51	10%
Q29	27	30%	0.47	21	33%	0.48	4%
Overall % of Correct	**27**	**61%**	**0.22**	**21**	**66%**	**0.25**	**5%**

Table E2. *Item Difficulty, UB/BPS ISEP Teacher PCK Assessment, Chemistry, Summer 2013 and Summer 2014*

Chemistry	July 2013 (Pre)			May/July 2014 (Post)			Mean Pre-Post Difference
	n	*M*	*SD*	*n*	*M*	*SD*	
Q1	4	100%	0.00	6	83%	0.41	-17%
Q2	4	75%	0.50	6	100%	0.00	25%
Q3	4	100%	0.00	6	83%	0.41	-17%
Q4	4	75%	0.50	6	100%	0.00	25%
Q5	4	75%	0.50	6	83%	0.41	8%
Q6	4	100%	0.00	6	83%	0.41	-17%

Q7	4	75%	0.50	6	83%	0.41	8%
Q8	4	100%	0.00	6	100%	0.00	0%
Q9	4	50%	0.58	6	67%	0.52	17%
Q10	4	100%	0.00	6	83%	0.41	-17%
Q11	4	50%	0.58	6	83%	0.41	33%
Q12	4	100%	0.00	6	100%	0.00	0%
Q13	4	100%	0.00	6	83%	0.41	-17%
Q14	4	75%	0.50	6	67%	0.52	-8%
Q15	4	75%	0.50	6	83%	0.41	8%
Q16	4	100%	0.00	6	100%	0.00	0%
Q17	4	50%	0.58	6	50%	0.55	0%
Q18	4	75%	0.50	6	83%	0.41	8%
Q19	4	100%	0.00	6	83%	0.41	-17%
Q20	4	25%	0.50	6	50%	0.55	25%
Q21	4	100%	0.00	6	100%	0.00	0%
Q22	4	75%	0.50	6	50%	0.55	-25%
Q23	4	100%	0.00	6	67%	0.52	-33%
Q24	4	100%	0.00	6	100%	0.00	0%
Q25	4	75%	0.50	6	67%	0.52	-8%
Q26	4	100%	0.00	6	100%	0.00	0%
Q27	4	100%	0.00	6	100%	0.00	0%
Q28	4	100%	0.00	6	83%	0.41	-17%
Q29	4	100%	0.00	6	83%	0.41	-17%
Q30	4	75%	0.50	6	33%	0.52	-42%
Overall % of Correct	**4**	**84%**	**0.14**	**6**	**81%**	**0.19**	**-3%**

Table E3. *Item Difficulty, UB/BPS ISEP Teacher PCK Assessment, Earth Science, Summer 2013 and Summer 2014*

Earth Science	**July 2013 (Pre)**			**May/July 2014 (Post)**			**Mean Pre-Post Difference**
	n	***M***	***SD***	***n***	***M***	***SD***	
Q1	6	83%	0.41	7	86%	0.38	2%
Q2	6	67%	0.52	7	100%	0.00	33%
Q3	6	100%	0.00	7	86%	0.38	-14%
Q4	6	100%	0.00	7	86%	0.38	-14%
Q5	6	83%	0.41	7	71%	0.49	-12%
Q6	6	100%	0.00	7	86%	0.38	-14%
Q7	6	67%	0.52	7	14%	0.38	-52%
Q8	6	50%	0.55	7	57%	0.53	7%
Q9	6	83%	0.41	7	57%	0.53	-26%
Q10	6	0%	0.00	7	29%	0.49	29%
Q11	6	100%	0.00	7	71%	0.49	-29%
Q12	6	83%	0.41	7	86%	0.38	2%
Q13	6	100%	0.00	7	71%	0.49	-29%
Q14	6	83%	0.41	7	43%	0.53	-40%
Q15	6	67%	0.52	7	57%	0.53	-10%
Q16	6	33%	0.52	7	29%	0.49	-5%
Q17	6	100%	0.00	7	86%	0.38	-14%
Q18	6	50%	0.55	7	14%	0.38	-36%

Q19	6	83%	0.41	7	86%	0.38	2%
Q20	6	83%	0.41	7	43%	0.53	-40%
Q21	6	33%	0.52	7	43%	0.53	10%
Q22	6	17%	0.41	7	43%	0.53	26%
Q23	6	83%	0.41	7	71%	0.49	-12%
Q24	6	83%	0.41	7	43%	0.53	-40%
Q25	6	67%	0.52	7	86%	0.38	19%
Q26	6	83%	0.41	7	86%	0.38	2%
Q27	6	100%	0.00	7	57%	0.53	-43%
Q28	6	100%	0.00	7	57%	0.53	-43%
Q29	6	67%	0.52	7	71%	0.49	5%
Q30	6	67%	0.52	7	86%	0.38	19%
Overall % of Correct	**6**	**74%**	**0.06**	**7**	**63%**	**0.15**	**-11%**

Table E4. *Item Difficulty, UB/BPS ISEP Teacher PCK Assessment, Engineering and Physics, Summer 2013 and Summer 2014*

Engineering and Physics	**July 2013 (Pre)**			**May/July 2014 (Post)**			**Mean Pre-Post Difference**
	n	***M***	***SD***	***n***	***M***	***SD***	
G1	8	100%	0.00	9	89%	0.33	-11%
G2	8	63%	0.52	9	78%	0.44	15%
G3	8	63%	0.52	9	89%	0.33	26%
G4	8	88%	0.35	9	89%	0.33	1%
G5	8	38%	0.52	9	78%	0.44	40%
G6	8	50%	0.53	9	67%	0.50	17%
G7	8	50%	0.53	9	78%	0.44	28%
G8	8	75%	0.46	9	78%	0.44	3%
G9	8	75%	0.46	9	89%	0.33	14%
G10	8	38%	0.52	9	44%	0.53	7%
G11	8	50%	0.53	9	67%	0.50	17%
G12	8	63%	0.52	9	67%	0.50	4%
G13	8	75%	0.46	9	89%	0.33	14%
G14	8	100%	0.00	9	100%	0.00	0%
G15	8	50%	0.53	9	78%	0.44	28%
G16	8	75%	0.46	9	56%	0.53	-19%
G17	8	88%	0.35	9	67%	0.50	-21%
G18	8	63%	0.52	9	22%	0.44	-40%
G19	8	50%	0.53	9	56%	0.53	6%
G20	8	88%	0.35	9	78%	0.44	-10%
G21	8	63%	0.52	9	56%	0.53	-7%
G22	8	75%	0.46	9	89%	0.33	14%
G23	8	88%	0.35	9	89%	0.33	1%
G24	8	38%	0.52	9	44%	0.53	7%
G25	8	100%	0.00	9	100%	0.00	0%
G26	8	50%	0.53	9	56%	0.53	6%
G27	8	63%	0.52	9	56%	0.53	-7%
G28	8	63%	0.52	9	67%	0.50	4%
G29	8	75%	0.46	9	89%	0.33	14%

Overall % of Correct	**8**	**67%**	**0.26**	**9**	**72%**	**0.24**	**5%**

Table E5. *Item Difficulty, UB/BPS ISEP Teacher PCK Assessment, Elementary School Science, Summer 2013 and Summer 2014*

Elementary School Science	**July 2013 (Pre)**			**May/July 2014 (Post)**			**Mean Pre-Post Difference**
	n	***M***	***SD***	***n***	***M***	***SD***	
Q1	11	18%	0.40	6	17%	0.41	-2%
Q2	11	9%	0.30	6	33%	0.52	24%
Q3	11	18%	0.40	6	33%	0.52	15%
Q4	11	27%	0.47	6	17%	0.41	-11%
Q5	11	9%	0.30	6	0%	0.00	-9%
Q6	11	55%	0.52	6	50%	0.55	-5%
Q7	11	0%	0.00	6	0%	0.00	0%
Q8	11	73%	0.47	6	50%	0.55	-23%
Overall % of Correct	**11**	**26%**	**0.18**	**6**	**25%**	**0.11**	**-1%**

Table E6. *Item Difficulty, UB/BPS ISEP Teacher PCK Assessment, Middle School Science, Summer 2013 and Summer 2014*

Middle School Science	**July 2013 (Pre)**			**May/July 2014 (Post)**			**Mean Pre-Post Difference**
	n	***M***	***SD***	***n***	***M***	***SD***	
Q1	13	8%	0.28	27	52%	0.51	44%
Q2	13	23%	0.44	27	30%	0.47	7%
Q3	13	31%	0.48	27	22%	0.42	-9%
Q4	13	8%	0.28	27	4%	0.19	-4%
Q5	13	38%	0.51	27	41%	0.50	2%
Q6	13	54%	0.52	27	67%	0.48	13%
Q7	13	54%	0.52	27	59%	0.50	5%
Q8	13	62%	0.51	27	48%	0.51	-13%
Overall % of Correct	**13**	**35%**	**0.15**	**27**	**40%**	**0.20**	**6%**

Appendix F. Findings from School-Level Enrollment and Report Card Data (2010-2011 to 2013-2014) Assessment

Table F1. *Aggregate Teacher Information for ISEP Partner Schools, 2010-2011 to 2013-2014*

		Middle (K-8) Schools					High Schools				CB/Gates Foundation School (6-12)	Vocational Schools			
	Year	**Harriet Ross Tubman Academy**	**Charles Drew Science Magnet**	**Lorraine Academy**	**Southside Elementary**	**Native American Magnet (NAMS)**	**East HS**	**Bennett HS**	**South Park HS**	**Riverside Institute of Technology HS**	**MST Preparatory School at Seneca**	**Burgard Vocational HS**	**Hutchinson Central Technical HS**	**BPS District Average**	**NY State Average**
% w/o Appropriate License/ Certificate [a]	2010-2011	1%	12%	0%	0%	4%	7%	0%	4%	8%	0%	8%	5%	3%	3%
	2011-2012	6%	0%	1%	1%	4%	6%	1%	2%	2%	2%	4%	4%	2%	4%
	2012-2013	3%	0%	2%	1%	2%	3%	3%	1%	5%	12%	0%	9%	3%	3%
	2013-2014	1%	-	0%	1%	5%	2%	1%	3%	6%	7%	4%	10%	3%	4%
% w/ Master's Plus 30 Hours or Doctorate [a]	2010-2011	20%	27%	35%	34%	20%	12%	36%	32%	27%	24%	24%	27%	29%	36%
	2011-2012	16%	31%	36%	33%	17%	13%	39%	37%	29%	21%	20%	26%	28%	39%
	2012-2013	19%	22%	34%	36%	23%	15%	38%	29%	34%	29%	20%	31%	28%	39%
	2013-2014	26%	-	32%	34%	26%	21%	35%	33%	33%	33%	24%	33%	28%	39%
% of Core Courses **NOT** Taught By Highly Qualified Teachers [a]	2010-2011	2%	12%	0%	0%	0%	7%	0%	4%	5%	0%	9%	6%	3%	5% in high-poverty schools statewide ;0% in low-poverty schools statewide
	2011-2012	5%	0%	0%	0%	0%	7%	0%	3%	0%	1%	1%	1%	2%	2%
	2012-2013	0%	0%	0%	0%	2%	3%	0%	0%	0%	2%	0%	1%	2%	3%
	2013-2014	0%	-	0%	6%	4%	0%	1%	0%	0%	7%	3%	9%	4%	4%
Turnover Rate of Teachers with Fewer than 5 Years of Experience [a]	2010-2011	33%	0%	20%	50%	18%	10%	67%	40%	25%	50%	27%	67%	27%	21%
	2011-2012	63%	0%	50%	33%	18%	47%	50%	33%	40%	63%	27%	40%	35%	25%
	2012-2013	67%	0%	50%	-	0%	0%	33%	0%	20%	40%	40%	33%	22%	23%
	2013-	0%	-	-	0%	50%	0%	-	25%	50%	20%	0%	25%	25%	NA

	2014														
Turnover Rate of All Teachers[a]	2010-2011	22%	24%	16%	17%	14%	13%	17%	25%	19%	27%	15%	17%	21%	13%
	2011-2012	5%	21%	17%	10%	17%	37%	12%	15%	16%	31%	19%	13%	20%	14%
	2012-2013	30%	12%	11%	7%	12%	7%	12%	12%	14%	21%	25%	8%	16%	14%
	2013-2014	14%	-	14%	6%	23%	20%	23%	18%	16%	20%	11%	8%	17%	NA
Number of ISEP Teachers	2012-2013	3	1	2	5	2	3	8	5	9	8	6	9	61	NA
	2013-2014	9	1	8	5	6	2	8	5	11	5	4	9	73	NA
Number of Science Teachers	2012-2013	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2013-2014	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

[a] Percentage for all teachers in the building, including science teachers.

Table F2. *Middle School Aggregate Student Demographic and Performance Data, 2010-2011 to 2013-2014*

		Middle (K-8) Schools						
	Year	**Harriet Ross Tubman Academy**	**Charles Drew Science Magnet**	**Lorraine Academy**	**Southside Elementary**	**Native American Magnet (NAMS)**	**BPS District Average**	**NY State Average**
Total number of students	2010-2011	455	470	556	957	405	31,590	2,692,649
	2011-2012	480	282	563	951	474	30,831	2,670,548
	2012-2013	450	273	550	1005	488	30,750	2,656,967
	2013-2014	403	-	659	1065	503	31,815	2,652,283
% American Indian or Alaska Native	2010-2011	1%	0%	2%	1%	22%	1%	-
	2011-2012	1%	1%	2%	1%	18%	1%	1%
	2012-2013	0%	0%	2%	1%	16%	1%	1%
	2013-2014	1%	-	1%	1%	16%	1%	1%
% Black or African American	2010-2011	89%	88%	22%	21%	39%	55%	19%
	2011-2012	84%	69%	23%	20%	36%	53%	19%
	2012-2013	83%	60%	20%	18%	37%	51%	18%
	2013-2014	81%	88%	28%	21%	37%	50%	18%
% Hispanic or Latino	2010-2011	4%	3%	10%	10%	16%	15%	22%
	2011-2012	6%	8%	10%	13%	18%	16%	23%
	2012-2013	5%	10%	13%	15%	16%	17%	24%
	2013-2014	5%	-	12%	14%	14%	17%	25%
% Asian or Native Hawaiian/ Other Pacific Islander	2010-2011	0%	1%	1%	2%	15%	5%	8%
	2011-2012	0%	2%	2%	2%	19%	6%	9%
	2012-2013	0%	4%	2%	3%	21%	6%	9%

	2013-2014	0%	-	2%	6%	23%	7%	9%
% White	2010-2011	5%	7%	63%	64%	6%	23%	50%
	2011-2012	7%	15%	62%	60%	8%	22%	48%
	2012-2013	8%	17%	61%	59%	9%	22%	47%
	2013-2014	9%	-	52%	55%	9%	21%	46%
% Multiracial	2010-2011	1%	0%	1%	3%	2%	2%	-
	2011-2012	2%	6%	1%	3%	1%	2%	1%
	2012-2013	4%	8%	2%	4%	1%	2%	1%
	2013-2014	2%	-	4%	5%	1%	3%	1%
% Limited English Proficient (LEP)	2010-2011	0%	1%	0%	1%	28%	10%	8%
	2011-2012	-	-	-	1%	31%	11%	8%
	2012-2013	0%	5%	0%	2%	33%	12%	8%
	2013-2014	1%	-	0%	7%	33%	13%	8%
% Students with disabilities	2010-2011	Data are not available on the New York State School Report Card.						
	2011-2012	27%	36%	26%	28%	15%	20%	15%
	2012-2013	28%	38%	27%	28%	16%	21%	15%
	2013-2014	30%	-	25%	29%	19%	21%	16%
% Poverty (% free/reduced lunch)	2010-2011	93%	92%	77%	80%	98%	79%	48%
	2011-2012	91%	94%	81%	86%	96%	77%	50%
	2012-2013	90%	93%	86%	81%	91%	81%	54%
	2013-2014	93%	-	65%	77%	89%	76%	53%
% Male	2010-2011	Data are not available on the New York State School Report Card.						
	2011-2012	52%	55%	51%	53%	46%	50%	51%
	2012-2013	52%	55%	51%	52%	48%	50%	51%
	2013-2014	50%	-	51%	52%	49%	51%	51%
% Female	2010-2011	Data are not available on the New York State School Report Card.						
	2011-2012	48%	45%	49%	47%	54%	50%	49%
	2012-2013	48%	45%	49%	48%	52%	50%	49%
	2013-2014	50%	-	49%	48%	51%	49%	49%
% of Students Meeting or Exceeding NY State Standards (Scoring at Level 3 or 4):								
Grade 4 Science %	2010-2011	32%	72%	96%	87%	74%	68%	88%
	2011-2012	23%	-	92%	65%	74%	62%	89%
	2012-2013	47%	-	90%	82%	58%	68%	90%
	2013-2014	39%	-	85%	76%	60%	62%	87%
Grade 8 Science %	2010-2011	50%	23%	50%	51%	47%	42%	72%
	2011-2012	57%	-	39%	54%	45%	40%	69%
	2012-2013	19%	-	50%	54%	51%	40%	69%
	2013-2014	5%	-	35%	47%	49%	29%	61%
Number of ISEP Teachers	2012-2013	3	1	2	5	2	13	-
	2013-2014	9	1	8	5	6	29	-

Table F3. *High School Aggregate Student Demographic and Performance Data, 2010-2011 to 2013-2014*

		High Schools				College Board / Gates Foundation School (6-12)	Vocational Schools			
	Year	**East HS**	**Bennett HS**	**South Park HS**	**Riverside Institute of Technology HS**	**MST Preparatory School at Seneca**	**Burgard Vocational HS**	**Hutchinson Central Technical HS**	**BPS District Average**	**NY State Average**
Total number of students	2010-2011	610	848	817	762	387	602	1069	31,590	2,692,649
	2011-2012	524	729	773	760	408	590	1052	30,831	2,670,548
	2012-2013	388	661	824	751	398	523	1073	30,750	2,656,967
	2013-2014	390	592	882	768	472	540	1097	31,815	2,652,283
% American Indian or Alaska Native	2010-2011	0%	0%	1%	4%	0%	1%	3%	1%	-
	2011-2012	0%	1%	1%	4%	1%	1%	2%	1%	1%
	2012-2013	1%	1%	1%	2%	1%	0%	2%	1%	1%
	2013-2014	1%	1%	1%	1%	0%	0%	2%	1%	1%
% Black or African American	2010-2011	90%	86%	25%	48%	85%	81%	42%	55%	19%
	2011-2012	88%	84%	23%	45%	81%	78%	39%	53%	19%
	2012-2013	84%	82%	25%	41%	85%	80%	41%	51%	18%
	2013-2014	83%	82%	25%	39%	86%	77%	42%	50%	18%
% Hispanic or Latino	2010-2011	5%	5%	16%	23%	6%	7%	10%	15%	22%
	2011-2012	6%	8%	18%	21%	7%	7%	12%	16%	23%
	2012-2013	5%	7%	18%	26%	6%	6%	14%	17%	24%
	2013-2014	5%	7%	19%	26%	5%	6%	16%	17%	25%
% Asian or Native Hawaiian/ Other Pacific Islander	2010-2011	1%	2%	2%	9%	1%	4%	6%	5%	8%
	2011-2012	1%	3%	1%	16%	2%	7%	6%	6%	9%
	2012-2013	2%	4%	3%	18%	2%	7%	5%	6%	9%
	2013-2014	4%	4%	2%	21%	4%	9%	6%	7%	9%
% White	2010-2011	3%	5%	55%	15%	7%	7%	40%	23%	50%
	2011-2012	2%	5%	55%	13%	8%	7%	41%	22%	48%
	2012-2013	2%	5%	52%	12%	7%	6%	37%	22%	47%
	2013-2014	3%	5%	50%	12%	5%	7%	34%	21%	46%
% Multiracial	2010-2011	0%	1%	1%	0%	1%	0%	0%	2%	-
	2011-2012	1%	0%	1%	0%	0%	0%	0%	2%	1%
	2012-2013	2%	1%	2%	0%	0%	0%	4%	2%	1%
	2013-2014	1%	2%	2%	1%	0%	1%	2%	3%	1%
% Limited English Proficient (LEP)	2010-2011	1%	4%	6%	20%	2%	6%	1%	10%	8%
	2011-2012	3%	5%	6%	26%	4%	10%	1%	11%	8%
	2012-2013	3%	6%	6%	28%	4%	8%	1%	12%	8%

	2013-2014	5%	7%	7%	34%	4%	9%	1%	13%	8%
% Students with disabilities	2010-2011	Data are not available on the New York State School Report Card.								
	2011-2012	21%	22%	27%	21%	16%	27%	5%	20%	15%
	2012-2013	23%	23%	28%	21%	19%	22%	5%	21%	15%
	2013-2014	23%	24%	25%	18%	21%	27%	6%	21%	16%
% Poverty (% free/reduced lunch)	2010-2011	80%	73%	73%	77%	68%	72%	66%	79%	48%
	2011-2012	76%	86%	63%	74%	76%	71%	61%	77%	50%
	2012-2013	79%	76%	69%	82%	82%	81%	69%	81%	54%
	2013-2014	74%	74%	63%	73%	74%	68%	61%	76%	53%
% Male	2010-2011	Data are not available on the New York State School Report Card.								
	2011-2012	47%	47%	51%	57%	52%	66%	53%	50%	51%
	2012-2013	45%	46%	52%	57%	55%	65%	54%	50%	51%
	2013-2014	46%	49%	52%	54%	54%	62%	53%	51%	51%
% Female	2010-2011	Data are not available on the New York State School Report Card.								
	2011-2012	53%	53%	49%	43%	48%	34%	47%	50%	49%
	2012-2013	55%	54%	48%	43%	45%	35%	46%	50%	49%
	2013-2014	54%	51%	48%	46%	46%	38%	47%	49%	49%
Graduation rate – All Students [d]	2010-2011	46%	49%	48%	31%	71%	52%	88%	50%	76%
	2011-2012	42%	39%	59%	34%	65%	33%	83%	56%	77%
	2012-2013	47%	37%	56%	22%	72%	28%	87%	53%	75%
	2013-2014	39%	37%	55%	16%	51%	39%	85%	53%	76%
Graduation rate - American Indian or Alaska Native [d]	2010-2011	-	-	-	-	-	-	-	47%	63%
	2011-2012	-	-	-	-	-	-	-	52%	63%
	2012-2013	0%	0%	-	-	-	-	-	38%	62%
	2013-2014	0%	-	-	-	-	-	-	55%	61%
Graduation rate - Black or African American [d]	2010-2011	45%	48%	32%	30%	70%	51%	87%	47%	61%
	2011-2012	44%	39%	48%	31%	69%	36%	84%	54%	63%
	2012-2013	46%	37%	47%	25%	72%	29%	85%	52%	60%
	2013-2014	39%	36%	46%	10%	45%	42%	86%	50%	62%
Graduation rate - Hispanic or Latino [d]	2010-2011	-	-	-	34%	-	-	-	41%	60%
	2011-2012	-	-	-	36%	-	-	-	45%	63%
	2012-2013	-	42%	71%	28%	-	25%	92%	44%	59%
	2013-2014	46%	44%	54%	16%	-	33%	77%	43%	62%
Graduation rate - Asian or Native Hawaiian/ Other [d]	2010-2011	-	-	-	-	-	-	-	52%	84%
	2011-2012	-	-	-	-	-	-	-	51%	86%
	2012-2013	-	-	67%	15%	0%	-	-	44%	81%
	2013-2014	-	38%	-	21%	-	31%	80%	38%	82%
Graduation rate – White [d]	2010-2011	-	-	56%	33%	-	-	88%	61%	85%
	2011-2012	-	-	66%	38%	-	-	80%	65%	87%
	2012-2013	60%	-	56%	18%	80%	31%	88%	67%	87%

	2013-2014	-	38%	61%	-	100%	-	89%	70%	87%
Graduation rate – Multiracial [d]	2010-2011	-	-	-	-	-	-	-	-	70%
	2011-2012	-	-	-	-	-	-	-	-	80%
	2012-2013	0%	0%	-	-	-	0%	-	38%	73%
	2013-2014	0%	-	67%	-	0%	0%	-	59%	77%
Graduation rate – Female [d]	2010-2011	54%	53%	53%	40%	80%	51%	93%	55%	80%
	2011-2012	48%	44%	58%	36%	74%	37%	87%	61%	81%
	2012-2013	54%	47%	64%	23%	79%	25%	91%	59%	79%
	2013-2014	41%	34%	59%	19%	53%	34%	85%	56%	80%
Graduation rate – Male [d]	2010-2011	36%	27%	43%	23%	61%	53%	83%	44%	71%
	2011-2012	35%	32%	59%	32%	58%	31%	79%	50%	74%
	2012-2013	35%	27%	49%	22%	66%	30%	83%	48%	71%
	2013-2014	36%	40%	52%	15%	50%	41%	85%	50%	73%
% of students attending post-secondary school [b]	2010-2011	82%	83%	67%	89%	97%	88%	88%	83%	82%
	2011-2012	9%	74%	74%	75%	92%	70%	86%	79%	81%
	2012-2013	86%	81%	72%	76%	92%	91%	90%	85%	7%
	2013-2014	87%	79%	74%	77%	93%	85%	89%	82%	80%
% of Students Meeting or Exceeding NY State Standards (Scoring at or above 65):										
Regents Living Environments %	2010-2011	42%	61%	57%	32%	58%	53%	93%	61%	78% [c]
	2011-2012	38%	51%	47%	31%	29%	36%	91%	55%	79%
	2012-2013	34%	38%	45%	35%	27%	37%	82%	53%	77%
	2013-2014	36%	33%	56%	38%	37%	41%	90%	57%	78%
Regents Physical Setting/Earth Science %	2010-2011	11%	25%	33%	15%	24%	8%	-	37%	74% [c]
	2011-2012	9%	36%	59%	17%	35%	8%	-	38%	73%
	2012-2013	5%	30%	49%	10%	24%	9%	-	33%	72%
	2013-2014	13%	24%	38%	14%	6%	18%	-	39%	72%
Regents Physical Setting/Chemistry %	2010-2011	-	10%	11%	50%	64%	-	42%	53%	73% [c]
	2011-2012	0%	44%	17%	17%	40%	-	51%	50%	78%
	2012-2013	16%	20%	0%	18%	55%	-	38%	43%	76%
	2013-2014	13%	46%	0%	14%	0%	-	34%	43%	73%
Regents Physics %	2010-2011	-	-	-	0%	-	-	58%	57%	82% [c]
	2011-2012	-	-	-	-	-	-	61%	63%	79%
	2012-2013	-	-	-	-	-	-	58%	60%	81%
	2013-2014	-	-	-	-	-	-	55%	59%	81%
Number of ISEP Teachers	2012-2013	3	8	5	9	8	6	9	48	-
	2013-2014	2	8	5	11	5	4	9	44	-

[b] This number was calculated using (Number going to 4 year + Number going to 2 year + Number going to other postsecondary)/Number of Completers.
[c] All State Regents data for 2010-2011 were from 2009-2010.
[d] Graduation rates in 2010-2011 were based on the 2007 four-year cohort for accountability.

Appendix G. UB-BPS ISEP Teacher Questionnaire Findings

Table G1. *Respondents' Needs for Professional Development, Summer2012/Summer 2013 and Summer 2014 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012/Summer 2013 and Summer 2014*

Q31. Professional Development Needs	**Time**	***n***	***M***	***SD***	**Wilcoxon Signed Rank Test *p***
1). Help students develop the ability to communicate with others an argument based on evidence.	Pre	9	3.22	0.67	.083
	Post	9	2.89	0.60	
2). Help students develop an understanding of scale, proportion, and quantity as these concepts are used to describe the natural world.	Pre	9	3.33	0.50	.317
	Post	9	3.11	0.60	
3). Help students develop an understanding of the behavior of organisms.	Pre	9	3.22	0.67	.157
	Post	9	3.00	0.50	
4). Help students develop the ability to use mathematics and computational thinking.	Pre	9	3.44	0.53	1.000
	Post	9	3.44	0.53	
5). Help students develop the ability to construct explanations and design solutions.	Pre	8	3.38	0.74	.317
	Post	8	3.63	0.52	
6). Help students develop an understanding of chemical reactions.	Pre	9	2.78	0.44	.157
	Post	9	3.00	0.71	
7). Help students develop an understanding of patterns in natural events.	Pre	8	3.50	0.54	.317
	Post	8	3.75	0.46	
8). Help students develop an understanding of the interactions of energy and matter.	Pre	8	3.25	0.71	.564
	Post	8	3.38	0.52	
9). Help students develop an understanding of form and function.	Pre	8	3.25	0.46	.655
	Post	8	3.38	0.74	
10). Help students develop an understanding of the structure and properties of matter.	Pre	8	3.00	0.54	.317
	Post	8	3.25	0.71	
11). Help students develop an understanding of the conservation of energy and increase in disorder.	Pre	8	3.13	0.35	.317
	Post	8	2.88	0.64	
12). Help students develop the abilities needed to do scientific inquiry.	Pre	9	3.33	0.71	.257
	Post	9	3.67	0.50	
13). Help students develop an understanding of the structure of the atom.	Pre	9	2.78	0.44	.317
	Post	9	2.89	0.60	
14). Help students develop an understanding of the molecular basis of heredity.	Pre	7	3.29	0.76	.180
	Post	7	2.86	0.90	
15). Help students develop an understanding of energy in the earth system.	Pre	8	3.13	0.64	.655
	Post	8	3.00	0.76	
16). Help students develop an understanding of the theory of biological evolution.	Pre	8	3.38	0.52	.480
	Post	8	3.13	0.84	
17). Help students develop the ability to develop and use valid models.	Pre	9	3.33	0.50	1.000
	Post	9	3.33	0.50	
18). Help students develop the ability to obtain, evaluate, and communicate information.	Pre	7	3.57	0.54	1.000
	Post	7	3.57	0.54	
19). Help students develop the ability to ask questions and define problems.	Pre	8	3.50	0.54	.317
	Post	8	3.38	0.52	
20). Help students develop an understanding of matter,	Pre	9	3.44	0.53	.083

energy, and organization in living systems.	Post	9	3.11	0.33	
21). Help students develop the ability to analyze and interpret data.	Pre	9	3.56	0.53	1.000
	Post	9	3.56	0.53	
22). Help students develop an understanding of systems, order, and organization.	Pre	9	3.56	0.53	.083
	Post	9	3.22	0.67	
23). Help students develop an understanding of evidence, models, and explanation.	Pre	9	3.44	0.73	.564
	Post	9	3.33	0.50	
24). Help students develop an understanding of the cell.	Pre	9	3.22	0.67	1.000
	Post	9	3.22	0.67	
25). Help students develop a scientific understanding of the earth in the solar system.	Pre	8	3.38	0.52	**.046**
	Post	8	2.88	0.64	
26). Help students develop an understanding of the interdependence of organisms.	Pre	9	3.11	0.78	1.000
	Post	9	3.11	0.78	
27). Help students develop the ability to plan and carry out investigations.	Pre	9	3.44	0.53	.564
	Post	9	3.56	0.53	
28). Help students develop an understanding of change, constancy, and measurement.	Pre	8	3.13	0.84	.655
	Post	8	3.25	0.46	
29). Help students develop an understanding of geochemical cycles.	Pre	8	2.88	0.35	1.000
	Post	8	2.88	0.84	
30). Help students develop a scientific understanding of the origins of the earth and the universe.	Pre	8	3.13	0.64	.783
	Post	8	3.25	0.71	

Table G2. *Respondents' Familiarity with DET and Perceived Importance of DET, Summer2012/Summer 2013 and Summer 2014 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012/Summer 2013 and Summer 2014*

DET 1	**Time**	***n***	***M***	***SD***	**Wilcoxon Signed Rank Test *p***
1. How familiar are you with Design/Engineering/Technology as typically demonstrated in the examples given above?	Pre	9	2.78	1.09	.408
	Post	9	3.11	1.05	
2. Have you had any specific courses in Design/Engineering/Technology outside of your preservice curriculum?	Pre	9	2.11	1.17	.496
	Post	9	2.44	1.42	
5. How confident do you feel about integrating more Design/Engineering/Technology into your curriculum?	Pre	9	3.00	1.32	.892
	Post	9	3.11	1.05	
7. Do you use Design/Engineering/Technology activities in the classroom?	Pre	8	2.50	1.69	.915
	Post	8	2.63	1.19	
8. Does your school support Design/Engineering/Technology activities?	Pre	9	2.44	1.42	.509
	Post	9	3.00	1.41	
9. Do you believe Design/Engineering/Technology should be integrated into the K-12 curriculum?	Pre	9	3.56	1.33	.272
	Post	9	4.11	1.05	

Table G3. *Teaching DET to Diverse Groups of Students, Summer2012/Summer 2013 and Summer 2014 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012/Summer 2013 and Summer 2014*

DET 2	**Time**	***n***	***M***	***SD***	**Wilcoxon Signed Rank Test *p***
10. Most people feel that female students can do well in Design/Engineering/Technology.	Pre	9	3.56	1.01	**.046**
	Post	9	3.11	0.78	
11. Most people feel that minority students (African American, Hispanic / Latino, and American Indian) can do well in Design/Engineering/Technology.	Pre	9	3.56	1.01	**.046**
	Post	9	3.11	0.78	

Table G4. *Importance of Including DET in Science Curriculum, Summer2012/Summer 2013 and Summer 2014 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012/Summer 2013 and Summer 2014*

DET 3	**Time**	***n***	***M***	***SD***	**Wilcoxon Signed Rank Test *p***
12. Planning a project.	Pre	8	4.63	0.74	.317
	Post	8	4.25	0.71	
13. Using engineering to develop new technologies.	Pre	8	3.63	0.52	.334
	Post	8	4.13	0.99	

Table G5. *Needs of Teaching DET, Summer2012/Summer 2013 and Summer 2014 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012/Summer 2013 and Summer 2014*

DET 4	**Time**	***n***	***M***	***SD***	**Wilcoxon Signed Rank Test *p***
14. Design process.	Pre	9	3.89	0.60	.480
	Post	9	4.11	0.78	
15. Use and impact of Design/Engineering/Technology.	Pre	9	3.89	0.60	.414
	Post	9	4.11	0.78	
16. Science underlying Design/Engineering/Technology.	Pre	9	3.78	0.67	.317
	Post	9	4.11	0.78	
17. Types of problems to which Design/Engineering/Technology should be applied.	Pre	9	3.78	0.44	.257
	Post	9	4.11	0.78	
18. Process of communicating technical information.	Pre	9	3.89	0.60	.414
	Post	9	4.11	0.78	

Table G6. *Respondents' Motivation for Teaching Science, Summer2012/Summer 2013 and Summer 2014 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012/Summer 2013 and Summer 2014*

DET 5	**Time**	***n***	***M***	***SD***	**Wilcoxon Signed Rank Test *p***
19. To prepare young people for the world of work.	Pre	9	4.00	0.71	.564
	Post	9	3.89	0.93	
20. To promote an enjoyment of learning.	Pre	9	4.33	0.71	.564

	Post	9	4.22	0.44	
21. To develop an understanding of the natural and technical world.	Pre	9	4.22	0.67	1.000
	Post	9	4.22	0.44	
22. To develop scientists, engineers, and technologists for industry.	Pre	9	4.11	0.78	.564
	Post	9	4.00	0.71	
23. To promote an understanding of how Design/Engineering/Technology affects society.	Pre	9	4.11	0.60	1.000
	Post	9	4.11	0.60	

Table G7 *Respondents' Perceived Barriers to Integrating DET in Classroom, Summer2012/Summer 2013 and Summer 2014 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012/Summer 2013 and Summer 2014*

DET 6: Barrier	**Time**	***n***	***M***	***SD***	**Wilcoxon Signed Rank Test *p***
24. Lack of time for teachers to learn about Design/Engineering/Technology.	Pre	9	3.67	1.32	.157
	Post	9	4.11	0.93	
25. Lack of teacher knowledge.	Pre	9	3.33	1.41	.442
	Post	9	3.78	1.09	
26. Lack of training.	Pre	9	3.67	1.32	.713
	Post	9	3.89	1.17	
27. Lack of administration support.	Pre	9	3.00	1.66	.399
	Post	9	3.78	1.48	

Table G8. *Respondents' Knowledge of DET Standards, Summer2012/Summer 2013 and Summer 2014 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012/Summer 2013 and Summer 2014*

DET 8	**Time**	***n***	***M***	***SD***	**Wilcoxon Signed Rank Test *p***
29. National science standards related to Design/Engineering/Technology?	Pre	9	2.78	1.39	.764
	Post	9	2.67	1.32	

Table G9. *Attitudes towards Teaching DET, Summer2012/Summer 2013 and Summer 2014 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012/Summer 2013 and Summer 2014*

DET 9	**Time**	***n***	***M***	***SD***	**Wilcoxon Signed Rank Test *p***
30. How enthusiastic do you feel about including Design/Engineering/Technology activities in your teaching?	Pre	9	4.11	1.05	.773
	Post	9	4.00	1.00	
31. How prepared do you feel to include Design/Engineering/Technology activities in your teaching?	Pre	9	3.00	1.22	.732
	Post	9	3.22	0.97	
32. How important is it for you that Design/Engineering/Technology activities are aligned to mathematics state and national standards?	Pre	9	4.22	1.09	1.000
	Post	9	4.22	0.83	
33. How important is it for you that Design/Engineering/Technology activities are aligned	Pre	9	3.89	1.27	.671
	Post	9	4.11	0.78	

to science state and national standards?					

Table G10. *Respondents' Attitudes and Beliefs about Teaching Science, Summer2012/Summer 2013 and Summer 2014 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012/Summer 2013 and Summer 2014*

Q46. Attitudes and Beliefs about Teaching Science	**Time**	***n***	***M***	***SD***	**Wilcoxon Signed Rank Test *p***
k. Using technologies (e.g., calculators, computers) in science lessons will improve students' understanding of science.	Pre	8	3.75	0.46	.083
	Post	8	4.13	0.35	
l. Getting the correct answer to a problem in the science classroom is more important than investigating the problem in a scientific manner.	Pre	8	2.38	0.74	1.000
	Post	8	2.38	1.41	
m. In Grades K-9, truly understanding science in the science classroom requires special abilities that only some people possess.	Pre	8	2.25	0.89	.705
	Post	8	2.38	1.41	
n. Students should be given regular opportunities to think about what they have learned in the science classroom.	Pre	7	4.14	0.38	.157
	Post	7	4.43	0.53	
q. To understand science, students must solve many problems following examples provided.	Pre	8	3.13	0.64	.083
	Post	8	3.50	0.76	
r. The use of technologies (e.g., calculators, computers) in science is an aid primarily for slow learners.	Pre	8	2.38	1.41	.414
	Post	8	2.63	1.51	
s. Students should have opportunities to experience manipulating materials in the science classroom before teachers introduce scientific vocabulary.	Pre	8	4.25	0.46	.157
	Post	8	3.75	0.89	
t. Science consists of unrelated topics such as biology, chemistry, geology, and physics.	Pre	8	3.50	1.20	.257
	Post	8	2.88	1.55	
u. Calculators should always be available for students in science classes.	Pre	8	4.13	0.64	.084
	Post	8	3.38	1.06	
v. The primary reason for learning science is to provide real-life examples for learning mathematics.	Pre	7	3.29	0.76	1.000
	Post	7	3.29	0.76	
w. Small group activity should be a regular part of the science classroom.	Pre	8	4.25	0.46	.317
	Post	8	4.38	0.52	
x. The idea of teaching science scares me.	Pre	8	2.38	1.06	1.000
	Post	8	2.38	1.19	
y. The idea of teaching engineering design concepts scares me.	Pre	7	3.43	0.79	.564
	Post	7	3.29	0.95	
z. I prefer to teach engineering design concepts and science emphasizing connections between the two disciplines.	Pre	8	3.13	0.35	1.000
	Post	8	3.13	0.83	
aa. I feel prepared to teach engineering design concepts and science emphasizing connections between the two disciplines.	Pre	8	3.00	0.53	.414
	Post	8	3.25	0.89	

Appendix H. UB-BPS ISEP Student Questionnaire Findings

Table H1. *Comparisons of Students' Responses by Teacher Participation Status, UB/BPS ISEP Student Questionnaire, Spring 2014, Elementary School Students*

Item	Participation	*n*	*M*	*SD*	*t*	*df*	*p*
Q8. Views of Science							
Q8a. I like science.	Control	12	4.00	0.95	-0.34	289	.737
	ISEP	279	4.09	0.94			
Q8b. I am good at science.	Control	12	4.33	0.49	2.55	280	**.011**
	ISEP	270	3.65	0.92			
Q8c. I would keep on taking science classes even if I did not have to.	Control	11	3.73	1.10	0.47	285	.640
	ISEP	276	3.55	1.21			
Q8d. I understand most of what goes on in science.	Control	12	3.92	0.67	0.18	287	.855
	ISEP	277	3.87	0.87			
Q8e. Almost all people use science in their jobs.	Control	12	3.92	0.90	1.92	286	**.055**
	ISEP	276	3.28	1.12			
Q8f. Science is useful for solving everyday problems.	Control	12	4.00	0.85	2.38	277	**.018**
	ISEP	267	3.22	1.11			
Q8g. Science is a way to study and understand the natural world.	Control	12	4.00	0.60	-0.95	283	.342
	ISEP	273	4.25	0.90			
Q8h. Scientists sometimes disagree about scientific knowledge.	Control	12	4.00	0.95	1.50	277	.135
	ISEP	267	3.55	1.03			
Q8i. All scientists do not follow the same step-by-step method to do science.	Control	12	3.92	0.79	1.21	282	.227
	ISEP	272	3.49	1.20			
Q8j. Scientists use their imagination when doing science.	Control	12	3.92	1.08	2.00	285	**.047**
	ISEP	275	3.14	1.32			
Q8k. Science ideas or hypotheses must be supported by evidence.	Control	11	4.00	0.89	-0.16	283	.872
	ISEP	274	4.05	0.96			
Q8l. Scientific theories can change when new evidence or a new explanation becomes available.	Control	11	4.00	0.77	-0.04	284	.970
	ISEP	275	4.01	0.95			
Q9. In this class, my teacher ...							
Q9a. arranges the classroom so students can have discussion.	Control	12	4.25	0.62	2.77	288	**.006**
	ISEP	278	3.12	1.40			
Q9b. asks questions that have more than one answer.	Control	12	4.50	0.67	2.13	284	**.034**
	ISEP	274	3.85	1.04			
Q9c. asks me to give reasons and provide evidence for my answers.	Control	12	4.17	0.72	-1.04	285	.302
	ISEP	275	4.46	0.96			
Q9d. encourages me to ask questions.	Control	12	4.25	0.75	1.42	283	.155
	ISEP	273	3.79	1.10			
Q9e. lets me work at my own pace.	Control	11	3.64	0.92	0.43	283	.668
	ISEP	274	3.49	1.15			
Q9f. encourages me to explain my	Control	12	3.83	1.03	0.87	284	.384

ideas to other students.	ISEP	274	3.53	1.17			
Q9g. encourage me to consider different scientific explanations.	Control	12	3.75	0.87	0.54	283	.587
	ISEP	273	3.57	1.12			
Q9h. provides time for me to discuss science ideas with other students.	Control	11	4.00	1.00	0.73	282	.464
	ISEP	273	3.75	1.12			
Q9i. checks that I have completed my assignments.	Control	12	3.83	1.03	-2.51	285	**.013**
	ISEP	275	4.50	0.89			
Q9j. provides meaningful and challenging assignments.	Control	12	4.00	0.95	1.09	282	.276
	ISEP	272	3.67	1.03			
Q9k. helps me apply my learning to real life.	Control	12	4.17	1.03	0.31	285	.759
	ISEP	275	4.07	1.12			
Q9l. expects me to do well.	Control	12	4.25	0.97	-2.17	287	**.031**
	ISEP	277	4.72	0.73			
Q10. In this class, I ...							
Q10a. use information and data to support my conclusions.	Control	10	3.90	0.99	-0.70	282	.483
	ISEP	274	4.12	0.99			
Q10b. talk with other students about how to do a science task or about how to interpret the data from an experiment.	Control	12	3.83	0.58	0.38	281	.701
	ISEP	271	3.70	1.18			
Q10c. learn from other students.	Control	12	3.83	0.94	1.18	282	.240
	ISEP	272	3.41	1.24			
Q10d. consider different scientific explanations.	Control	12	3.92	0.79	0.74	280	.462
	ISEP	270	3.69	1.07			
Q10e. have a say in deciding what activities I do.	Control	12	3.83	0.72	2.29	280	**.023**
	ISEP	270	2.89	1.42			
Q10f. use a computer or the Internet for science assignments or activities.	Control	12	4.08	0.67	3.13	281	**.002**
	ISEP	271	2.83	1.38			
Q10g. write about how I solved a science task or about what I am learning.	Control	12	3.67	0.78	-0.05	277	.964
	ISEP	267	3.68	1.14			
Q10h. learn that there are different solutions to science tasks.	Control	12	4.08	0.67	0.68	282	.500
	ISEP	272	3.87	1.08			
Q10i. use multiple sources of information to learn.	Control	12	3.75	1.14	-0.86	276	.389
	ISEP	266	4.02	1.05			
Q10j. develop my skills for doing science.	Control	12	3.92	0.79	-0.38	281	.703
	ISEP	271	4.03	0.98			
Q10k. learn about how science is important in the real world.	Control	12	3.83	1.19	-0.99	282	.321
	ISEP	272	4.14	1.04			
Q10l. work on science tasks in a group with other students.	Control	12	3.75	0.75	-0.85	282	.396
	ISEP	272	4.01	1.07			
Q11. At least one adult in my home, ...							

Q11a. makes me do my science homework.	Control	12	3.42	1.16	-1.23	282	.219
	ISEP	272	3.95	1.47			
Q11b. asks about what I am learning in science class.	Control	11	4.00	1.00	0.79	282	.429
	ISEP	273	3.68	1.33			
Q11c. helps me with my science homework.	Control	12	3.67	1.23	0.37	281	.715
	ISEP	271	3.51	1.47			
Q11d. helps me work on my science projects.	Control	11	3.64	0.92	0.13	280	.899
	ISEP	271	3.58	1.48			
Q11e. expects me to do well in science.	Control	12	3.83	1.03	-2.38	281	**.018**
	ISEP	271	4.51	0.95			
Q11f. expects me to go to college.	Control	12	4.58	0.79	-0.14	283	.889
	ISEP	273	4.62	0.87			
Q11g. expects me to have a science-related career.	Control	12	3.58	1.31	1.83	281	.068
	ISEP	271	2.77	1.52			

Table H2. *Comparisons of Students' Responses by Teacher Participation Status, UB/BPS ISEP Student Questionnaire, Spring 2014, High School Students*

Item	**Participation**	***n***	***M***	***SD***	***t***	***df***	***p***
Q8. Views of Science							
Q8a. I like science.	Control	79	3.32	1.24	-1.61	312	.109
	ISEP	235	3.56	1.12			
Q8b. I am good at science.	Control	79	3.14	1.06	-0.81	310	.416
	ISEP	233	3.24	0.97			
Q8c. I would keep on taking science classes even if I did not have to.	Control	79	2.81	1.32	-0.43	312	.667
	ISEP	235	2.88	1.24			
Q8d. I understand most of what goes on in science.	Control	79	3.52	0.97	0.77	310	.442
	ISEP	233	3.42	0.93			
Q8e. Almost all people use science in their jobs.	Control	78	3.17	0.96	0.43	310	.669
	ISEP	234	3.11	1.00			
Q8f. Science is useful for solving everyday problems.	Control	79	3.46	1.10	0.97	309	.333
	ISEP	232	3.32	1.03			
Q8g. Science is a way to study and understand the natural world.	Control	78	4.13	0.89	1.20	301	.232
	ISEP	225	3.98	0.98			
Q8h. Scientists sometimes disagree about scientific knowledge.	Control	79	3.87	0.91	2.59	302	**.010**
	ISEP	225	3.54	1.02			
Q8i. All scientists do not follow the same step-by-step method to do science.	Control	78	3.85	0.93	3.09	304	**.002**
	ISEP	228	3.42	1.10			
Q8j. Scientists use their imagination when doing science.	Control	79	3.22	1.02	-0.08	306	.934
	ISEP	229	3.23	1.13			
Q8k. Science ideas or hypotheses must be supported by evidence.	Control	79	4.08	1.01	-0.09	306	.927
	ISEP	229	4.09	0.93			
Q8l. Scientific theories can change when new evidence or a new explanation becomes available.	Control	79	4.28	0.75	2.45	307	**.015**
	ISEP	230	4.00	0.89			
Q9. In this class, my teacher ...							

Q9a. arranges the classroom so students can have discussion.	Control	79	3.25	1.27	0.75	301	.452
	ISEP	224	3.13	1.25			
Q9b. asks questions that have more than one answer.	Control	77	3.32	1.13	-1.26	298	.207
	ISEP	223	3.50	1.04			
Q9c. asks me to give reasons and provide evidence for my answers.	Control	79	3.99	0.98	0.49	299	.626
	ISEP	222	3.92	1.01			
Q9d. encourages me to ask questions.	Control	79	3.80	1.09	0.32	297	.749
	ISEP	220	3.75	1.15			
Q9e. lets me work at my own pace.	Control	79	3.66	0.99	0.81	299	.419
	ISEP	222	3.55	1.10			
Q9f. encourages me to explain my ideas to other students.	Control	79	3.41	1.38	0.16	299	.870
	ISEP	222	3.38	1.19			
Q9g. encourage me to consider different scientific explanations.	Control	78	3.44	1.22	0.18	296	.859
	ISEP	220	3.41	1.12			
Q9h. provides time for me to discuss science ideas with other students.	Control	79	3.62	1.21	1.30	298	.194
	ISEP	221	3.42	1.19			
Q9i. checks that I have completed my assignments.	Control	78	4.32	0.99	1.94	295	.053
	ISEP	219	4.05	1.08			
Q9j. provides meaningful and challenging assignments.	Control	79	3.94	1.09	1.56	295	.121
	ISEP	218	3.71	1.11			
Q9k. helps me apply my learning to real life.	Control	78	3.58	1.25	0.03	296	.978
	ISEP	220	3.57	1.13			
Q9l. expects me to do well.	Control	77	4.49	0.77	1.34	297	.181
	ISEP	222	4.33	0.98			
Q10. In this class, I ...							
Q10a. use information and data to support my conclusions.	Control	78	3.88	1.02	0.85	289	.399
	ISEP	213	3.77	1.03			
Q10b. talk with other students about how to do a science task or about how to interpret the data from an experiment.	Control	76	3.55	1.25	0.08	283	.939
	ISEP	209	3.54	1.15			
Q10c. learn from other students.	Control	77	3.31	1.23	-0.90	283	.371
	ISEP	208	3.46	1.21			
Q10d. consider different scientific explanations.	Control	76	3.51	0.99	0.01	283	.993
	ISEP	209	3.51	1.11			
Q10e. have a say in deciding what activities I do.	Control	77	2.77	1.28	-1.46	286	.146
	ISEP	211	3.00	1.21			
Q10f. use a computer or the Internet for science assignments or activities.	Control	77	2.61	1.45	-1.36	282	.176
	ISEP	207	2.85	1.27			
Q10g. write about how I solved a science task or about what I am learning.	Control	77	3.03	1.27	-1.08	285	.282
	ISEP	210	3.21	1.28			
Q10h. learn that there are different solutions to science tasks.	Control	75	3.68	1.02	0.64	284	.520
	ISEP	211	3.59	1.08			
Q10i. use multiple sources of information to learn.	Control	77	3.61	1.15	0.67	286	.506
	ISEP	211	3.51	1.10			
Q10j. develop my skills for doing science.	Control	77	3.77	1.06	0.62	285	.538
	ISEP	210	3.68	1.11			

Q10k. learn about how science is important in the real world.	Control	77	3.68	1.20	0.10	284	.920
	ISEP	209	3.66	1.09			
Q10l. work on science tasks in a group with other students.	Control	77	3.43	1.23	-1.39	287	.165
	ISEP	212	3.66	1.22			
Q11. At least one adult in my home, ...							
Q11a. makes me do my science homework.	Control	75	3.08	1.52	0.46	282	.643
	ISEP	209	2.99	1.51			
Q11b. asks about what I am learning in science class.	Control	74	2.78	1.47	-0.22	280	.830
	ISEP	208	2.83	1.48			
Q11c. helps me with my science homework.	Control	75	2.21	1.37	-1.59	282	.112
	ISEP	209	2.52	1.43			
Q11d. helps me work on my science projects.	Control	75	2.16	1.33	-2.45	279	**.015**
	ISEP	206	2.64	1.48			
Q11e. expects me to do well in science.	Control	76	4.20	1.25	0.92	282	.360
	ISEP	208	4.04	1.25			
Q11f. expects me to go to college.	Control	76	4.43	1.18	0.46	281	.645
	ISEP	207	4.37	1.05			
Q11g. expects me to have a science-related career.	Control	76	2.41	1.43	-1.41	283	.159
	ISEP	209	2.68	1.47			
Q12. I plan to . . .							
Q12a. take (or have taken) only the science courses I am required to take in high school.	Control	77	3.51	1.30	-0.38	283	.705
	ISEP	208	3.57	1.29			
Q12b. take (or have taken) the most challenging science courses offered in my high school.	Control	77	3.05	1.39	-0.01	280	.992
	ISEP	205	3.05	1.25			
Q12c. take (or have taken) 4 years of science courses in high school.	Control	77	3.64	1.41	1.39	280	.166
	ISEP	205	3.40	1.25			
Q12d. pursue a science-related career.	Control	77	2.83	1.46	-0.81	282	.417
	ISEP	207	2.98	1.34			
Q12e. go to a 2- or 4-year college.	Control	76	4.45	0.84	1.95	278	.052
	ISEP	204	4.19	1.05			
Q12f. take science courses in college.	Control	77	3.44	1.34	-0.36	280	.716
	ISEP	205	3.50	1.22			
Q12g. major in a science field in college.	Control	76	2.87	1.45	-0.45	280	.653
	ISEP	206	2.95	1.23			
Q12h. major in an engineering field in college.	Control	77	2.94	1.41	0.92	281	.356
	ISEP	206	2.78	1.23			
Q12i. major in a science or engineering technical field in college.	Control	77	3.04	1.50	0.94	281	.346
	ISEP	206	2.87	1.23			

Appendix I. UB-BPS ISEP Student Content Knowledge Assessment Findings

Table I1. *Comparisons of ISEP Students' Pre-Post Content Knowledge Assessment, UB/BPS ISEP Student Questionnaire, Fall 2013 and Spring 2014, Elementary School Students*

ES Content Knowledge	**Time**	***n***	***M***	***SD***	***t***	***df***	***p***
Q1	Fall 2013	198	0.52	0.50	-1.60	197	.112
	Spring 2014	198	0.60	0.49			
Q2	Fall 2013	198	0.59	0.49	0.99	197	.324
	Spring 2014	198	0.54	0.50			
Q3	Fall 2013	198	0.40	0.49	-0.11	197	.910
	Spring 2014	198	0.40	0.49			
Q4	Fall 2013	198	0.37	0.48	1.54	197	.120
	Spring 2014	198	0.29	0.46			
Q5	Fall 2013	198	0.61	0.49	0.12	197	.907
	Spring 2014	198	0.61	0.49			
Q6	Fall 2013	198	0.41	0.49	-2.10	197	**.037**
	Spring 2014	198	0.51	0.50			
Q7	Fall 2013	198	0.22	0.41	1.39	197	.166
	Spring 2014	198	0.17	0.37			
Q8	Fall 2013	198	0.18	0.39	1.34	197	.180
	Spring 2014	198	0.14	0.34			
Q9	Fall 2013	198	0.61	0.49	-0.23	197	.817
	Spring 2014	198	0.62	0.49			
Q10	Fall 2013	198	0.35	0.48	0.00	197	1.000
	Spring 2014	198	0.35	0.48			
Q11	Fall 2013	198	0.48	0.50	0.22	197	.824
	Spring 2014	198	0.47	0.50			
Q12	Fall 2013	198	0.35	0.48	0.24	197	.812
	Spring 2014	198	0.34	0.47			
Q13	Fall 2013	198	0.68	0.47	0.35	197	.730
	Spring 2014	198	0.66	0.47			
Q14	Fall 2013	198	0.37	0.49	-0.65	197	.514
	Spring 2014	198	0.40	0.49			
Q15	Fall 2013	198	0.26	0.44	-0.12	197	.906
	Spring 2014	198	0.26	0.44			
Q16	Fall 2013	198	0.45	0.50	1.38	197	.169
	Spring 2014	198	0.39	0.49			
Q17	Fall 2013	198	0.50	0.50	-0.98	197	.330
	Spring 2014	198	0.55	0.50			
Q18	Fall 2013	198	0.37	0.48	-1.51	197	.131
	Spring 2014	198	0.44	0.50			
Q19	Fall 2013	198	0.57	0.50	1.05	197	.293
	Spring 2014	198	0.53	0.50			
Q20	Fall 2013	198	0.65	0.48	1.91	197	.058
	Spring 2014	198	0.56	0.50			
Total Score	Fall 2013	198	8.92	2.94	0.42	197	.675
	Spring 2014	198	8.81	3.54			

Table I2. *Comparisons of ISEP Students' Pre-Post Content Knowledge Assessment, UB/BPS ISEP Student Questionnaire, Fall 2013 and Spring 2014, Middle School Students*

MS Content Knowledge	**Time**	***n***	***M***	***SD***	***t***	***df***	***p***
Q1	Fall 2013	54	0.59	0.50	0.57	53	.569
	Spring 2014	54	0.54	0.50			
Q2	Fall 2013	54	0.65	0.48	-0.42	53	.674
	Spring 2014	54	0.69	0.47			
Q3	Fall 2013	54	0.54	0.50	0.22	53	.830
	Spring 2014	54	0.52	0.50			
Q4	Fall 2013	54	0.50	0.50	-0.72	53	.470
	Spring 2014	54	0.56	0.50			
Q5	Fall 2013	54	0.80	0.41	-0.27	53	.784
	Spring 2014	54	0.81	0.39			
Q6	Fall 2013	54	0.76	0.43	0.50	53	.622
	Spring 2014	54	0.72	0.45			
Q7	Fall 2013	54	0.26	0.44	1.00	53	.322
	Spring 2014	54	0.19	0.39			
Q8	Fall 2013	54	0.26	0.44	1.40	53	.168
	Spring 2014	54	0.17	0.38			
Q9	Fall 2013	54	0.89	0.32	0.57	53	.569
	Spring 2014	54	0.85	0.36			
Q10	Fall 2013	54	0.57	0.50	-0.62	53	.537
	Spring 2014	54	0.63	0.49			
Q11	Fall 2013	54	0.59	0.50	0.23	53	.821
	Spring 2014	54	0.57	0.50			
Q12	Fall 2013	54	0.59	0.50	0.00	53	1.000
	Spring 2014	54	0.59	0.50			
Q13	Fall 2013	54	0.81	0.39	1.63	53	.109
	Spring 2014	54	0.69	0.47			
Q14	Fall 2013	54	0.57	0.50	0.19	53	.849
	Spring 2014	54	0.56	0.50			
Q15	Fall 2013	54	0.22	0.42	-0.21	53	.837
	Spring 2014	54	0.24	0.43			
Q16	Fall 2013	54	0.46	0.50	-1.74	53	.088
	Spring 2014	54	0.61	0.49			
Q17	Fall 2013	54	0.63	0.49	-0.85	53	.399
	Spring 2014	54	0.70	0.46			
Q18	Fall 2013	54	0.67	0.48	0.78	53	.438
	Spring 2014	54	0.59	0.50			
Q19	Fall 2013	54	0.76	0.43	0.44	53	.659
	Spring 2014	54	0.72	0.45			
Q20	Fall 2013	54	0.65	0.48	0.00	53	1.000
	Spring 2014	54	0.65	0.48			
Total Score	Fall 2013	54	11.78	3.39	0.32	53	.750
	Spring 2014	54	11.59	3.08			

Table I3. *Comparisons of ISEP Students' Pre-Post Content Knowledge Assessment, UB/BPS ISEP Student Questionnaire, Fall 2013 and Spring 2014, High School Students*

HS Content Knowledge	**Time**	***n***	***M***	***SD***	***t***	***df***	***p***
Q1	Fall 2013	64	0.59	0.50	0.73	63	.470
	Spring 2014	64	0.53	0.50			
Q2	Fall 2013	64	0.27	0.45	-0.22	63	.829
	Spring 2014	64	0.28	0.45			
Q3	Fall 2013	64	0.25	0.44	0.22	63	.829
	Spring 2014	64	0.23	0.43			
Q4	Fall 2013	64	0.41	0.50	-0.22	63	.829
	Spring 2014	64	0.42	0.50			
Q5	Fall 2013	64	0.45	0.50	0.19	63	.849
	Spring 2014	64	0.44	0.50			
Q6	Fall 2013	64	0.31	0.47	0.62	63	.536
	Spring 2014	64	0.27	0.45			
Q7	Fall 2013	64	0.39	0.49	1.00	63	.321
	Spring 2014	64	0.31	0.47			
Q8	Fall 2013	64	0.36	0.48	1.52	63	.135
	Spring 2014	64	0.27	0.45			
Q9	Fall 2013	64	0.25	0.44	0.53	63	.597
	Spring 2014	64	0.22	0.42			
Q10	Fall 2013	64	0.22	0.42	0.00	63	1.000
	Spring 2014	64	0.22	0.42			
Q11	Fall 2013	64	0.36	0.48	0.65	63	.517
	Spring 2014	64	0.31	0.47			
Q12	Fall 2013	64	0.20	0.41	-1.73	63	.088
	Spring 2014	64	0.33	0.47			
Q13	Fall 2013	64	0.38	0.49	1.14	63	.260
	Spring 2014	64	0.28	0.45			
Q14	Fall 2013	64	0.17	0.38	-0.69	63	.496
	Spring 2014	64	0.22	0.42			
Q15	Fall 2013	64	0.31	0.47	0.20	63	.843
	Spring 2014	64	0.30	0.46			
Q16	Fall 2013	64	0.20	0.41	0.57	63	.568
	Spring 2014	64	0.17	0.38			
Q17	Fall 2013	64	0.31	0.47	0.47	63	.641
	Spring 2014	64	0.28	0.45			
Q18	Fall 2013	64	0.30	0.46	0.19	63	.849
	Spring 2014	64	0.28	0.45			
Q19	Fall 2013	64	0.31	0.47	1.63	63	.109
	Spring 2014	64	0.20	0.41			
Q20	Fall 2013	64	0.36	0.48	-0.50	63	.621
	Spring 2014	64	0.39	0.49			
Total Score	Fall 2013	64	6.41	3.30	1.17	63	.248
	Spring 2014	64	5.95	3.12			

4. b. Response to External Evaluation Report

Joseph A. Gardella, Jr. and Xiufeng Liu

The external evaluation provided useful feedback on the project's progress toward achieving its stated goals. Specifically,

1. Goal 1: Improving teacher knowledge and skills related to inquiry science teaching

It is clear that after three years of research, teachers have improved their understanding of interdisciplinary science and the nature of science, but from research results and evaluation, it is clear that this has not been effectively translated into and understanding or implementation of inquiry based teaching or development of inquiry based classroom materials and experiments.

In next year's implementation, we will plan specific sessions during the academic year to help teachers reflect on their summer research experiences in order to develop more appropriate understanding of the inquiry based teaching and experimental work. We will include new workshop/presentations in academic year professional development as part of ISEP. The new structure of academic year content PD with support from New York State Education MSP funding would make this possible to a wide audience of teachers. ISEP teachers will be required to write an essay response to these presentations.

The evaluation also found that students of ISEP teachers reported more learning activities consistent with science inquiry than students of non-ISEP teachers. This is assuring in that ISEP teachers demonstrated change in their teaching approaches. We believe this finding might largely be due to the presence in the classrooms of STEM graduate students and undergraduate service learning students. The variety of out-of-school activities facilitated by STEM students might have also contributed to this positive change in student learning.

2. Goal 2: Increasing teacher quality, quantity, diversity and retention.

Although the evaluation found some possible signs toward achieving the above stated goal, we are cautious in making any conclusive statement on our progress toward achieving this goal. This is because there are many factors outside the control of the ISEP project working against achieving the above goal. These factors include but not limited to decreasing student enrollment in some ISEP schools, State accountability measures that result in closing or restructuring some ISEP schools, and teacher low morale due to ongoing instability in the school district leadership and stalemate in contract negotiation.

3. Goal 3: Developing and sustaining PLCs

Although evaluation showed that the extensive work in the Parent PLC has made this a viable and unique operation that supports ISEP participation of parents and students. Translating this success into the teacher based PLCs is underway with a more serious emphasis on a limited and regular set of PLC face to face meetings, and implementation of social network off line discussion using EdWeb. New subject based PLCs with middle and high school teachers have been formed for summer 2015 and are meeting at a regular, fixed time twice during the summer.

4. Extending interdisciplinary science inquiry from middle school to high school

Although evaluation did not find enough evidence on the continuation of interdisciplinary science inquiry from middle school to high school, we expect that as more students progress from middle school to high school in ISEP schools, we will see more positive evidence on this continuation of interdisciplinary inquiry over grades.

5. Improving student achievement, attitude and interest in science

We are very pleased to know that evaluation found improved student attitude and interest in science after participating in ISEP summer activities. This area was a struggle in years 1 and 2 and significant increases were made in summer in year 3. This seems to confirm that our approach of year round wrap around support for students is a necessary component to keep and grow student interest.

6. Improving collaboration among project partners

We are very pleased that participation of ISEP school teachers, STEM students and undergraduate service learning students was extremely high. Although no data were collected on university STEM faculty, our experiences over the past three years suggest that university faculty are very enthusiastic and supportive of the ISEP project.

The external evaluation also found some positive outcomes related to STEM students. We realized that in the past few years, we focused more on the process of STEM students developing science communication skills. In the next year, we will pay more attention to collecting data on STEM students achieving other project goals including understanding the nature of interdisciplinary science inquiry, appreciation of PLCs, and developing collaborative skills. We will facilitate data collection by the external evaluator on the above measures.

Next year, we will continue work with our external evaluator to synthesize all pieces of data collected from both external evaluation by the external evaluator and internal evaluation by the research team. Specifically, we will conduct preliminary structure equation modeling to test various hypotheses on possible causal relations among variables related to students (e.g., achievement, attitude and interest in science), teachers (e.g., participation in summer research and ongoing professional development along with their demographics), school characteristics, and parent involvement in student learning. We will also conduct hierarchical linear modeling to identify different effects associated with teachers, schools and students.

Section 5: Implementation Plan

University at Buffalo/ Buffalo Public Schools ISEP

Year 5: 2015 - 2016

ISEP Year 5 Plan: July 2015 – July 2016

For Year 5 we anticipate full implementation of core activities detailed in grant application and in 5-year plan including the following categories which are detailed in the following chart:

- Teacher professional development
- School-based wrap-around supports, especially results of summer student activities
- PLC's
- Research & evaluation
- Develop and Execute Sustainability Plan for future funding
- Develop an ecosystem based Theory of Action

	July & August	Fall	Spring	June 2015
Teacher professional development	Teachers engaging in research experiences and share projects through PLC's; planning for implementation in upcoming school-year 17 BPS teachers participating in 3-week Summer STEM Institutes at Buffalo State College 5 BPS teachers participate in Exploring CS Workshop at Buffalo State College 10 BPS teachers and 6 BPS students participate in GIS camp at UB. 15 English as New (Second) Language teachers and 2 BPS science teachers collaborate on translations of high school class material. Identify continuing and new graduate and undergraduate students to work with teachers during the upcoming school-year through consultation with district and school leadership	Monthly pedagogical workshops on inquiry and interdisciplinary inquiry teaching (with graduate credit option from Graduate School of Education) Teacher implementation of inquiry science teaching with support by STEM and STEM education faculty, graduate and undergraduate students as well as retired master teachers	Monthly pedagogical workshops on inquiry and interdisciplinary inquiry teaching (with graduate credit option from Graduate School of Education) Teacher implementation of inquiry science teaching with support by STEM and STEM education faculty, graduate and undergraduate students as well as retired master teachers Teachers nominated/ self-nominated for summer 2016 research experiences and Summer STEM Institute (proposed summer programs finalized by May) Faculty/research teams and mentors identified Ongoing communication with school and district leadership to align and maximize resources, placements, and opportunities	Placements finalized for research projects and plans; Proposed implementation including short and long term inquiry projects and afterschool programs Proposed dissemination plan developed for teachers with standard rubrics for lesson planning and supporting materials for upload onto ISEP website and NYLearns.org.

School-based wrap-Around supports	Reflect on summer research activities and curriculum plans; explore related school needs and collaboratively plan for in-school activities for upcoming year Examine results of students from each school in summer research opportunities or middle school summer camps and identify follow up academic year activities for continuing emphasis on student development Develop student focused leadership and STEM activities to develop mentoring and academic success in STEM with measures reflecting Common Core standards	School meetings to review building plans and activities; identify ongoing needs and changes; assess viability of plans and assign GA/RA and undergraduate support. Meet with school based parent group to plan activities. Review building supplies and equipment requests. GA's and RA's support in-class and afterschool activities and service learning students; in-school and afterschool activities Ongoing purchasing of STEM related equipment as determined through collaborative discussions and planning with school and district leadership	Ongoing activities (begun in fall) with extensive communication between all parties to ensure benefit and alignment with grant and school/district planning Ongoing partner events including family nights at BMS Announcement of summer camps for middle school students and summer research internship opportunities for high school students	Complete school year with regard to graduate and undergraduate students placed in schools and prepare for summer research programs Summer research internships made available with application process Summer camp enrichment opportunities for participating middle school students

PLC's	Communication to invited new member participation in PLCs and initial meeting with participants Teachers engaged in summer research prepare products to share through PLC's Test social network tools for each PLC	Explore EdWeb characteristics for online communication by testing questions to teacher PLCs Scheduled meetings and communication to support PLC's Develop new interfaces and PLC's as needed/ warranted	Ongoing monitoring of PLC activity; communication and meetings to encourage participation and alignment with ongoing STEM related activities associated with ISEP Ongoing interactions with DPCC and Parent PLC to encourage parent involvement Ongoing interactions with core partners to encourage their participation in support of ISEP goals	Plan to incorporate new research activities and new teachers, graduate students, researchers, parents, and teachers in PLC's (existing and evolving)

Evaluation	Develop and pilot instrument to assess STEM faculty perceptions (ISEP Faculty Questionaire Analyze UB/BPS ISEP Teacher Questionnaire pre/post comparisons Analyze BPS ISEP Student Questionnaire data from treatment and comparison students- Spring 2013 Collect 2014-2015 School/classroom/teacher-level demographic data Collaborate with the Research Team to develop and pilot test Teacher Content and PCK Assessment Observation and informal interviews of ISEP teacher participants, STEM students, and faculty during summer lab experiences Administer instrument to assess student summer program experiences	Administer pre-intervention instruments to measure changes in BPS students' perceptions of science and engineering (UB/ BPS ISEP Student Questionnaire) Administer UB/BSC Faculty Questionnaire Ongoing collection of data and monitoring of ISEP components and responding to project team needs Administer and analyze STEM Student Survey data Analyze BPS student summer program experience data Meet with ISEP Project Team on site	Administer and analyze fully developed instruments measuring content knowledge and pedagogical content knowledge (UB/ BPS ISEP STEM Teacher Content Knowledge & Pedagogical Content Knowledge Assessments) Ongoing collection of data and monitoring of ISEP components and responding to project team needs Administer and analyze STEM Student Survey Data Meet with ISEP Project Team on site	Administer post-intervention instruments to measure changes in BPS students' perceptions of science and engineering (UB/ BPS ISEP Student Questionnaire) Administer UB/BPS ISEP Teacher Questionnaire Ongoing collection of data and monitoring of ISEP components and responding to project team needs Preparing for evaluation of summer research components and final activities in schools and revision of evaluation plan as necessary

Research	Participant observation of teachers conducting research at university research laboratories and industrial partner sites during the summer 2013 Working with the external evaluator to develop standardized measurement instruments on science teachers' interdisciplinary science inquiry content knowledge and pedagogical content knowledge Participant observation of STEM graduate students conducting research with teachers, summer 2013	Observation of teachers implementing interdisciplinary science inquiry in their classrooms Supporting teachers in implementation interdisciplinary science inquiry through a monthly seminar Periodic interviews of teachers on their changing conceptions of interdisciplinary science inquiry teaching Observation of the undergraduate academy seminar on preparation of STEM students to work in schools Organizing graduate student orientation sessions to prepare them to work in schools; Interview of STEM graduate and undergraduate students on their experiences and perceptions of communicating science to students and teachers	Observation of teachers implementing interdisciplinary science inquiry in their classrooms Supporting teachers in implementation interdisciplinary science inquiry through a monthly seminar Ongoing activities related to studying graduate student impacts (continuation of fall activities)	Prepare journal articles and other relevant publications to disseminate research findings The Research Team will prepare for studying the next round of teachers conducting research at UB and partnering facilities