# Annual Report to NSF

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

**Year 3: 2013 – 2014**

# Section 1: Activities and Findings

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

**Year 3: 2013 – 2014**

## 1. Introduction and Summary: Activities and Findings

This Activities and Findings report from the second 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 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 ***and***
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

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 2013-2014.

Highlights from the third year of the NSF support for ISEP include:
- placement of 75 teachers in summer professional development (PD) in 2013, including 64 teachers in research opportunities,
- research results reported in several submitted and with one published paper (see references in research review),

- development of a STEM/English as Second Language (ESL) 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, Somali and Bhutanese,
- development and implementation of a computer science initiative and submission of a supplemental request for ISEP to the STEM-C program,
- development of subject based PLC's and expansion of the Parent PLC to include parents from each ISEP School,
- as a result of collaboration in research teams in 2013-2014, and the PLCs, highly focused STEM teaching teams emerge in K-8 schools among middle school science teachers (grades 4-8),
- 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 April 7-11,
- Social media and ISEP websites (isep.buffalo.edu) developed to communicate with stakeholders, and report results of implementation from poster sessions with materials made available for download from website,
- a series of grant submissions to supplement and expand ISEP work, including a new BPS/ISEP application to New York State Education Department MSP that brings ISEP work into the academic year PD for all science teachers, applications to NSF and solicitation of foundation funding,
- award of additional funds from Praxair to expand corporate commitment to ISEP,
- ISEP Grad Assistant Michael Gallisdorfer authored a successful Google grant application and was awarded 30 software licenses for Google Earth Pro. These were utilized with tablet computers for remote GIS environmental planning and sampling with middle school students at School 93, Southside Academy,
- extensive recruiting based on parent PLC input for opportunities for summer high school student research and middle school science camps are added for summer 2014 ***and***
- Substantial results on classroom implementation in academic year 2013-2014.

The issues that have complicated ISEP progress in year 3 include:

- The leadership of BPS Superintendent Dr. Pamela Brown in her second year 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. Dr. Brown has announced that she will negotiate a resignation. This has complicated ISEP work with schools and partners. ISEP program progress is often pitted against NY State Ed School Turnaround initiatives and the identified goal of some Board members to remove the Superintendent. Despite the political troubles, ISEP access to and cooperation with Dr. Brown and her leadership team improved quickly over the year and had been excellent. Regular presentations were made to the Buffalo Board of Education, despite the split on the BOE 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.
- Summer student placement in STEM middle school camps at BSC and UB and summer high school research has been below expectations in both years 1 and 2. Efforts to increase participation for 2014 were organized in response, with extensive help from the Parent PLC.
- Despite the concern from NY State Education Department (NYSED) about progress in BPS, there has been a lack of response from leadership from NYSED to requests to discuss opportunities to align with other Race to the Top funded STEM PD efforts. This is despite numerous outreach attempts through multiple channels.

However, as noted above, ISEP partnered with BPS leadership, in particular, Ms. Kelly Baudo, in submitting a NYSED MSP application.

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, Part 1, Appendix 1, following)*** offered a combined (2013) summer teacher PD course, taught by coPI Prof. Dan MacIsaac and Prof. Clark Greene of Technology Education. 12 teachers completed the course and are prepared for summer research in 2014. 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)*** 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, Dr. Charles Drew Science Magnet. The Museum of Science strongly supported the Parent PLC with Museum memberships for all participants. Many ISEP events are held regularly at the Museum, such as the ISEP Student Science Summit (see PLC report below). Teachers have accessed field trips for Museum major exhibitions, such as Mummies of the World. Museum and BPS completed renovation of Museum space (by Museum funding) and connected School 59 space (BPS/NYS Funding) to make more hands on workstations for use daily by School 59. Continued hosting field trips by ISEP schools.
- ***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 (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. 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 he personally recruited students at ISEP schools and hosted a field trip with 70 ISEP students and a Parent PLC meeting.
- ***Praxair Technology Center (Corporate supporting partner)*** hosted two physics teachers in 2013, who developed unique laboratory based work (Schlieren camera for transparent gas phase fluid dynamic measurements). Praxair will host four teachers with partial support of finances for 2014. 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)*** established their partnership commitments this year and hosted one teacher in summer research in 2013, who will continue in 2014. In addition, they have hosted multiple field trips in the past year.
- ***Medaille College (supporting partner)*** provided over 30 service learning students through leadership of Professor Brenda Fredette to Riverside High School and Lorraine Academy, also offered an ISEP supported summer middle school STEM camp which emphasizes STEM based entrepreneurship (another Riverside magnet academic program). The camp will continue in 2014.

- ***WNY Service Learning Coalition (supporting partner)*** helped recruit Daemen College, Niagara University and Canisius College. Each began SL student collaboration in Fall 2013.
- ***District Parent Coordinating Council (DPCC, supporting partner)*** provided new opportunities in communication to district parents by hosting public access TV shows on Buffalo Community Television with interviews with ISEP leadership.

Professor Gardella and Ms. Kelly Baudo of BPS participated in a December 3, 3013 Workshop on STEM-C opportunities, and ISEP has submitted a $500,000 three year supplement request for development and expansion of computer science initiatives. We recruited seven faculty from UB Computer Science and Engineering and BSC Computer and Information Science and Mathematics to build a summer workshop program and offer new interdisciplinary computer science and engineering research opportunities. We have identified four teachers for this summer's work. If funded, the Supplement would support expansion of opportunities to five selected schools in year 1. Further year work would expand the initiative to all 12 ISEP schools and then to all BPS high schools. 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.

On May 23, 2014, the ISEP Steering Committee convened the initial review of ISEP by the External Advisory Committee. The committee reviewed a draft of this report, and presentations and meetings were arranged with all core and supporting partners. The committee summarized their findings in a SWOT analysis and reported to the Steering Committee and to the Core Partners. Specific suggestions were made to deal with the identified weaknesses: develop and refine the dissemination plan more clearly, adopt a theory of action with the preliminary research and evaluation results, and clarify the relationship of technology within teacher PD.

The coming year will focus on the Theory of Action. Dissemination plans initially were based on the use of NYLearns.org, a statewide standards based curriculum and lesson plan database. Superintendent Pamela Brown asked to revise that dissemination plan to focus on extending classroom materials and curriculum development dissemination first to other BPS teachers. The ISEP website has been the focus for this effort. But a comprehensive dissemination plan must be revised, and this is planned for Summer 2014. The SWOT analysis is shown in Appendix 2 of Part 1, following the Buffalo State College Report and the Implementation Matrix.

**2. School Based Wrap-Around Support for Implementation in Year 3**

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

In year 3 of the program, support for the number of graduate assistants was decreased from a high of 18 in the fall 2013 semester to 14 full time grad assistants to find a sustainable balance from funding. The original support plan in the proposal was for each school to be supported by one full time graduate assistant, committed to 16-20 hours/week with support from paid part time graduate students and undergraduates. We modified and increased the commitment to add six full time graduate students, to replace the part time undergraduate support, with the time split so that each school had at least one additional ½ time graduate student, spending 8 hours/week in each of two schools. Half time/split graduate assistants were chosen to help connect middle school teachers to high school teachers and promote common research themes between schools. However, with an increase in experienced undergraduate students, we scaled back to fourteen with two graduate assistants with specific experiences, one in computer science and one in physics. The graduate assistants 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, based in year 1 with contributions from UB and BSC, were increased by recruitment of four additional schools through the Western New York Service Learning Coalition (WNY SLC), a supporting partner on the grant. Niagara University, Daemen College and Canisius College also added students to the program, with six students participating from Canisius, three presently at South Park High School, two students in the fall from Daemen College, also at South Park, and one student from Niagara University at the Math Science and Technology Prep School. The combination of UB, Buffalo State, Canisius, Daemen, Medaille and Niagara increased the participation in both paid internships and course based service-learning at the undergraduate level from 25-45 students last year to approximately 50-80 during each semester depending on student interest. This allowed for every school to be staffed in-class and after school with students, and three schools- School 19, MST and Burgard, to be supported by staff from our initial corporate partner, Praxair. Corporate Supporting Partner Life Technologies is currently considering providing staff at the high school level. 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**

With planning from the Vice President for Research and Economic Development, coPI Alex Cartwright, and leadership from SUNY Trustee Eunice Lewin, major events on STEM education in Buffalo Schools were organized into events in March and April 2014 (http://www.research.buffalo.edu/ovpr/stemmonth/). Annual support from the School of Engineering, ISEP and Praxair funded Tech Savvy (http://www.eng.buffalo.edu/techsavvy/), a program focused on female middle school students. BPS students participated in larger numbers at the annual Science Exploration Day at UB, where 25 tours, presentations and lectures attract nearly 800 middle and high school students, sponsored by UB and NY NSTA chapter (STANYS). A number of schools organized science nights for parents including School 19 which held the annual Science Fun night March 25th. This event drew approximately 300 participants at a school with an enrollment from K-8 of 450 students. School 72, Lorraine Academy held their Science and Career Night also held their annual event on March 19th with considerable Buffalo State faculty involvement, drawing over half of the Lorraine student families, with nearly 400 participants. The ISEP Parent PLC organized the ISEP Student Science Summit on March 15th 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.

Finally, BPS Science week, April 7-11, 2014 was announced by Mayor Byron Brown of the City of Buffalo at a press conference, and opened and closed with showcase events at ISEP Schools. April 7th opened the week at Native American Magnet School 19, where 8th grade students in a physiology experiment with live EKG collection of distinguished visitors. Science Week closed April 11th with an event at Burgard High School, where Wind Tunnel and Schleiren photography were complemented by a table top earthquake simulator designed by an earth science teacher in Summer 2013. Dr. Shirley Malcom spoke at Burgard to the entire school assembly as a closing event. ISEP work was heavily emphasized each day of the week. A special PD day on Wednesday for 280 BPS science teachers demonstrated ISEP developed classroom materials for the entire district staff, with reference to the ISEP website for downloadable support materials.

The ability for schools to schedule field trips continues to be a significant activity which has been expanded in year 3. The Museum of Science hosted several trips around major exhibitions, Climate Change, Science of Sports, Human Body, Our Marvelous Earth and Mummies of the World. Tifft Nature Preserve, a recovered Brownfield managed by the Museum was a popular outdoor choice. 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 14 high school field trips and 11 middle school field trips were funded by ISEP this past year, compared to 23 total field trips last year.

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 have partnered with Cradle Beach SOAR mentoring program. Cradle Beach is a historic camp for disadvantaged and disabled children in WNY. They are interested in leveraging their Lake Erie beachfront and wooded campsite for summer STEM activities to complement their in-school mentoring program. 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 ISEP staff person 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 will coordinate recruitment of ISEP students for that program. Our participation in these opportunities has been lower than expected but efforts to increase recruiting seem to be paying off for summer 2014.

**e. 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 contributes to both ***institutional change and sustainability.*** Thus, four of the five key features are central to this area of the ISEP program.

### 3. Summer Teacher Professional Development year 1, Summer 2012 & plans for year 2, Summer 2013

#### a. Interdisciplinary Research Placements and Results for Summer 2013

Table 1 shows the assignments, subjects and numbers of teachers summarized for each school for summer 2013. The organization of the teacher placements into these interdisciplinary subject "clusters" has continued this year (Table 2) with increases compared to 2012. Six teachers were supported for curriculum writing project at Lorraine Academy, at the request of the Principal and Coordinating teacher

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 program enrolled more than the twelve teachers envisioned in the strategic plan. This first year experience sets a basis to identify partner faculty, develop procedures for recruitment of teachers and for applications and MOUs. We expect the placement process continue following the strategic plan for the subsequent years of ISEP.

Table 2 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.

Table 1: Summary of **2013** 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, | 9 | 3 Collaborative Research, Disease/Immune System<br>6 BSC Course |
| **Charles Drew Sci Magnet School 59** | 7/8th Grade Living Environment | 1 | First research Assignment, Crystallography |
| **Lorraine Academy School 72** | 4th Grade, 7/8th Grade Curriculum Writing 1-8 | 8 | Environmental, Bioinorganic, Curriculum Writing across grade levels |
| **Southside Elementary School 93** | 4-8th Grade | 5 | All five in Environmental group<br>SEPUP development<br>ESL Team |
| **Native American Magnet School 19** | 5, 7/8th Living Environment<br>6th grade Social Studies<br>ESL Team | 6 | Anat/Phys, Env. Science, Social Studies/Native American Studies, ESL Team |
| **Combined 5-12** | | | |
| **MST Prep School School 197** | Eight Grade Sci, Research Living Env, Special Ed, Earth Science, Chemistry | 5 | 5 Research Placements, Env Team, Earth Sci, Chemistry |
| **High Schools** | | | |
| **East High School 307** | Living Env, Chemistry Anat/Physio | 3 | 3 Research Assignments, including Anat/Phys team |
| **Bennett High School 200** | Living Env, Earth Science | 9 | 8 Research Placements,<br>1 BSC Course |
| **South Park High School 206** | Living Env, Chemistry Special Ed | 5 | 5 Research Placements, Genetics, Environment, Public Health |
| **Riverside Institute of Technology School 205** | Anat/Physio, Physics, Living Environment, English as Second Language, Special Ed. | 11 | 6 Research Placements Praxair, Anat/Physio/Env.<br>3 BSC Course<br>2 ESL Team |
| **Burgard High School 301** | Physics, Earth Science, Living Environment | 4 | 3 Research Placements<br>1 BSC Course |
| **Hutchinson Central Technical High School 304** | Living Enviroment, Chemistry, Physics | 9 | 8 Research Placements<br>1 BSC Course |

Table 2: 2013 Teacher Research Placement Summary

## *Teacher Research Placement Summary Summer 2013*

| Group Name, Subject Area | Course areas represented | Number of Teachers | UB2020 Strategic Areas and Faculty Departments |
|---|---|---|---|
| **Environmental Science, Social Science and Engineering** | Chemistry, Earth Science, Living Environment (Bio), Middle Schools | 16 | ERIE IGERT, Chemistry, Geology, Geography |
| **Biology and Genetics** | Living Environment, Biochemistry | 10 | Biological Sciences, Pharmacology and Toxicology, Genetics |
| **Anatomy and Physiology** | Living Environment, Medical Careers, Middle Schools | 6 | Physiology and Anatomy and Pathology (Basic Medical Sciences) |
| **Cancer Research** | Living Environment, Bioinformatics, Chemistry | 3 | Roswell Park Cancer Institute, Hauptman Woodward Institute |
| **Interdisciplinary Chemistry** | Living Environment, Chemistry | 5 | Chemistry, Physics |
| **Extreme Events** | Earth Science | 4 | Civil, Structural and Environmental Engineering, Geography, Mechanical and Aerospace Engineering |
| **Computer Science/Engineering** | Engineering, Technology | 1 | Computer Science and Engineering |
| **Bioengineering** | Living Environment | 1 | Bioengineering |
| **Physics** | Physics, Technology, Engineering | 5 | Physics, Praxair |
| **English as Second Language Materials Development** | Living Environment, English as a Second Language, Special Ed | 7 + 1* | Multiple languages and dialects of refugee and immigrant population in Buffalo |
| **STEM Curriculum across grades 1-8 at Lorraine Academy School 72** | Elementary to Middle school | 6 + 1* | Engage curriculum writing in interdisciplinary environmental and medical career topics at all grade levels to guide transitions for STEM content |
| **Praxair Technologies, Surface science and engineering** | Physics/Technology, Conceptual Physics | +2* | Applications in gas purification and production, welding etc. at Praxair Technologies |
| **Life Technologies** | Living Environment, Biochemistry | +1* | Applications to genetics research Biological reagents for genetics and biological research |
| **Buffalo State College Courses** | Living Environment, Careers and Technology, Special Education, English as a Second Language | 12 | Physics, Technology Education |

* +1, +2 indicates the number of coordinating teachers, already represented in research assignments

64 teachers in research and classroom content development, 12 teachers in BSC Course, 76 teachers served in summer 2013

Specific placements are being made presently for the summer 2014 through review of detailed teacher proposals. Approximately 60 teachers have been placed as of June 3, 2014. This is accomplished by a committee staffed by members of the Executive Committee, chaired by Co-PI MacIsaac, and including four faculty. Fourteen teachers have been selected for the Buffalo State College course, and seven are

recommended for the new CS Principles workshop with the remainder being placed in research positions at the present time. We expect to have a similar number of research placements as 2013 (approx. 70).
Eight ESL teachers have applied and matched with two science teacher leaders in the 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.*** All five key features are central to this part of ISEP's program.

## 4. 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. Additionally parents are involved in a parent based PLC and will be involved in multi-stake holder PLC's in the coming 2014-15 school year. Teachers involved in the summer research will continue to identify other teachers within their school building to participate.

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, Intuitional Change and Sustainability**

During the 2013 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 following 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.

During the 2013-14 school years, parent involvement has increased significantly. The ISEP Parent PLC has solidified into a well-organized, highly engaged community that has resulted in creating intuitional change in several key areas. Two significant programming events were created and implemented by the ISEP parent based PLC.

- **The ISEP Parent PLC STEM and Social Justice Conference, January, 11, 2013:**
  This conference included presenters from University at Buffalo; Dr. Joseph Gardella, ISEP PI; ISEP parents, Angelica Rivera and Mike Quinniey and Antoine Thompson, former New York State Senator, and current executive director of the Buffalo Employment and Training Center. The conference theme: STEM Fields and Environmental Justice, examined how environmental issues facing the city of Buffalo effect communities. This will become an annual conference event that the ISEP parent PLC will organize, establish STEM based themes and invite the University of Buffalo and Buffalo States College communities and larger Buffalo community to participate in.

- **The ISEP Student Science Summit, March 15, 2013:**
  The purpose of the ISEP Student 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.

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 ISEP Student Science Summit judges included: Dr. Daniel MacIsaac, ISEP, Co-PI, Dr. William Duax, Research partner, Hauptman Woodward Institute, Dr. Mwita Phelps, corporate partner, Life Technologies and Dr. Larry Megan, corporate partner, Praxair. There were approximately 300 attendees at the summit including: ISEP parents, grandparents and siblings; Buffalo Pubic School Superintendent Dr .Pamela Brown, 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.

Each of the 12 ISEP schools had teams participate in the Summit competition. (Please see table below) For most of the students this marked the first time that they had presented research as a team outside of their immediate classroom setting. 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.

| School | Teacher/s | Graduate/Undergraduate Students | Presentation Description |
|---|---|---|---|
| Bennett High School # 200 | Mr. Carl Bish<br>Mr. Kissel | **Janhavi Moharil**<br>(PhD Student)<br>**Chelsea DiPizio**<br>(Undergraduate Student) | **Team1:** Aquaponics project;<br>**Team2:** Imaging of different stages of embryogenesis of chickens; **Team3:** Protein visualization and protein docking |
| Burgard Vocational High School # 301 | Mr. Bruce Allen | **Katie Hofer-Collins**<br>(PhD student)<br>**Katherine Kniessen**<br>(PhD student) | **Team1:** Structural integrity using different foundation materials.<br>**Team2:** Earthquake analysis |
| Charles Drew Science Magnet # 59 | Ms. Dara Dorsey<br>Ms. Stephanie Finn | **Robin Foster**<br>(PhD student) | **Grade5:** soil testing, 2 known and 1 unknown sample.<br>**Grade6:** volcanic eruption demo, igneous rock exercise.<br>**Grade7:** wet-cell battery, electricity demo.<br>**Grade8:** ecology, investigation of sustainable resources |
| East High School # 307 | Mr. Pat McQuaid | **Amy Zelinski**<br>(PhD student)<br>**Steve Rogers**<br>(Master's student) | E. coli transformation with green fluorescence protein. Students will prepare media, grow bacteria, attempt to genetically transform bacteria to express GFP and quantify their rate of transformation efficiency. Display will show wild type bacteria vs transformed bacteria |
| Harriett Ross Tubman Academy # 31 | Mr. Steven Indalecio | **Steve Rogers**<br>(Masters student)<br>**Ekue Adamah-Biassi**<br>(PhD student) | **Grades 7/8:** Demonstration of student created robot, wheeled vehicle, helicopter etc |
| Hutchinson Central Technical #304 | Ms. Jill Jakubowicz | **Suyog Pol**<br>(PhD student) | **Team 1:** Demonstration of Gel electrophoresis and present application of PCR on poster.<br>**Team 2:** Design and optimization of Boomilever bridge. |
| Lorraine Academy #72 | Ms. Sharon Pikul | **Michael Gross**<br>(PhD student) | **Team 1:** Courtyard project (harvesting of different plants/fruit) |
| MST Preparatory #197 | Ms. Michelle Zimmerman | **Heather Rudolph**<br>(PhD student) | **Team 1:** Student hands-on demonstration with Ward's Data Hubs. Experiments planned: Gas Laws; Algae Colorimetric |
| Native American Magnet #19 | Ms. Heather Gerber<br>Ms. Mary Ellement | **Angelina Montes**<br>(PhD student)<br>**Valerie Goodness**<br>(PhD student) | **Team 1:** pH of household substances; demonstration of acid reflux in humans |
| Riverside Institute of Technology #205 | Mr. Brad Gearhart<br>Mr. Karl Wagner | **Shannon Clough**<br>(PhD student)<br>**Katherine Kniessen**<br>(PhD student) | **Team 1:** Testing of pH of household substances and water samples, anatomy and physiology activities (cardiac, gel electrophoresis) |
| Southside Elementary # 93 | Ms. Susan Wade<br>Mr. Carlo Casolini | **Michael Gallisdorfer**<br>(PhD students) | **Team 1:** Engineering Design and Analysis of Model Electric Cars<br>**Team 2:** Identifying Genetically-Modified Organisms (GMOs) in Common Foods |
| South Park High School # 206 | Ms. Kathleen Marren<br>Ms. Ann Mychajiliw | **Michael Habberfield**<br>(PhD student)<br>**Valerie Goodness**<br>(PhD student) | **Team 1:** Experimentation of solid phase extraction filtration using grapheme<br>**Team 2:** The science and genetics of cancer |

### d. Outcomes from 2013-2014 PLC's

The most significant outcome for the 2013-14 school year has been the growth and engagement of the parent based PLC and the focus and productivity of the graduate student PLC. The creation of the STEM Social Justice Conference and the ISEP Student Science Summit provided significant opportunities for collaboration for all ISEP stakeholders. The Student Science Summit, in addition to ISEP schools' individual after school programs, clubs and science fun nights will continue to serve as the main driver for collaboration.

**PLC clusters:**

**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.

**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, programs that focus on the transition from middle to high school. This community meets Monthly.

**Multi-Stakeholder Based-** This cluster will become the organizing community for all future ISEP science summits. As well as engage Parent/Guardian, Teachers, UB doctoral students, UB STEM faculty, ISEP Research and Corporate in creating strategies to keep children/students engaged in classroom activities, subject content, and afterschool ISE based activities, as well as the annul ISEP Science Summit..

**School Building Based PLC**- Coordinating Teacher will continue to convene during common planning time to share research project, implementation and other ISEP based programs and opportunities and to actively recruit fellow teachers in ISEP buildings.

**Building Principal Based PLC**- This PLC will focus on collaboration across the 12 ISEP participating schools, leveraging resources, and collaborating with fellow ISEP participating schools on various school projects and initiatives. Thus far, we have formed a leadership team consisting of two ISEP building principals, Terry Schuta from South Park high school and Terry Ross from Bennett high school. Per their recommendation, the principal PLC will convene during early summer of 2014 to establish regular meeting schedule which will consist of 4 meeting annually.

**e. Moving Forward**

Phase three of the PLC clusters will commence during the summer of 2014 and continue throughout 2014-15 school year. The following PLC Cluster will be implemented:

- Building Principal Based

Additionally, the existing PLC clusters will continue to meet during the summer 2014 and continue throughout the 2014-15 school year.

The parent based PLC will hold a retreat in August, 2014. This retreat will serve as an opportunity to further develop programmatic plans for the 2014-15 school years, including the focus of the STEM Social Justice conference and the ISEP Science Summit. Additionally the retreat will offer parents more learning opportunities regarding interdisciplinary science from doctoral students, ISEP coordinating teachers and UB and BSC STEM faculty; and how to work with and keep their children engaged in interdisciplinary science as they transition from middle to high school and college.

**Table 2: Overview of Professional Learning Communities 2013-2014**

| Timetable | Participants | Responsibilities | Issue/Concerns | Outcomes |
|---|---|---|---|---|
| July, 2013-June 2014 school year | Participating BPS teachers in summer research<br><br>UB doctoral students<br><br>UB STEM faculty<br><br>BPS Parents | 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<br><br>Parents access to transportation<br><br>Social Network support of participant involvement | Initial PLC Clusters were created and implemented<br><br>PLC Clusters created opportunities for teachers within school buildings to work together in groups and as a team for upcoming summer 2013 research<br><br>Graduate students created collaborative opportunities between middle and high school teachers and students<br><br>Parent PLC created opportunities for parents to collaborate with BPS teachers, UB doctoral students, STEM faculty, research, corporate and community partners through the creation of the ISEP STEM Social Justice Conference and the ISEP Student Science Summit. |

As a result of parent input, programmatic opportunities were created and implemented during the 2013-2014 school year including:

- Opportunities for parents to co-present with STEM faculty, BPS teachers and UB and BSC graduate students at conferences.

- Parent involvement and participation in school based and field trip activities with students and teachers.

As a result of input form doctoral and undergraduate students, several PLC programmatic opportunities were created and implemented during 2013-14 school year including:

- Understanding and managing classroom dynamics
- Middle and High School content based collaboration including after school programs and science fairs, and the Science Summit.

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.

## 5. Research Report

The research team consists of Dr. Xiufeng Liu (co-PI), Michelle Eades-Baird, Lei Fu and Erica Smith (doctoral student research assistants). Shao-Hui Chi, a visiting scholar from China, also participated in research activities. We conducted a series of studies to research teachers' development of pedagogical content knowledge (PCK) on interdisciplinary science inquiry and STEM students' development of science communication skills. The preliminary findings were reported at the annual meeting of NARST – A Worldwide Organization for Improving Science Teaching through Research in April 2014. Two articles based on research findings have been submitted to *Science Communication* and *Journal of Career Development*. Two more articles will be submitted in the summer to *Journal of Research in Science Teaching* and *The Science Educator*.

This section describes major research activities we implemented from June 1 2013 through May 31 2014 and major findings we have obtained so far.

### 5.1 Activities

#### *5.1.1 Pedagogical Workshops*

Beginning in November, we conducted monthly workshops related to different aspects of the ISEP team's conception of interdisciplinary science inquiry (ISI). These aspects include: (1) creating meaningful and authentic experiences for students through ISI-based experiences, (2) developing the practices of science and engineering, (3) utilizing crosscutting concepts to create connections within and across disciplines of science and engineering for students, and (4) developing a deeper understanding of the disciplinary core ideas of science and engineering. The activities highlighted in these sessions were based on the participating teachers' requested topics and were meant to provide them with support for implementing and transforming their summer research experiences into interdisciplinary science teaching and learning opportunities. In order to provide incentives for teachers to participate in these monthly workshops, we offered 1 graduate credit to the participating teachers with tuition paid by the UB Graduate School of Education in the fall semester. Table 5.1.1 lists the workshops.

Table 5.1.1 Monthly Pedagogical Workshops

| Month | Focus | Major Activities | # Of Attendees |
|---|---|---|---|
| November | Practicing and Highlighting ISI Instructional Strategies | (1) Warm-up to Inquiry: Creating a Rainbow in a Straw<br>(2) Connecting Activity to ISI Framework<br>(3) Lesson Sharing: Summer Research Connection to Classroom<br>(4) Lesson Creating<br>Part 1: Energy Inquiry Activities (by Tik L. Liem)<br>Part 2: Using the Crosscutting Concept of Energy to Create Connections Across Content Areas | 17 |
| December | ISI and Literacy | (1) Holiday ISI & Common Core Lesson Exchange<br>(2) Connecting ISI to the Common Core<br>(3) Determining Literacy Levels (Lexile.com)<br>(4) Ready-to-use Science Literacy Classroom Modules and Connection to ISI and Next Generation Science Standards | 15 |
| January | Informal Science Education: Science Learning at the Buffalo Museum of Science and Tifft Nature Preserve | (1) Icebreaker: Mystery Boxes<br>(2) Informal Science Education Research and Practices: Strands of Learning<br>(3) Museum's Mission Statement and Educational Pedagogy<br>(4) Curiosity in Science - Inquiry Approaches Activity: Insulation<br>(5) New Science Studios: Opportunities for BPS Students | 13 |
| February | Implementing Engineering Design | (1) Inquiry-Based Science and Engineering Design – Relationships and Differences<br>(2) Pragmatic Approaches to Using Design Challenges in Mathematics and Science<br>(3) Hands-on STEM Activity | 15 |
| March | Interdisciplinary Science Inquiry – Teaching Modules and Assessment | (1) Inquiry Activity – *How Does Pollution Get from Land to the Ocean?*<br>(2) Examining Elements of ISI – Identifying Aspects of ISI within a Developed, Problem-Based Inquiry | 3 |

| | | | |
|---|---|---|---|
| | | Unit<br>(3) Co-Development of a Situated Problem-Based Learning Unit | |
| April | Cancelled due to overlap of professional development opportunity provided through STEM Week. | | |
| May | ISI Science Fair | Poster Presentations Showcasing BPS Teachers' Use of ISI in the Classroom | TBA |

*5.1.2: Research on Teachers' Development of ISI Pedagogical Content Knowledge*

*5.1.2a Pedagogical Content Knowledge Pre-Test*

In July of 2013, a survey was administered to the participating ISEP teachers. This survey was comprised of three parts: demographics information, standardized PCK assessment of the teacher's knowledge of their practice and subject matter, and an assessment of ISI, both knowledge and practice.

The PCK 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.

*5.1.2b 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.

*5.1.3: Research on Teachers' Beliefs and Practices of Incorporating Literacy 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). Specifically, this research study investigated: (1) how science teachers demonstrated knowledge and values of CCSS for ELA curricula when they conducted ISI in their classroom practices and (2) the relationship, if any, that exists between teacher beliefs and perceptions of the CCSS for ELA and its implementation within the science classroom within the context of ISI. 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 – Summer 2014) qualitative and quantitative data is and will continue to be collected via a late Spring 2014 questionnaire and a Summer 2014 survey. Specifically, the qualitative data will be gathered via their answers on their May 2014 PCK assessment that probes their approach to implementing literacy skills as they plan to implement a proposed research problem. The quantitative data will be obtained from teachers' responses to survey questions gathered in partnership with external evaluators during Summer 2014. These survey questions will elicit information about teachers' beliefs, perceived values and levels of confidence in implementing CCSS for ELA within their science instruction. The survey data will be analyzed using descriptive statistical analysis and will be compared to the teachers' interview responses and classroom practices. The data gathered during Phase 2 of the study will provide 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.

*5.1.4: 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. 2013, and again in May 2014.

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.

**5.2. Findings**

*5.2.1: Teachers' Development of ISI Pedagogical Content Knowledge*

*5.2.1a Results of Pedagogical Content Knowledge Pre-Test*

The results of the standardized assessments (section 2 of survey) are provided in Table 5.2.1a. The teachers' open-ended answers for section 3 of the survey were used to generate multiple choice questions, which will be administered in May 2014.

Table 5.2.1a

Pre-year 2 scores on biology, earth science, chemistry, physics, middle school science, and elementary science PCK assessments for all participating teachers

| Assessment | N | Total Possible Score | Mean | Minimum Score | Maximum Score | SD |
|---|---|---|---|---|---|---|
| Biology (ATLAST Flow of Matter and Energy) | 27 | 29 | 17.7 | 7 | 28 | 6.3 |
| Earth Science (ATLAST Plate Tectonics) | 6 | 29 | 22.2 | 19 | 24 | 1.7 |
| Chemistry (AIM Properties of and Change in Matter) | 4 | 30 | 25.3 | 19 | 28 | 4.2 |
| Physics (ATLAST Force and Motion) | 8 | 29 | 19.4 | 8 | 29 | 7.6 |
| Middle School Science (POSTT Assessment of PCK of Inquiry Science Instruction) | 13 | 8 | 3.5 | 2 | 7 | 1.5 |
| Elementary School Science (POSTT Assessment of PCK of Inquiry Science Instruction) | 11 | 8 | 3.5 | 1 | 5 | 1.6 |

*5.2.1b Development of ISI Pedagogical Content Knowledge*

In analysis of the findings three main themes emerged. These themes can be summarized as:

(1) The development of in-service science teachers' PCK is not a linear progression.
(2) Teachers' experiences in science and engineering act as filters in their perception and translation of ISI into a K-12 science classroom.

(3) The dynamic interplay of core features of the professional development model and contextual factors impact implementation of ISI within the classroom.

*The Development of In-service Science Teachers' PCK is not a Linear Progression.*

The model proposed by the project illustrated a linear progression of teacher professional development opportunities to improved teacher knowledge and skills in science inquiry and inquiry science teaching to improved student science achievements, as measured by NYS science examinations. This study examined the first progression, from professional development to improved teacher knowledge and teaching skills in interdisciplinary science inquiry. Overall, analysis of the 10 teachers highlighted in the study indicates that the involvement in the summer research experiences did not have any consistent effects on the development of their PCK as it relates to ISI. Furthermore, the progression of involvement in professional development to the development of teacher PCK is not linear.

The teachers who were identified as stagnate did not illustrate any significant qualitative changes in their PCK over the course of the two years. These teachers still maintained a teacher-centered, traditional view of teaching science that did not align with the project's perception of ISI or with a student-centered, inquiry-based approach to teaching. Even though these teachers had access to and used new materials and laboratory exercises in their classrooms, the nature in which these new resources were utilized were indicative of a highly structured, teacher-mediated learning experience. Student exploration and discovery was overshadowed by the need for students to learn basic skills and follow a set of prescribed directives.

The teachers who fell in the middle of the PCK assessment spectrum illustrate teachers whose orientations to teaching science and perception of their how their students learn best do always not match how science is taught in their classrooms. While they worked towards implementing more inquiry-based lessons into their instruction, there are aspects of their understanding of ISI that are still not well aligned with the four components of ISI and instruction that held onto a more traditional style of teaching science.

The teachers who initially scored higher on the PCK assessment did not necessarily illustrate significant growth in their PCK over the course of their involvement in the project. These teachers, who already illustrated an inquiry-based, student-centered orientation towards teaching science, were, however, more willing to make changes in their instruction. The professed impact of the summer research experiences on these three teachers illustrate the potential of providing classroom teachers with opportunities to participate in authentic science or engineering enterprises can reassert the need for science in the classroom to be student-centered, inquiry-based, and integrate multiple disciplines and perspectives in a way that mirrors science in today's society.

*Teacher Background as a Filter to Teachers' Perception and Translation of ISI in K-12 Science Classrooms*

Interdisciplinary science inquiry consists of four dimensions: (1) the purpose (i.e. drivers) of ISI; (2) science and engineering practices; (3) crosscutting concepts; and (4) disciplinary core ideas in life science, physical science, earth and space science, and engineering and technology.

The aspects of this framework most evident and translatable for all of the teachers highlighted were integrating the practices of science and the importance of connecting science in the classroom to students' lives and communities (i.e. purpose or drivers of ISI). For many of the teachers, the practices of science were simply a rewording of the scientific method, which is a concept that they all felt they taught well within their courses.

The main aspect of ISI that the teachers struggled with in their understanding and in implementation was the crosscutting concepts or unifying themes in science and engineering. For many of the teachers, crosscutting concept was construed as cross-curricular. Therefore, in their descriptions of what a crosscutting concept meant to them and how they were implemented into their classrooms, they focused on how they incorporated English Language Arts techniques and mathematics. When teachers were shown or told of the list of seven crosscutting concepts and their descriptions, most, with the exception of the trailblazer group, would make comments like "oh yeah, I teach that here…" The focus of these concepts was not on how they could be unifying themes across the different disciplines of science or even within a single discipline of science, but on a single topic. This singularity in understanding may be due to the background these teachers have in studying and teaching a single discipline of science. For the teachers who do teach another subject area outside that discipline, such as environmental science, it is taught within the confines of the district's pacing guide (i.e. mandated curriculum). This particular finding has implications for how secondary science teachers are taught to teach science within their education programs. Focus within a single discipline, such as biology or chemistry, may not be sufficient in the future if teachers are being asked to implement a reform-based, spiral curriculum where these unifying themes develop over time and link together different disciplines of science.

Within the trailblazer group, two separate pathways were evident. Scott initially construed crosscutting to mean cross-curricular with ELA and math, in the first year of his involvement his understanding of what crosscutting meant changed and more closely mirrored that of the project in terms of the integration of different disciplines of science. He still however, did not articulate clearly how the different crosscutting concepts could be used within his classroom as a way for students to grasp how the "big picture". Mark and Parker, from the beginning, were able to explain a more exact understanding of what crosscutting concepts were, as defined by the project, and how they could be and were implemented into their classroom practice. The ability of Mark and Parker to explain how crosscutting concepts could be used within their practice may be attributable to their own backgrounds and the nature of the curriculum that they both teach. Both teachers have physics and engineering education backgrounds. Mark teaches senior-level engineering and Parker teaches conceptual physics and medical physics to high school students. Even though very different in nature, their summer research experiences focused on the application of different physics and engineering principles. Their physics background and research experiences seems to help with their understanding of unifying themes, particularly energy and forces.

*Dynamic Interplay of Core Features of the Professional Development Model and Contextual Factors Impact Implementation of ISI within the Classroom*

Using the model for studying professional development proposed by Desimone (2009), the core features of the project that were identified and analyzed to determine whether or not they contributed to the development of the participating science teachers' PCK. Desimone (2009) identified 5 core features of effective PD: content focus, active learning, coherence, duration, and collective participation (p. 184). Examining the original model of the project, Desimone's five core features could be redefined into (1) the summer research connection, (2) collaboration between STEM students and in-service science teachers, (3) an active learning environment, (4) coherence and (5) duration. These core features interplayed with one another in various ways leading to varied changes in teacher knowledge regarding the practices of science and engineering as well as ISI that in turn did or did not lead to changes in their practice.

Looking first to how involvement in the project led to increased knowledge and practice, the core features that appeared to have the greatest impact were the summer research connection to the teachers' curriculum and coherence between the aspects of ISI and the teachers' orientations towards teaching science. Even though the teachers professed to have learned new ideas and skills over the course of their summer research experience, the connection between those experiences and the teachers' curriculum played a significant role in whether or not the teachers attempted to implement those newly learned skills within their classrooms. The teachers who professed that the research experiences had direct connections to specific aspects their mandated curriculum were those that were most likely to change aspects of their practice. Additionally to aid in the implementation of reform-based practices, the development of curriculum materials that are aligned with ISI needs to be provided to teachers. For the teachers who struggled with how their research experiences connected to their curriculum, additional and more specific models and practice should be provided to aid them in the transition of applying ISI-perspectives and experiences in their classrooms.

The impact of coherence between the teachers' orientations towards teaching science, how students learn science best and the aspects of ISI was most evident in the comparison between the stagnate group of teachers and the trailblazer group. The stagnate group's teacher centered and traditional orientations towards teaching science was a stumbling block for their successful implementation of ISI in their classrooms. The trailblazers' orientation, on the other hand, enabled them to make changes in their practice. This was evidenced by the implementation of new laboratory activities that they had developed and practiced over the course of their summer research experiences, of new skills and technology in the classroom, and their increased effort to establish connections between science content, current research in science and engineering and to students' lives.

The other core features also played a role in the progression of professional development opportunities to change in practice. In particular, for several of the teachers the summer research experience offered them the opportunity to become engaged in a collaborative and active learning environment. The roles were reversed as the teachers were asked to become students again as they worked alongside research faculty, STEM students, and their colleagues. The teachers were exposed to completely new areas of scientific research, technology, and often skill sets that put that back into role of learner. With that came the frustrations of learning something new as well as ultimately the sense of success when those skills were mastered. The active learning environment, rather than the passive transmission of information provided the teachers with a more meaningful and authentic learning experience that for several teachers served as a model for how to implement ISI within their classrooms. Mark, in particular, highlighted how his frustrations and failures with designing and building the boomilever was a valuable asset in helping his students with the same process during the school year.

Even though it was implied within the original model proposed by the project, participation did not always lead to change in participating teachers' knowledge and beliefs regarding interdisciplinary science inquiry or within their practice. Over the course of the two years of full implementation, 72 % of the teachers could be classified as stagnate. Upon analysis of the teachers' interviews several contextual factors were identified as constraining the teachers' perceived ability to implement aspects of their summer research and/or ISI in their classroom. These factors included (1) the lack of coherence between the teachers' research experience and the areas of science with which they taught; (2) the teachers' beliefs regarding their summer experience and their own abilities to translate those experiences into the classroom as well as their students' abilities to do inquiry; (3) the teachers' knowledge of ISI as a limiting factor into their ability to find or perceive the relevance of the summer research experience; (5) students' overall academic weaknesses, particularly in mathematics and reading; (6) the time required to develop and implement activities or lessons that were based on either the teachers' summer research experiences or ISI, in general; and (7) the lack resources, in terms of equipment, needed to successfully implement the teachers' summer research experiences.

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

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

(1) Teachers' perceptions of the definition and goals of interdisciplinary science inquiry (ISI) play an important role in how they implement literacy skills within their science instruction.
(2) Teacher beliefs surrounding the goals of the CCSS for ELA and their level of comfort with its implementation within their instruction plays a crucial role in how literacy is implemented into their science instruction.

*5.2.2a Teachers' Perceptions of the Definition and Goals of Interdisciplinary Science Inquiry (ISI) Play a Key Role in How They Implement Literacy Skills Within Their Science Instruction*

The framework of interdisciplinary science inquiry clearly articulates four dimensions: (1) the drivers of ISI; (2) science and engineering practices; (3) crosscutting concepts and (4) disciplinary core ideas. During interviews, most of the teachers articulated their understanding of the drivers of ISI as authentic learning experiences where "the curriculum is connected to students' daily lives" and addresses "the needs of the society in which [students] live". However, when it came to sharing their understanding of the dimensions of disciplinary core ideas and crosscutting concepts, many of the teachers within the ISEP project differed significantly in their definition of interdisciplinary. While some teachers described *interdisciplinary* as connecting the core ideas and concepts within the disciplines of life science, earth science, physics, chemistry and engineering, some teachers viewed interdisciplinary differently. For these teachers, interdisciplinary was viewed as being "cross-curricular" – connecting the science and engineering disciplines with the domains of math, ELA, and social studies.

Several teachers who defined interdisciplinarity as connecting science and engineering disciplines in ISI also held a strong understanding of the role of inquiry within science learning – "inquiry means that students are investigating their own ideas of science" and sometimes also included that inquiry also included the role of "collaboration between students" and many times also included thoughts of inquiry-based instruction as being "student-driven" or "student-centered" within their definitions. Some of the teachers who held an alternative interpretation of interdisciplinarity (connecting science and engineering disciplines to math, ELA and social studies) defined inquiry as "any science activity that is hands-on". Contingent on their interpretation of interdisciplinary, the teachers tended to focus on different aspects of literacy skills within their instruction. Additionally, there were some teachers who fell into an intermediate category; these teachers held the alternative definition of interdisciplinary (i.e., being cross-curricular) and may or may not conveyed a clear understanding of the goals of inquiry within science instruction. This group of teachers implemented literacy skills into their science instruction differently than their colleagues in the other two groups.

The teachers in Group 1 articulated the importance of connecting the science and engineering fields and held a clear understanding of inquiry. These teachers included all three aspects of literacy: reading, writing and oral communication within their instruction. The reading and writing components of literacy were organically included in their instruction with an intentional focus on oral communication among students. Bryce, a teacher of medical physics, utilized white boards to help facilitate inquiry within his instruction. Although writing and reading were a part of using the white boards, they were not the main focus of this type of pedagogy. Reading and writing skills were used as a vehicle for gathering student thoughts and explanations of science phenomena as they were written on the white boards. Bryce's goal of using this "white board pedagogy" was to capture the oral communication that took place between students in a small group as they generate ideas and to assist the students to orally communicate their thoughts and findings to the entire class. Simon, a teacher of middle school science, also held a clear understanding of ISI and included oral communication in his lessons, in particular the lessons he does with his students that are a part of the Science Olympiad. Although the inclusion of reading and writing skills are also a part of his lessons like Bryce, the skills associated with oral communication between students during the inquiry process separate Simon and Bryce from the other teachers in this ISEP cohort. What is also interesting about both Simon and Bryce is that they both participated in summer research (as opposed to taking a summer course or participating in summer curriculum writing) and were able to connect ELA and literacy skills to their ISI summer research experiences, stating that communication plays a key role when conducting research. Both Bryce and Simon participated in the literacy PLC session. During an interview, Simon acknowledged that during the first year of his participation in the ISEP project (2012-2013) that he thought interdisciplinary meant cross-curricular. He cited his participation in the ISEP project as being responsible for helping him to change his understanding of this term and its role in ISI instruction.

The teachers in Group 2 all participated in summer curriculum writing as part of their participation in the ISEP project. Ridley, Anica and Antonio all defined ISI as connecting science, engineering and other non-science disciplines using a hands-on approach through laboratory exercises. During classroom observations, all three teachers placed a particular focus on domain-specific vocabulary and did not include any inquiry-based activities. During an observed lesson, Ridley conducted a 40-minute "close read" of text on the topic of the human circulatory system with his students. The students took turns reading aloud and Ridley would clarify the text and vocabulary, pausing to ask students questions and presenting graphic representations on the SmartBoard of the biology vocabulary and processes. Anica's lesson also focused on vocabulary as her students participated in a vocabulary review game to prepared them for a test they would take the following day. Antonio, a special education teacher, and his coordinating science teacher, Mrs. Simmons, worked through a packet of guided notes with their Earth Science students. The students filled-in the guided notes on weather and erosion which focused on using domain-specific vocabulary. During the last 10 minutes of the class period, the students participated in an activity where they cut a "rock" out of construction paper. Using a string, they were asked to measure the surface area before and after they cut their rock into smaller pieces and re-measured the surface area. The students did not orally share their findings; instead they displayed their work on a bulletin board in the classroom. During these observed lessons, all three teachers focused on aspects of reading and writing, in particular science vocabulary. There was no focus on oral communication of ideas during these lessons and it was noted that the lessons were teacher-centered and the students did not participate in any inquiry-based activities. It is worthwhile to mention that Ridley, Anica and Antonio did not attend the December PLC session that focused on literacy within the context of ISI.

The teachers in Group 3 demonstrated various understandings of inquiry and interdisciplinarity; some teachers held a cross-curricular view of interdisciplinarity but did not include inquiry in their observed lessons while others held a cross-curricular view of interdisciplinarity and a more comprehensive view of inquiry. Maura, a high school science teacher, viewed inquiry as laboratory activities that were hands-on and demonstrated interdisciplinarity within her lessons by connecting science with ELA and the Arts. By reading *The Immortal Life of Henrietta Lacks* with her students, Maura connected genetics with reading, writing and art. Students were asked to create a paper-mache identity mask as part of this project. During an observed lesson, Maura's students participated in an activity that exemplified her cross-curricular approach to science learning but did not incorporate science inquiry into the lesson. Shelagh, a veteran elementary teacher, described interdisciplinarity and inquiry as part of ISI as "the opportunity for kids to get a deeper understanding of some things based on questioning through an investigation that they do to figure that out…interdisciplinary uses the vehicle of ELA to do that." During the observed lesson, students participated in a guided-inquiry activity during which they investigated the electrical conductivity of various household materials. After testing the materials, students were prompted to answer conclusion questions by writing them in their science journals and then orally sharing their responses with the class. At several points in sharing their findings with their peers, the students were encouraged to site evidence from their investigation to support their claims. Both Maura and Shelagh participated in hands-on science research during their summer experiences as part of their participation in the ISEP project. In addition both of these teachers attended the PLC session that focused on CCSS for ELA and literacy and the connection to ISI.

*5.2.2b Teachers' beliefs surrounding the goals of the CCSS for ELA and their level of comfort with its implementation within their instruction plays a role in how literacy is implemented into their science instruction.*

During the 2013-2014 school year, semi-structured interviews were conducted with participants in this study who responded to requests to be interviewed. These teachers were asked questions pertaining to CCSS for ELA and literacy that elicited their thoughts, beliefs, values and level of comfort with implementing literacy skills within their science instruction, in particular when implementing ISI. During data analysis, several interesting patterns emerged. Although most of the teachers who were interviewed placed a high value on the incorporation of literacy and the Common Core State Standards (CCSS) for ELA within their classroom practice, their beliefs surrounding the goals of the CCSS for ELA and their level of comfort with its implementation within their instruction varied significantly.

The participants expressed their perceptions of the major goals of the CCSS for ELA as being to improve students' skills in reading and writing and some felt it was also to better prepare students for careers and college. While most teachers indicated that reading and writing were the primary focus of implementing the CCSS for ELA, several teachers also included oral communication as being another facet of literacy that should be implemented in the classroom. Some teachers who participated in summer research were able to connect the importance of literacy skills to conducting research, in particular the skills surrounding communication.

The degree of comfort and confidence teachers felt with implementing the CCSS for ELA and literacy skills within their classroom instruction varied among the participants in this study. The elementary and special education teachers felt the most comfortable with implementing literacy skills while the secondary science teachers tended to feel less confident in their ability to implement these skills. Among the most confident secondary teachers were those who held additional teacher certifications in elementary education or special education. The majority of the teachers conveyed that they did not feel they were sufficiently prepared or supported by their school district to implement the CCSS for ELA and expressed interest in additional training to implement these literacy skills effectively.

Due to limited access to classroom observations, it would be premature to draw connections and conclusions between teachers' professed level of confidence, perceptions and beliefs and the implementation of literacy skills within their classroom instruction. Additional classroom observations planned to take place during the 2014-2015 school year may shed more light on any existing relationships. During Phase 2 of data collection for this study, the quantitative data gathered during the Summer 2014 survey will provide an overview of the spectrum of values, perceptions and beliefs for all the teachers who participated in the 2013-2014 ISEP project. Additional qualitative data is currently being collected as the teachers complete their PCK assessments; this section of the PCK assessment focuses on teachers' responses to a hypothetical research scenario and how they would incorporate literacy skills during its implementation in their classroom instruction. Since a limited number of teachers in the 2013-2014 ISEP project participated in interviews during the school year, the Phase 2 qualitative data has the potential to provide additional information on teachers' ability to implement literacy into their science instruction.

During December 2013, a PLC session that focused on CCSS for ELA and its connection to ISI was held for the ISEP teachers. The 15 teachers who participated in this PLC session will be followed closely during the 2014-2015 school year. The goal is to gain more insight on how their views on literacy and CCSS for ELA may have changed since their participation in the PLC session and to observe any evidence of changes to their classroom practices in relation to the incorporation of literacy skills within their particular curriculum.

*5.2.3 Findings on STEM students*

*5.2.3.1 STEM student activities in schools*

Table 5.2.3.1a presents the descriptive statistics of activities engaged by students based on the survey.

Table 5.2.3.1a

Descriptive Statistics of STEM Student Experiences in Schools (n=106) (Survey)

| Activity | Frequency (%) |
|---|---|
| Assisted teachers in teaching lessons | 67(63.2%) |
| Assisted teachers in conducting labs | 74(69.8%) |
| Developed science labs for class use | 34(32.1%) |
| Developed out-of-school science learning activities | 17(16%) |
| Led small group activities/discussions with students in class | 74(69.8%) |
| Led small group activities/discussions with students after school or during weekend | 24(22.6%) |
| Demonstrated scientific content, procedures, tools, or techniques to students | 69(65.1%) |
| Helped teachers find relevant resources (e.g., science activities) | 42(39.6%) |
| Presented lessons/lectures to students in class | 35(33.0%) |
| Tutored students after school or during weekends | 12(12.3%) |
| Other | 19(17.9%) |

In Table 5.2.3.1a, *Other* includes organizing UB lab tour for students, lab preparation (setting lab materials), assisting in field trips, filing papers, helping students on homework/labs and working one-on-one with ESL students.

Table 5.2.3.1b presents the descriptive statistics of activities engaged by students based on the log sheets in 2013 fall semester.

Table 5.2.3.1b
Descriptive Statistics of STEM Student Experiences in Schools (n=241) in Fall 2013

| Activity | Frequency (%) | | |
|---|---|---|---|
| | Experienced frequently | Experienced infrequently | Did not experience |
| Assisted teachers in teaching lessons | 112(46.5%) | 58(24.1%) | 71(29.5%) |
| Assisted teachers in conducting labs | 119(49.4%) | 38(15.8%) | 84(34.9%) |
| Developed science labs for class use | 66(27.4%) | 67(27.8%) | 108(44.8%) |
| Developed out-of-school science learning activities | 36(14.9%) | 33(13.7%) | 172(71.4%) |
| Led small group activities/discussions with students in class | 108(44.8%) | 47(19.5%) | 86(35.4%) |
| Led small group activities/discussions with students after school or during weekend | 8(3.3%) | 4(1.7%) | 229(95.0%) |
| Demonstrated scientific content, procedures, tools, or techniques to students | 97(40.2%) | 59(24.5%) | 85(35.3%) |
| Helped teachers find relevant resources (e.g., science activities) | 87(36.1%) | 80(33.2%) | 74(37.0%) |
| Presented lessons/lectures to students in class | 25(10.4%) | 67(27.8%) | 149(61.8%) |
| Tutored students after school or during weekends | 2(0.8%) | 4(1.7%) | 235(97.5%) |

Table 5.2.3.1c presents the descriptive statistics of activities engaged by students based on the log sheets in 2014 spring semester (Jan. through April).

Table 5.2.3.1c

Descriptive Statistics of STEM Student Experiences in Schools (n=159) in 2014 Spring Semester

| Activity | Frequency (%) | | |
|---|---|---|---|
| | Experienced frequently | Experienced infrequently | Did not experience |
| Assisted teachers in teaching lessons | 47(29.6%) | 46(28.9%) | 66(41.5%) |
| Assisted teachers in conducting labs | 67(42.1%) | 34(21.4%) | 58(36.5%) |
| Developed science labs for class use | 55(34.6%) | 29(18.2%) | 75(47.2%) |
| Developed out-of-school science learning activities | 44(27.7%) | 21(13.2%) | 94(59.1%) |
| Led small group activities/discussions with students in class | 48(30.2%) | 30(18.9%) | 81(50.9%) |
| Led small group activities/discussions with students after school or during weekend | 19(11.9%) | 8(5.0%) | 132(83.0%) |
| Demonstrated scientific content, procedures, tools, or techniques to students | 77(48.4%) | 23(14.5%) | 59(37.1%) |
| Helped teachers find relevant resources (e.g., science activities) | 63(39.6%) | 43(27.0%) | 53(33.3%) |
| Presented lessons/lectures to students in class | 17(10.7%) | 38(23.9%) | 104(65.4%) |
| Tutored students after school or during weekends | 5(3.1%) | 11(6.9%) | 143(89.9%) |

The distributions of activities in 2013 fall and 2014 spring semesters are similar to that based on the survey. The four most common activities STEM students experienced in school were: *Assisted teachers in teaching lessons, Assisted teachers in conducting labs, Demonstrated scientific content, procedures, tools, or techniques to students* and *Led small group activities/discussions with students in class*. School observations in 2014 spring semester also support this conclusion.

*5.2.3.2. Self-efficacy in science communication*

We conducted Rasch analysis of data from the survey over the past three years related to STEM students' self-efficacy in science communication. This analysis intends to validate the scale of STEM student self-communication self-efficacy. We summarize the validity and reliability evidence obtained below.
Figure 5.2.3.2a presents the Wright map of the revised instrument. We can see that students' self-efficacy had a wider range of variation from -2.33 logits to 5.92 logits, while the revised item measures ranged from -0.68

logits to 0.84 logits.  There was still one gap located near two standard deviations from the mean of the items; fifteen students had a lower self-efficacy than any item could assess.  Another gap existed at the top of the continuum, where 14 higher self-efficacy students were in that gap.

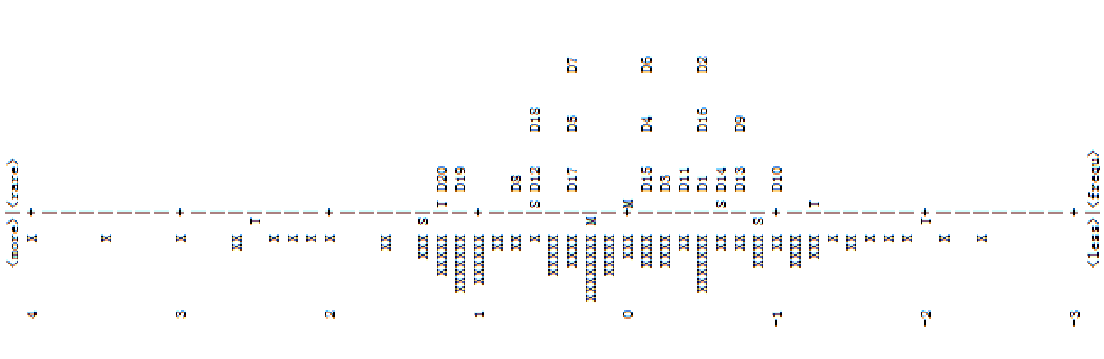

*Figure* 5.2.3.2a*.* Wright Map of Person-Item distribution

Table 5.2.3.2a presents fit statistics for the 20 items.  We can see that, infit MNSQs ranged from 0.65 to 1.29 whereas the outfit MNSQs ranged from 0.69 to 1.31; both were regarded as being acceptable.  Infit ZSTDs and outfit ZSTDs all ranged from -2.0 to +2.0 with the exception of item 2 ( infit ZSTD= -3.0 and outfit ZSTD=-2.5), item 6 ( infit ZSTD=1.8 and outfit ZSTD= 2.2).  All the items exhibited strong positive point-measure correlations (PTMEA) ranging from 0.50 to 0.70.

Table 5.2.3.2a

*Item Statements and Fit Statistics*

| Item | Statement | Infit | | Outfit | | Measure | PTMEA |
|---|---|---|---|---|---|---|---|
| | | MNSQ | ZSTD | MNSQ | ZSTD | | |
| 1 | Understand middle and high school students' science background knowledge | 0.81 | -1.5 | 0.82 | -1.3 | -0.54 | 0.61 |
| 2 | Understand middle and high school students' interest in science | 0.65 | -3.0 | 0.69 | -2.5 | -0.54 | 0.62 |
| 3 | Understand middle and high school students' cognitive abilities | 0.94 | -0.5 | 1.02 | 0.2 | -0.20 | 0.50 |
| 4 | Decide what science topics are appropriate to students | 0.94 | -0.4 | 0.97 | -0.2 | -0.11 | 0.60 |
| 5 | Decide how much science content is appropriate to students | 1.12 | 1.0 | 1.19 | 1.4 | 0.33 | 0.50 |
| 6 | Help teachers find relevant resources (e.g., science activities) | 1.25 | 1.8 | 1.31 | 2.2 | -0.15 | 0.57 |
| 7 | Develop science labs | 1.24 | 1.8 | 1.21 | 1.6 | 0.42 | 0.65 |
| 8 | Develop out-of-school science learning activities | 1.12 | 1.0 | 1.08 | 0.6 | 0.73 | 0.62 |
| 9 | Assist teachers in teaching lessons | 1.17 | 1.3 | 1.18 | 1.3 | -0.70 | 0.56 |
| 10 | Assist teachers in conducting labs | 1.08 | 0.6 | 1.10 | 0.7 | -0.97 | 0.61 |
| 11 | Teach science labs to students | 0.97 | -0.2 | -0.93 | -0.5 | -0.34 | 0.68 |
| 12 | Facilitate out-of-school science learning activities | 0.88 | -0.9 | 0.87 | -1.0 | 0.66 | 0.69 |
| 13 | Lead small group activities/discussions with students in class | 1.14 | 1.1 | 1.09 | 0.7 | -0.71 | 0.55 |
| 14 | Demonstrate scientific content, procedures, tools, or techniques to students | 0.92 | -0.6 | 0.87 | -0.9 | -0.68 | 0.65 |
| 15 | Teach lessons or give lectures to students in class | 0.90 | -0.8 | 0.90 | -0.7 | -0.09 | 0.70 |
| 16 | Explain a difficult science concept to students | 0.77 | -1.9 | 0.76 | -1.9 | -0.45 | 0.69 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 17 | Relate current research to K-12 curriculum | 1.07 | 0.3 | 1.03 | 0.2 | 0.39 | 0.64 |
| 18 | Explain current research to teachers | 1.04 | 0.2 | 0.97 | 0.0 | 0.60 | 0.65 |
| 19 | Facilitate student learning in museums | 1.29 | 1.0 | 1.20 | 0.7 | 1.12 | 0.66 |
| 20 | Explain science to parents | 1.23 | 0.8 | 1.29 | 1.0 | 1.23 | 0.60 |

variance explained by measures = 43.9%   unexplained variance (total) = 56.1%

Table 5.2.3.2b presents the category structure statistics. As shown in Table 5.2.3.2b, with four categories instead of five, each category count satisfied the criterion for minimum counts of 10 observations. The average category measures were ordered and increased monotonically from -1.01 logits to 1.60 logits. The outfit MNSQ ranged from 0.96 logits to 1.02 logits, indicating expected category usage. In addition, the category threshold calibrations increased monotonically with categories and the distances were all more than 1.1 logits. Inspecting the category probability curves (see Figure 5.2.3.2b), we see that each category represented a distinct region of the underlying construct, thus, collapsing category 1 and 2 had indeed improved our rating scale diagnostics.

Table 5.2.3.2b

*Summary of Rating Scale*

| Rating Scale Category | Observed Count | Observed% | Average Measure | Outfit MNSQ | Step Calibrations |
|---|---|---|---|---|---|
| 1=None | 203 | 12 | -1.01 | 1.02 | NONE |
| 2=Some | 482 | 28 | -0.17 | 0.96 | -1.46 |
| 3=Quite a bit | 631 | 36 | 0.58 | 1.05 | -0.07 |
| 4=A great deal | | | | | |

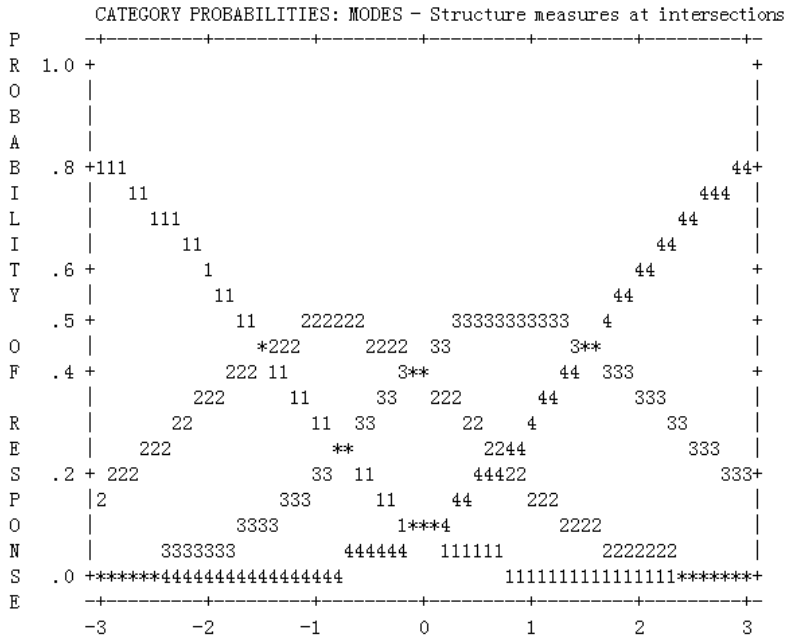


*Figure* 5.2.3.2b. Category structure probabilities curves

Figure 5.2.3.2c presents the dimensionality map based on PCA (principal component analysis). PCA was applied to standardized residuals to identify possible dimensions existing in the scale. A variance greater than or equal to 50% for the Rasch dimension can be regarded as evidence that the scale is unidimensional, and scale unidimensionality can be assumed if the second dimension (first contrast) has the strength of less than 3 items (in terms of eigenvalues) and the unexplained variance by the first contrast is less than 5%. Measures resulted from the revised measurement accounted for 43.9% of total variance, though 4% higher than pilot measurement, yet still below the expected norm. Besides, the second dimension had an eigenvalue of 3.2 and accounted for 9% of the variance, indicating that unidimensionality of items was still not ideal. From Figure 5.2.3.2c, we see that items A, B, C, D, a, b (corresponding to items 11, 10, 14, 9, 4, 5) had the largest contrast loadings (>0.50), suggesting that they might measure an additional dimension.

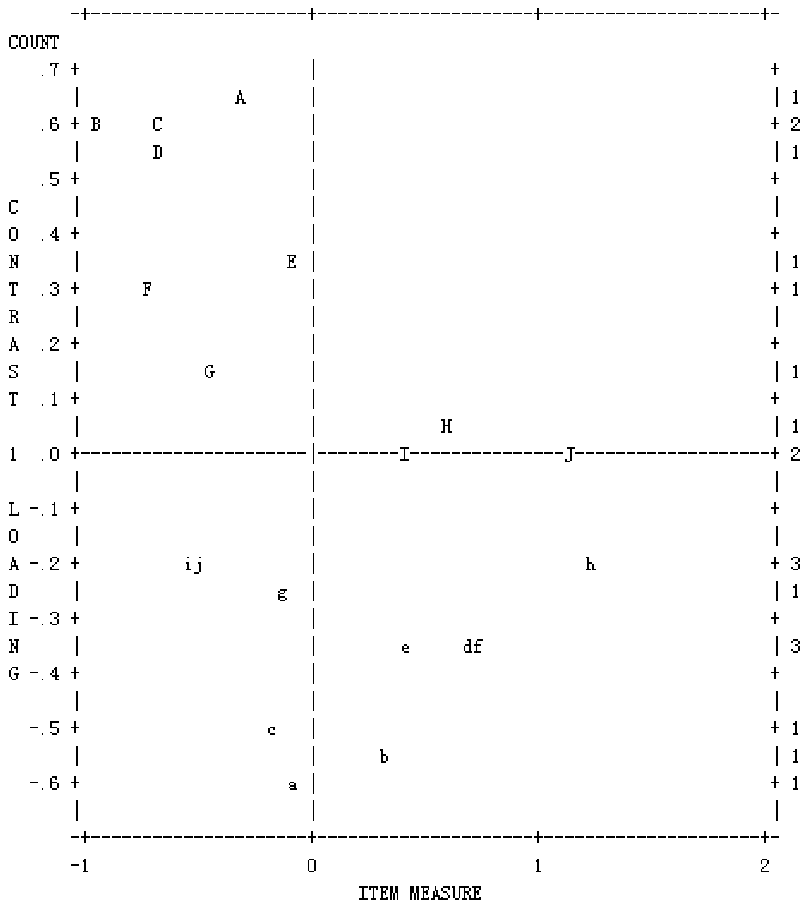


*Figure* 5.2.3.2c*.* Factor analysis of residuals

Table 5.2.3.2c presents the summary statistics related to reliability. It can be seen in the table that the person separation index was 2.77, with an equivalent Cronbach's reliability coefficient (α value) of 0.88. Item separation index was 2.94, and its corresponding Cronbach's α value was 0.90, indicating reliable item and person estimation. Further, Rasch measurement produces an SEM as an additional measure of reliability for each individual person and item measure. Persons and items with measures closer to their means have smaller SEMs than those further from the means. As shown in Table 5.2.3.2c, SEM values for persons and items were small, ranging from 0.14 to 0.33.

Table 5.2.3.2c

*Summary Output for All Test Items*

| | | | Infit | | Outfit | |
|---|---|---|---|---|---|---|
| PERSON | MEASURE | SEM | MNSQ | ZSTD | MNSQ | ZSTD |
| MEAN | 0.29 | 0.18 | 1.01 | -0.2 | 1.00 | -0.2 |
| SD | 1.26 | 0.08 | 0.55 | 1.7 | 0.53 | 1.7 |
| | Person separation= 2.77 (reliability=0 .88) | | | | | |
| | Item separation =2.94 (reliability=0 .90) | | | | | |

In conclusion, the results suggest that the 20-item self-efficacy scale is well-targeted at the STEM students. Measures from this instrument are reasonably valid and reliable, thus are appropriate for assessing university STEM students' science communication self-efficacy.

*5.2.3.3. Career orientation toward teaching professions*

We also conducted descriptive and non-parametric statistical analysis of data from the survey over the past three years with a focus on STEM students' career orientation toward teaching professions. This analysis 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. The key findings are as follows.

*Change of Interest in Teaching*

Table 5.2.3.3a presents the cross-tab frequency analysis result on difference in change of interests in teaching in K-12 level among students of different semesters. According to the result, semester number was not significantly related with the interest change at the K-12 level. Thus, subsequent results in K-12 teaching are reported with all semester together.

Table 5.2.3.3a

Association between Semester and Change in Interest in K-12 Teaching

| | | Interest in K-12 Teaching | | | | | |
|---|---|---|---|---|---|---|---|
| | | Strongly decreased | Decreased | Was unchanged | Increased | Strongly increased | Total |
| Semester | 2011 Fall | 1 | 2 | 6 | 6 | 1 | 16 |
| | 2012 Spring | 1 | 1 | 3 | 3 | 1 | 9 |
| | 2012 Fall | 1 | 3 | 6 | 9 | 5 | 24 |
| | 2013 Spring | 1 | 0 | 5 | 3 | 1 | 10 |
| | 2013 Fall | 0 | 1 | 8 | 6 | 1 | 16 |
| Total | | 4 | 7 | 28 | 27 | 9 | 75 |

Pearson Chi-Square value = 8.236, *df* = 16, Sig = .942

Table 5.2.3.3b presents the cross-tab frequency analysis result on difference in change of interests in teaching in university/college level among students of different semesters. According to the result, semester number was not significantly related with the interest change for the university/college level. Thus subsequent results on university teaching are reported with all semester altogether.

Table 5.2.3.3b
Association between Semester and Change in Interest in University Teaching

| | | Interest in University Teaching | | | | | |
|---|---|---|---|---|---|---|---|
| | | Strongly decreased | Decreased | Was unchanged | Increased | Strongly increased | Total |
| Semester | 2011 Fall | 0 | 0 | 10 | 3 | 3 | 16 |
| | 2012 Spring | 0 | 0 | 6 | 3 | 0 | 9 |
| | 2012 Fall | 0 | 0 | 9 | 8 | 7 | 24 |
| | 2013 Spring | 0 | 0 | 6 | 3 | 1 | 10 |
| | 2013 Fall | 0 | 0 | 7 | 5 | 4 | 16 |
| Total | | 0 | 0 | 38 | 22 | 15 | 75 |

Pearson Chi-Square value = 6.374, *df* = 8, Sig = .605

Table 5.2.3.3c presents the cross-tab frequency analysis result on difference in change of interests in teaching at the K-12 level among students of different education levels. According to the result, education level was not significantly related with the interest change for the K-12 level.

Table 5.2.3.3c
Association between Education Levels and Change in Interests in K-12 Teaching

| | | Interest in K-12 Teaching | | | | | |
|---|---|---|---|---|---|---|---|
| | | Strongly decreased | Decreased | Was unchanged | Increased | Strongly increased | Total |
| Educational_ Status | Undergraduate | 3 | 3 | 16 | 19 | 8 | 49 |
| | Doctoral | 1 | 4 | 12 | 8 | 1 | 26 |
| Total | | 4 | 7 | 28 | 27 | 9 | 75 |

Pearson Chi-Square value = 5.063, *df* = 4, Sig = .281

Table 5.2.3.3d presents the cross-tab frequency analysis result on difference in change of interests in teaching for the university/college level among students of different education levels. According to the result, education level was significantly related with the interest change at the university/college level. The interest of doctoral students increased more compared to that of undergraduate students'.

Table 5.2.3.3d

Association between Education Level and Change in Interest in University Teaching

| | | Interest in University Teaching | | | | | |
|---|---|---|---|---|---|---|---|
| | | Strongly decreased | Decreased | Was unchanged | Increased | Strongly increased | Total |
| Educational Level | Undergraduate | 0 | 0 | 30 | 10 | 9 | 49 |
| | Doctoral | 0 | 0 | 8 | 12 | 6 | 26 |
| Total | | 0 | 0 | 38 | 22 | 15 | 75 |

Pearson Chi-Square value = 7.136, *df* = 2, Sig =.028

Tables 5.2.3.3e-h present the descriptive statistical analysis results on changes in interests in teaching at K-12 and university by students of different education levels.

Table 5.2.3.3e
Distribution of Change in Interest in K-12 Teaching of Undergraduate Students

| | Frequency | Percentage | Cumulative Percent |
|---|---|---|---|
| Strongly decreased | 3 | 6.1 | 6.1 |
| Decreased | 3 | 6.1 | 12.2 |
| Was unchanged | 16 | 32.7 | 44.9 |
| Increased | 19 | 38.8 | 83.7 |
| Strongly increased | 8 | 16.3 | 100 |
| Total | 49 | 100 | |

Table 5.2.3.3f
Distribution of Change in Interest in University Teaching of Undergraduate Students

| | Frequency | Percentage | Cumulative Percent |
|---|---|---|---|
| Strongly decreased | 0 | 0 | 0 |
| Decreased | 0 | 0 | 0 |
| Was unchanged | 30 | 61.2 | 61.2 |
| Increased | 10 | 20.4 | 81.6 |
| Strongly increased | 9 | 18.4 | 100 |
| Total | 49 | 100 | |

Table 5.2.3.3g
Distribution of Change in Interest in K-12 Teaching of Doctoral Students

| | Frequency | Valid Percentage | Cumulative Percent |
|---|---|---|---|
| Strongly decreased | 1 | 3.8 | 3.8 |
| Decreased | 4 | 15.4 | 19.2 |
| Was unchanged | 12 | 46.2 | 65.4 |
| Increased | 8 | 30.8 | 96.2 |
| Strongly increased | 1 | 3.8 | 100 |
| Missing | 2 | | |
| Total | 49 | 100 | |

Table 5.2.3.3h
Distribution of Change in Interest in University Teaching of Doctoral Students

| | Frequency | Valid Percentage | Cumulative Percent |
|---|---|---|---|
| Strongly decreased | 0 | 0 | 0 |
| Decreased | 0 | 0 | 0 |
| Was unchanged | 8 | 30.8 | 30.8 |
| Increased | 12 | 46.2 | 76.9 |
| Strongly increased | 6 | 23.1 | 100 |
| Missing | 2 | | |
| Total | 28 | 100 | |

According to Table 5.2.3.3e – Table 5.2.3.3h, for undergraduate students, 55.2% reported increase in interest of teaching at the K-12 level, and only 38.8% reported increase in interest of teaching at the college/university level. Most undergraduate students (61.2%) felt their interest of teaching in college/university level was unchanged. Compared with undergraduate students, doctoral students had less increase in teaching in K-12 level (32.2% increase, 42.9% unchanged), while more increase in teaching at the college/university level (64.4% increase, 28.6% unchanged). Another interesting result was that 12.2% of undergraduate students and 17.9% of doctoral students reported decrease in interest of teaching at the K-12 level, while none of them reported decrease in interest of teaching at the college/university level.

*Association with School Experiences*

No significant association was found between specific school experiences and interest change of teaching at the K-12 or university/college level, neither for undergraduate students nor for doctoral students.

*Association with Perceived Benefits*

Table 5.2.3.3i presents the association between change of interest and their perceived benefits of participating in the ISEP program. According to Table 5.2.3.3i, for undergraduate students those who participated in ISEP program because “I was interested in a teaching career (C16)” or they want “to develop my teaching skills (C19)” reported more positive change in interest of teaching at the K-12 level, while the those who participated in IESP “to share my knowledge of science, technology, engineering and/or mathematics (C14)” or “to develop my research skills (C112)” reported more positive change in interest of teaching at the college/university level. For doctoral students, however, no significant difference was found for any items in this section.

Table 5.2.3.3i
Association between Reasons for Participation in the Program and their Change in Interest in Teaching at K-12 and University Levels

| | Undergraduate | | Doctoral | |
|---|---|---|---|---|
| | K-12 | University | K-12 | University |
| C11.To gain financial support for my education | -- | -- | -- | -- |
| C12.My faculty advisor or another faculty member encouraged me | -- | -- | -- | -- |
| C13.Another student(s) encouraged me to participate | -- | -- | -- | -- |
| C14.To share my knowledge of science, technology, engineering and/or mathematics | -- | * | -- | -- |
| C15.To work with school-age students | ** | -- | -- | -- |
| C16.I was interested in a teaching career | -- | -- | -- | -- |
| C17.To have new experiences | -- | -- | -- | -- |
| C18.To enhance my C.V. or resume | -- | -- | -- | -- |
| C19.To develop my teaching skills | ** | -- | -- | -- |
| C110.To develop my teamwork skills | -- | -- | -- | -- |
| C111.To develop my science communication skills | -- | -- | -- | -- |
| C112.To develop my research skills | -- | ** | -- | -- |

* $p$<0.05, ** $p$<0.01

Table 5.2.3.3j presents the correlation between change of interest and the perceived benefits from the program. According to Table 5.2.3.3j, for undergraduate students, benefits of “teaching STEM concepts and methods (C2d)” and “Explaining STEM research and concepts to public (non-technical) audience (C2l)” were significantly related with their interest change in teaching at the college/university level, while “decide a career in education (C2m)” was significantly related with their interest change in teaching at the K-12 level. For undergraduate students, the benefit of “deciding a career in education” was significant associated with their interest in teaching at the K-12 level.  For doctoral students, there was no significant association between any perceived benefits and their change in interest in teaching.

Table 5.2.3.3j
Spearman correlation between Change in Interest in Teaching and Perceived Benefits from the Program

| | Undergraduate | | Doctoral | |
|---|---|---|---|---|
| | K-12 | University | K-12 | University |
| C2a. Work on a Team | .074 | .140 | .119 | -.055 |
| C2b. Lead a team | -.220 | .229 | -.165 | .091 |
| C2c. Facilitate group discussions | .250 | -.030 | .118 | .129 |
| C2d. Teach STEM concepts and methods | -.007 | .342* | -.270 | .024 |
| C2e. Develop instructional materials about STEM concepts and methods | .037 | .264 | .145 | .158 |
| C2f. Generate others' interest in STEM research and activities | .256 | .207 | .165 | .336 |
| C2g. Conduct research as part of a collaborative team | -.003 | .214 | -.024 | -.018 |
| C2h. Conduct independent research | -.084 | .252 | -.054 | .143 |
| C2i. Develop a research and/or technology agenda | .072 | .269 | -.090 | .239 |
| C2j. Write papers and reports about my work | -.074 | -.007 | .276 | .215 |
| C2k. Present my work at a professional conference | -.118 | .003 | -.032 | .001 |
| C2l. Explain STEM research and concepts to public (non-technical) audience | -.016 | .289* | -.134 | -.038 |
| C2m. Decide a career in education | .333* | .133 | .218 | .310 |
| C2n. Understand science concepts better | .279 | .087 | -.057 | .119 |

* $p<0.05$

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**Published and submitted papers from ISEP Research**

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.

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.)

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.)

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.)

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.)

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.)

Part 1, Activities and Findings, Appendix 1
July 2013-July2014 ISEP Project activity for SUNY Buffalo State College

***The Summer Course***

TED594/PHY594: Integrated Physics and Engineering for K-12 Teacher II ran 8-19 July 2013 in the Technology Education Department classrooms at Buffalo State. This summer the instructor of record was Clark Greene of BSC Technology Education, assisted by Dan MacIsaac of Physics. Our maximum attendance was 15 teachers, but three of these were non-ISEP teachers (who paid for registration and fees to take the course), and one BPS teacher (from Hutchinson Central Technical HS) left the course after three days attendance without ever managing to complete registration. The remaining 14 teachers worked five hours a day for two weeks on NGSS style integrated physics and engineering activities, primarily in mechanics (engineering design and physics analysis of skim cars and mousetrap cars through several iterations of improvements for the most part) with a multi day major project for use in BPS teachers own classrooms, documented via a poster ending the course. A significant team (six ISEP teachers) was from a single school Harriet Ross Tubman and these teachers ordered and received a large kit of engineering apparatus for use in their own classrooms at Tubman. Of the remaining teachers, four were from Riverside HS (including two returnees from 2013) and one each from Bennett HS and Hutchinson Central Technical HS.

Final project poster topics included engineering portable or re-locatable gardens (Crittenden from Bennett and Crimmins from Riverside), designing marshmallow blasters (Glascott, Hawkes and Wright from Tubman), magnetic fiends (Aumick of Riverside and Spahn of HTHS), using slingshots to teach the physics of energy by Bihr and Eichner of Riverside), an adaptation of the skimmer car activity for elementary classrooms (Hovarth, Lockhart and Reynolds of Tubman), and a poster by two non-ISEP students on Engineering Design in MS Tech Ed (by Pihlblad and Tucker). 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/13/summer/TED594PHY594/.

ISEP teachers received and evaluated the course quite well, indicating an interest in attending for more than five hours per day if their stipends were increased accordingly, which was noted and is likely to take place in 2014. Now that both courses (Integrated Physics and Engineering for Teachers I and II) have been offered for a first time, 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 2014/15 meetings of the CSCC.

All 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 2013/14 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 and Bihr (one of the course students) further prepared a poster presentation on using student whiteboard discourse to improve conceptual physics learning based upon their work at Riverside HS, and presented that work at multiple venues, including at the National Meeting of the American Association of Physics Teachers in Orlando FL in January 2014.

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 2013, and again at the BSC Faculty Staff Research Forum on 31 October 2013, as well as final versions at the March 2014 meeting of the Western NY Physics Teachers Alliance, and finally at the BPS Science Week STEM professional development events on 9 April 2014 at McKinley HS.

***The Summer Camp***

In August 2013, we again ran a two week elementary / middle school science camp, managed by Dara Dorsey of BSC Earth Science and Science Education, assisted by BPS substitute teachers Christine Lamont and Kelly Bohren. Pre-service STEM teachers and graduate students Alyssa Cederman and Nadine Ayoub also assisted with the camp. During week one (12-16 August 2013) the camp was run at South Side Academy (a BPS ISEP school building open for summer school classes; hence co-convened with some other BPS student activity) and during week two (19-26 August 2013) the camp was run at the Buffalo Museum of Science. These venues were selected because we wanted to significantly increase student participation and BPS parents stated they had troubles transporting their students to the Science Building at BSC in August 2012. The curriculum was mainly space science and astronomy activities.

Again, numbers were disappointingly low, never exceeding twelve students, though three were special needs students and took great advantage of the low teacher to student ratios afforded them. After the summer 2013 kid science camp, Dorsey resigned from Buffalo State and was hired as a STEM teacher and ISEP coordinating teacher for BPS Charles Drew Science Magnet School, and will not be available for coordinating and instructional activities in August 2014. As an outcome we propose a radical rethinking of the summer middle school science academy.

In 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. We propose to provide coordination for science activities from BSC managed by Michelle Parente (new to ISEP but not to summer student camp coordination), Professors Cathy Lange and Joe Zawicki of Earth Science and Science Education and Professor Dan MacIsaac and Instructor Kathleen Falconer of Physics and Mathematics. Falconer, Lange, Zawicki and MacIsaac are already supported by ISEP and their duties to the summer Cradle Beach camp will be rolled into their current time funded, supplanting duties associated with recruiting and participating in the summer camp. Parente would coordinate the recruiting and funding for, and monitor our ISEP funded students before camp start and throughout the camp; her time would be funded from a portion of Dorsey's budget line. A small portion would also support 1-2 graduate STEM Ed students who will either stay at or commute to Cradle Beach for science activities at the camp. The remaining funds for the instructors, materials and meals for the ISEP camp would be turned into supplementary scholarship support for students from ISEP schools who applied for Cradle Beach. We hope to fund more than 50 (you make up a number here???) students for summer 2014 which is considerably more than the twelve students funded in Aug 2013. This will also give the students a STEM experience situated into a much more immersive high impact summer camp experience.

***Preparation of A Targeted MSP STEM-CS Proposed Extension for ISEP***

Considerable time was spent in February and March mainly negotiating across BSC schools, departments and faculty to prepare a STEM-CS MSP extension proposal involving BPS, UB, and at BSC the faculty, chairs and deans of the Departments of Physics and Mathematics from the School of Natural and Social Sciences, the Departments of Computing Information Systems, and Technology Education from the School of Professions, and the Computer Information Systems (CIS) professional support unit of the College. This was the first time these organizations had collaborated on an external proposal of any sort, let along for STEM teacher preparation.

***High-Impact Event: SUNY STEM Faculty Led Day of STEM Professional Development for BPS STEM Teachers***

Although this event occupied only a single day (plus several more for planning and preparation), ISEP UB and Buffalo State STEM faculty, professional staff and graduate students lead two of four afternoon sessions on grade school conceptual physics teaching and earth and space science teaching on April 9, 2014 at McKinley HS for all 200+ Buffalo Public School STEM teachers. Teacher feedback indicated this event had an outsized impact on their enthusiasm, and we plan to repeat this event next year as part of BPS Science and Math week. As noted, this is the format proposed for NY State Ed (NYSED) MSP funding of Academic Year PD program.

***Synergistic Work With Other Organizations And Projects***

In Fall 2013 and especially Spring 2014, the Western NY STEM Hub was organized as a STEM / STEM-Education umbrella organization at http://wnystem.org/. ISEP and ISEP investigators are founding members of the WNY STEM Hub. The community interest in STEM is driving a BSC effort led by the BSC Deans of Education, SNSS and School of Professions currently evaluating whether to instantiate a STEM-Ed center at the College. 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 2013-14 related to BSC ISEP activity (note several are synergistic with related projects at BSC):

Cederman, A C., MacIsaac, D.L., Abbott, D.S., Falconer, K.A., & Henry D.R. (2014). PST2B06: SUNY Buffalo State Summer Physics Teachers' Academy: The First Decade. National Meeting of the American Association of Physics Teachers in Orlando, FL, January 2014.

Falconer, K.A. & MacIsaac, D.L. (2014). W04: Workshop on the Reformed Teaching Observation Protocol. National Meeting of the American Association of Physics Teachers in Orlando, FL, January 2014.

Falconer, K.A., MacIsaac, D.L., & Harmon, G. (2014). PST2B02: Characterizing Noyce Scholars' Classrooms with RTOP. National Meeting of the American Association of Physics Teachers in Orlando, FL, January 2014.

Gearhart, B.F., Bihr, J., & MacIsaac, D.L. (2014). Whiteboarding in Conceptual Physics: Evidence from a First Year Experience. National Meeting of the American Association of Physics Teachers in Orlando, FL, January 2014.

Harmon, G., Falconer, K.A. & MacIsaac, D.L. (2014). PST2B03: Using RTOP and Other Reformed Tools to Build and Strengthen My Teaching. National Meeting of the American Association of Physics Teachers in Orlando, FL, January 2014.

MacIsaac, D.L., (2014). Invited Presentation: Likely Impact of the Next Generation Science Standards (NGSS) on NYS Physics Teaching. Meeting of the NY State Section of the American Association of Physics Teachers (NYSS-AAPT) at the Rochester Institute of Technology, March 29th, 2014.

MacIsaac, D.L., Cirpili, S., Gearhart, B. Stadler, K. & Greene, C. (2014). PST2B08: Merging Engineering Design, Technology and Physics for K-12 Teachers. National Meeting of the American Association of Physics Teachers in Orlando, FL, January 2014.

Falconer, K.A. (2013). Invited Paper: Using the Reformed Teaching Observation Protocol with K-12 Mathematics Classrooms. Centre for Mathematics, Science and Technology Education (CMASTE), University of Alberta, Edmonton, Alberta, Dec 5, 2013. Available from the author.

Greene, C.W. & MacIsaac, D.L. (2013). Merging Engineering and Physics for K-12 Teachers. Fourteenth Annual Faculty/Staff Research and Creativity Fall Forum, Buffalo State College 31 October 2013.

MacIsaac, D.L., & Falconer, K.A. (2013). Invited Paper: Learning Trajectories: Fostering Learning of Introductory Physics via Student Interactions. Physics Teachers Day Meeting of the Alberta-British Columbia section of the American Association of Physics Teachers at the University of Alberta in Edmonton, Alberta, Dec 6, 2013. Available from http://physicsed.buffalostate.edu/pubs/AAPTmtgs/EdmontonDec2013/.

MacIsaac, D.L., & Falconer, K.A. (2013). Invited Paper: Fostering Learning of Introductory Physics via Intensive Student Discourse. Physics Teachers Day Meeting of the Alberta-British Columbia section of the American Association of Physics Teachers at the University of Alberta in Edmonton, Alberta, Dec 6, 2013. Available from http://physicsed.buffalostate.edu/pubs/AAPTmtgs/EdmontonDec2013/.

Wilson, D.C., MacIsaac, D.L., Gomez, L.S. & Falconer, K.A. (2013). WNY Noyce Scholars Partnership Phase II: Advancing STEM Educators. Fourteenth Annual Faculty/Staff Research and Creativity Fall Forum, Buffalo State College 31 October 2013.

MacIsaac, D.L., Snook, J., Abbott, D.S. & Falconer, K.A. (2013). Lessons from a Summer PET Course for In-service K-12 teachers. Fourteenth Annual Faculty/Staff Research and Creativity Fall Forum, Buffalo State College 31 October 2013.

## 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 planne d | Activity delayed | Activity revised | Activity eliminate d | New activity substituted | |
| Objective 1:<br><br>To enhance science teachers' ability to demonstrate advanced knowledge and skills in conducting scientific research and engineering design<br><br>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<br>• Teacher Quality, Quantity & Diversity<br>• Challenging Courses & Curricula<br>• Evidence-based design & Outcomes<br>• Institutional Change & Sustainability | ✓ | | | | | |
| | Activity 1b: All participating schools establish in-class and afterschool programs and informal science activities | • Partnership Driven<br>• Teacher Quality, Quantity & Diversity<br>• Challenging Courses & Curricula<br>• Evidence-based design & Outcomes<br>• 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<br>• Teacher Quality, Quantity & Diversity<br>• Challenging Courses & Curricula<br>• Evidence-based design & Outcomes<br>• 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<br><br>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:<br>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:<br>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,<br>• Teacher Quality, Quantity & Diversity<br>• Challenging Courses & Curricula<br>• Evidence-Based Design & Outcomes<br>• Institutional Change & Sustainability | ✓ | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Engage teachers (with a focus on beginning and under-represented teachers) in professional development offerings.<br><br>Provide support and resources in and after school.<br><br>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.<br><br>Activity 2c: Providing teachers with interdisciplinary science inquiry pedagogical support through monthly professional development workshops | • Partnership Driven,<br>• Teacher Quality, Quantity & Diversity<br>• Challenging Courses & Curricula<br>• Evidence-Based Design & Outcomes<br>• Institutional Change & Sustainability<br><br>• Partnership Driven<br>• Teacher Quality, Quantity & Diversity<br>• Challenging Courses & Curricula<br>• Evidence-based design & Outcomes | ✓<br><br>✓ | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Activity 2c:<br>PLC's:<br>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.<br><br>Activity 2e:<br><br>External project evaluators collected and compared baseline.<br><br>Year 1 and Year 2 teacher, student, and school demographic data | • Partnership Driven,<br>• Teacher Quality, Quantity & Diversity<br>• Challenging Courses & Curricula<br>• Evidence-Based Design & Outcomes<br>• Institutional Change & Sustainability | ✓<br><br>✓ | | | | | | Teacher based PLC continued throughout 2014 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:<br><br>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:<br>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.<br><br>Activity 3b:<br><br>External project evaluators collected and analyzed data from parents in PLC in 2013-2014 | • Partnership Driven,<br>• Teacher Quality, Quantity & Diversity<br>• Challenging Courses & Curricula<br>• Evidence-Based Design & Outcomes<br>• Institutional Change & Sustainability | ✓<br>?<br><br><br><br>✓ | | | | | Currently all PLC's are being conducted face-to-face.<br><br>Initial PLC Clusters were created and implemented.<br>PLC Clusters created opportunities for teachers within school buildings to work together in groups and as a team for upcoming summer 2013 research and 2013-14 school year.<br><br>Graduate students created collaborative opportunities between middle and high school teachers and students<br><br>Parent PLC created opportunities for parents to collaborate with STEM faculty and BPS teachers through the creation f two key events: The ISEP STEM Social Justice Conference and the ISEP Student Science Summit. | |

| Goal 4: Extend interdisciplinary inquiry based science and engineering learning to high school | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Objective 4:<br><br>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:<br>Expansion of the roster of ISEP participating schools, to include more high schools. | • Partnership Driven,<br>• Teacher Quality, Quantity & Diversity<br>• Challenging Courses & Curricula<br>• Evidence-Based Design & Outcomes<br>• Institutional Change & Sustainability | ✓ | | | | | |
| | Activity 4b:<br>Informal science activities both in and out of class. | • Partnership Driven,<br>• Teacher Quality, Quantity & Diversity<br>• Challenging Courses & Curricula<br>• Evidence-Based Design & Outcomes<br>• Institutional Change & Sustainability | ✓ | | | | | |
| | Activity 4c:<br>ISEP offerings will also include summer enrichment and university research internships for BPS students starting in Summer 2013. | • Partnership Driven,<br>• Teacher Quality, Quantity & Diversity<br>• Challenging Courses & Curricula<br>• Evidence-Based Design & Outcomes<br>• Institutional Change & Sustainability | ✓ | | | | | |

| Goal 5: Improve student achievement in science, attitude toward science-technology-society, and interest in pursuing advanced science studies | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Objective 5:<br><br>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:<br>Teachers implement interdisciplinary science inquiry teaching and learning in their classrooms.<br><br>Activity 5b:<br>STEM Ph.D. graduate assistants & service learning students support teacher implementation of inquiry science teaching<br><br>Activity 5c:<br>STEM PhD students organize after-school opportunities for students e.g. clubs, tutoring, etc.<br>to pedagogical content knowledge<br><br>Activity 5e:<br>External evaluators administered ISEP BPS Student Questionnaire to compare BPS students to assess differences in students' interest in science careers | Partnership Driven,<br><br>Teacher Quality, Quantity & Diversity<br><br>Challenging Courses & Curricula<br><br>Evidence-Based Design & Outcomes<br><br>Partnership Driven,<br><br>Teacher Quality, Quantity & Diversity<br><br>Challenging Courses & Curricula<br><br>Evidence-Based Design & Outcomes<br><br>Partnership Driven,<br><br>Teacher Quality, Quantity & Diversity<br><br>Challenging Courses & Curricula<br><br>Evidence-Based Design & Outcomes | ✓<br><br>✓<br><br>✓<br><br>✓<br><br>✓ | | | | | |

| **Goal 6: Improve collaboration in student learning among university, school, and parents** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Objective 6:<br><br>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.<br><br>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,<br>• Teacher Quality, Quantity & Diversity<br>• Challenging Courses & Curricula<br>• Evidence-Based Design & Outcomes<br>• Institutional Change & Sustainability | ✓ | | | | | | |
| | Activity 6b: Implement The District Parent Coordinating Council into the ISEP program involvement. | • Partnership Driven,<br>• Teacher Quality, Quantity & Diversity<br>• Challenging Courses & Curricula<br>• Evidence-Based Design & Outcomes<br>• 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. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Activity 6c:<br>Create active and constructive interactions amongst the parents and teachers through PLCs.<br><br>Activity 6d:<br>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,<br>• Teacher Quality, Quantity & Diversity<br>• Challenging Courses & Curricula<br>• Evidence-Based Design & Outcomes<br>• Institutional Change & Sustainability | ✓<br><br>✓ | | | | | Parent based PLC commenced in spring 2013 and will continued to meet during 2013-14 school year and will meet during summer 2014.<br><br>Parents will partake in a parent retreat that will focus on upcoming programmatic events for 2013-14 school year as well as visit labs where BPS teachers are working with UB STEM faculty and doctoral students to observe firsthand what teachers will be implementing in classroom stating in fall 2014. |

# Appendix 2 Report of ISEP External Advisory Committee Summary

- The ISEP program is well established already, with a remarkable set of partnerships in place that are clearly based on mutual respect and a strong sense of community
- The program is at a crucial stage, in that the evaluation of multiple efforts can be brought together to enable definition of legacies that will outlive the project
- Once a suite of legacies is agreed upon across the partnership, clear steps can be outlined to achieve them and share the project findings to multiple stakeholder communities

# Strengths

- The PI, Dr. Gardella
  - Community building experience and skill
  - Systems understanding
  - Stature in broad community (within and outside campus)
- Strong team assembled
- Strong institutional support and engagement across multiple colleges and UB
- Strong level of inclusiveness
  - Parents
  - 2 yr colleges (private and public)
  - Industry
  - Informal educational sector
- Focus on capacity building
- Existing PLCs have helped build and sustain program

# Weaknesses

- Lack of 'theory of action' (more clarity of focus and plans)
- Definitions of metrics for success
- Dissemination plan for data and outcomes
- Use of technology within program needs to be made integral (data collection, teaching tools, teacher training, etc.)

# Opportunities

- Define expected legacies of ISEP
- Work with industry partners to improve readiness to host students and teachers, and on measuring outcomes
- Define infrastructure requirements for institutional change at participating units
- Improve marketing of program – state level, and more broadly

# Threats

- Instability in BPS leadership
- State recognition is lacking

# Questions

- Parent PLC – is there participation of minority groups other than African-Americans?
- On teacher surveys, are we asking about the confidence teachers have to teach material after training?
- To what extent is the evaluator helping the project team to shape legacies, and to formulate ‘a theory of action’?

# Section 2: Management Report

**University at Buffalo/ Buffalo Public Schools ISEP**

**Year 3: 2013 – 2014**

**Overview**

Year 3 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 (who completed her Ph.D. in May 2013) 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 1 are the finalized appointments of the members of the External Advisory Committee.

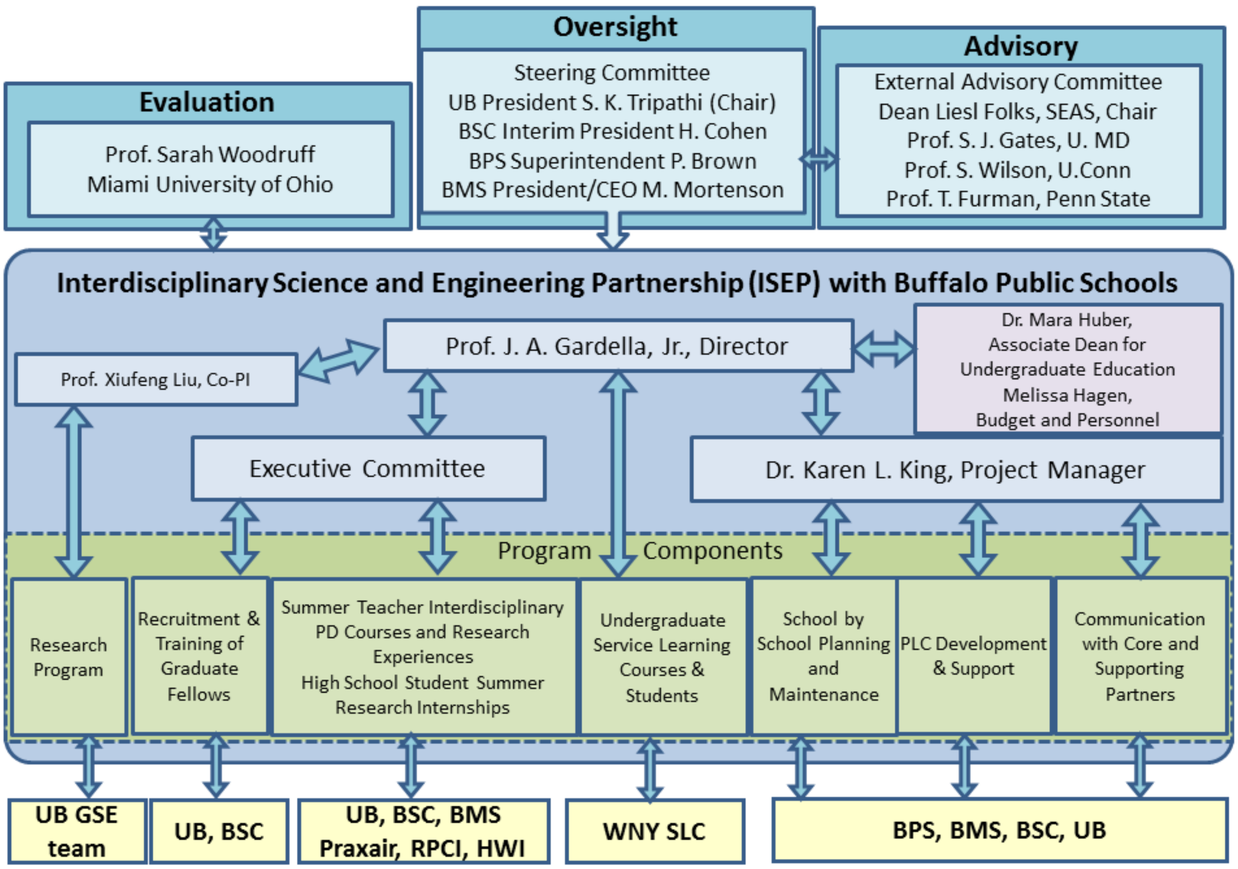


Figure 1: ISEP: Current (2014) Organizational Chart

In particular, the appointments of members of the External Advisory Board were completed. Dean Liesl Folks of the School of Engineering and Applied Sciences (SEAS) was appointed by President Tripathi of UB to serve as local chair of the Advisory Committee. The members are Professors Tanya Furman, Associate Vice President and Associate Dean for Undergraduate Education and Professor, Department of Geosciences at Penn State (also Director of Penn State NSF funded Math Science Partnership); S. James Gates, University System of Maryland Regents Professor, John S. Toll Professor of Physics, and Center for String and Particle Theory Director, Dept. of Physics, University of; and Suzanne Wilson, Professor and

Neag Endowed Professor of Teacher Education, Dept. of Curriculum and Instruction, University of Connecticut. The Committee convened in Buffalo May 23rd to review the present report and offer advice to the Steering Committee. Responses to the External Advisory Review are included in Section 1.

Important management activities were both expanded from year 1 and new activities were established, according to the strategic plan in year 3. Executive Committee involvement in key components of the recruitment and evaluation of teachers in ISEP was improved in year 3 by subcommittee work to screen teacher summer applications (Prof. Dan MacIsaac, BSC CoPI, Chair), developing summer programs for students , reviewing applicants for graduate assistantships, chaired by Prof. Alan Rabideau, (NSF ERIE IGERT Director and Professor of Environmental Engineering) and a subcommittee to review and establish summer middle school science camps and summer high school research opportunities for students in ISEP schools co-chaired by Dr. Mara Huber and 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 1 summarizes school leadership from year 2-3. Results of the school based theme development are discussed in Activities and Findings.

**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.

**Collaboration with BPS**

Dr. Pamela Brown's engagement in ISEP direction continued to be very fruitful with quarterly meetings and regular shared meetings in schools through May of this year. Further, Prof. Gardella has presented regularly to the Board of Education, with two major presentations this past year, on teacher outcomes in September, and for planning of STEM Week in March. Basic operational issues such as district staff time in support of the ISEP program, school by school planning initiatives and linkage of ISEP to other ISEP school community partners continue to be a major focus. Dr. Brown attended the second ISEP Teacher poster session in September, 2013, and several ISEP events, including the Student Science Summit event in March 2015, and was present every day of STEM Week in Buffalo in April.

ISEP leadership continued regular collaboration at other BPS leadership levels, with regular organizational meetings with the Chiefs of School Leadership (formerly known as Community Superintendents). There are three of these supervisors, who are the main point of contact between principals and other district leadership. Dr. Brown has organized more specific school based budgeting, so principals have more direct management responsibilities. Thus, the Chiefs of School Leadership help ISEP programmatic collaborations between schools and help principals identify central resources to support ISEP (and other academic) programs, such as after school programs, etc. Dr. David Mauricio, the primary point of contact for ISEP, was formerly Principal at Bennett High (one of the largest ISEP high schools), took the lead in oversight of all ISEP high schools and middle schools, and also collaborating with the other two Chiefs of School Leadership (one a parent of students at the MST school).

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.

Ms. Baudo will remain the point person for all teacher selection processes and decision-making

A particular responsibility engaging Ms. Baudo along with Principals is ISEP school based leadership transitions. This year saw the first transition to a new Coordinating Teacher at Bennett High. 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**

As noted in Activities and Findings, ISEP newest partnerships are with colleges and Niagara University to develop additional service learning activities. These are:

- Canisius College (www.canisius.edu )
- Medaille Colllege (www.medaille.edu)
- Daemen College (www.daemen.edu )
- Niagara University (www.niagara.edu)

Memoranda of Understanding were co-signed by Prof. Alex Cartwright (ISEP coPI and Vice President for Research and Economic Development) along with the requisite President or VP for Academic Affairs. Efforts of supporting partner WNY SLC organization led to the addition of the four new college partners for service learning collaboration in ISEP. Medaille College students serve at Riverside High and Lorraine Academy, Daemen College students served at South Park High, Niagara University students served at the Math Science and Technology School and Canisius College students served at South Park High.

Supporting partners for research development, Praxair, Roswell Park Cancer Institute and Hauptman Woodward Institute all hosted teachers in year 1 and plan to host teachers for research in year 3. As noted in Activities and Findings, HWI was awarded a major NSF STC grant which included funds for four ISEP teachers in summer research. 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 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. Yellow Highlighted Graduate Students are presently supporting the schools. As noted in Activities and Findings, new graduate assistants were recruited and started in Fall 2013 and January 2014 following completion of 2 year appointments of several graduate assistants. There was one change in Coordinating Teacher, as Carl Bish was appointed to replace Tanya Johnson at Bennett High. Ms. Johnson remains active in ISEP through other programs, but moved to be science coach and coordinator at the International Prep School in Buffalo.  Two other shifts in coordinating teachers are anticipated for Fall 2014.  The process is described above in the section on Collaboration with BPS.

| 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<br>Valerie Goodness (1/2 time)<br>Emily Warren (part time) | Eleni Mazur (Intern)<br>Mitchell Nguyen (Volunteer)<br>Joseph J. Gardella (Intern) | Praxair |
| Harriett Tubman 31 (K-8) PS | Steven Indelacio | Biomedical, Environmental Science | Ekue Bright Adamah-Brassi<br>Steve Rogers (1/2 time) | Matthew Cato (SL Student)<br>Gabriel Kahn (SL Student)<br>Antara Majumdar (SL Student)<br>Jacob Caldwell (SL Student)<br>Christopher Dundas (Intern) | Roswell Park Cancer Institute |
| Science Magnet 59 (K-8) PS | Dara Dorsey | Biomedical and Environmental Sciences | Robin Foster (Jan 2014)<br>Michael Habberfield (1/2 time, prev) | Robert Mora (SL Student)<br>Patricia Johnson (SL Student)<br>Joshua Beres (SL Student) | Museum of Science |
| Lorraine Academy 72 (K-8) | Sharon Pikul | Medical Careers<br>Environmental Science | Michael Gross | Vanessa Akiki (Medaille SL)<br>Pearl Guerin (SL Student)<br>Christopher Brais (Intern) | Mercy Hospital, Trocaire College |
| Southside Academy 93 (K-8) | Susan Wade | Environmental Science, Link to South Park High | Michael Gallisdorfer<br>Sarah Whiteway (1/2 time) (on maternity leave) | Alec Rosati-Hohensee (SL Student)<br>Kathryn Sands (SL Student)<br>Stephanie Kong (SL Student)<br>Emily Snyder (SL Student) | |
| MST Seneca 197 (Grades 5-12) | Michelle Zimmerman | Environmental Science and Engineering | Heather Rudolph (Jan 2014)<br>Jonathan Malzone (prev)<br>Sarah Whiteway (1/2 time) (on maternity leave) | | Praxair |
| Bennett High 200 (Grades 9-12)PS | Carl Bish | Pharmaceutical Sciences, Environmental, Extreme Events | Janhavi Moharil<br>Michael Habberfield (prev) | Chelsea Dipizio (Intern)<br>Fathima Yasin (Volunteer)<br>Eric Lentz (Intern)<br>Aaron Sheng (SL Student)<br>Michael Derr (SL Student)<br>Meghan Capeling (SL Student)<br>10 UB Pharmacy Grad Students (Volunteer) | UB School of Pharmacy and Pharmaceutical Sciences |
| Riverside Tech 205 (Grades 9-12) PS | Bradley Gearhart | Medical Careers | Shannon Clough<br>Katherine Niessen ( ½ time)<br>Tom Scrace (prev ½ time)<br>Bishwas Thapa (part time) | Cesar Carrion (SL Student)<br>Dan Vekhter (Volunteer)<br>Alissa Cederman (Buffalo State)<br>Medaille SL Students | Medaille College |

| | | | | | |
|---|---|---|---|---|---|
| South Park 206<br>(Grades 9-12) PS | Kathleen Marren | Environmental Science and Social Sciences | Michael Habberfield<br>Valerie Goodness (1/2 time)<br>Alex Ticoalu (prev) | Chris Reinhardt (SL Student)<br>Maggie Petrella (SL Student)<br>Megan Corcoran (SL Student)<br>Pearl Guerin (SL Student)<br>Abby Rogers (Canisius SL)<br>Vincent Bargnes (Canisius SL)<br>Benton Swanson (Canisius SL) | |
| Burgard 301<br>(Grades 9-12) PS | Bruce Allen | Auto Technology, Physics | Katie Hofer<br>Katherine Niessen ( ½ time)<br>Thomas Scrace (prev ½ time) | Dylan Burrows (Intern)<br>Curtis Monin (SL Student)<br>Christopher Rector (SL Student) | Praxair |
| Hutch Tech 304<br>(Grades 9-12) | Jill Jakubowicz | Engineering, Physics, Biochemistry | Suyog Pol<br>Ben (XiaLiang) Wang (prev)<br>Heather Rudolph (prev ½ time) | Caleb Walters (SL Student)<br>Leatrice Bennett (SL Student)<br>Alyssa Negron (SL Student)<br>Shohini Sen (intern)<br>Chris Dundas (intern)<br>Leandra DeSouza (intern) | |
| East High 307<br>(Grades 9-12) PS | Pat McQuaid | Bioinformatics, Forensics | Amy Zielinski<br>Steve Rogers ( ½ time) | Payraw Salih (SL Student)<br>Enzo Benfanti (SL Student)<br>Timothy Dubill (SL Student)<br>Gregory George (SL Student)<br>Matthew Falcone (SL Student)<br>Sarah Baron (SL Student) | Roswell Park Cancer Institute |

# Section 3: Financial Report

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

**Year 2: 2013 – 2014**

### 3.1 Status

Spreadsheet projections (below) show just 13% of UB's portion award will be left at the end of the year (August 31, 2014). All other funds in the subcontracts to partners (Buffalo State College, the Buffalo Museum of Science and Miami University of Ohio (evaluation) have been fully expended.

We are requesting carry over to 2014-2015 for six major categories:

- Faculty 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
- Parent stipends for participating in committees and meetings

### 3.2 Background related to shortfalls and justification for use of carryover to 2014-2015.

Teacher participation increased in Summer 2013, as planned, through the use of formalized work plans. We are implementing this model for Summer 2014 and expect the same level of teacher participation, with the possibility of a small rejection rate as participation demand increases.

With the successful expansion of summer PD for teachers, we will continue to focus on expanding the support for Teacher Travel for professional meetings during Y4. We request to carry over these funds to meet upcoming needs.

***Student*** summer research programming was increased in Y3 with plans for expansion to include additional three additional programs for middle and high school programs in the areas of GIS and Environmental Camps at Cradle Beach (a historic camp for the disabled and disadvantaged on Lake Erie South of Buffalo). Further, we have three active summer research initiatives for high school students, one funded by NSF support to Professor David Watson, a second at Hauptmann Woodward Institute and a third in the School of Medicine. We hope that the additional summer programming will increase the ISEP student audience by 40%. With approved carry over funds, we expect to continue programming expansion into the academic year of 2014-2015 by offering year round support for research programs in the areas of computer engineering and genetics research. We propose that with an increase in student programming, there will be an increased need for parent participation in programming and committee meetings. We would like to carry over the funding available for parent stipends to promote support and participation within the community.

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 2014.

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 1 (2011-2012)

| Category | | Funds Budgeted | | Funds Expended | | Funds Carried Over |
|---|---|---|---|---|---|---|
| Faculty Salaries | $ | 41,502.00 | $ | 35,239.55 | $ | 6,262.45 |
| Staff Salary | $ | 3,517.00 | $ | 10,502.95 | $ | (6,985.95) |
| Graduate Students | $ | 398,000.00 | $ | 399,416.75 | $ | (1,416.75) |
| Undergraduates | $ | 64,000.00 | $ | 20,601.07 | $ | 43,398.93 |
| Fringe Benefits | $ | 70,954.00 | $ | 70,152.25 | $ | 801.75 |
| | | | | | | |
| Participant Support Costs | | | | | | |
| Stipends | | | | | | |
| Teachers | $ | 282,000.00 | $ | 269,850.00 | $ | 12,150.00 |
| Middle/High School Students | $ | 84,000.00 | $ | 8,100.00 | $ | 75,900.00 |
| PT grad assistants | $ | 48,000.00 | $ | 17,000.00 | $ | 31,000.00 |
| Parents | $ | 1,800.00 | $ | - | $ | 1,800.00 |
| Travel | $ | 48,000.00 | $ | 2,358.93 | $ | 45,641.07 |
| Supplies | $ | 72,000.00 | $ | 39,579.97 | $ | 32,420.03 |
| | | | | | | |
| Supplies | $ | 38,400.00 | $ | 2,335.56 | $ | 36,064.44 |
| Tuition | $ | 12,876.00 | $ | 38,208.00 | $ | (25,332.00) |
| Travel | $ | - | $ | 6,251.93 | $ | (6,251.93) |
| Total UB Direct Costs | $ | 1,165,049.00 | $ | 919,596.96 | $ | 245,452.04 |
| | | | | | $ | - |
| | | | | | $ | - |
| | | | | | $ | - |
| | | | | | $ | - |
| | | | | | | **21.07%** |

Budget Summary
Year 2 (2012-2013)

| Category | Funds Budgeted | Carry Over from Y1 | Total Funds Available | Funds Expended | Funds Carried Over |
|---|---|---|---|---|---|
| Faculty Salaries | $ 43,577.00 | $ 6,262.45 | $ 49,839.45 | $ 26,868.83 | $ 22,970.62 |
| Staff Salary | $ 3,693.00 | $ (6,985.95) | $ (3,292.95) | $ 53,602.57 | $ (56,895.52) |
| Graduate Students | $ 417,900.00 | $ (1,416.75) | $ 416,483.25 | $ 568,351.82 | $ (151,868.57) |
| Undergraduates | $ 67,200.00 | $ 43,398.93 | $ 110,598.93 | $ 17,675.00 | $ 92,923.93 |
| Fringe Benefits | $ 79,202.00 | $ 801.75 | $ 80,003.75 | $ 111,100.27 | $ (31,096.52) |
| | | | | | |
| Participant Support Costs | | | | | |
| Stipends | | | | | |
| Teachers | $ 282,000.00 | $ 12,150.00 | $ 294,150.00 | $ 389,400.00 | $ (95,250.00) |
| Middle/High School Students | $ 84,000.00 | $ 75,900.00 | $ 159,900.00 | $ 8,200.00 | $ 151,700.00 |
| PT grad assistants | $ 48,000.00 | $ 31,000.00 | $ 79,000.00 | $ 49,732.00 | $ 29,268.00 |
| Parents | $ 1,800.00 | $ 1,800.00 | $ 3,600.00 | $ 200.00 | $ 3,400.00 |
| Travel | $ 48,000.00 | $ 45,641.07 | $ 93,641.07 | $ 39,556.00 | $ 54,085.07 |
| Supplies | $ 72,000.00 | $ 32,420.03 | $ 104,420.03 | $ 88,804.00 | $ 15,616.03 |
| | | | | | |
| Supplies | $ 38,400.00 | $ 36,064.44 | $ 74,464.44 | $ (34,072.31) | $ 108,536.75 |
| Tuition | $ 12,876.00 | $ (25,332.00) | $ (12,456.00) | $ 66,457.00 | $ (78,913.00) |
| Travel | $ - | $ (6,251.93) | $ (6,251.93) | $ 7,324.25 | $ (13,576.18) |
| Total UB Direct Costs | $ 1,198,648.00 | $ 245,452.04 | $ 1,444,100.04 | $ 1,393,199.43 | $ 50,900.61 |
| | | | | | **3.52%** |

Budget Summary
Year 3 (2013-2014)

| Category | Funds Budgeted | Carry Over from Y2 | Total Funds Available | Funds Expended | Summer 2014 Committed Funds | Total Expected to Expend | Projected Carryover Funds |
|---|---|---|---|---|---|---|---|
| Faculty Salaries | $ 45,756.00 | $ 22,970.62 | $ 68,726.62 | $ 43,326.73 | $ 17,464.00 | $ 60,790.73 | $ 7,935.89 |
| Staff Salary | $ 3,877.00 | $ (56,895.52) | $ (53,018.52) | $ 7,687.96 | $ 1,450.00 | $ 9,137.96 | $ (62,156.48) |
| Graduate Students | $ 438,795.00 | $ (151,868.57) | $ 286,926.43 | $ 355,235.70 | $ 9,000.00 | $ 364,235.70 | $ (77,309.27) |
| Undergraduates | $ 70,560.00 | $ 92,923.93 | $ 163,483.93 | $ 5,718.75 | $ 2,500.00 | $ 8,218.75 | $ 155,265.18 |
| Fringe Benefits | $ 89,498.00 | $ (31,096.52) | $ 58,401.48 | $ 80,386.89 | $ 5,150.13 | $ 85,537.02 | $ (27,135.54) |
| | | | | | | | |
| Participant Support Costs | | | | | | | |
| Stipends | | | | | | | |
| Teachers | $ 282,000.00 | $ (95,250.00) | $ 186,750.00 | $ 25,570.00 | $ 210,000.00 | $ 235,570.00 | $ (48,820.00) |
| Middle/High School Students | $ 84,000.00 | $ 151,700.00 | $ 235,700.00 | $ 7,850.00 | $ 25,000.00 | $ 32,850.00 | $ 202,850.00 |
| PT grad assistants | $ 48,000.00 | $ 29,268.00 | $ 77,268.00 | $ 7,169.00 | $ 105,000.00 | $ 112,169.00 | $ (34,901.00) |
| Parents | $ 1,800.00 | $ 3,400.00 | $ 5,200.00 | $ 1,450.00 | $ 1,800.00 | $ 3,250.00 | $ 1,950.00 |
| Travel | $ 48,000.00 | $ 54,085.07 | $ 102,085.07 | $ 19,100.00 | $ 5,000.00 | $ 24,100.00 | $ 77,985.07 |
| Supplies | $ 72,000.00 | $ 15,616.03 | $ 87,616.03 | $ 46,148.00 | $ 75,000.00 | $ 121,148.00 | $ (33,531.97) |
| | | | | | | | |
| Supplies | $ 38,400.00 | $ 108,536.75 | $ 146,936.75 | $ - | $ - | $ - | $ 146,936.75 |
| Tuition | $ 12,876.00 | $ (78,913.00) | $ (66,037.00) | $ 63,993.00 | $ - | $ 63,993.00 | $ (130,030.00) |
| Travel | $ - | $ (13,576.18) | $ (13,576.18) | $ 2,047.58 | $ - | $ 2,047.58 | $ (15,623.76) |
| Total UB Direct Costs | $ 1,235,562.00 | $ 50,900.61 | $ 1,286,462.61 | $ 665,683.61 | $ 457,364.13 | $ 1,123,047.74 | $ 163,414.87 |
| | | | | | | | **12.70%** |

# Section 4

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

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

**Year 3: 2013 – 2014**

Ohio Evaluation & Assessment Center

MATHEMATICS • SCIENCE • EDUCATION

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

## Annual Report 2013-2014

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Oxford, OH 45056

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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 to be 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 will come from service learning students from UB, BSC, and area colleges. ISEP offerings also will 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 provides external summative evaluation services for the ISEP project and 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 and final reports that synthesize findings from all measures. During project Year 3, the evaluation collected and/or analyzed qualitative and quantitative data from all project participants, including ISEP project team members, ISEP participating teachers, students of ISEP teachers, 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 January 2013 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. An updated summative evaluation matrix can be found in Appendix A. Table 1 shows an updated timeline of annual evaluation activities.

Table 1. *E & A Center Annual Evaluation Activities and Timeline*

| **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** | | | |
| Conduct teacher interviews | **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** |

| Evaluation Activity | Jul - Sept | Oct - Dec | Jan - Mar | Apr - Jun |
|---|---|---|---|---|
| Analyze Parent PLC instrument | | | | X |
| Administer Faculty Questionnaire | | | | X |
| Collect School/Teacher-level Data | | | | X |

During Year 3 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) recommending, developing, and 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; (f) conducting interviews of teachers during summer research experiences; and (g) preparing and submitting the Year 3 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 K-12 schools, their students in Grades 5 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.

## Instruments

### *UB/BPS ISEP Teacher Questionnaire (Summer 2013)*

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] The questionnaire is used to collect data from three groups of teachers: 1) Group 1 - teachers who have participated in ISEP since Summer 2012 and responded to the teacher questionnaire in Summer 2012 and Summer 2013, 2) Group 2 - teachers who have participated in ISEP since Summer 2012 and responded to the teacher questionnaire only in

[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.

Summer 2013, and 3) Group 3 - teachers who began participating in ISEP in Summer 2013 and completed the questionnaire before their participation in project activities. Summer 2013 Teacher Questionnaire data serves as post-questionnaire data for the first two groups of teachers and as pre-questionnaire data for the third group.

The teacher questionnaire is composed of 181 to 233 items divided among 6 sections. Different versions of the questionnaire were administered to each teacher group based on participation in the project and completion of pre- and post-questionnaires. The Demographic section asked for comprehensive demographics, including teachers' professional development history, and complete demographic data were collected from each participant only once. This section contained 30 items for Group 1 teachers, 50 items for Group 2, and 40 items for Group 3. Items in this section were modified with permission from RMC Research (2009). The remaining five sections of the Summer 2013 Teacher Questionnaire were exactly the same as the Summer 2012 version. 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 2011-2012* (Woodruff & Li, 2012). This questionnaire can be found in Appendix B.

## UB/BPS ISEP Teacher Pedagogical Content Assessment (PCK) Assessment (Summer 2013)

The ISEP research team used the following seven instruments to collect 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, and it was 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, and 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]
- *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.

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[2] The *Biology, Chemistry, Earth Science, Engineering/Physics, and Physics PCK Assessments* were used, with permission, from instruments created by 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.
[6] Horizon Research, Inc. (2011). *ATLAST Plate Tectonics*. Chapel Hill, NC: Author.

- *Physics PCK Assessment* consists of 29 items from ATLAST Force and Motion 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 (Spring 2013 and Fall 2013)*

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 Spring 2013 (post for 2012-2013) and Fall 2013 (pre for 2013-2014). 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).

In Spring 2013, both ES/MS and HS versions of this instrument included seven questions collecting demographic data as well as four additional subscales. The "My Opinion about Science" subscale contained 12 items on a 5-point Likert-type scale, with responses ranging from *strongly disagree* (1) to *strongly agree* (5), asking about students' views of science and understanding of the Nature of Science. The "What Teachers Do in Classrooms" subscale contained 12 items on a 5-point Likert-type scale, with responses ranging from *almost never* (1) to *very often* (5), asking for students' reported frequency of teacher's using inquiry-based science teaching practices. The "What Students Do in Classrooms" subscale contained 12 items on a 5-point Likert-type scale, with responses ranging from *almost never* (1) to *very often* (5), asking for students' self-reported frequency of using inquiry-based science learning practices. The "Parental/Adult Support at Home" subscale contained 7 items on a 5-point Likert-type scale, with responses ranging from *almost never* (1) to *very often* (5), asking for students' reported frequency of adult/parental involvement at home for science learning. The HS version of the student questionnaire is similar to the ES/MS questionnaire but has an additional subscale, "My Opinion about My Future," that contained 9 items on a 5-point Likert-type scale, with responses ranging from *strongly disagree* (1) to *strongly agree* (5), asking for high school students' post-secondary and career plans.

In Fall 2013, a content assessment section was added to both the ES/MS and HS versions of the *UB/BPS ISEP Student Questionnaire*. The ISEP content assessments were compiled by the E & A Center and reviewed by the ISEP research team. Developmentally appropriate items were selected to represent each cross-cutting concept of the *Next Generation Science Standards.*[8] The ES/MS content assessment contains 20 multiple-choice items from the following sources with permission:

- Kahle, J. B. & Rogg, S. R. (1997). *Discovery Inquiry Test (DIT).* Oxford, OH: Ohio's Evaluation & Assessment Center for Mathematics and Science Education.
- Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Forms 1-3.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers
- Ohio Department of Education. (2007 May). *Ohio Achievement Tests: Grade 5 Science Student Test Booklet.* Columbus, OH: Author.
- Ohio Department of Education. (2010 Spring). *Ohio Achievement Assessments: Grade 5 Science Student Test Booklet.* Columbus, OH: Author.
- Ohio Department of Education. (2011 Spring). *Ohio Achievement Assessments: Grade 5 Science Student Test Booklet.* Columbus, OH: Author.

The HS content assessment contains 19 multiple-choice items compiled by the E & A Center using items from the following sources with permission:

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[7] Horizon Research, Inc. (2011). *ATLAST Force and Motion.* Chapel Hill, NC: Author.
[8] NGSS Lead States. (2013). *Next Generation Science Standards: For States, By States.* Washington, DC: The National Academies Press.

- Kahle, J. B. & Rogg, S. R. (1997). *Discovery Inquiry Test (DIT).* Oxford, OH: Ohio's Evaluation & Assessment Center for Mathematics and Science Education.
- Lawson, A. E. (2000 September). *Science Attitudes, Skills, & Knowledge Survey (SASKS): Forms 1-3.* Arizona State University, Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers
- Ohio Department of Education. (2007 May). *Ohio Achievement Tests: Grade 8 Science Student Test Booklet.* Columbus, OH: Author.
- Ohio Department of Education (2009 Spring). *Ohio Graduation Tests: Science.* Columbus, OH: Author.
- Ohio Department of Education. (2010 Spring). *Ohio Achievement Assessments: Grade 8 Science Student Test Booklet.* Columbus, OH: Author.
- Ohio Department of Education. (2011 Spring). *Ohio Achievement Assessments: Grade 8 Science Student Test Booklet.* Columbus, OH: Author.

Both ES/MS and HS Fall 2013 versions of this instrument can be found in Appendix C.

## *Factor Analysis and Reliability*

In Spring 2014, E & A Center evaluators performed factor analyses to establish reliable subscales for the *UB/BPS ISEP Student Questionnaire.* Using all student responses from Spring 2013 ($n$ = 1,098), nine factors were established from the four subscales using the principal components method with varimax rotation.[9] The list of subscales, factors, and their reliabilities are shown in Table 2. High internal consistency reliability were found for five of nine factors, i.e., F1. "Students' Views of Science" from the subscale "My Opinion about Science," both F4 and F5 from the "What Teachers Do in Classroom" subscale, F6 from the "What Students Do in Classrooms" subscale, and F8 from the "Parental/Adult Support at Home" subscale, with Cronbach's coefficient alpha values for these factors equal to or higher than .75. Three other factors had moderate reliabilities ranging from .61 (F3. Understanding of the Nature of Science (NOS) from the "My Opinion about Science" subscale) to .70 (F9. Expectation Related to Education" from the "Parental/Adult Support at Home" subscale). One factor did not perform reliably (.50; F7 from the "What Students Do in Classrooms" subscale). The moderate to low reliabilities are likely due to a) small numbers of items loaded on these factors, b) ambiguity of the definition of these factors and the underlying constructs; that is, some items loaded on more than one factor, and c) lack of accurate understanding of some of the items by students from lower grade levels.

[9] The "My Opinion about My Future" subscale was not designed to be reported at the factor level.

Table 2. *Reliability of UB/BPS ISEP Student Questionnaire Factors, Spring 2013*

| Subscale | Total # of Items | Factor | Variable Name | # of Items in Each Factor | Cronbach's Alpha | *n* |
|---|---|---|---|---|---|---|
| S1. My Opinion about Science | 12 | F1. Students' views of science | Q8a-Q8d | 4 | .80 | 1050 |
| | | F2. The use of science | Q8e-Q8g | 3 | .64 | 1020 |
| | | F3. Understanding of the Nature of Science (NOS) | Q8h-Q8l | 5 | .61 | 1011 |
| S2. What Teachers Do in Classrooms | 12 | F4. Teacher support | Q9a, Q9b, Q9d, Q9f-Q9h | 6 | .80 | 963 |
| | | F5. Structure/ Expectations | Q9c, Q9e, Q9i-Q9l | 6 | .76 | 974 |
| S3. What Students Do in Classrooms | 12 | F6. Structure/ Opportunity | Q10a, Q10b, Q10d, Q10g-Q10l | 9 | .84 | 947 |
| | | F7.Self support | Q10c, Q10e, Q10f | 3 | .50 | 985 |
| S4. Parental/Adult Support at Home | 7 | F8. Parent support | Q11a-Q11d, Q11g | 5 | .80 | 973 |
| | | F9. Expectation related to education | Q11e, Q11f | 2 | .70 | 1007 |

Further investigation of instrument properties via factor analysis using Fall 2013 and Spring 2014 data will be done once Spring 2014 student data are collected. It is not recommended that the data be analyzed at the construct level (factor level) until each factor can be validated and the performance of each subscale is internally consistent and within an acceptable range.

## *UB-BPS ISEP STEM Student Questionnaire (Fall 2013)*

The *UB-BPS ISEP STEM Student Questionnaire* was formerly called *UB/BPS ISEP Survey of UB STEM Students* in 2011-2012 and 2012-2013. It collected data from UB STEM graduate and undergraduate students who participated in project activities in Fall 2013. The instrument was developed by Dr. Liu, internal evaluator and researcher for the ISEP project, and was administered online to new and returning UB STEM students by the E & A Center in Fall 2013 using Qualtrics®. The current version of *UB/BPS ISEP STEM Student Questionnaire* contains the following sections and can be found in Appendix D.

### *Section A: Preparation*

This section contains 1 multiple-choice item asking about students’ preparedness for aspects of project activities in schools.

### *Section B: Experiences*

This section contains 1 multiple-choice item asking about students’ self-reported experiences in schools.

### *Section C: Perceived Value of UB/BPS ISEP*

This section 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: Self-Efficacy in Communicating Science*

This section 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: Comprehensive Demographics*

This section contains 8 items requesting students' comprehensive demographics, experiential history, and career plan data.

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

The *UB/BPS MSP ISEP Parent-Based PLC Questionnaire* collected data from parents of the students who were enrolled in the 12 ISEP participating schools from Spring 2013 through Spring 2014. The instrument was developed by the E & A Center with input from the ISEP project team. It contained three demographic items, four yes/no items, and five open-response items asking parents' perceptions of the parent-based PLC session and expectations for their children's science education. The *UB/BPS MSP ISEP Parent-Based PLC Questionnaire* can be found in Appendix E.

## Data Collection

### ***School-Level Enrollment and Report Card Data***

School-level baseline data for each of the 12 ISEP partner schools were collected for the 2010-2011 school year and are reported in the *Evaluation of University at Buffalo/Buffalo Public Schools (UB/BPS) Interdisciplinary Science and Engineering Partnership: Annual Report 2011-2012* (Woodruff & Li, 2012).[10] School-level enrollment and report card data for the 2011-2012 year were collected this year from the New York State Education Department (NYSED) Website (http://data.nysed.gov/lists.php?type=school) 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 in June 2012 but have not yet been delivered.

### ***UB/BPS ISEP Teacher Questionnaire***

The three online versions (one for each teacher group) of the *UB/BPS ISEP Teacher Questionnaire* were administered by Ohio's Evaluation and Assessment Center using Qualtrics®. The link to the instrument was sent (with an invitation to participate in the questionnaire) to the teacher groups participating in the ISEP summer institute on June 7, 2013, and the questionnaires remained active online until August 13, 2013. Of the 76 teachers who participated in Summer 2012 and/or Summer 2013 PD activities, 28 responded to this questionnaire. The overall response rate was approximately 37%. Table 3 shows the response rate for each teacher group.

[10] Woodruff, S. B., & Li, Y. (2012*). Evaluation of University of Buffalo/Buffalo Public Schools (UB/BPS) Interdisciplinary Science and Engineering Partnership: Annual report 2011-2012.* Oxford, OH: Miami University, Ohio's Evaluation & Assessment Center for Mathematics and Science Education.

Table 3. *Response Rate by Teacher Group, UB/BPS ISEP Teacher Questionnaire, Summer 2013*

| Group | Number of Teachers Involved in ISEP | Number of Responses Received | Response Rate |
|---|---|---|---|
| 1-Participated since 2012 & responded to survey in Summer 2012 and Summer 2013 | 46 | 17 | 37% |
| 2-Participated since 2012 but responded to survey only in Summer 2013, not in Summer 2012 | 13 | 3 | 23% |
| 3-New to ISEP in Summer 2013 | 17 | 8 | 47% |
| **Total** | **76** | **28** | **37%** |

### *UB/BPS ISEP Teacher PCK Assessment (Summer 2013)*

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). The same instruments will be administered to teachers again at the end of May 2014 (post).

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

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, at the end of Spring 2013 and in Fall 2013. Spring 2013 data served as post-data for school year 2012-2013, while Fall 2013 data served as pre-data for the 2013-2014 school year. Of the 70 teachers who received a package of this instrument (55 ISEP and 15 comparison teachers) in Spring 2013, 59 returned completed student instruments (48 ISEP and 11 comparison teachers, $n_{student}$ = 1,,098). 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). The response rates were 82% in Spring 2013 and 62% in Fall 2013, based on the number of teachers who were contacted.

### *UB-BPS ISEP STEM Student Questionnaire (Fall 2013)*

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 Fall 2013 and Spring 2014 using Qualtrics®. Nineteen STEM students completed this questionnaire in Fall 2013. Spring 2014 data were still being collected at the time of this report.

### *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 the parent-based PLC sessions between January 2013 and May 2014. Fifteen parents completed this questionnaire during their first PLC session.

## Data Analysis

### *School-Level Enrollment and Report Card Data*

Descriptive statistics (e.g., frequencies and percentages) were used to report changes between baseline (2010-2011) and the most up-to-date school-level data (2011-2012).

### *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 (pre) and Summer 2013 (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 2013 are not reported in this report. Summer 2013 (pre) and Summer 2014 (post) comparisons for those teachers who began participating in ISEP in Summer 2013 will be reported in the next annual evaluation report, along with questionnaire data from ISEP teachers who completed a second year with the project in 2013-2014. Factor analysis and reliability testing results using data collected in Summer 2012 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 *UB/BPS ISEP Teacher Questionnaire* only collected responses from 28 teachers in Summer 2013; no further factor analysis was conducted at this point. 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 analysis 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)*

Findings from the Summer *2013 UB/BPS ISEP Teacher PCK Assessment* data will be reported by the ISEP research team. The E & A Center will perform psychometric tests on the instruments using 2013-2014 pre- and post-data when they become available.

## *UB/BPS ISEP Student Questionnaire (Spring 2013)*

Independent-samples *t*-tests were conducted to compare students' responses to the *UB/BPS ISEP Student Questionnaire* in Spring 2013 (post) between students of ISEP participant teachers and of comparison teachers. Findings from Fall 2013 data (pre) will not be reported in this report. Instead, Fall 2013 (pre) and Spring 2014 (post) student data comparisons will be conducted and reported to the Project Team in Fall 2014 and will appear in the next annual evaluation report.

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. The next round of factor analysis will be conducted using Fall 2013 and Spring 2014 data. Latent variables will be constructed and inferential statistical analysis 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 student questionnaire data were conducted at the item level.

## *UB-BPS ISEP STEM Student Questionnaire (Fall 2013)*

Descriptive statistics (e.g., frequencies and percentages) were used to report the findings from the *UB-BPS ISEP STEM Student Questionnaire* (Fall 2013). Due to small sample sizes, non-parametric tests such as Mann-Whitney *U*-test were used to conduct comparisons at the item level between the responses of STEM undergraduate and STEM graduate students, as well as, 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. Data collected in Spring 2014 will be reported in the next annual evaluation report.

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

# Findings

## School-Level Enrollment and Report Card Data (2010-2011 and 2011-2012)

School-level data were collected and analyzed to compare aggregated teacher information, student demographics, and middle/high school student performance data for each ISEP partner school in 2010-2011 and in 2011-2012. Data for the 2012-2013 school year (first year of ISEP) were not publically available at the time of this report.

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 2011-2012, the percentage of teachers teaching without an appropriate license/certificate decreased at 6 of the 12 ISEP partner schools; the percentage of teachers with a Master's plus 30 hours or doctorate degree increased at 5 schools; the percentage of core courses not taught by highly qualified teachers decreased at 5 schools; 6 schools had all core courses taught by highly qualified teachers; the turnover rate of teachers with fewer than 5 years of experience decreased at 4 schools and remained the same at 2 other schools; and the turnover rate for all teachers decreased at 7 schools (Appendix F, Table F1).

From 2010-2011 to 2011-2012, the percentage of White students decreased across the New York State, across the BPS District, and at 4 of the 12 ISEP partner schools. The percentage of students eligible for free or reduced lunch increased at the state level, decreased at the district level, and decreased at 7 of the 12 ISEP partner schools (Appendix F, Tables F2 and F3).

For the 7 ISEP partner high schools, 4 had graduation rates lower than the BPS District average and only 1 was higher than the New York State average in 2011-2012. Two schools had increased graduation rates for students in all racial/ethnical subgroups, as well as for both male and female students in 2011-2012 (Appendix F, Table F3).

## UB/BPS ISEP Teacher Questionnaire Data, Summer 2012 and Summer 2013

### *Demographics*

Seventeen teachers responded to the *UB/BPS ISEP Teacher Questionnaire* in Summer 2012 before starting ISEP summer activities and again in Summer 2013 at the end of the 2012-2013 school year. Together, 1,215 students were taught by these teachers in science classes during the 2012-2013 school year. Demographic frequencies were calculated as shown in Tables 4 to 9.

Table 4 shows that 82% of these matched teacher respondents were White and 59% were female.

Table 4. *Respondents' Race and Gender, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

| Race/Ethnicity | Female | Male | Total (%) |
|---|---|---|---|
| White | 8 | 6 | 14 (82%) |
| Black or African American | 1 | 0 | 1 (6%) |
| Multi-Race | 0 | 1 | 1 (6%) |
| Not Indicated | 1 | 0 | 1 (6%) |
| **Total (%)** | **10 (59%)** | **7 (41%)** | **17 (100%)** |

Table 5 shows that all ISEP teachers were teaching science during the 2012-2013 school year. In addition, 18% were special education teachers.

Table 5. *Respondents' Position/Subject Taught During 2012-2013, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2013*

| **Taught During 2012-2013** | ***n*** | **Percent** |
|---|---|---|
| Science | 17 | 100 |
| Mathematics | 0 | 0 |
| Special Education Teacher | 3 | 18 |
| Career/Technical Education Teacher | 0 | 0 |

*Note.* Teachers could choose more than one subject.

As shown in Table 6, 88% of teachers were certified to teach science and 6% were certified to teach mathematics.

Table 6. *Respondents' Teaching Credential, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

| **Teaching Credential** | ***n*** | **Percent** |
|---|---|---|
| Certified to Teach Science | 15 | 88 |
| Certified to Teach Mathematics | 1 | 6 |

*Note.* Not all teachers responded to this item.

When asked about their teaching experience, most teachers reported that they had more than 13 years of K-12 teaching experience. Of the 17 teachers who had science teaching experience, the average number of years teaching science was 15 years. The average teaching experience in the current school was 9 years (Table 7).

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

| **Years of Experience** | ***n*** | ***M*** | ***SD*** | **Minimum** | **Median** | **Maximum** |
|---|---|---|---|---|---|---|
| Teaching in a K-12 school | 17 | 16 | 10 | 5 | 13 | 43 |
| Teaching K-12 Math | 17 | 3 | 9 | 0 | 0 | 35 |
| | | | | | | |
| Teaching K-12 Science | 17 | 15 | 10 | 5 | 13 | 43 |
| Teaching in Current School | 17 | 9 | 7 | 1 | 9 | 31 |

Table 8 shows the grade levels and subjects taught by ISEP teacher respondents. Most ISEP teachers taught at the high school level and taught Living Environment, Earth Science, or Environmental Science in 2012-2013.

Table 8. *Subject Area Taught by Respondents, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2013*

| **Courses Currently Teaching** | ***n*** | **Percent** |
|---|---|---|
| 7th Grade Physical Science | 3 | 18 |
| 8th Grade Life Science | 3 | 18 |
| Regents Living Environment | 8 | 47 |

| Courses Currently Teaching | *n* | Percent |
|---|---|---|
| Regents Earth Science | 4 | 24 |
| Regents Chemistry | 1 | 6 |
| Regents Physics | 1 | 6 |
| High School Biology and Lab | 3 | 18 |
| High School Environmental Science | 5 | 29 |
| High School AP Biology | 1 | 6 |
| High School Advanced Biology | 1 | 6 |
| High School Anatomy & Physiology | 2 | 12 |

*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 2012-2013. In addition, teachers reported that they had participated in an average of 33 hours of professional development activities outside of PD courses or activities with UB and/or BSC in 2012-2013, as shown in Table 9.

Table 9. *Amount of PD Hours in 2012-2013, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2013*

| | *n* | *M* | *SD* | Minimum | Median | Maximum | Sum |
|---|---|---|---|---|---|---|---|
| **UB/BSC ISEP PD Hours on…** | | | | | | | |
| Content | 13 | 32 | 45 | 0 | 10 | 160 | 414 |
| Assessment | 10 | 10 | 15 | 0 | 5 | 50 | 96 |
| Curriculum | 11 | 8 | 10 | 0 | 4 | 30 | 85 |
| Pedagogy | 12 | 35 | 90 | 0 | 9 | 320 | 421 |
| **Non-UB/BSC PD Hours** | 13 | 33 | 41 | 6 | 20 | 164 | 435 |

## Science Preparation and Professional Development Needs

Table 10 shows ISEP teachers' self-reported preparedness for science instruction. Teachers indicated that they were better prepared to encourage participation of females and minorities in science courses after participating in ISEP professional development. Teachers reported less preparedness to teach scientific inquiry; lead a class of students using investigative strategies; take into account students' prior conceptions when planning instruction; and align standards, curriculum, instruction, and assessment to enhance student science learning. Though these changes were not statistically significant, they may indicate that teachers were developing new, deeper understandings of inquiry teaching and learning; and therefore, they felt less prepared to implement this new learning in their classrooms. Other gains of practical significance reported by teachers included better preparedness to teach a diverse range of students and make curricular decisions aligned with standards.

Table 10. *Respondents' Preparedness for Science Instruction, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012 and Summer 2013*

| **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 | 13 | 3.54 | 0.52 | 1.000 |
| | Post | 13 | 3.54 | 0.66 | |
| b. Teach scientific inquiry. | Pre | 14 | 3.43 | 0.76 | .102 |
| | Post | 14 | 3.14 | 0.86 | |
| c. Manage a class of students who are using hands-on or laboratory activities. | Pre | 13 | 3.38 | 0.77 | .655 |
| | Post | 13 | 3.46 | 0.78 | |
| d. Lead a class of students using investigative strategies. | Pre | 13 | 3.23 | 0.93 | .785 |
| | Post | 13 | 3.15 | 0.90 | |
| e. Take into account students' prior conceptions about natural phenomena when planning instruction. | Pre | 13 | 3.38 | 0.87 | .414 |
| | Post | 13 | 3.23 | 0.83 | |
| f. Align standards, curriculum, instruction, and assessment to enhance student science learning. | Pre | 13 | 3.38 | 0.65 | .564 |
| | Post | 13 | 3.31 | 0.85 | |
| g. Sequence (articulation of) science instruction to meet instructional goals across grade levels and courses. | Pre | 13 | 2.92 | 1.04 | .107 |
| | Post | 13 | 3.46 | 0.78 | |
| h. Select and/or adapt instructional materials to implement your written curriculum. | Pre | 13 | 3.31 | 0.85 | .180 |
| | Post | 13 | 3.54 | 0.52 | |
| i. Know the major unifying concepts of all sciences and how these concepts relate to other disciplines. | Pre | 13 | 2.92 | 0.86 | .366 |
| | Post | 13 | 3.15 | 0.69 | |
| j. Understand how students differ in their approaches to learning and create instructional opportunities that are adapted to diverse learners. | Pre | 13 | 3.31 | 0.85 | .480 |
| | Post | 13 | 3.46 | 0.78 | |
| k. Teach science to students from a variety of cultural backgrounds. | Pre | 13 | 3.15 | 1.07 | .096 |
| | Post | 13 | 3.54 | 0.52 | |
| l. Teach science to students who have limited English proficiency. | Pre | 13 | 2.54 | 1.20 | .304 |
| | Post | 13 | 3.08 | 1.26 | |
| m. Teach students who have a learning disability which impacts science learning. | Pre | 13 | 2.92 | 1.19 | .107 |
| | Post | 13 | 3.46 | 0.97 | |
| n. Encourage participation of females and minorities in science courses. | Pre | 12 | 3.42 | 0.51 | **.025** |
| | Post | 12 | 3.83 | 0.39 | |
| o. Provide a challenging curriculum for all students you teach. | Pre | 11 | 3.45 | 0.69 | .564 |
| | Post | 11 | 3.55 | 0.69 | |
| p. Learn the processes involved in reading and how to teach reading in science. | Pre | 13 | 3.00 | 1.08 | .655 |
| | Post | 13 | 2.92 | 1.04 | |

| 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 | 13 | 3.46 | 0.78 | 1.000 |
| | Post | 13 | 3.46 | 0.66 | |
| r. Use a variety of technological tools (student response systems, lab interfaces and probes, etc) to enhance student learning. | Pre | 13 | 2.69 | 0.85 | .144 |
| | Post | 13 | 3.23 | 0.73 | |
| s. Teach interdisciplinary science inquiry. | Pre | 13 | 3.08 | 0.95 | .564 |
| | Post | 13 | 3.15 | 0.90 | |

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) and practices of science and engineering (i.e., construct explanations and design solutions) than they did following one 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., plan and carry out investigations) after their year of participation as shown in Appendix G, Table G1.

## *Science as Inquiry & Understanding the Nature of Science*

Table 11 shows teachers' views of inquiry-based science teaching and learning practices. Following their first year of participation in ISEP activities, teacher participants agreed more with the misconception that inquiry-based learning requires more sophisticated materials and equipment than other types of classroom learning.

Table 11. *Respondents' Views of Inquiry-Based Science Teaching and Learning, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012 and Summer 2013*

| 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 | 14 | 3.64 | 0.93 | .161 |
| | Post | 14 | 4.07 | 0.92 | |
| 2.Inquiry-based learning requires that learners gather (or are given) data to use as evidence for answering a scientifically-oriented question. | Pre | 15 | 3.93 | 0.59 | .166 |
| | Post | 15 | 4.27 | 0.80 | |
| 3.Inquiry-based learning requires that learners manipulate and analyze data to develop evidenced-based explanations, by looking for patterns and drawing conclusions. | Pre | 15 | 4.13 | 0.52 | .414 |
| | Post | 15 | 4.27 | 0.70 | |
| 4.Inquiry-based learning requires that learners connect their explanations with explanations and concepts developed by the scientific community. | Pre | 15 | 4.00 | 0.65 | .480 |
| | Post | 15 | 4.13 | 0.64 | |

| **Q32. Views of inquiry-based science teaching and learning.** | **Time** | ***n*** | ***M*** | ***SD*** | **Wilcoxon Signed Rank Test *p*** |
|---|---|---|---|---|---|
| 5.Inquiry-based learning requires that learners communicate, justify, and defend their explanations. | Pre | 15 | 4.07 | 0.88 | .582 |
| | Post | 15 | 4.27 | 0.88 | |
| 6.Inquiry-based learning requires that learners first understand basic, key science concepts prior to engaging in inquiry activities. | Pre | 14 | 3.71 | 0.99 | .582 |
| | Post | 14 | 3.50 | 1.22 | |
| 7.Inquiry-based learning assumes that all science subject matter should be taught through inquiry. | Pre | 15 | 2.87 | 1.06 | .660 |
| | Post | 15 | 2.93 | 1.10 | |
| 8.Inquiry-based learning requires that learners generate and investigate their own questions. | Pre | 15 | 3.80 | 0.86 | .096 |
| | Post | 15 | 4.13 | 0.83 | |
| 9.Inquiry-based learning requires the use of hands-on or kit-based instructional materials. | Pre | 15 | 3.67 | 0.98 | .755 |
| | Post | 15 | 3.60 | 0.91 | |
| 10.Inquiry-based learning requires that learners are engaged in hands-on activities. | Pre | 15 | 4.00 | 0.76 | 1.000 |
| | Post | 15 | 4.00 | 0.85 | |
| 11.Inquiry, as a process of science, can be taught without attention to specific science content or subject matter. | Pre | 15 | 3.00 | 1.31 | .560 |
| | Post | 15 | 3.33 | 1.05 | |
| 12.Inquiry-based learning assumes that learners build new knowledge and understanding on what they already know. | Pre | 15 | 4.27 | 0.70 | .102 |
| | Post | 15 | 4.00 | 0.76 | |
| 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 | 15 | 3.93 | 0.70 | .096 |
| | Post | 15 | 4.27 | 0.59 | |
| 14.Inquiry-based learning assumes that learning is mediated by the social environment in which learners interact with others. | Pre | 15 | 3.47 | 0.83 | .248 |
| | Post | 15 | 3.73 | 0.70 | |
| 15.Inquiry-based learning requires that learners take control of their own learning. | Pre | 15 | 4.07 | 0.70 | .317 |
| | Post | 15 | 4.27 | 0.70 | |
| 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 | 15 | 3.87 | 0.64 | .166 |
| | Post | 15 | 4.20 | 0.68 | |
| 17.Inquiry-based learning requires more sophisticated materials and equipment than other types of classroom learning. | Pre | 15 | 2.60 | 1.18 | **.032** |
| | Post | 15 | 3.40 | 1.24 | |
| 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 | 15 | 3.87 | 1.13 | .119 |
| | Post | 15 | 4.27 | 0.70 | |
| 19.Inquiry-based teaching focuses more on what the students do, rather than on what the teacher does. | Pre | 15 | 3.87 | 1.06 | .340 |
| | Post | 15 | 4.13 | 1.19 | |
| 20.Inquiry-based teaching requires that the teacher have a strong background in the science content related to the inquiry. | Pre | 15 | 3.87 | 0.74 | .334 |
| | Post | 15 | 4.07 | 0.70 | |

Table 12 shows data regarding teachers' understanding of the Nature of Science. Following participation in ISEP activities, teacher participants agreed more that scientific knowledge is reliable and durable so having confidence in scientific knowledge is reasonable. Teachers also agreed more with misconceptions regarding scientific methods and how scientists might use their imagination and creativity. Although teachers demonstrated a good understanding of some aspects of the Nature of Science, they held misconceptions on scientific methods and knowledge.

Table 12. *Respondents' Understanding of the Nature of Science, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012 and Summer 2013*

| **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 | 15 | 4.00 | 0.53 | .180 |
| | Post | 15 | 4.20 | 0.56 | |
| 2.Scientific knowledge is reliable and durable so having confidence in scientific knowledge is reasonable. | Pre | 14 | 3.57 | 0.76 | **.020** |
| | Post | 14 | 4.07 | 0.73 | |
| 3.A universal step-by-step scientific method is used by all scientists. | Pre | 15 | 3.47 | 0.99 | **.038** |
| | Post | 15 | 3.93 | 0.88 | |
| 4.Scientific experiments are the only means used to develop scientific knowledge. | Pre | 15 | 2.87 | 0.83 | .891 |
| | Post | 15 | 2.87 | 1.06 | |
| 5.Contributions to science are made by people from all cultures around the world. | Pre | 15 | 4.40 | 0.51 | .414 |
| | Post | 15 | 4.27 | 0.46 | |
| 6.Scientific observations and conclusions are influenced by the existing state of scientific knowledge. | Pre | 15 | 4.07 | 0.46 | .414 |
| | Post | 15 | 4.20 | 0.41 | |
| 7.With new evidence and/or interpretation, existing scientific ideas are replaced or supplemented by newer ones. | Pre | 15 | 3.93 | 0.70 | .257 |
| | Post | 15 | 4.13 | 0.52 | |
| 8.Basic scientific research is concerned primarily with practical outcomes related to developing technology. | Pre | 15 | 2.80 | 0.77 | .248 |
| | Post | 15 | 3.07 | 1.22 | |
| 9.The principal product of science is conceptual knowledge about and explanations of the natural world. | Pre | 15 | 3.47 | 0.83 | .470 |
| | Post | 15 | 3.67 | 0.72 | |
| 10.Scientific laws are generalizations or universal relationships about some aspect of the natural world and how it behaves under certain conditions. | Pre | 15 | 3.33 | 0.82 | .054 |
| | Post | 15 | 3.87 | 0.64 | |
| 11.Scientific theories are inferred explanations of some aspect of the natural world. | Pre | 15 | 3.73 | 0.80 | 1.000 |
| | Post | 15 | 3.73 | 0.59 | |
| 12.All scientific laws have accompanying explanatory theories. | Pre | 15 | 3.67 | 0.62 | .470 |
| | Post | 15 | 3.47 | 1.06 | |
| 13.Scientific conclusions are to some extent influenced by the social and cultural context of the researcher. | Pre | 15 | 3.27 | 1.10 | .518 |
| | Post | 15 | 3.47 | 1.13 | |

| Q33. Understanding the Nature of Science. | Time | *n* | *M* | *SD* | Wilcoxon Signed Rank Test *p* |
|---|---|---|---|---|---|
| 14.Scientific observations are to some extent influenced by the observer's experiences and expectations. | Pre | 15 | 3.33 | 1.05 | .429 |
| | Post | 15 | 3.60 | 1.06 | |
| 15.Scientists may make different interpretations based on the same observations. | Pre | 15 | 3.73 | 0.59 | .785 |
| | Post | 15 | 3.67 | 0.90 | |
| 16.Scientific theories are subject to on-going testing and revision. | Pre | 15 | 4.00 | 0.53 | .206 |
| | Post | 15 | 4.27 | 0.59 | |
| 17.Scientific laws are theories that have been proven. | Pre | 15 | 3.67 | 0.82 | .317 |
| | Post | 15 | 3.80 | 0.86 | |
| 18.Cultural values and expectations do not influence scientific research because scientists are trained to conduct unbiased studies. | Pre | 14 | 3.14 | 0.86 | .157 |
| | Post | 14 | 3.43 | 1.02 | |
| 19.Scientists do not use their imagination and creativity because these can interfere with objectivity. | Pre | 14 | 2.29 | 0.99 | **.033** |
| | Post | 14 | 2.86 | 1.17 | |
| 20.Scientific knowledge is tentative and may be abandoned or modified in light of new evidence or reconceptualization of prior evidence and knowledge. | Pre | 14 | 3.64 | 0.93 | .084 |
| | Post | 14 | 4.07 | 0.83 | |

### *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. There were no statistically significant changes in teachers' reported familiarity, beliefs, or attitudes about design, engineering, and technology following PD participation More than half (65%) of ISEP teachers reported using science kits during science instruction. Among science kits used, SEPUP kits were used most frequently by teachers (see Appendix G, Tables G2 through G10.)

### *Attitudes and Beliefs about Teaching Science and Mathematics*

As shown in Table 13, compared to before participating in ISEP activities, teacher participants agreed more that the use of technologies (e.g., calculators, computers) in science is an aid primarily for slow learners after completing the first year of ISEP activities.

Table 13. *Respondents' Attitudes and Beliefs about Teaching Science and Mathematics, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012 and Summer 2013*

| **Q46. Attitudes and Beliefs about Teaching Science and Mathematics** | **Time** | ***n*** | ***M*** | ***SD*** | **Wilcoxon Signed Rank Test *p*** |
|---|---|---|---|---|---|
| a. In Grades K-9, truly understanding mathematics in schools requires special abilities that only some people possess. | Pre | 4 | 3.00 | 0.82 | 1.000 |
| | Post | 4 | 2.75 | 1.50 | |
| b. The use of technologies (e.g., calculators, computers) in mathematics is an aid primarily for slow learners. | Pre | 4 | 2.50 | 1.00 | .655 |
| | Post | 4 | 2.75 | 1.50 | |
| c. Mathematics consists of unrelated topics (e.g., algebra, arithmetic, calculus, geometry). | Pre | 4 | 2.75 | 0.96 | 1.000 |
| | Post | 4 | 2.75 | 1.50 | |
| d. To understand mathematics, students must solve many problems following examples provided. | Pre | 4 | 3.75 | 0.50 | .655 |
| | Post | 4 | 3.50 | 1.73 | |
| e. Students should have opportunities to experience manipulating materials in the mathematics classroom before teachers introduce mathematics vocabulary. | Pre | 4 | 3.75 | 0.50 | .414 |
| | Post | 4 | 3.00 | 1.41 | |
| f. Getting the correct answer to a problem in the mathematics classroom is more important than investigating the problem in a mathematical manner. | Pre | 3 | 2.00 | 0.00 | 1.000 |
| | Post | 3 | 2.00 | 1.00 | |
| g. Students should be given regular opportunities to think about what they have learned in the mathematics classroom. | Pre | 4 | 4.00 | 0.82 | .655 |
| | Post | 4 | 3.25 | 1.50 | |
| h. Using technologies (e.g., calculators, computers) in mathematics lessons will improve students' understanding of mathematics. | Pre | 4 | 3.50 | 1.00 | .655 |
| | Post | 4 | 3.25 | 1.50 | |
| i. The primary reason for learning mathematics is to learn skills for doing science. | Pre | 4 | 3.50 | 1.00 | .317 |
| | Post | 4 | 2.75 | 1.50 | |
| j. Small group activity should be a regular part of the mathematics classroom. | Pre | 4 | 4.00 | 0.00 | .317 |
| | Post | 4 | 3.25 | 1.50 | |
| k. Using technologies (e.g., calculators, computers) in science lessons will improve students' understanding of science. | Pre | 15 | 3.93 | 0.80 | .666 |
| | Post | 15 | 3.73 | 1.28 | |
| l. Getting the correct answer to a problem in the science classroom is more important than investigating the problem in a scientific manner. | Pre | 15 | 2.00 | 0.38 | .271 |
| | Post | 15 | 2.27 | 1.03 | |
| m. In Grades K-9, truly understanding science in the science classroom requires special abilities that only some people possess. | Pre | 15 | 1.93 | 0.80 | .429 |
| | Post | 15 | 2.20 | 1.15 | |
| n. Students should be given regular opportunities to think about what they have learned in the science classroom. | Pre | 15 | 4.27 | 0.59 | .317 |
| | Post | 15 | 4.07 | 0.70 | |

| Q46. Attitudes and Beliefs about Teaching Science and Mathematics | Time | *n* | *M* | *SD* | Wilcoxon Signed Rank Test *p* |
|---|---|---|---|---|---|
| o. Science is a constantly expanding field. | Pre | 15 | 4.47 | 0.52 | .083 |
| | Post | 15 | 4.27 | 0.70 | |
| p. Theories in science are rarely replaced by other theories. | Pre | 15 | 2.40 | 1.18 | .546 |
| | Post | 15 | 2.60 | 1.12 | |
| q. To understand science, students must solve many problems following examples provided. | Pre | 14 | 2.79 | 0.70 | .527 |
| | Post | 14 | 2.93 | 1.00 | |
| r. The use of technologies (e.g., calculators, computers) in science is an aid primarily for slow learners. | Pre | 15 | 1.60 | 0.63 | **.017** |
| | Post | 15 | 2.67 | 1.18 | |
| s. Students should have opportunities to experience manipulating materials in the science classroom before teachers introduce scientific vocabulary. | Pre | 15 | 3.40 | 0.99 | .314 |
| | Post | 15 | 3.67 | 0.72 | |
| t. Science consists of unrelated topics such as biology, chemistry, geology, and physics. | Pre | 15 | 2.40 | 1.12 | .236 |
| | Post | 15 | 2.73 | 1.33 | |
| u. Calculators should always be available for students in science classes. | Pre | 15 | 3.80 | 0.68 | .070 |
| | Post | 15 | 3.33 | 1.11 | |
| v. The primary reason for learning science is to provide real-life examples for learning mathematics. | Pre | 15 | 2.33 | 0.98 | .713 |
| | Post | 15 | 2.47 | 0.92 | |
| w. Small group activity should be a regular part of the science classroom. | Pre | 15 | 4.07 | 0.59 | .131 |
| | Post | 15 | 3.73 | 0.70 | |
| x. The idea of teaching science scares me. | Pre | 15 | 1.47 | 0.74 | .163 |
| | Post | 15 | 1.80 | 1.15 | |
| y. The idea of teaching engineering design concepts scares me. | Pre | 15 | 2.07 | 1.10 | .584 |
| | Post | 15 | 2.27 | 0.70 | |
| z. I prefer to teach engineering design concepts and science emphasizing connections between the two disciplines. | Pre | 15 | 3.20 | 0.86 | .426 |
| | Post | 15 | 3.40 | 0.63 | |
| aa. I feel prepared to teach engineering design concepts and science emphasizing connections between the two disciplines. | Pre | 15 | 3.00 | 1.00 | 1.000 |
| | Post | 15 | 3.00 | 0.65 | |

## UB/BPS ISEP Student Questionnaire Data, Spring 2013

### *Demographics*

In Spring 2013, 1,098 students responded to the *UB/BPS ISEP Student Questionnaire.* Among them, 918 students from the 12 BPS ISEP partner schools taught by ISEP teachers were compared with 180 students served by teachers who were not involved in ISEP, but who also taught in the 12 partner schools.

Tables 14 to 17 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.

Table 14. *Respondents' Grade Band by Teacher and School Participation Status, UB/BPS ISEP Student Questionnaire, Spring 2013*

| Grade Band | Teacher Participation | Schools with Only ISEP Data | Schools with both Control and ISEP Data | Total |
|---|---|---|---|---|
| ES | Control | 0 | 29 | 29 |
| | ISEP | 75 | 79 | 154 |
| | **Total** | **75** | **108** | **183** |
| MS | Control | 0 | 54 | 54 |
| | ISEP | 78 | 96 | 174 |
| | **Total** | **78** | **150** | **228** |
| HS | Control | 0 | 97 | 97 |
| | ISEP | 314 | 276 | 590 |
| | **Total** | **314** | **373** | **687** |
| **Total** | Control | 0 | 180 | 180 |
| | ISEP | 467 | 451 | 918 |
| | **Total** | **467** | **631** | **1098** |

Table 15. *Respondents' Gender by Teacher and School Participation Status, UB/BPS ISEP Student Questionnaire, Spring 2013*

| School Type | Gender | Control Teacher | ISEP Teacher | Total |
|---|---|---|---|---|
| Schools with Only ISEP Data | Not Reported | -- | 5 | 5 |
| | Female | -- | 221 | 221 |
| | Male | -- | 241 | 241 |
| | **Total** | **--** | **467** | **467** |
| Schools with both Control and ISEP Data | Not Reported | 1 | 3 | 4 |
| | Female | 88 | 224 | 312 |
| | Male | 91 | 224 | 315 |
| | **Total** | **180** | **451** | **631** |
| **Total** | Not Reported | 1 | 8 | 9 |
| | Female | 88 | 445 | 533 |
| | Male | 91 | 465 | 556 |
| | **Total** | **180** | **918** | **1098** |

Table 16. *Respondents' Race/Ethnicity by Teacher and School Participation Status, UB/BPS ISEP Student Questionnaire, Spring 2013*

| School Type | Race/Ethnicity | Control Teacher | ISEP Teacher | Total |
|---|---|---|---|---|
| Schools with Only ISEP Data | Not Reported | -- | 7 | 7 |
| | American Indian or Alaska Native | -- | 11 | 11 |
| | Asian | -- | 65 | 65 |
| | Black or African American | -- | 153 | 153 |
| | Hispanic/Latino(a) | -- | 89 | 89 |
| | Multi-Race | -- | 42 | 42 |
| | Native Hawaiian Or Other Pacific Islander | -- | 1 | 1 |
| | Not Hispanic/Latino(a)* | -- | 8 | 8 |
| | White | -- | 91 | 91 |
| | **Total** | **--** | **467** | **467** |
| Schools with both Control and ISEP Data | Not Reported | 4 | 5 | 9 |
| | American Indian or Alaska Native | 1 | 6 | 7 |
| | Asian | 11 | 16 | 27 |
| | Black or African American | 90 | 203 | 293 |
| | Hispanic/Latino(a) | 26 | 68 | 94 |
| | Multi-Race | 6 | 54 | 60 |
| | Native Hawaiian Or Other Pacific Islander | 0 | 1 | 1 |
| | Not Hispanic/Latino(a)* | 3 | 5 | 8 |
| | White | 39 | 93 | 132 |
| | **Total** | **180** | **451** | **631** |
| **Total** | Not Reported | 4 | 12 | 16 |
| | American Indian or Alaska Native | 1 | 17 | 18 |
| | Asian | 11 | 81 | 92 |
| | Black or African American | 90 | 356 | 446 |
| | Hispanic/Latino(a) | 26 | 157 | 183 |
| | Multi-Race | 6 | 96 | 102 |
| | Native Hawaiian Or Other Pacific Islander | 0 | 2 | 2 |
| | Not Hispanic/Latino(a)* | 3 | 13 | 16 |
| | White | 39 | 184 | 223 |
| | **Total** | **180** | **918** | **1098** |

* Respondents reported ethnicity, but did not report race.

*Table 17. Respondents' Grade by Teacher and School Participation Status, UB/BPS ISEP Student Questionnaire, Spring 2013*

| School Type | Grade | Control Teacher | ISEP Teacher | Total |
|---|---|---|---|---|
| Schools with Only ISEP Data | 5 | -- | 30 | 30 |
| | 6 | -- | 45 | 45 |
| | 7 | -- | 22 | 22 |
| | 8 | -- | 56 | 56 |
| | 9 | -- | 92 | 92 |
| | 10 | -- | 101 | 101 |
| | 11 | -- | 88 | 88 |
| | 12 | -- | 33 | 33 |
| | **Total** | **--** | **467** | **467** |
| Schools with both Control and ISEP Data | 5 | 18 | 60 | 78 |
| | 6 | 11 | 19 | 30 |
| | 7 | 15 | 27 | 42 |
| | 8 | 39 | 69 | 108 |
| | 9 | 31 | 99 | 130 |
| | 10 | 58 | 24 | 82 |
| | 11 | 8 | 56 | 64 |
| | 12 | 0 | 97 | 97 |
| | **Total** | **180** | **451** | **631** |
| **Total** | 5 | 18 | 90 | 108 |
| | 6 | 11 | 64 | 75 |
| | 7 | 15 | 49 | 64 |
| | 8 | 39 | 125 | 164 |
| | 9 | 31 | 191 | 222 |
| | 10 | 58 | 125 | 183 |
| | 11 | 8 | 144 | 152 |
| | 12 | 0 | 130 | 130 |
| | **Total** | **180** | **918** | **1098** |

## *Elementary Grades Students' Attitudes and Perceptions About Science Learning*

When comparing attitudes and opinions of elementary grades control and ISEP participant students, students of ISEP teachers agreed more that they like science, and would keep on taking science classes even if they did not have to, than did students of non-ISEP teachers. Students of ISEP teachers also demonstrated a better understanding of the Nature of Science than did their peers taught by teachers not participating in ISEP. In addition, students of ISEP teachers reported that their teachers more frequently asked them to give reasons and provide evidence for their answers; encouraged them to ask questions, to explain their ideas to other students, to consider different scientific explanations; provided time for them to discuss science ideas with other students; and provided meaningful and challenging assignments, than did students of control teachers. Students of ISEP teachers also self-reported that they talked with other students about how to do a science task or about how to interpret the data from an experiment and considered different scientific explanations more often than did students of control teachers. Of the 24 items asking students' perceptions of their classroom experiences, ISEP teachers' students reported more often that their classrooms were inquiry-oriented than did students of non-ISEP teachers. Students of ISEP teachers also indicated there were adults at home who made them do their science homework more often than did students of control teachers (Table 18).

Table 18. *Comparisons of Students' Responses by Teacher Participation Status, UB/BPS ISEP Student Questionnaire, Spring 2013, Elementary School Students*

| Item | Teacher Participation | *n* | *M* | *SD* | *t* | *df* | *p* |
|---|---|---|---|---|---|---|---|
| **Q8. Views of Science** | | | | | | | |
| Q8a. I like science. | Control | 27 | 3.41 | 1.25 | -2.25 | 175 | **.026** |
| | ISEP | 150 | 3.94 | 1.11 | | | |
| Q8b. I am good at science. | Control | 27 | 3.37 | 1.28 | -0.59 | 31 | .563 |
| | ISEP | 146 | 3.52 | 0.90 | | | |
| Q8c. I would keep on taking science classes even if I did not have to. | Control | 26 | 2.69 | 1.46 | -2.24 | 169 | **.027** |
| | ISEP | 145 | 3.32 | 1.28 | | | |
| Q8d. I understand most of what goes on in science. | Control | 28 | 3.46 | 1.07 | -1.51 | 175 | .133 |
| | ISEP | 149 | 3.76 | 0.92 | | | |
| Q8e. Almost all people use science in their jobs. | Control | 27 | 2.37 | 1.04 | -3.49 | 169 | **.001** |
| | ISEP | 144 | 3.13 | 1.04 | | | |
| Q8f. Science is useful for solving everyday problems. | Control | 26 | 2.65 | 1.38 | -1.96 | 31 | .060 |
| | ISEP | 146 | 3.21 | 1.07 | | | |
| Q8g. Science is a way to study and understand the natural world. | Control | 24 | 3.92 | 1.28 | -0.87 | 163 | .386 |
| | ISEP | 141 | 4.11 | 0.93 | | | |
| Q8h. Scientists sometimes disagree about scientific knowledge. | Control | 26 | 3.04 | 1.18 | -2.56 | 164 | **.011** |
| | ISEP | 140 | 3.61 | 1.03 | | | |
| Q8i. All scientists do not follow the same step-by-step method to do science. | Control | 27 | 3.04 | 1.48 | -1.20 | 169 | .230 |
| | ISEP | 144 | 3.36 | 1.24 | | | |
| Q8j. Scientists use their imagination when doing science. | Control | 27 | 2.96 | 1.29 | -0.87 | 170 | .384 |
| | ISEP | 145 | 3.19 | 1.21 | | | |
| Q8k. Science ideas or hypotheses must be supported by evidence. | Control | 27 | 3.41 | 1.31 | -1.40 | 171 | .165 |
| | ISEP | 146 | 3.75 | 1.16 | | | |
| Q8l. Scientific theories can change when new evidence or a new explanation becomes available. | Control | 27 | 3.11 | 1.05 | -3.68 | 171 | **< .001** |
| | ISEP | 146 | 3.89 | 1.00 | | | |
| **Q9. In this class, my teacher ...** | | | | | | | |
| Q9a. arranges the classroom so students can have discussion. | Control | 27 | 3.19 | 1.59 | -0.71 | 172 | .480 |
| | ISEP | 147 | 3.40 | 1.43 | | | |
| Q9b. asks questions that have more than one answer. | Control | 25 | 3.40 | 1.22 | -1.48 | 168 | .139 |
| | ISEP | 145 | 3.79 | 1.20 | | | |
| Q9c. asks me to give reasons and provide evidence for my answers. | Control | 27 | 3.89 | 1.19 | -2.34 | 171 | **.020** |
| | ISEP | 146 | 4.38 | 0.96 | | | |
| Q9d. encourages me to ask questions. | Control | 27 | 3.15 | 1.38 | -2.85 | 172 | **.005** |
| | ISEP | 147 | 3.90 | 1.23 | | | |

| Item | Teacher Participation | *n* | *M* | *SD* | *t* | *df* | *p* |
|---|---|---|---|---|---|---|---|
| **Q9. In this class, my teacher ...** | | | | | | | |
| Q9e. let me work at my own pace. | Control | 26 | 3.15 | 1.57 | -0.05 | 30 | .957 |
| | ISEP | 146 | 3.17 | 1.21 | | | |
| Q9f. encourages me to explain my ideas to other students. | Control | 27 | 2.85 | 1.59 | -2.79 | 32 | **.009** |
| | ISEP | 147 | 3.75 | 1.20 | | | |
| Q9g. encourage me to consider different scientific explanations. | Control | 26 | 2.50 | 1.17 | -5.03 | 169 | **< .001** |
| | ISEP | 145 | 3.79 | 1.21 | | | |
| Q9h. provides time for me to discuss science ideas with other students. | Control | 27 | 3.04 | 1.53 | -2.14 | 169 | **.033** |
| | ISEP | 144 | 3.65 | 1.32 | | | |
| Q9i. checks that I have completed my assignments. | Control | 27 | 3.96 | 1.37 | -1.41 | 169 | .161 |
| | ISEP | 144 | 4.31 | 1.12 | | | |
| Q9j. provides meaningful and challenging assignments. | Control | 26 | 3.50 | 1.17 | -2.20 | 168 | **.029** |
| | ISEP | 144 | 3.99 | 1.01 | | | |
| Q9k. helps me apply my learning to real life. | Control | 27 | 3.74 | 1.20 | -1.06 | 170 | .291 |
| | ISEP | 145 | 4.01 | 1.24 | | | |
| Q9l. expects me to do well. | Control | 27 | 4.04 | 1.51 | -1.62 | 30 | .116 |
| | ISEP | 147 | 4.52 | 0.97 | | | |
| **Q10. In this class, I ...** | | | | | | | |
| Q10a. use information and data to support my conclusions. | Control | 26 | 3.69 | 1.38 | -1.08 | 30 | .287 |
| | ISEP | 145 | 4.00 | 1.05 | | | |
| Q10b. talk with other students about how to do a science task or about how to interpret the data from an experiment. | Control | 25 | 3.20 | 1.35 | -2.37 | 163 | **.019** |
| | ISEP | 140 | 3.79 | 1.10 | | | |
| Q10c. learn from other students. | Control | 25 | 3.24 | 1.16 | -1.67 | 161 | .096 |
| | ISEP | 138 | 3.68 | 1.22 | | | |
| Q10d. consider different scientific explanations. | Control | 26 | 2.88 | 1.28 | -2.89 | 166 | **.004** |
| | ISEP | 142 | 3.59 | 1.12 | | | |
| Q10e. have a say in deciding what activities I do. | Control | 26 | 2.77 | 1.21 | -0.05 | 167 | .959 |
| | ISEP | 143 | 2.78 | 1.27 | | | |
| Q10f. use a computer or the Internet for science assignments or activities. | Control | 25 | 3.04 | 1.67 | 0.74 | 28 | .467 |
| | ISEP | 143 | 2.78 | 1.18 | | | |
| Q10g. write about how I solved a science task or about what I am learning. | Control | 27 | 3.44 | 1.45 | -1.00 | 167 | .319 |
| | ISEP | 142 | 3.71 | 1.24 | | | |
| Q10h. learn that there are different solutions to science tasks. | Control | 24 | 3.38 | 1.31 | -1.76 | 28 | .090 |
| | ISEP | 144 | 3.87 | 1.01 | | | |
| Q10i. use multiple sources of information to learn. | Control | 25 | 3.56 | 1.19 | -1.41 | 167 | .161 |
| | ISEP | 144 | 3.91 | 1.14 | | | |
| Q10j. develop my skills for doing science. | Control | 24 | 3.58 | 1.14 | -1.74 | 163 | .083 |
| | ISEP | 141 | 3.99 | 1.05 | | | |

| Item | Teacher Participation | *n* | *M* | *SD* | *t* | *df* | *p* |
|---|---|---|---|---|---|---|---|
| **Q10. In this class, I ...** | | | | | | | |
| Q10k. learn about how science is important in the real world. | Control | 26 | 3.62 | 1.27 | -1.62 | 31 | .115 |
| | ISEP | 141 | 4.04 | 1.03 | | | |
| Q10l. work on science tasks in a group with other students. | Control | 25 | 3.68 | 1.46 | -0.99 | 29 | .328 |
| | ISEP | 142 | 3.99 | 1.12 | | | |
| **Q11. At least one adult in my home, ...** | | | | | | | |
| Q11a. makes me do my science homework. | Control | 25 | 2.40 | 1.78 | -3.40 | 163 | **.001** |
| | ISEP | 140 | 3.55 | 1.51 | | | |
| Q11b. asks about what I am learning in science class. | Control | 24 | 3.08 | 1.38 | -0.85 | 162 | .396 |
| | ISEP | 140 | 3.35 | 1.42 | | | |
| Q11c. helps me with my science homework. | Control | 24 | 2.63 | 1.69 | -1.33 | 161 | .185 |
| | ISEP | 139 | 3.09 | 1.55 | | | |
| Q11d. helps me work on my science projects. | Control | 24 | 3.21 | 1.53 | 0.52 | 161 | .605 |
| | ISEP | 139 | 3.02 | 1.65 | | | |
| Q11e. expects me to do well in science. | Control | 26 | 4.04 | 1.37 | -1.79 | 165 | .075 |
| | ISEP | 141 | 4.45 | 1.00 | | | |
| Q11f. expects me to go to college. | Control | 27 | 4.33 | 1.33 | -1.63 | 29 | .114 |
| | ISEP | 138 | 4.76 | 0.66 | | | |
| Q11g. expects me to have a science-related career. | Control | 26 | 3.35 | 1.65 | 1.77 | 163 | .078 |
| | ISEP | 139 | 2.77 | 1.50 | | | |

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

### *Middle Grades Students' Attitudes and Perceptions About Science Learning*

When comparing attitudes and opinions of middle school control and ISEP participant teachers' students, ISEP students reported more often that they would keep on taking science classes even if they did not have to. In addition, students of ISEP teachers reported that their teachers more frequently arranged the classroom so students can have discussion; asked questions that have more than one answer; asked them to give reasons and provide evidence for their answers; encouraged them to ask questions, explain their ideas to other students, to consider different scientific explanations; provided time for them to discuss science ideas with other students; and helped them apply their learning to real life than did students of control teachers. Students of ISEP teachers also self-reported that they talked with other students about how to do a science task or about how to interpret the data from an experiment; considered different scientific explanations; used a computer or the Internet for science assignments or activities; wrote about how they solved a science task or about what they were learning; learned that there were different solutions to science tasks; developed their skills for doing science; learned about how science is important in the real world; and worked on science tasks in a group with other students more often than did students' of control teachers (Table 19). Of the 24 items asking students to report on their classroom inquiry experiences, ISEP teachers' students reported more positively than did non-ISEP teachers students on all but 2 items.

Table 19. *Comparisons of Students' Responses by Teacher Participation Status, UB/BPS ISEP Student Questionnaire, Spring 2013, Middle School Students*

| Item | Teacher Participation | *n* | *M* | *SD* | *t* | *df* | *p* |
|---|---|---|---|---|---|---|---|
| **Q8. Views of Science** | | | | | | | |
| Q8a. I like science. | Control | 53 | 3.57 | 1.18 | -1.95 | 76 | .055 |
| | ISEP | 169 | 3.92 | 1.00 | | | |
| Q8b. I am good at science. | Control | 51 | 3.59 | 0.96 | 0.09 | 218 | .931 |
| | ISEP | 169 | 3.57 | 1.04 | | | |
| Q8c. I would keep on taking science classes even if I did not have to. | Control | 52 | 2.77 | 1.17 | -2.75 | 218 | **.006** |
| | ISEP | 168 | 3.32 | 1.29 | | | |
| Q8d. I understand most of what goes on in science. | Control | 53 | 3.75 | 0.81 | -0.05 | 219 | .961 |
| | ISEP | 168 | 3.76 | 0.96 | | | |
| Q8e. Almost all people use science in their jobs. | Control | 51 | 3.25 | 1.04 | -0.74 | 217 | .463 |
| | ISEP | 168 | 3.38 | 1.08 | | | |
| Q8f. Science is useful for solving everyday problems. | Control | 50 | 3.22 | 1.06 | -0.24 | 211 | .808 |
| | ISEP | 163 | 3.26 | 1.13 | | | |
| Q8g. Science is a way to study and understand the natural world. | Control | 50 | 4.02 | 0.84 | -1.34 | 215 | .183 |
| | ISEP | 167 | 4.22 | 0.93 | | | |
| Q8h. Scientists sometimes disagree about scientific knowledge. | Control | 51 | 3.43 | 1.01 | -0.68 | 215 | .496 |
| | ISEP | 166 | 3.54 | 1.02 | | | |
| Q8i. All scientists do not follow the same step-by-step method to do science. | Control | 52 | 3.27 | 1.17 | -0.18 | 214 | .857 |
| | ISEP | 164 | 3.30 | 1.26 | | | |
| Q8j. Scientists use their imagination when doing science. | Control | 53 | 3.06 | 1.08 | 0.64 | 216 | .523 |
| | ISEP | 165 | 2.93 | 1.26 | | | |
| Q8k. Science ideas or hypotheses must be supported by evidence. | Control | 52 | 3.94 | 0.92 | -0.84 | 217 | .401 |
| | ISEP | 167 | 4.08 | 1.10 | | | |
| Q8l. Scientific theories can change when new evidence or a new explanation becomes available. | Control | 52 | 3.85 | 0.92 | -2.45 | 218 | **.015** |
| | ISEP | 168 | 4.19 | 0.88 | | | |
| **Q9. In this class, my teacher ...** | | | | | | | |
| Q9a. arranges the classroom so students can have discussion. | Control | 52 | 2.37 | 1.21 | -4.01 | 215 | **< .001** |
| | ISEP | 165 | 3.15 | 1.24 | | | |
| Q9b. asks questions that have more than one answer. | Control | 52 | 3.35 | 1.08 | -2.10 | 211 | **.037** |
| | ISEP | 161 | 3.69 | 1.01 | | | |
| Q9c. asks me to give reasons and provide evidence for my answers. | Control | 51 | 3.90 | 0.94 | -3.00 | 211 | **.003** |
| | ISEP | 162 | 4.32 | 0.85 | | | |
| Q9d. encourages me to ask questions. | Control | 52 | 3.38 | 1.22 | -3.09 | 213 | **.002** |
| | ISEP | 163 | 3.95 | 1.13 | | | |
| Q9e. let me work at my own pace. | Control | 49 | 3.53 | 1.21 | 0.13 | 211 | .899 |
| | ISEP | 164 | 3.51 | 1.19 | | | |

| Item | Teacher Participation | *n* | *M* | *SD* | *t* | *df* | *p* |
|---|---|---|---|---|---|---|---|
| **Q9. In this class, my teacher ...** | | | | | | | |
| Q9f. encourages me to explain my ideas to other students. | Control | 53 | 2.96 | 1.16 | -2.48 | 213 | **.014** |
| | ISEP | 162 | 3.44 | 1.25 | | | |
| Q9g. encourage me to consider different scientific explanations. | Control | 50 | 3.00 | 0.95 | -3.44 | 90 | **.001** |
| | ISEP | 164 | 3.54 | 1.07 | | | |
| Q9h. provides time for me to discuss science ideas with other students. | Control | 50 | 2.68 | 1.32 | -4.29 | 71 | **< .001** |
| | ISEP | 165 | 3.56 | 1.10 | | | |
| Q9i. checks that I have completed my assignments. | Control | 50 | 4.12 | 1.10 | -1.09 | 212 | .278 |
| | ISEP | 164 | 4.30 | 0.99 | | | |
| Q9j. provides meaningful and challenging assignments. | Control | 50 | 3.56 | 1.13 | -1.84 | 213 | .067 |
| | ISEP | 165 | 3.87 | 1.03 | | | |
| Q9k. helps me apply my learning to real life. | Control | 52 | 3.33 | 1.17 | -2.41 | 214 | **.017** |
| | ISEP | 164 | 3.76 | 1.12 | | | |
| Q9l. expects me to do well. | Control | 51 | 4.37 | 0.96 | -1.43 | 214 | .154 |
| | ISEP | 165 | 4.58 | 0.86 | | | |
| **Q10. In this class, I ...** | | | | | | | |
| Q10a. use information and data to support my conclusions. | Control | 50 | 3.62 | 1.10 | -1.91 | 213 | .058 |
| | ISEP | 165 | 3.99 | 1.25 | | | |
| Q10b. talk with other students about how to do a science task or about how to interpret the data from an experiment. | Control | 51 | 3.00 | 1.30 | -3.63 | 71 | **.001** |
| | ISEP | 164 | 3.72 | 1.02 | | | |
| Q10c. learn from other students. | Control | 51 | 3.06 | 1.30 | -1.96 | 212 | .051 |
| | ISEP | 163 | 3.44 | 1.16 | | | |
| Q10d. consider different scientific explanations. | Control | 49 | 3.20 | 1.08 | -2.51 | 210 | **.013** |
| | ISEP | 163 | 3.64 | 1.05 | | | |
| Q10e. have a say in deciding what activities I do. | Control | 49 | 3.14 | 1.27 | 0.18 | 209 | .859 |
| | ISEP | 162 | 3.10 | 1.32 | | | |
| Q10f. use a computer or the Internet for science assignments or activities. | Control | 50 | 2.46 | 1.27 | -3.20 | 210 | **.002** |
| | ISEP | 162 | 3.10 | 1.24 | | | |
| Q10g. write about how I solved a science task or about what I am learning. | Control | 49 | 3.22 | 1.19 | -2.00 | 209 | **.047** |
| | ISEP | 162 | 3.59 | 1.11 | | | |
| Q10h. learn that there are different solutions to science tasks. | Control | 49 | 3.45 | 0.89 | -2.01 | 207 | **.046** |
| | ISEP | 160 | 3.78 | 1.02 | | | |
| Q10i. use multiple sources of information to learn. | Control | 49 | 3.53 | 1.04 | -1.53 | 209 | .127 |
| | ISEP | 162 | 3.80 | 1.07 | | | |
| Q10j. develop my skills for doing science. | Control | 49 | 3.49 | 1.00 | -2.96 | 208 | **.003** |
| | ISEP | 161 | 3.97 | 0.99 | | | |

| Item | Teacher Participation | *n* | *M* | *SD* | *t* | *df* | *p* |
|---|---|---|---|---|---|---|---|
| **Q10. In this class, I ...** | | | | | | | |
| Q10k. learn about how science is important in the real world. | Control | 50 | 3.40 | 1.14 | -3.58 | 71 | **.001** |
| | ISEP | 163 | 4.04 | 0.94 | | | |
| Q10l. work on science tasks in a group with other students. | Control | 49 | 3.04 | 1.35 | -3.52 | 65 | **.001** |
| | ISEP | 164 | 3.77 | 1.01 | | | |
| **Q11. At least one adult in my home, ...** | | | | | | | |
| Q11a. makes me do my science homework. | Control | 49 | 3.76 | 1.42 | 0.22 | 212 | .827 |
| | ISEP | 165 | 3.70 | 1.47 | | | |
| Q11b. asks about what I am learning in science class. | Control | 50 | 3.10 | 1.39 | -1.58 | 211 | .115 |
| | ISEP | 163 | 3.46 | 1.42 | | | |
| Q11c. helps me with my science homework. | Control | 50 | 3.10 | 1.50 | -0.64 | 212 | .525 |
| | ISEP | 164 | 3.25 | 1.45 | | | |
| Q11d. helps me work on my science projects. | Control | 48 | 3.35 | 1.44 | -0.50 | 210 | .617 |
| | ISEP | 164 | 3.47 | 1.39 | | | |
| Q11e. expects me to do well in science. | Control | 50 | 4.42 | 1.05 | -0.46 | 213 | .644 |
| | ISEP | 165 | 4.49 | 0.91 | | | |
| Q11f. expects me to go to college. | Control | 51 | 4.51 | 0.95 | -0.20 | 214 | .845 |
| | ISEP | 165 | 4.54 | 0.94 | | | |
| Q11g. expects me to have a science-related career. | Control | 50 | 2.42 | 1.47 | -1.64 | 214 | .103 |
| | ISEP | 166 | 2.81 | 1.46 | | | |

*Note.* Q8 & Q12: 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 20, there were no statistically significant differences between the responses of high school students of ISEP and control teachers. However, of the 24 items asking students about their classroom inquiry experiences, students of ISEP teachers responded more positively on 16 of these items than did their non-ISEP peers. Further, students of ISEP teachers reported that they had less parental support at home for studying science and were less likely to major in a science or engineering field in college than did students of control teachers. This implies that the ISEP project is serving students that are in high-need situations.

Table 20. *Comparisons of Students' Responses by Teacher Participation Status, UB/BPS ISEP Student Questionnaire, Spring 2013, High School Students*

| Item | Teacher Participation | *n* | *M* | *SD* | *t* | *df* | *P* |
|---|---|---|---|---|---|---|---|
| **Q8. Views of Science** | | | | | | | |
| Q8a. I like science. | Control | 97 | 3.42 | 1.14 | -0.74 | 679 | .458 |
| | ISEP | 584 | 3.51 | 1.12 | | | |
| Q8b. I am good at science. | Control | 97 | 3.24 | 1.06 | -0.59 | 676 | .555 |
| | ISEP | 581 | 3.30 | 1.01 | | | |
| Q8c. I would keep on taking science classes even if I did not have to. | Control | 96 | 2.92 | 1.25 | 0.61 | 673 | .539 |
| | ISEP | 579 | 2.83 | 1.24 | | | |
| Q8d. I understand most of what goes on in science. | Control | 97 | 3.67 | 0.87 | 1.18 | 676 | .240 |
| | ISEP | 581 | 3.55 | 0.93 | | | |
| Q8e. Almost all people use science in their jobs. | Control | 97 | 3.18 | 1.05 | 0.47 | 675 | .641 |
| | ISEP | 580 | 3.12 | 1.07 | | | |
| Q8f. Science is useful for solving everyday problems. | Control | 93 | 3.31 | 1.00 | 0.52 | 663 | .602 |
| | ISEP | 572 | 3.25 | 1.10 | | | |
| Q8g. Science is a way to study and understand the natural world. | Control | 96 | 4.04 | 0.82 | 0.00 | 667 | .998 |
| | ISEP | 573 | 4.04 | 0.93 | | | |
| Q8h. Scientists sometimes disagree about scientific knowledge. | Control | 94 | 3.71 | 0.90 | 0.00 | 659 | .998 |
| | ISEP | 567 | 3.71 | 0.94 | | | |
| Q8i. All scientists do not follow the same step-by-step method to do science. | Control | 96 | 3.57 | 1.10 | -0.22 | 665 | .828 |
| | ISEP | 571 | 3.60 | 1.09 | | | |
| Q8j. Scientists use their imagination when doing science. | Control | 97 | 3.13 | 1.24 | -0.50 | 670 | .618 |
| | ISEP | 575 | 3.20 | 1.16 | | | |
| Q8k. Science ideas or hypotheses must be supported by evidence. | Control | 95 | 3.96 | 1.02 | -0.78 | 669 | .434 |
| | ISEP | 576 | 4.04 | 0.98 | | | |
| Q8l. Scientific theories can change when new evidence or a new explanation becomes available. | Control | 96 | 4.10 | 0.83 | 0.07 | 673 | .942 |
| | ISEP | 579 | 4.10 | 0.94 | | | |
| **Q9. In this class, my teacher ...** | | | | | | | |
| Q9a. arranges the classroom so students can have discussion. | Control | 92 | 3.18 | 1.16 | -1.41 | 635 | .158 |
| | ISEP | 545 | 3.37 | 1.17 | | | |
| Q9b. asks questions that have more than one answer. | Control | 96 | 3.54 | 1.04 | -0.42 | 643 | .672 |
| | ISEP | 549 | 3.59 | 0.99 | | | |
| Q9c. asks me to give reasons and provide evidence for my answers. | Control | 93 | 4.05 | 1.00 | -0.09 | 640 | .928 |
| | ISEP | 549 | 4.06 | 0.99 | | | |
| Q9d. encourages me to ask questions. | Control | 94 | 4.01 | 1.07 | 1.26 | 637 | .209 |
| | ISEP | 545 | 3.86 | 1.07 | | | |
| Q9e. let me work at my own pace. | Control | 94 | 3.68 | 1.04 | -0.24 | 635 | .807 |
| | ISEP | 543 | 3.71 | 1.03 | | | |

| Item | Teacher Participation | *n* | *M* | *SD* | *t* | *df* | *P* |
|---|---|---|---|---|---|---|---|
| **Q9. In this class, my teacher ...** | | | | | | | |
| Q9f. encourages me to explain my ideas to other students. | Control | 95 | 3.40 | 1.06 | -0.48 | 640 | .629 |
| | ISEP | 547 | 3.46 | 1.10 | | | |
| Q9g. encourage me to consider different scientific explanations. | Control | 95 | 3.52 | 1.06 | 0.35 | 632 | .727 |
| | ISEP | 539 | 3.47 | 1.10 | | | |
| Q9h. provides time for me to discuss science ideas with other students. | Control | 94 | 3.21 | 1.11 | -1.35 | 634 | .178 |
| | ISEP | 542 | 3.38 | 1.14 | | | |
| Q9i. checks that I have completed my assignments. | Control | 95 | 4.17 | 0.90 | -1.47 | 639 | .142 |
| | ISEP | 546 | 4.32 | 0.90 | | | |
| Q9j. provides meaningful and challenging assignments. | Control | 94 | 3.76 | 0.98 | -1.53 | 638 | .126 |
| | ISEP | 546 | 3.92 | 0.95 | | | |
| Q9k. helps me apply my learning to real life. | Control | 95 | 3.57 | 1.20 | -1.49 | 635 | .136 |
| | ISEP | 542 | 3.76 | 1.13 | | | |
| Q9l. expects me to do well. | Control | 96 | 4.42 | 0.99 | -0.56 | 643 | .574 |
| | ISEP | 549 | 4.47 | 0.90 | | | |
| **Q10. In this class, I ...** | | | | | | | |
| Q10a. use information and data to support my conclusions. | Control | 97 | 3.90 | 0.97 | -0.13 | 641 | .899 |
| | ISEP | 546 | 3.91 | 0.95 | | | |
| Q10b. talk with other students about how to do a science task or about how to interpret the data from an experiment. | Control | 95 | 3.62 | 1.07 | 0.48 | 635 | .633 |
| | ISEP | 542 | 3.56 | 1.10 | | | |
| Q10c. learn from other students. | Control | 94 | 3.43 | 1.09 | 0.01 | 630 | .989 |
| | ISEP | 538 | 3.42 | 1.14 | | | |
| Q10d. consider different scientific explanations. | Control | 97 | 3.34 | 0.97 | -1.51 | 629 | .133 |
| | ISEP | 534 | 3.50 | 0.99 | | | |
| Q10e. have a say in deciding what activities I do. | Control | 96 | 3.07 | 1.12 | 0.03 | 628 | .978 |
| | ISEP | 534 | 3.07 | 1.18 | | | |
| Q10f. use a computer or the Internet for science assignments or activities. | Control | 94 | 3.15 | 1.16 | 0.53 | 141 | .596 |
| | ISEP | 539 | 3.08 | 1.36 | | | |
| Q10g. write about how I solved a science task or about what I am learning. | Control | 94 | 3.29 | 1.10 | 0.63 | 629 | .531 |
| | ISEP | 537 | 3.21 | 1.16 | | | |
| Q10h. learn that there are different solutions to science tasks. | Control | 97 | 3.60 | 1.01 | -1.02 | 627 | .307 |
| | ISEP | 532 | 3.71 | 0.99 | | | |
| Q10i. use multiple sources of information to learn. | Control | 97 | 3.63 | 1.00 | -1.77 | 633 | .077 |
| | ISEP | 538 | 3.82 | 0.95 | | | |
| Q10j. develop my skills for doing science. | Control | 96 | 3.74 | 0.89 | 0.48 | 143 | .632 |
| | ISEP | 538 | 3.69 | 1.01 | | | |
| Q10k. learn about how science is important in the real world. | Control | 95 | 3.78 | 1.07 | -0.14 | 633 | .886 |
| | ISEP | 540 | 3.80 | 1.09 | | | |

| Item | Teacher Participation | *n* | *M* | *SD* | *t* | *df* | *P* |
|---|---|---|---|---|---|---|---|
| **Q10. In this class, I ...** | | | | | | | |
| Q10l. work on science tasks in a group with other students. | Control | 97 | 3.53 | 1.06 | -1.56 | 635 | .120 |
| | ISEP | 540 | 3.71 | 1.11 | | | |
| **Q11. At least one adult in my home, ...** | | | | | | | |
| Q11a. makes me do my science homework. | Control | 94 | 3.40 | 1.39 | 2.60 | 635 | **.010** |
| | ISEP | 543 | 2.98 | 1.46 | | | |
| Q11b. asks about what I am learning in science class. | Control | 95 | 3.36 | 1.38 | 2.90 | 636 | **.004** |
| | ISEP | 543 | 2.91 | 1.40 | | | |
| Q11c. helps me with my science homework. | Control | 95 | 2.85 | 1.34 | 2.37 | 631 | **.018** |
| | ISEP | 538 | 2.49 | 1.36 | | | |
| Q11d. helps me work on my science projects. | Control | 93 | 3.08 | 1.34 | 2.31 | 627 | **.021** |
| | ISEP | 536 | 2.71 | 1.40 | | | |
| Q11e. expects me to do well in science. | Control | 95 | 4.41 | 0.89 | 2.04 | 148 | **.043** |
| | ISEP | 540 | 4.20 | 1.10 | | | |
| Q11f. expects me to go to college. | Control | 96 | 4.61 | 0.73 | 1.27 | 160 | .207 |
| | ISEP | 539 | 4.51 | 0.96 | | | |
| Q11g. expects me to have a science-related career. | Control | 95 | 2.78 | 1.54 | 0.86 | 632 | .388 |
| | ISEP | 539 | 2.64 | 1.43 | | | |
| **Q12. I plan to . . .** | | | | | | | |
| Q12a. take (or have taken) only the science courses I am required to take in high school. | Control | 94 | 3.63 | 1.30 | 0.98 | 649 | .326 |
| | ISEP | 557 | 3.49 | 1.29 | | | |
| Q12b. take (or have taken) the most challenging science courses offered in my high school. | Control | 94 | 2.84 | 1.17 | -1.91 | 649 | .056 |
| | ISEP | 557 | 3.11 | 1.31 | | | |
| Q12c. take (or have taken) 4 years of science courses in high school. | Control | 94 | 3.50 | 1.23 | -0.04 | 643 | .965 |
| | ISEP | 551 | 3.51 | 1.31 | | | |
| Q12d. pursue a science-related career. | Control | 93 | 2.83 | 1.26 | -0.87 | 645 | .383 |
| | ISEP | 554 | 2.96 | 1.37 | | | |
| Q12e. go to a 2- or 4-year college. | Control | 94 | 4.16 | 1.06 | -0.71 | 646 | .480 |
| | ISEP | 554 | 4.24 | 1.07 | | | |
| Q12f. take science courses in college. | Control | 95 | 3.31 | 1.18 | -1.82 | 647 | .070 |
| | ISEP | 554 | 3.55 | 1.20 | | | |
| Q12g. major in a science field in college. | Control | 93 | 2.90 | 1.23 | -0.21 | 641 | .832 |
| | ISEP | 550 | 2.93 | 1.33 | | | |
| Q12h. major in an engineering field in college. | Control | 94 | 3.31 | 1.16 | 3.15 | 644 | **.002** |
| | ISEP | 552 | 2.85 | 1.32 | | | |
| Q12i. major in a science or engineering technical field in college. | Control | 93 | 3.38 | 1.24 | 2.04 | 642 | **.041** |
| | ISEP | 551 | 3.07 | 1.36 | | | |

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

Further analyses compared 441 students of ISEP teachers to 180 students of control teacher only using data from the 6 BPS ISEP partner schools (i.e., Schools #31, #59, #72, #200, #304, and #307) that had both control and ISEP teachers in the same building. The findings of this subset analysis were consistent with the findings using student data from all 12 schools, with a few exceptions.

- Both elementary and middle school ISEP students agreed more often that there was at least one adult at home who made them do their science homework, than did control students. This finding was not significant using data from all schools (Appendix H, Tables H1 and H2).
- For high school students, there were a few positive, significant findings regarding student perceptions of teaching and learning practices, when comparing students of ISEP and non-ISEP teachers. Yet, ISEP high school students still reported less parental support at home but were more likely to take challenging high school science courses, plan for post-secondary education, and plan to take science courses in college (Appendix H, Table H3).

Complete findings of this analysis can be found in Appendix H, Tables H1 through H3.

## UB-BPS ISEP STEM Student Questionnaire Data, Fall 2013

As shown in Table 21, 6 STEM undergraduate students and 12 STEM graduate students (including 2 Master's students and 12 doctoral students) who participated in the ISEP project in Fall 2013 responded to the *UB-BPS ISEP STEM Student Questionnaire*. Among them, 2 STEM undergraduate and 8 STEM graduate students indicated that they were returning participants to the ISEP project. Two STEM graduate students participated in the UB IGERT project prior to entering the ISEP project.

Table 21. *Respondents' Student Status by Years of Participation, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| Number of Years in ISEP | STEM Undergraduate | STEM Graduate | Total |
|---|---|---|---|
| This is my first year. | 4 | 4 | 8 |
| This is my second year. | 2 | 4 | 6 |
| This is my third year. | 0 | 4 | 4 |
| Total | 6 | 12 | 18 |

### *Comparisons of STEM Undergraduate Students and STEM Graduate Students*

STEM undergraduate and graduate students' responses were compared using Fall 2013 data. Table 22 shows their roles in the ISEP project in Fall 2013.

Table 22. *Respondents' Role in ISEP by Student Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| Role in ISEP | STEM Undergraduate | STEM Graduate | Total |
|---|---|---|---|
| Service learning student | 4 | 0 | 4 |
| Undergraduate intern | 2 | 0 | 2 |
| Graduate student | 0 | 11 | 11 |
| Building coordinator | 0 | 1 | 1 |
| Total | 6 | 12 | 18 |

As shown in Table 23, most STEM undergraduate students indicated that they had volunteered in an elementary, middle, or high school classroom (66%) and/or worked with K–12 students outside of a classroom setting (83%) before participating in the ISEP project. Most STEM graduate students indicated that they had volunteered in an elementary, middle, or high school classroom and/or were teaching or laboratory assistants for undergraduate or graduate courses (58%) prior to joining the ISEP project.

Table 23. *Respondents' Experience Prior to the UB/BPS ISEP Project by Student Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| 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 | 0 (0%) | 3 (25%) | 3 (16%) |
| Volunteered in an elementary, middle, or high school classroom | 4 (66%) | 6 (50%) | 10 (55%) |
| Tutored K–12 students in STEM | 1 (16%) | 5 (41%) | 6 (33%) |
| Tutored undergraduate students in STEM | 1 (16%) | 5 (41%) | 6 (33%) |
| Volunteered or worked with K–12 students outside of a classroom setting | 5 (83%) | 4 (33%) | 9 (50%) |
| Taught at a college or university (2- or 4-year) | 0 (0%) | 3 (25%) | 3 (16%) |
| Was a teaching or laboratory assistant for undergraduate or graduate courses | 1 (16%) | 7 (58%) | 8 (44%) |
| Worked or volunteered at a science/technology museum, nature center, aquarium, zoo, or similar institution open to the public | 0 (0%) | 3 (25%) | 3 (16%) |
| Worked or volunteered for social, environmental, or political projects/organizations | 0 (0%) | 3 (25%) | 3 (16%) |
| Published a STEM-related research paper or presented a STEM-related paper or poster at a professional conference | 1 (16%) | 5 (41%) | 6 (33%) |
| Wrote about or presented STEM content to a non-scientific audience | 2 (33%) | 1 (8%) | 3 (16%) |
| Participated in an IGERT project | 0 (0%) | 3 (25%) | 3 (16%) |
| None of the above | 2 (33%) | 1 (8%) | 3 (16%) |

*Note.* Respondents could choose more than one option.

Table 24 shows STEM undergraduate and graduate students' career plans and goals.

Table 24. *Respondents' Career Goals by Student Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| E8. Career Goals | STEM Undergraduate (%) | STEM Graduate (%) | Total (%) |
|---|---|---|---|
| College or university faculty position with both teaching and research responsibilities | 1 (16%) | 4 (33%) | 5 (27%) |
| College or university faculty position with primarily teaching responsibilities (greater emphasis on teaching than research) | 2 (33%) | 5 (41%) | 7 (38%) |
| College or university faculty position with primarily research responsibilities (greater emphasis on research than teaching) | 1 (16%) | 2 (16%) | 3 (16%) |
| College or university faculty position preparing K–12 teachers in science or mathematics education | 1 (16%) | 2 (16%) | 3 (16%) |
| Researcher at a government laboratory or research institution | 0 (0%) | 3 (25%) | 3 (16%) |
| Researcher/developer in industry/business | 0 (0%) | 5 (41%) | 5 (27%) |
| Non-research position in the government or nonprofit sectors | 0 (0%) | 3 (25%) | 3 (16%) |
| K–12 science or mathematics teacher | 1 (16%) | 1 (8%) | 2 (11%) |
| K–12 administrator (e.g., school, district, State-level educational administration) | 0 (0%) | 1 (8%) | 1 (5%) |
| K-12 teacher (not science or mathematics) | 1 (16%) | 0 (0%) | 1 (5%) |
| Medical/Dentistry/Veterinary | 1 (16%) | 1 (8%) | 2 (11%) |
| Unsure at this time | 0 (0%) | 3 (25%) | 3 (16%) |

*Note.* Respondents could choose more than one option.

Of all orientations available to students prior to working in BPS schools, very few STEM undergraduate students indicated that they attended orientations (Table 25). A majority of graduate students (66%) reported that they attended orientation in science teaching and learning.

Table 25*. Respondents' Preparation for Working in Schools by Student Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| A. Preparation for working in schools | STEM Undergraduate (%) | STEM Graduate (%) | Total (%) |
|---|---|---|---|
| Orientation in urban education | 1 (16%) | 3 (25%) | 4 (22%) |
| Orientation in culture and diversity | 0 (0%) | 2 (16%) | 2 (11%) |
| Orientation in teamwork/collaboration | 1 (16%) | 3 (25%) | 4 (22%) |
| Orientation in science teaching and learning | 1 (16%) | 8 (66%) | 9 (50%) |
| Orientation in science communications | 0 (0%) | 4 (33%) | 4 (22%) |

| A. Preparation for working in schools | STEM Undergraduate (%) | STEM Graduate (%) | Total (%) |
|---|---|---|---|
| Orientation in mentoring | 1 (16%) | 5 (41%) | 6 (33%) |
| Teaching Experience | 0 (0%) | 2 (16%) | 2 (11%) |
| Other | 2 (32%) | 1 (8%) | 3 (16%) |
| None/Don't remember | 1 (16%) | 2 (16%) | 3 (16%) |

*Note.* Respondents could choose more than one option.

As shown in Table 26, both 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, and demonstrating scientific content, procedures, tools, or techniques. In addition, the majority of graduate students also indicated that they developed science labs for class use (75%), helped teachers find resources (91%), and presented lessons/lectures to students in class (75%).

Table 26. *Respondents' Experience in Schools by Student Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| B. Experiences in schools | STEM Undergraduate (%) | STEM Graduate (%) | Total (%) |
|---|---|---|---|
| Assisted teachers in teaching lessons | 6 (100%) | 10 (83%) | 16 (88%) |
| Assisted teachers in conducting labs | 5 (83%) | 11 (91%) | 16 (88%) |
| Developed science labs for class use | 1 (16%) | 9 (75%) | 10 (55%) |
| Developed out-of-school science learning activities | 1 (16%) | 4 (33%) | 5 (27%) |
| Led small group activities/discussions with students in class | 5 (83%) | 10 (83%) | 15 (83%) |
| Led small group activities/discussions with students after school or during weekend | 0 (0%) | 4 (33%) | 4 (22%) |
| Demonstrated scientific content, procedures, tools, or techniques to students | 4 (66%) | 10 (83%) | 14 (77%) |
| Helped teachers find relevant resources (e.g., science activities) | 2 (33%) | 11 (91%) | 13 (72%) |
| Presented lessons/lectures to students in class | 2 (33%) | 9 (75%) | 11 (61%) |
| Tutored students after school or during weekends | 1 (16%) | 2 (16%) | 3 (16%) |
| Other | 1 (16%) | 5 (42%) | 6 (33%) |

*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 working with school-age students, having new experiences, and developing teaching skills were important reasons for their participation. Most STEM undergraduate students also indicated that faculty encouragement and interest in teaching as a career were reasons for participating in this project; while STEM graduate students indicated that financial support for education, sharing knowledge of science, technology, engineering and/or mathematics, enhancing the C.V., and developing science communication skills were reasons for participating (Table 27).

Table 27. *Respondents' Reasons for Participating in UB/BPS ISEP Project by Student Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| **C1. Reasons for participating in UB/BPS ISEP** | **STEM Undergraduate (%)** | **STEM Graduate (%)** | **Total (%)** |
|---|---|---|---|
| To gain financial support for my education | 0 (0%) | 9 (75%) | 9 (50%) |
| My faculty advisor or another faculty member encouraged me | 3 (50%) | 5 (41%) | 8 (44%) |
| Another student(s) encouraged me to participate | 1 (16%) | 4 (33%) | 5 (27%) |
| To share my knowledge of science, technology, engineering and/or mathematics | 2 (33%) | 10 (83%) | 12 (66%) |
| To work with school-age students | 4 (66%) | 11 (92%) | 15 (83%) |
| I was interested in a teaching career | 5 (83%) | 4 (33%) | 9 (50%) |
| To have new experiences | 4 (66%) | 9 (75%) | 13 (72%) |
| To enhance my C.V. or resume | 2 (33%) | 8 (66%) | 10 (55%) |
| To develop my teaching skills | 5 (83%) | 8 (66%) | 13 (72%) |
| To develop my teamwork skills | 1 (16%) | 5 (41%) | 6 (33%) |
| To develop my science communication skills | 2 (33%) | 8 (66%) | 10 (55%) |
| To develop my research skills | 1 (16%) | 2 (16%) | 3 (16%) |

*Note.* Respondents could choose more than one option.

Table 28 shows the differences between STEM undergraduate and graduate students' responses about the benefits of participating in the ISEP project. Compared to STEM undergraduate students, graduate students reported significantly higher levels of agreement that the ISEP experience enhanced their abilities to generate others' interest in STEM research and activities. STEM undergraduate students, on the other hand, reported a high level of agreement that the ISEP project improved their ability to write papers and reports about their work.

Table 28. *Respondents' Perceived Benefit in Participating in UB/BPS ISEP Project by Student Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| **C2. My UB/BPS ISEP Experiences Have Benefited My Ability to…** | **Student Status** | ***n*** | ***M*** | ***SD*** | **Mean Rank** | **Mann-Whitney *U*-statistics** | ***p* (2-tailed)** |
|---|---|---|---|---|---|---|---|
| C2a. Work on a Team | STEM Undergraduate | 6 | 2.83 | 0.41 | 7.25 | 22.50 | .081 |
| | STEM Graduate | 12 | 3.25 | 0.45 | 10.63 | | |
| C2b. Lead a team | STEM Undergraduate | 6 | 3.00 | 0.89 | 8.50 | 30.00 | .548 |
| | STEM Graduate | 12 | 3.25 | 0.75 | 10.00 | | |
| C2c. Facilitate group discussions | STEM Undergraduate | 6 | 3.00 | 0.63 | 7.83 | 26.00 | .310 |
| | STEM Graduate | 12 | 3.33 | 0.78 | 10.33 | | |
| C2d. Teach STEM concepts and methods | STEM Undergraduate | 6 | 2.83 | 0.98 | 7.00 | 21.00 | .128 |
| | STEM Graduate | 12 | 3.50 | 0.52 | 10.75 | | |

| **C2. My UB/BPS ISEP Experiences Have Benefited My Ability to…** | **Student Status** | ***n*** | ***M*** | ***SD*** | **Mean Rank** | **Mann-Whitney *U*-statistics** | ***p* (2-tailed)** |
|---|---|---|---|---|---|---|---|
| C2e. Develop instructional materials about STEM concepts and methods | STEM Undergraduate | 6 | 2.83 | 0.75 | 6.50 | 18.00 | .062 |
| | STEM Graduate | 12 | 3.50 | 0.52 | 11.00 | | |
| C2f. Generate others' interest in STEM research and activities | STEM Undergraduate | 6 | 2.50 | 0.55 | 6.25 | 16.50 | **.036** |
| | STEM Graduate | 12 | 3.17 | 0.58 | 11.13 | | |
| C2g. Conduct research as part of a collaborative team | STEM Undergraduate | 6 | 2.33 | 1.03 | 8.33 | 29.00 | .485 |
| | STEM Graduate | 12 | 2.58 | 0.79 | 10.08 | | |
| C2h. Conduct independent research | STEM Undergraduate | 6 | 2.67 | 1.21 | 10.75 | 28.50 | .458 |
| | STEM Graduate | 12 | 2.25 | 0.87 | 8.88 | | |
| C2i. Develop a research and/or technology agenda | STEM Undergraduate | 6 | 2.83 | 0.75 | 10.75 | 28.50 | .442 |
| | STEM Graduate | 12 | 2.58 | 0.79 | 8.88 | | |
| C2j. Write papers and reports about my work | STEM Undergraduate | 6 | 3.00 | 0.63 | 12.92 | 15.50 | **.035** |
| | STEM Graduate | 12 | 2.25 | 0.62 | 7.79 | | |
| C2k. Present my work at a professional conference | STEM Undergraduate | 6 | 2.00 | 0.89 | 8.50 | 30.00 | .548 |
| | STEM Graduate | 12 | 2.25 | 0.75 | 10.00 | | |
| C2l. Explain STEM research and concepts to public (non-technical) audience | STEM Undergraduate | 6 | 2.83 | 0.75 | 6.58 | 18.50 | .076 |
| | STEM Graduate | 12 | 3.50 | 0.67 | 10.96 | | |
| C2m. Decide a career in education | STEM Undergraduate | 6 | 3.00 | 0.63 | 12.17 | 20.00 | .114 |
| | STEM Graduate | 12 | 2.33 | 0.98 | 8.17 | | |
| C2n. Understand science concepts better | STEM Undergraduate | 6 | 2.50 | 0.84 | 9.25 | 34.50 | .875 |
| | STEM Graduate | 12 | 2.67 | 0.65 | 9.63 | | |

*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 29 shows there were no statistically significant differences in the results of participating in the ISEP reported by STEM undergraduate and graduate students.

Table 29. *Respondents' Perceived Effects of Participating in UB/BPS ISEP Project by Student Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| **C3. As a result of my UB/BPS ISEP experiences…** | **Student Status** | ***n*** | ***M*** | ***SD*** | **Mean Rank** | **Mann-Whitney *U*-statistics** | ***p* (2-tailed)** |
|---|---|---|---|---|---|---|---|
| C3a. My interest in conducting research | STEM Undergraduate | 6 | 3.50 | 0.84 | 10.67 | 29.00 | .366 |
| | STEM Graduate | 12 | 3.17 | 0.39 | 8.92 | | |
| C3b. My interest in teaching at the college/university level | STEM Undergraduate | 6 | 3.83 | 0.98 | 9.67 | 35.00 | .920 |
| | STEM Graduate | 12 | 3.75 | 0.75 | 9.42 | | |
| C3c. My interest in teaching at the K–12 level | STEM Undergraduate | 6 | 3.83 | 0.75 | 12.42 | 18.50 | .066 |
| | STEM Graduate | 12 | 3.17 | 0.58 | 8.04 | | |
| C3d. My interest in influencing public policy related to STEM education | STEM Undergraduate | 6 | 3.67 | 0.52 | 7.33 | 23.00 | .192 |
| | STEM Graduate | 12 | 4.17 | 0.83 | 10.58 | | |

*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 level of self-efficacy in communicating science, as shown in Table 30. Compared to STEM undergraduate students, STEM graduate students reported that they were more effective at understanding middle and high school students' science background knowledge and interest in science, and helping teachers find relevant resources.

Table 30. *Respondents' Self-Efficacy in Communicating Science by Student Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| **D. How much I can do in order to…** | **Student Status** | ***n*** | ***M*** | ***SD*** | **Mean Rank** | **Mann-Whitney *U*-statistics** | ***p* (2-tailed)** |
|---|---|---|---|---|---|---|---|
| D1. Understand middle and high school students' science background knowledge | STEM Undergrad | 6 | 2.50 | 0.84 | 6.17 | 16.00 | **.046** |
| | STEM Graduate | 12 | 3.33 | 0.98 | 11.17 | | |
| D2. Understand middle and high school students' interest in science | STEM Undergrad | 6 | 2.33 | 0.52 | 6.00 | 15.00 | **.037** |
| | STEM Graduate | 12 | 3.25 | 0.87 | 11.25 | | |
| D3. Understand middle and high school students' cognitive abilities | STEM Undergrad | 6 | 2.67 | 1.21 | 8.25 | 28.50 | .455 |
| | STEM Graduate | 12 | 3.08 | 0.67 | 10.13 | | |
| D4. Understand middle and high school students' social and cultural backgrounds | STEM Undergrad | 6 | 3.00 | 0.89 | 8.33 | 29.00 | .668 |
| | STEM Graduate | 11 | 3.18 | 0.75 | 9.36 | | |

| D. How much I can do in order to… | Student Status | *n* | *M* | *SD* | Mean Rank | Mann-Whitney *U*-statistics | *p* (2-tailed) |
|---|---|---|---|---|---|---|---|
| D5. Understand middle and high school students' attention span | STEM Undergrad | 6 | 2.50 | 0.84 | 8.25 | 28.50 | .458 |
| | STEM Graduate | 12 | 2.92 | 0.90 | 10.13 | | |
| D6. Decide what science topics are appropriate to students | STEM Undergrad | 6 | 2.83 | 0.98 | 8.33 | 29.00 | .488 |
| | STEM Graduate | 12 | 3.17 | 0.94 | 10.08 | | |
| D7. Decide how much science content is appropriate to students | STEM Undergrad | 6 | 2.67 | 1.03 | 9.17 | 34.00 | .843 |
| | STEM Graduate | 12 | 2.83 | 0.83 | 9.67 | | |
| D8. Help teachers find relevant resources (e.g., science activities) | STEM Undergrad | 6 | 2.50 | 0.84 | 5.92 | 14.50 | **.029** |
| | STEM Graduate | 12 | 3.50 | 0.90 | 11.29 | | |
| D9. Develop science labs | STEM Undergrad | 6 | 2.67 | 0.82 | 7.00 | 21.00 | .131 |
| | STEM Graduate | 12 | 3.33 | 0.89 | 10.75 | | |
| D10. Develop out-of-school science learning activities | STEM Undergrad | 6 | 2.83 | 0.98 | 10.25 | 31.50 | .661 |
| | STEM Graduate | 12 | 2.67 | 1.07 | 9.13 | | |
| D11. Assist teachers in teaching lessons | STEM Undergrad | 6 | 3.33 | 0.52 | 9.17 | 34.00 | .837 |
| | STEM Graduate | 12 | 3.25 | 0.97 | 9.67 | | |
| D12. Assist teachers in conducting labs | STEM Undergrad | 6 | 3.67 | 0.52 | 10.33 | 31.00 | .589 |
| | STEM Graduate | 12 | 3.25 | 1.14 | 9.08 | | |
| D13. Teach science labs to students | STEM Undergrad | 6 | 2.83 | 0.75 | 7.17 | 22.00 | .161 |
| | STEM Graduate | 12 | 3.33 | 0.98 | 10.67 | | |
| D14. Facilitate out-of-school science learning activities | STEM Undergrad | 6 | 2.17 | 0.75 | 6.33 | 17.00 | .061 |
| | STEM Graduate | 12 | 3.08 | 0.90 | 11.08 | | |
| D15. Lead small group activities/discussions with students in class | STEM Undergrad | 5 | 2.60 | 0.55 | 6.30 | 16.50 | .127 |
| | STEM Graduate | 12 | 3.17 | 0.94 | 10.13 | | |
| D16. Lead small group activities/discussions with students after school or during weekends | STEM Undergrad | 6 | 2.50 | 0.84 | 9.75 | 34.50 | .884 |
| | STEM Graduate | 12 | 2.50 | 1.09 | 9.38 | | |
| D17. Demonstrate scientific content, procedures, tools, or techniques to students | STEM Undergrad | 6 | 3.17 | 0.75 | 8.00 | 27.00 | .351 |
| | STEM Graduate | 12 | 3.42 | 0.90 | 10.25 | | |
| D18. Teach lessons or give lectures to students in class | STEM Undergrad | 6 | 2.83 | 0.75 | 6.92 | 20.50 | .116 |
| | STEM Graduate | 12 | 3.42 | 0.67 | 10.79 | | |

| D. How much I can do in order to… | Student Status | *n* | *M* | *SD* | Mean Rank | Mann-Whitney *U*-statistics | *p* (2-tailed) |
|---|---|---|---|---|---|---|---|
| D19. Tutor students after school or during weekends | STEM Undergrad | 6 | 2.83 | 0.98 | 9.92 | 33.50 | .807 |
| | STEM Graduate | 12 | 2.67 | 1.07 | 9.29 | | |
| D20. Explain a difficult science concept to students | STEM Undergrad | 6 | 2.67 | 1.03 | 6.50 | 18.00 | .068 |
| | STEM Graduate | 12 | 3.50 | 0.67 | 11.00 | | |
| D21. Relate current research to K-12 curriculum | STEM Undergrad | 6 | 2.17 | 0.98 | 6.50 | 18.00 | .078 |
| | STEM Graduate | 12 | 3.08 | 1.00 | 11.00 | | |
| D22. Explain current research to teachers | STEM Undergrad | 6 | 2.17 | 1.17 | 7.17 | 22.00 | .175 |
| | STEM Graduate | 12 | 2.92 | 1.00 | 10.67 | | |
| D23. Plan a field trip to museums | STEM Undergrad | 6 | 1.83 | 0.98 | 6.83 | 20.00 | .113 |
| | STEM Graduate | 12 | 2.83 | 1.40 | 10.83 | | |
| D24. Facilitate student learning in museums | STEM Undergrad | 6 | 1.83 | 0.75 | 7.08 | 21.50 | .161 |
| | STEM Graduate | 12 | 2.67 | 1.23 | 10.71 | | |
| D25. Organize a science family night in school | STEM Undergrad | 6 | 1.83 | 0.98 | 8.17 | 28.00 | .426 |
| | STEM Graduate | 12 | 2.33 | 1.30 | 10.17 | | |
| D26. Explain science to parents | STEM Undergrad | 6 | 2.00 | 0.63 | 7.67 | 25.00 | .282 |
| | STEM Graduate | 12 | 2.50 | 1.09 | 10.42 | | |

*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 12 responses received from STEM graduate students who participated in the UB/BPS ISEP project in Fall 2013, 4 were in their first year with the project and 8 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 Fall 2013.

Compared to first-year STEM graduate student participants, veteran participants reported less interest in pursuing college or university faculty positions with primarily teaching responsibilities and more interest in pursuing college or university faculty positions with both teaching and research responsibilities and/or research/development positions in industry or business (Table 31).

Table 31. *Respondents' Career Goals by Participation Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| E8. Career Goals | Not First Year in ISEP (%) | First Year in ISEP (%) | Total (%) |
|---|---|---|---|
| College or university faculty position with both teaching and research responsibilities | 2 (50%) | 2 (25%) | 4 (33%) |
| College or university faculty position with primarily teaching responsibilities (greater emphasis on teaching than research) | 1 (25%) | 4 (50%) | 5 (41%) |
| College or university faculty position with primarily research responsibilities (greater emphasis on research than teaching) | 1 (25%) | 1 (12%) | 2 (16%) |
| College or university faculty position preparing K–12 teachers in science or mathematics education | 1 (25%) | 1 (12%) | 2 (16%) |
| Researcher at a government laboratory or research institution | 0 (0%) | 3 (37%) | 3 (25%) |
| Researcher/developer in industry/business | 3 (75%) | 2 (25%) | 5 (41%) |
| Non-research position in the government or nonprofit sectors | 1 (25%) | 2 (25%) | 3 (25%) |
| K–12 science or mathematics teacher | 0 (0%) | 1 (12%) | 1 (8%) |
| K–12 administrator (e.g., school, district, State-level educational administration) | 0 (0%) | 0 (0%) | 0 (0%) |
| Medical/Dentistry/Veterinary | 0 (0%) | 1 (12%) | 1 (8%) |
| I am unsure at this time | 0 (0%) | 3 (37%) | 3 (25%) |

*Note.* Respondents could choose more than one option.

As shown in Table 32, first-year graduate student participants indicated that they participated in more orientations than did returning participants.

Table 32. *Respondents' Preparation for Working in Schools by Participation Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| A. Preparation for working in schools | Not First Year in ISEP (%) | First Year in ISEP (%) | Total (%) |
|---|---|---|---|
| Orientation in urban education | 1 (25%) | 2 (25%) | 3 (25%) |
| Orientation in culture and diversity | 0 (0%) | 2 (25%) | 2 (16%) |
| Orientation in teamwork/collaboration | 0 (0%) | 3 (37%) | 3 (25%) |
| Orientation in science teaching and learning | 1 (25%) | 7 (87%) | 8 (66%) |
| Orientation in science communications | 0 (0%) | 4 (50%) | 4 (33%) |
| Orientation in mentoring | 0 (0%) | 5 (62%) | 5 (41%) |
| Teaching Experience | 1 (25%) | 1 (12%) | 2 (16%) |
| Other | 0 (0%) | 1 (12%) | 1 (8%) |
| None | 1 (25%) | 1 (12%) | 2 (16%) |

*Note.* Respondents could choose more than one option.

As shown in Table 33, both first year and veteran graduate student participants indicated that their activities in schools were highly integrated and comprehensive. In addition, more first-year graduate students indicated that they developed labs for classroom use and out-of-school science learning activiti3es

Table 33. *Respondents' Experience in Schools by Participation Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| B. Experiences in schools | Not First Year in ISEP (%) | First Year in ISEP (%) | Total (%) |
|---|---|---|---|
| Assisted teachers in teaching lessons | 3 (75%) | 7 (87%) | 10 (83%) |
| Assisted teachers in conducting labs | 3 (75%) | 8 (100%) | 11 (91%) |
| Developed science labs for class use | 2 (50%) | 7 (87%) | 9 (75%) |
| Developed out-of-school science learning activities | 0 (0%) | 4 (50%) | 4 (33%) |
| Led small group activities/discussions with students in class | 3 (75%) | 7 (87%) | 10 (83%) |
| Led small group activities/discussions with students after school or during weekend | 2 (50%) | 2 (25%) | 4 (33%) |
| Demonstrated scientific content, procedures, tools, or techniques to students | 2 (50%) | 8 (100%) | 10 (83%) |
| Helped teachers find relevant resources (e.g., science activities) | 3 (75%) | 8 (100%) | 11 (91%) |
| Presented lessons/lectures to students in class | 2 (50%) | 7 (87%) | 9 (75%) |
| Tutored students after school or during weekends | 1 (25%) | 1 (12%) | 2 (16%) |
| Other | 3 (75%) | 2 (25%) | 5 (42%) |

*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 34). More returning participants than new participants listed peer encouragement as one of the reasons for participating in the ISEP project, while more first-year ISEP participant students listed faculty encouragement as one of the reasons.

Table 34. *Respondents' Reasons for Participating in UB/BPS ISEP Project by Participation Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| C1. Reasons for participating in UB/BPS ISEP | Not First Year in ISEP (%) | First Year in ISEP (%) | Total (%) |
|---|---|---|---|
| To gain financial support for my education | 3 (75%) | 6 (75%) | 9 (75%) |
| My faculty advisor or another faculty member encouraged me | 1 (25%) | 4 (50%) | 5 (41%) |
| Another student(s) encouraged me to participate | 2 (50%) | 2 (25%) | 4 (33%) |
| To share my knowledge of science, technology, engineering and/or mathematics | 3 (75%) | 7 (87%) | 10 (83%) |
| To work with school-age students | 3 (75%) | 8 (100%) | 11 (92%) |
| I was interested in a teaching career | 1 (25%) | 3 (37%) | 4 (33%) |
| To have new experiences | 4 (100%) | 5 (62%) | 9 (75%) |
| To enhance my C.V. or resume | 2 (50%) | 6 (75%) | 8 (66%) |
| To develop my teaching skills | 3 (75%) | 5 (62%) | 8 (66%) |

| C1. Reasons for participating in UB/BPS ISEP | Not First Year in ISEP (%) | First Year in ISEP (%) | Total (%) |
|---|---|---|---|
| To develop my teamwork skills | 1 (25%) | 4 (50%) | 5 (41%) |
| To develop my science communication skills | 3 (75%) | 5 (62%) | 8 (66%) |
| To develop my research skills | 1 (25%) | 1 (12%) | 2 (16%) |

*Note.* Respondents could choose more than one option.

Table 35 shows that veteran ISEP graduate students agreed more often that ISEP experiences had benefited their ability to teach STEM concepts and methods than did first-year ISEP participants.

Table 35. *Respondents' Perceived Benefit in Participating in UB/BPS ISEP Project by Participation Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| C2. My UB/BPS ISEP Experiences Have Benefited My Ability to… | Experience in ISEP | *n* | *M* | *SD* | Mean Rank | Mann-Whitney *U*-statistics | *p* (2-tailed) |
|---|---|---|---|---|---|---|---|
| C2a. Work on a Team | First Year in ISEP | 4 | 3.00 | 0.00 | 5.00 | 10 | .176 |
| | Not First Year in ISEP | 8 | 3.38 | 0.52 | 7.25 | | |
| C2b. Lead a team | First Year in ISEP | 4 | 3.00 | 0.82 | 5.38 | 12 | .409 |
| | Not First Year in ISEP | 8 | 3.38 | 0.74 | 7.06 | | |
| C2c. Facilitate group discussions | First Year in ISEP | 4 | 3.00 | 0.82 | 5.00 | 10 | .266 |
| | Not First Year in ISEP | 8 | 3.50 | 0.76 | 7.25 | | |
| C2d. Teach STEM concepts and methods | First Year in ISEP | 4 | 3.00 | 0.00 | 3.50 | 4 | **.019** |
| | Not First Year in ISEP | 8 | 3.75 | 0.46 | 8.00 | | |
| C2e. Develop instructional materials about STEM concepts and methods | First Year in ISEP | 4 | 3.25 | 0.50 | 5.00 | 10 | .241 |
| | Not First Year in ISEP | 8 | 3.63 | 0.52 | 7.25 | | |
| C2f. Generate others' interest in STEM research and activities | First Year in ISEP | 4 | 2.75 | 0.50 | 4.38 | 8 | .083 |
| | Not First Year in ISEP | 8 | 3.38 | 0.52 | 7.56 | | |
| C2g. Conduct research as part of a collaborative team | First Year in ISEP | 4 | 2.75 | 0.96 | 6.88 | 15 | .781 |
| | Not First Year in ISEP | 8 | 2.50 | 0.76 | 6.31 | | |
| C2h. Conduct independent research | First Year in ISEP | 4 | 2.50 | 0.58 | 7.75 | 11 | .360 |
| | Not First Year in ISEP | 8 | 2.13 | 0.99 | 5.88 | | |

| C2. My UB/BPS ISEP Experiences Have Benefited My Ability to… | Experience in ISEP | *n* | *M* | *SD* | Mean Rank | Mann-Whitney *U*-statistics | *p* (2-tailed) |
|---|---|---|---|---|---|---|---|
| C2i. Develop a research and/or technology agenda | First Year in ISEP | 4 | 2.25 | 0.50 | 5.25 | 11 | .338 |
| | Not First Year in ISEP | 8 | 2.75 | 0.89 | 7.13 | | |
| C2j. Write papers and reports about my work | First Year in ISEP | 4 | 2.25 | 0.50 | 6.38 | 16 | .923 |
| | Not First Year in ISEP | 8 | 2.25 | 0.71 | 6.56 | | |
| C2k. Present my work at a professional conference | First Year in ISEP | 4 | 2.50 | 0.58 | 7.50 | 12 | .463 |
| | Not First Year in ISEP | 8 | 2.13 | 0.83 | 6.00 | | |
| C2l. Explain STEM research and concepts to public (non-technical) audience | First Year in ISEP | 4 | 3.50 | 0.58 | 6.25 | 15 | .846 |
| | Not First Year in ISEP | 8 | 3.50 | 0.76 | 6.63 | | |
| C2m. Decide a career in education | First Year in ISEP | 4 | 1.75 | 0.50 | 4.50 | 8 | .145 |
| | Not First Year in ISEP | 8 | 2.63 | 1.06 | 7.50 | | |
| C2n. Understand science concepts better | First Year in ISEP | 4 | 2.25 | 0.50 | 4.38 | 8 | .108 |
| | Not First Year in ISEP | 8 | 2.88 | 0.64 | 7.56 | | |

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

Table 36. *Respondents' Perceived Effects of Participating in UB/BPS ISEP Project by Participation Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| C3. As a result of my UB/BPS ISEP experiences… | Experience in ISEP | *n* | *M* | *SD* | Mean Rank | Mann-Whitney *U*-statistics | *p* (2-tailed) |
|---|---|---|---|---|---|---|---|
| C3a. My interest in conducting research | First Year in ISEP | 4 | 3.25 | 0.50 | 7.00 | 14 | .600 |
| | Not First Year in ISEP | 8 | 3.13 | 0.35 | 6.25 | | |
| C3b. My interest in teaching at the college/university level | First Year in ISEP | 4 | 3.25 | 0.50 | 4.25 | 7 | .099 |
| | Not First Year in ISEP | 8 | 4.00 | 0.76 | 7.63 | | |

| C3. As a result of my UB/BPS ISEP experiences… | Experience in ISEP | *n* | *M* | *SD* | Mean Rank | Mann-Whitney *U*-statistics | *p* (2-tailed) |
|---|---|---|---|---|---|---|---|
| C3c. My interest in teaching at the K–12 level | First Year in ISEP | 4 | 3.00 | 0.00 | 5.50 | 12 | .414 |
| | Not First Year in ISEP | 8 | 3.25 | 0.71 | 7.00 | | |
| C3d. My interest in influencing public policy related to STEM education | First Year in ISEP | 4 | 4.50 | 0.58 | 7.75 | 11 | .366 |
| | Not First Year in ISEP | 8 | 4.00 | 0.93 | 5.88 | | |

*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 37 shows that there were no statistically significant differences in first-year and veteran graduate students' responses about their level of self-efficacy in communicating science.

Table 37. *Respondents' Self-Efficacy in Communicating Science by Participation Status, UB-BPS ISEP STEM Student Questionnaire, Fall 2013*

| D. How much I can do in order to… | Experience in ISEP | *n* | *M* | *SD* | Mean Rank | Mann-Whitney *U*-statistics | *p* (2-tailed) |
|---|---|---|---|---|---|---|---|
| D1. Understand middle and high school students' science background knowledge | First Year in ISEP | 4 | 3.75 | 0.50 | 7.75 | 11 | .339 |
| | Not First Year in ISEP | 8 | 3.13 | 1.13 | 5.88 | | |
| D2. Understand middle and high school students' interest in science | First Year in ISEP | 4 | 3.75 | 0.50 | 8.38 | 9 | .167 |
| | Not First Year in ISEP | 8 | 3.00 | 0.93 | 5.56 | | |
| D3. Understand middle and high school students' cognitive abilities | First Year in ISEP | 4 | 3.00 | 0.82 | 6.13 | 15 | .774 |
| | Not First Year in ISEP | 8 | 3.13 | 0.64 | 6.69 | | |
| D4. Understand middle and high school students' social and cultural backgrounds | First Year in ISEP | 4 | 3.25 | 0.50 | 6.13 | 14 | .919 |
| | Not First Year in ISEP | 7 | 3.14 | 0.90 | 5.93 | | |
| D5. Understand middle and high school students' attention span | First Year in ISEP | 4 | 2.75 | 0.96 | 5.88 | 14 | .651 |
| | Not First Year in ISEP | 8 | 3.00 | 0.93 | 6.81 | | |
| D6. Decide what science topics are appropriate to students | First Year in ISEP | 4 | 3.00 | 1.15 | 6.00 | 14 | .711 |
| | Not First Year in ISEP | 8 | 3.25 | 0.89 | 6.75 | | |

| D. How much I can do in order to… | Experience in ISEP | *n* | *M* | *SD* | Mean Rank | Mann-Whitney *U*-statistics | *p* (2-tailed) |
|---|---|---|---|---|---|---|---|
| D7. Decide how much science content is appropriate to students | First Year in ISEP | 4 | 2.50 | 1.00 | 5.00 | 10 | .278 |
| | Not First Year in ISEP | 8 | 3.00 | 0.76 | 7.25 | | |
| D8. Help teachers find relevant resources (e.g., science activities) | First Year in ISEP | 4 | 3.75 | 0.50 | 7.13 | 14 | .610 |
| | Not First Year in ISEP | 8 | 3.38 | 1.06 | 6.19 | | |
| D9. Develop science labs | First Year in ISEP | 4 | 3.00 | 1.15 | 5.50 | 12 | .444 |
| | Not First Year in ISEP | 8 | 3.50 | 0.76 | 7.00 | | |
| D10. Develop out-of-school science learning activities | First Year in ISEP | 4 | 2.50 | 1.00 | 6.00 | 14 | .711 |
| | Not First Year in ISEP | 8 | 2.75 | 1.16 | 6.75 | | |
| D11. Assist teachers in teaching lessons | First Year in ISEP | 4 | 3.75 | 0.50 | 8.25 | 9 | .195 |
| | Not First Year in ISEP | 8 | 3.00 | 1.07 | 5.63 | | |
| D12. Assist teachers in conducting labs | First Year in ISEP | 4 | 3.75 | 0.50 | 7.75 | 11 | .338 |
| | Not First Year in ISEP | 8 | 3.00 | 1.31 | 5.88 | | |
| D13. Teach science labs to students | First Year in ISEP | 4 | 3.25 | 0.96 | 6.00 | 14 | .702 |
| | Not First Year in ISEP | 8 | 3.38 | 1.06 | 6.75 | | |
| D14. Facilitate out-of-school science learning activities | First Year in ISEP | 4 | 3.00 | 1.15 | 6.25 | 15 | .856 |
| | Not First Year in ISEP | 8 | 3.13 | 0.83 | 6.63 | | |
| D15. Lead small group activities/discussions with students in class | First Year in ISEP | 4 | 3.50 | 0.58 | 7.50 | 12 | .464 |
| | Not First Year in ISEP | 8 | 3.00 | 1.07 | 6.00 | | |
| D16. Lead small group activities/discussions with students after school or during weekends | First Year in ISEP | 4 | 2.75 | 0.96 | 7.38 | 13 | .533 |
| | Not First Year in ISEP | 8 | 2.38 | 1.19 | 6.06 | | |
| D17. Demonstrate scientific content, procedures, tools, or techniques to students | First Year in ISEP | 4 | 3.50 | 0.58 | 6.25 | 15 | .846 |
| | Not First Year in ISEP | 8 | 3.38 | 1.06 | 6.63 | | |

| D. How much I can do in order to… | Experience in ISEP | *n* | *M* | *SD* | Mean Rank | Mann-Whitney *U*-statistics | *p* (2-tailed) |
|---|---|---|---|---|---|---|---|
| D18. Teach lessons or give lectures to students in class | First Year in ISEP | 4 | 3.25 | 0.50 | 5.38 | 12 | .395 |
| | Not First Year in ISEP | 8 | 3.50 | 0.76 | 7.06 | | |
| D19. Tutor students after school or during weekends | First Year in ISEP | 4 | 2.75 | 1.50 | 6.88 | 15 | .792 |
| | Not First Year in ISEP | 8 | 2.63 | 0.92 | 6.31 | | |
| D20. Explain a difficult science concept to students | First Year in ISEP | 4 | 3.50 | 0.58 | 6.25 | 15 | .846 |
| | Not First Year in ISEP | 8 | 3.50 | 0.76 | 6.63 | | |
| D21. Relate current research to K-12 curriculum | First Year in ISEP | 4 | 3.25 | 0.96 | 7.00 | 14.00 | .719 |
| | Not First Year in ISEP | 8 | 3.00 | 1.07 | 6.25 | | |
| D22. Explain current research to teachers | First Year in ISEP | 4 | 3.50 | 0.58 | 8.50 | 8.00 | .156 |
| | Not First Year in ISEP | 8 | 2.63 | 1.06 | 5.50 | | |
| D23. Plan a field trip to museums | First Year in ISEP | 4 | 2.25 | 1.50 | 5.00 | 10.00 | .266 |
| | Not First Year in ISEP | 8 | 3.13 | 1.36 | 7.25 | | |
| D24. Facilitate student learning in museums | First Year in ISEP | 4 | 2.25 | 1.50 | 5.38 | 11.50 | .429 |
| | Not First Year in ISEP | 8 | 2.88 | 1.13 | 7.06 | | |
| D25. Organize a science family night in school | First Year in ISEP | 4 | 2.25 | 1.50 | 6.25 | 15.00 | .858 |
| | Not First Year in ISEP | 8 | 2.38 | 1.30 | 6.63 | | |
| D26. Explain science to parents | First Year in ISEP | 4 | 3.00 | 0.82 | 8.00 | 10.00 | .285 |
| | Not First Year in ISEP | 8 | 2.25 | 1.16 | 5.75 | | |

*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 Parent-Based PLC Questionnaire (Spring 2013 – Spring 2014)*

The *UB/BPS MSP ISEP Parent-Based PLC Questionnaire* collected data from parents who attended meetings of the ISEP project's parent-based professional learning community from Spring 2013 through Spring 2014. These parents have one or more students enrolled in the 12 ISEP participating schools. Fifteen parents responded to the questionnaire. Tables 38 to 40 list schools their children attended and what science courses their children took, as well as whether their children's science teachers were involved with ISEP.

Table 38. *Schools Attended by Respondents' Children, UB/BPS MSP ISEP Parent-Based PLC Questionnaire, Spring 2013 – Spring 2014*

| School | *n* |
|---|---|
| Burgard Vocational HS | 1 |
| East HS | 2 |
| Harriet Ross Tubman Academy | 2 |
| Hutchinson Central Technical HS | 4 |
| Lorraine Academy & Hutchinson Central Technical HS | 1 |
| MST | 1 |
| Native American Magnet (NAMS) & Hutchinson Central Technical HS | 2 |
| Riverside Institute of Technology HS | 1 |
| Southside Elementary | 1 |
| **Total** | **15** |

Table 39. *Science Courses Taken by Respondents' Children, UB/BPS MSP ISEP Parent-Based PLC Questionnaire, Spring 2013 – Spring 2014*

| Science Class | *n* |
|---|---|
| 3rd Grade Science | 1 |
| 3rd Grade Science, Regents Chemistry, Regents Physics | 2 |
| 4th Grade Science, Regents Biology | 1 |
| Environmental Science, AP Biology | 1 |
| Environmental Science, AP Biology, AP Environmental Science, Advanced Biology | 1 |
| None or not reported | 3 |
| Regents Biology | 4 |
| Regents Chemistry | 2 |
| **Total** | **15** |

Table 40. *ISEP Participation Status of Teachers of Respondents' Children, UB/BPS MSP ISEP Parent-Based PLC Questionnaire, Spring 2013 – Spring 2014*

| Science Teacher Involved in ISEP? | *n* |
|---|---|
| Yes | 3 |
| I don't know | 12 |
| **Total** | **15** |

Table 41 shows that all parents agreed that the purpose and goals of the parent-based PLC were explained to them clearly, their questions about involvement in the PLC were answered completely, they believed their participation in the parent-based PLC would be an effective way to support their children's science education, and they wanted to continue to participate in the parent-based PLC.

Table 41. *Respondents' Views of PLC, UB/BPS MSP ISEP Parent-Based PLC Questionnaire, Spring 2013 – Spring 2014*

| Item | Yes | No | *n* |
|---|---|---|---|
| The purpose and goals of the parent-based PLC were explained to me clearly. | 100% | 0 | 15 |
| My questions about my involvement in the PLC were answered completely. | 100% | 0 | 15 |
| I believe my participation in this parent-based PLC will be an effective way to support my child's science education. | 100% | 0 | 15 |
| Based on my understanding of the PLC at this point, I want to continue to participate in the parent-based PLC. | 100% | 0 | 15 |

Parents completing the questionnaire also responded to 5 open-ended questions regarding their involvement with the parent-based PLC and their expectations for their students' science learning.

A majority of parents (70%) indicated that their primary reason for participating in the parent-based PLC was to be involved in their students' education. Parents also commented on how their students' involvement in the project, thus far, had positively impacted them, including one parent who noted that *"This program is a great asset to our community. Programs like this in my opinion are valuable to my kids and all kids*." Four of the 15 parents indicated that their involvement with the project was based on future expectations for their children's college and career success.

Parents shared a variety of short-term expectations for their children's science education, including enjoyment of and developing more interest in science, learning about science in everyday life, developing skills for academic success, and actively participating in science through programs such as ISEP.

Parent long-term expectations for their children's science education included: exciting children about science, preparing students for careers in science-related fields; improving science programs/courses in schools, including developing more after school and summer programs; and developing skills in science that will be important to students' futures. One parent shared the expectation that *"every child will be a ISEP graduate."*

Parents indicated a range of existing resources and opportunities that supported their children in reaching expectations related to science education. Six parents indicated that collaboration of parents, schools, and community resources (i.e., library) provided support for students learning science. Five parents specifically mentioned the ISEP project or its components as important resources for science education. Three parents noted that good teachers and continuing professional development for teachers were contributing to their students' science education. Additional resources or opportunities that parents believed were needed to support their children's science education included: stronger school-parent partnerships, more opportunities for students to learn about science careers, continued involvement with the ISEP program, and more age-appropriate science programs for younger students, including field trips.

# Summary and Recommendations

## Summary of Evidence of Progress Toward Project Goals

During Year 3 of the ISEP project, the E & A Center evaluation team turned their 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 first year of implementation with teachers (Summer 2012 - Spring 2013). Spring 2013 data also were collected post-Year 1 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 Fall 2013 and from parents involved in professional learning communities during 2013 and 2014. Spring 2014 data are being collected from ISEP teachers and their BPS students, comparison BPS students, and STEM students at the time of this report. Findings reported here, though more summative in nature than Year 1 and 2 findings, 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. Evaluators will work with the ISEP project team to determine how data will be collected, or if goals need to be modified based on access to appropriate data sources. Findings from the Year 3 evaluation are summarized under each of the ISEP project goals.

**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?*

Prior to participating in ISEP project activities, more than half of the participating teachers indicated they were well prepared in all areas related to providing science instruction to students. Teachers reported high levels of preparedness to provide standards-based science instruction and to teach and assess scientific inquiry, including interdisciplinary science inquiry. ISEP teachers reported lower levels of preparedness for teaching science to a diverse range of students (e.g., those with limited English proficiency or a learning disability). Though ISEP teachers generally reported high levels of preparedness to teach science, more than half indicated moderate to high priority professional development needs in all 30 areas related to providing science instruction to students. Further, ISEP teachers reported that helping students develop the understanding and ability to do scientific inquiry was the top priority, and teachers reported lower priority needs related to subject-specific aspects of science teaching.

Regarding development of teachers' knowledge and skills, statistically significant improvements included that teachers indicated better preparedness to encourage participation of females and minorities in science courses after participating in ISEP professional development. Other gains of practical significance reported by teachers included better preparedness to teach a diverse range of students and make curricular decisions aligned with standards.

Following one year of participation in ISEP project activities, teachers reported less preparedness to teach scientific inquiry; lead a class of students using investigative strategies; take into account students' prior conceptions when planning instruction; and align standards, curriculum, instruction, and assessment to enhance student science learning. Similar responses were found to questions asking teachers to indicate their highest priority professional development needs, where teachers reported higher priority professional development needs related to some aspects of inquiry teaching (i.e., plan and carry out investigations) after their year of participation. These findings suggest that teachers may be developing new, deeper understandings of inquiry teaching and learning; and therefore, they felt less prepared to implement this new learning in their classrooms. As noted by other researchers, teachers prior conceptions of inquiry may hinder or facilitate implementation of inquiry teaching and learning practices.

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; systems, order and organization) and practices of science and engineering (i.e., construct explanations and design solutions). 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.  As noted in the report of the ISEP Research Team, teachers' self-reported knowledge development did not necessarily translate to improved knowledge of interdisciplinary science inquiry or implementation of interdisciplinary science in their classrooms.

Prior to participating in ISEP professional development, the majority of ISEP teachers indicated that support for teaching design, engineering, and technology in their schools was insufficient. Most teachers indicated that they had very little preparation to teach DET, and that their schools' curricula provided few opportunities to incorporate DET activities. 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. These findings suggest that DET either was not an explicit focus of the 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****?*

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. ISEP teachers also held positive attitudes and beliefs about teaching science and mathematics in general before engaging with the project. Following their first year of participation in ISEP activities, the only statistically significant change in teacher understanding of inquiry was that teacher participants agreed more with the misconception that inquiry-based learning requires more sophisticated materials and equipment than does other types of classroom learning. Additionally, their levels of agreement with other common misconceptions about classroom inquiry were largely unchanged by their project experiences.

Similar to their views of inquiry, although ISEP teachers demonstrated a good understanding of most aspects of the Nature of Science, they held common misconceptions regarding scientific methods, and the relationship between scientific laws and theories prior to their participation with the project. Following participation in ISEP activities, teacher participants demonstrated better understanding of some aspects of the Nature of Science, including the relationship between scientific theory and law, and the development of scientific knowledge. Conversely, teachers also agreed more with misconceptions regarding scientific methods and the influence of culture, creativity and imagination on the scientific enterprise.

*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.

Elementary grades students of ISEP teachers reported that their teachers demonstrated many behaviors that characterize inquiry teaching, including teachers more frequently asked them to give reasons and provide evidence for their answers; encouraged them to ask questions, explain their ideas to other students, and consider different scientific explanations; provided time for them to discuss science ideas with other students; and provided meaningful and challenging assignments. These differences between the reports of ISEP teachers' students and students of control teachers were all statistically significant.

Students of ISEP teachers also self-reported more of their own behaviors that characterize inquiry learning, including that they talked with other students about how to do a science task or about how to interpret the data from an experiment and considered different scientific explanations more often than did students' of control teachers. Of the 24 items asking students' perceptions of their classroom experiences, ISEP teachers' students reported more often that their classrooms were inquiry-oriented than did students of non-ISEP teachers on all but 1 item.

When comparing attitudes and opinions of middle school control and ISEP participant teachers' students, students of ISEP teachers reported that their teachers more frequently arranged the classroom for student discussion; asked questions that have more than one answer; asked them to give reasons and provide evidence for their answers; encouraged them to ask questions, explain their ideas to other students, and consider different scientific explanations; provided time for them to discuss science ideas with other students; and helped them apply their learning to real life. Students of ISEP teachers also self-reported that they talked with other students about how to do a science task or about how to interpret the data from an experiment; considered different scientific explanations; used a computer or the Internet for science assignments or activities; wrote about how they solved a science task or about what they were learning; learned that there were different solutions to science tasks; developed their skills for doing science; learned about how science is important in the real world; and worked on science tasks in a group with other students more often than did students' of control teachers. Of the 24 items asking students to report on their classroom inquiry experiences, ISEP teachers' students reported more positively than did non-ISEP teachers students on all but 2 items.

**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 in 2010-2011 and in 2011-2012. A limited data set is publically available and data that may respond more directly to the evaluation question will need to be obtained from the BPS central administration. Further, data for the 2012-2013 school year (first year of ISEP) were not publically available at the time of this report. 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 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.

While these data are not specific to science teachers, from 2010-2011 to 2011-2012, the percentage of teachers teaching without an appropriate license/certificate decreased at 6 of the 12 ISEP partner schools; the percentage of teachers with a Master's plus 30 hours or a doctorate degree increased at 5 ISEP schools; the percentage of core courses not taught by highly qualified teachers decreased at 5 schools; 6 ISEP schools had all core courses taught by highly qualified teachers; the turnover rate of teachers with fewer than 5 years of experience decreased at 4 and remained the same at 2 other ISEP schools; and the turnover rate for all teachers decreased at 7 ISEP partner 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?*

Fifteen parents attended meetings of the ISEP project's parent-based professional learning community from Spring 2013 through Spring 2014. These parents have one or more students enrolled in the 12 ISEP participating schools. All participating parents believed their participation in the parent-based PLC would be an effective way to support their children's science education, and they wanted to continue to participate in the parent-based PLC. Parents participating in the parent-based PLC indicated that their primary reason for participating in the parent-based PLC was to be involved in their students' education and commented on how their students' involvement in the project thus far had positively impacted them, including one parent who noted that *"this program is a great asset to our community. Programs like this in my opinion are valuable to my kids and all kids*."

Students also were asked about their parents' involvement in their science learning. Analyses comparing students of ISEP teachers to students of control teacher using data from the 6 BPS ISEP partner schools that had both control and ISEP teachers in the same building found that both elementary and middle school ISEP students agreed more often that there was at least one adult at home who made them do their science homework, than did control students.

**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?*

Though there were no statistically significant differences between the responses of high school students of ISEP and control teachers regarding their classroom learning environments, of the 24 items asking students about their classroom inquiry experiences, students of ISEP teachers responded more positively on 16 of these items than did their non-ISEP peers.

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 on any 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?*

Data regarding students' performance on science assessments in 2012-2013 were not available at the time of this report. Students' achievement on the Regents Exams for high school and on State exams at Grade 4 and 8 will be collected for each of the 12 ISEP partner schools. Baseline (2010-2011) and 2011-2012 data were reported in herein (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. The assessment was designed to probe students' learning of interdisciplinary science by utilizing items aligned with NGSS cross-cutting concepts. Pre/post and comparative analyses will be done upon completion of data collection; results will be reported to the ISEP project team in Fall 2014 and appear in the 2015 annual report.

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

When comparing attitudes and opinions of elementary grades control and ISEP participant students, students of ISEP teachers agreed more that they like science, and would keep on taking science classes even if they did not have to, than did students of non-ISEP teachers. Students of ISEP teachers also demonstrated a better understanding of the Nature of Science than did their peers taught by teachers not participating in ISEP. Middle school ISEP participant teachers' students also reported more often that they would keep on taking science classes even if they did not have to, when compared to their non-ISEP peers.

Analyses comparing students of ISEP teachers to students of control teachers at the high school level using data from the 6 BPS ISEP partner schools that had both control and ISEP teachers in the same building found that ISEP high school students were more likely to take challenging high school science courses, plan for post-secondary education, and plan to take science courses in college than were their non-ISEP peers.

**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 1 survey, most ISEP teachers reported moderate to high levels of participation in ISEP professional development activities focused on content and pedagogy in 2012-2013. ISEP teachers reported an average of 85 hours of professional development in addition to their Summer 2012 laboratory experiences. In addition, teachers reported that they had participated in an average of 33 hours of professional development activities outside of PD courses or activities with UB and/or BSC in 2012-2013. According to the records of project personnel, teachers' participation in professional development (learning community) sessions during the academic year ranged from 0% to 100% by individual and by building.

*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 suggest that their commitment to the work of the project is based on some common reasons, including interest in working with school-age students, having new experiences, and developing teaching skills. Most STEM undergraduate students also indicated that faculty encouragement and interest in teaching as a career were reasons for participating in this project; while STEM graduate students indicated that sharing knowledge of science, technology, engineering and/or mathematics and developing science communication skills were reasons for participating.

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

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. 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. These objectives and associated evaluation questions are:

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

*Evaluation Question 13: Have STEM undergraduate students' and graduate students' improved their understanding of the nature of interdisciplinary science and engineering research?*

No data have been collected by the external evaluation team to assess progress toward this objective. The internal evaluation and ISEP Research Team are collecting and analyzing data on the experiences of STEM students which will be incorporated into future evaluation reports as appropriate. Findings of the ISEP Research Team regarding this objective are included in the section of this report on project 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.

*Evaluation Question 12: Have STEM undergraduate students' and graduate students' developed communication skills to promote interdisciplinary science inquiry to middle and high school science teachers and students?*

Data collected from ISEP STEM graduate students in 2012 and 2013 indicate that the ISEP experience improved students' abilities to provide meaningful science instruction. ISEP graduate students felt more effective at communicating science content to students and at working with science teachers to develop science learning experiences. They also reported that their interest in teaching and in influencing public policy related to STEM education were increased by their participation, more than did STEM undergraduate students. Returning ISEP STEM graduate students reported better understanding of students' cognitive abilities after the second year of participation. However, STEM undergraduate students reported more skill in working with students informally and individually than did STEM graduate students.

An in-depth study of STEM students involvement in and learning from their ISEP experiences is being conducted by the ISEP Research Team. Findings of the ISEP Research Team regarding this objective are included in the section of this report on project research.

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

*Evaluation Question 14: Have To STEM undergraduate students' and graduate students' developed an appreciation of professional learning communities and collaborative skills to actively contribute to the PLCs?*

No data have been collected by the external evaluation team to assess progress toward this objective. The internal evaluation and research team are collecting and analyzing data on the experiences of STEM students which will be incorporated into future evaluation reports as appropriate.

## Observations and Recommendations

Based upon the findings of the external evaluation, the E & A Center makes the following recommendations for Year 4:

1. After performing analysis of pre/post *UB/BPS ISEP Teacher Questionnaire* 2012-2013 and 2013-2014 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 2012-2014, 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 2 years of 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 2013-2014 teacher and student pre/post data 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 Rausch 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 in collaboration with the ISEP Research Team.
4. Evaluators will use data provided by the 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 2013-2014.
5. Evaluators plan to visit the ISEP project this summer to observe and interact informally with ISEP teachers, STEM graduate students, and STEM faculty during teachers' summer laboratory experiences. Evaluators did conduct observations and interviews of many ISEP teachers and graduate students in Summer 2013 but did not interact with faculty. Evaluators would look forward to collecting data on faculty perceptions of ISEP teachers' and STEM students' experiences in their research as well as their own perspectives on involvement with the project.

# Appendices

## Appendix A. Summative Evaluation Matrix (Updated)

### *Summative Evaluation of Teachers*

*Project Goal 1: Improve middle school science teachers' knowledge and skills in science inquiry through conducting interdisciplinary science research and engineering design with university STEM faculty.*

| ***Anticipated Outcomes*** | ***Evaluation Design and Data Collection/Analysis*** | ***Instruments and Protocols to be used in development*** | ***UB/BPS ISEP Instrument*** |
|---|---|---|---|
| Summative Evaluation Question 1: Have middle school science teachers' knowledge and skills improved as the result of conducting interdisciplinary science research and engineering design with university STEM faculty? | | | |
| Science teachers will demonstrate advanced knowledge and skills in conducting interdisciplinary scientific research and engineering design | Pre- and post-assessments of teacher CK and PCK and engineering design<br><br>(Years 1-5)<br><br>ANOVA | POSTT (Schuster, et al, 2010)<br><br>ATLAST (Horizon Research, 2008) | *US/BPS ISEP Teacher Content and Pedagogical Content Knowledge Assessment* |
| Summative Evaluation Question 2: Have middle school science teachers improved their understanding of the nature of science and inquiry science teaching? | | | |
| Science teachers will demonstrate improved understanding of nature of science and inquiry science teaching | Pre- and post-assessments of teacher understanding of NOS and SI (open-response items)<br><br>(Years 1-5)<br><br>Rubric scored<br><br>ANOVA | Teacher Views of NOS and SI (Crawford, Capps, & Woodruff, 2008) based on VNOS-Form C (Lederman et al, 2002)<br><br>Teacher Survey of Design, Engineering, and Technology – Importance of DET and Familiarity with DET subscales (Yasar, et al, 2006)<br><br>Attitudes and Beliefs about the Nature and the Teaching of Mathematics and Science (McGinnis et al, 2002) | *UB/BPS ISEP Teacher Questionnaire* |
| Summative Evaluation Question 3: Have middle school science teachers improved their competence in conducting inquiry science teaching? | | | |
| Science teachers will demonstrate improved practice in conducting inquiry science teaching | Pre- and post-questionnaires administered to teachers and their students (Years 1-5)<br><br>Protocol-based observations of teacher classrooms (Years 2-5)<br><br>Rasch modeling<br><br>Hierarchical linear modeling (growth models) when quality of data and sample size are sufficient. | OMSP CPE Teacher Needs Assessment (Woodruff & Zorn, 2010)<br><br>OMSP CPE Teacher Instructional Practices Questionnaire (Woodruff, 2010) based on Local Systemic Change teacher questionnaire (Horizon Research, Inc)<br><br>Fossil Finders Teacher Views of NOS and SI (Crawford, Capps, & Woodruff, 2008) based on VNOS-Form C (Lederman et al, 2002)<br><br>Local Systemic Change | *UB/BPS ISEP Teacher Questionnaire*<br><br>*UB/BPS ISEP BPS Student Questionnaire* |

| | | | |
|---|---|---|---|
| | | Classroom Observation Protocol (Horizon Research, Inc)<br><br>What Is Happening in This Class (WIHIC) Questionnaire (Aldridge & Fraser, 2000)<br><br>Science Lesson Plan Analysis Instrument (SLPAI) (Jacobs, Martin, & Otieno, 2008) | |

*Project Goal 2: Increase science teacher quantity, quality, diversity and retention in urban schools.*

| ***Anticipated Outcomes*** | ***Evaluation Design and Data Collection/Analysis*** | ***Instruments and Protocols to be used in development*** | ***UB/BPS ISEP Instrument*** |
|---|---|---|---|
| Summative 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? | | | |
| Total number of highly-qualified science teachers teaching in the participating schools will increase<br><br>Science teacher population diversity will increase<br><br>Participating science teachers will be retained in their urban teaching positions | Collect longitudinal descriptive demographic, performance, and retention data on teachers from participating schools (from 2009-2014) and district trend data regarding HQT status of teacher candidate pool and new hires (from 2004-2014)<br><br>Descriptive statistics disaggregated by race/ethnicity and gender<br><br>Chi-square analysis and/or Qualitative categorization | District HR data<br><br>OMSP CPE Teacher Needs Assessment (Woodruff & Zorn, 2010) | *UB/BPS ISEP Teacher Questionnaire*<br><br>*UB/BPS ISEP School-level Data (2009-2014)*<br><br>*UB/BPS ISEP Teacher-level Data (2010-2014)* |

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

| ***Anticipated Outcomes*** | ***Evaluation Design and Data Collection/Analysis*** | ***Instruments and Protocols to be used in development*** | ***UB/BPS ISEP Instrument*** |
|---|---|---|---|
| Summative Evaluation Question 5: Are professional learning communities formed and active in each school? | | | |
| Participating teachers will form learning communities with other teachers in their schools and the district | Repeated measures, post-questionnaire administered to all teachers in participating schools (Years 2-5)<br><br>Descriptive statistics and ANOVA | School Culture Assessment Questionnaire (Sashkin, 1995)<br><br>Science Teacher School Environment Questionnaire (STSEQ) (Huang, 2006) | *UB/BPS ISEP Teacher PLC Reflection – subscale on post-Teacher Questionnaire* |

*Project Goal 4: Extend interdisciplinary inquiry based science and engineering learning to high school.*

| ***Anticipated Outcomes*** | ***Evaluation Design and Data Collection/Analysis*** | ***Instruments and Protocols to be used in development*** | ***UB/BPS ISEP Instrument*** |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Summative Evaluation Question 6: Are high schools with participating students implementing interdisciplinary inquiry in classrooms? | | | |
| Students of participating middle school teachers will continue experiencing interdisciplinary science inquiry learning in high school and will achieve higher than other students | Pre- and post-questionnaire administered to sample of participating district high school science teachers<br><br>(Years 1 and 5)<br><br>Descriptive statistics and ANOVA | Teacher Communication and Collaboration Questionnaire (OPAPP, E & A Center) | |

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

| ***Anticipated Outcomes*** | ***Evaluation Design and Data Collection/Analysis*** | ***Instruments and Protocols to be used in development*** | ***UB/BPS ISEP Instrument*** |
|---|---|---|---|
| Summative Evaluation Question 7: Are students achieving higher learning standards in science? | | | |
| Students of participating teachers will achieve at a higher level standard than students of non-participating teachers | Comparing performance of students of participating teachers with that of other students (Years 1, 3, 5)<br><br>ANCOVA | District or classroom data regarding student district and/or state standardized test scores | *UB/BPS ISEP School-level Data (2009-2014)*<br><br>*UB/BPS ISEP Teacher-level Data (2010-2014)* |
| Summative Evaluation Question 8: Are students more interested in learning science and pursing advanced studies in science? | | | |
| Students of participating teachers will become more interested in science | Pre- and post-questionnaire administered to a sample of students of participating and non-participating teachers (Years 1-5)<br><br>Rasch modeling and ANOVA | Science, Technology, and Society Attitude Scale (Attitude Domain) (Enger & Yager, 2000)<br><br>Student Questionnaire (OPAPP, E&A Center) | *UB/BPS ISEP BPS Student Questionnaire* |

*Project Goal 6: Improve collaboration in student learning among university, school and parents.*

| ***Anticipated Outcomes*** | ***Evaluation Design and Data Collection/Analysis*** | ***Instruments and Protocols to be used in development*** | ***UB/BPS ISEP Instrument*** |
|---|---|---|---|
| Summative Evaluation Question 9: Are parents actively involved in project activities that support student learning? | | | |
| Parents will become more actively involved in school-based after-school programs | Tracking participation of parents in project-related activities (Years 1-5)<br><br>Pre- and post-questionnaire administered to participating teachers and principals<br><br>(Years 1-5) | Tracking sheet of parent participation at school or classroom level (TBD by project team)<br><br>Parent/Adult Support of Science (PENN, E & A Center) | *UB/BPS ISEP Parent Questionnaire* |

| | | | |
|---|---|---|---|
| | Descriptive statistics | | |
| Summative Evaluation Question 10: Are science teachers actively participating in project activities? | | | |
| Science teachers in the participating schools will maintain their involvement in the partnership | Project record of teacher participation (Years 1-5)<br>Repeated measures, post-questionnaire administered annually to teachers (Years 1-5)<br>Descriptive statistics | Project database | *UB/BPS ISEP Teacher PLC Reflection –subscale on post- Teacher Questionnaire* |
| Summative Evaluation Question 11: Are university STEM faculty and students actively participating in project activities that improve K-12 science education? | | | |
| University STEM faculty and students will be actively involved in activities improving K-12 science education | Repeated measures, post-questionnaire administered annually to STEM faculty (Years 1-5)<br>Repeated measures, post-questionnaire administered annually to STEM students (Years 1-5)<br>Rasch modeling<br>Hierarchical linear modeling (growth models) when quality of data and sample size are sufficient | Faculty Questionnaire (E & A Center) | *UB/BPS ISEP Faculty Questionnaire*<br>*UB/BPS ISEP STEM Student Questionnaire* |

### *Summative Evaluation of STEM Students*

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

| ***Anticipated Outcomes*** | ***Evaluation Design and Data Collection/Analysis*** | ***Instruments and Protocols to be used in development*** | ***UB/BPS ISEP Instrument*** |
|---|---|---|---|
| Summative Evaluation Question 1: Have STEM undergraduate students' and graduate students' improved their understanding of the nature of interdisciplinary science and engineering research? | | | |
| University STEM students will have increased abilities to develop interdisciplinary scientific and engineering research plans. | Survey at the end of each year | Survey of Faculty Advisors (E & A Questionnaire)<br>Analysis of dissertation/thesis proposals | *UB/BPS ISEP Faculty Questionnaire* |
| University STEM students will demonstrate increased understanding of the nature of interdisciplinary science inquiry. | Survey at the beginning and end of an academic year | Teacher Views of NOS and SI (Crawford, Capps, & Woodruff, 2008) based on VNOS-Form C (Lederman et al, 2002)<br>Teacher Survey of Design, | *UB/BPS ISEP STEM Student Questionnaire* |

| | | | |
|---|---|---|---|
| | | Engineering, and Technology – Importance of DET and Familiarity with DET subscales (Yasar, et al, 2006)<br>Attitudes and Beliefs about the Nature and the Teaching of Mathematics and Science (McGinnis et al, 2002) | |

*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.*

| ***Anticipated Outcomes*** | ***Evaluation Design and Data Collection/Analysis*** | ***Instruments and Protocols to be used in development*** | ***UB/BPS ISEP Instrument*** |
|---|---|---|---|
| Summative Evaluation Question 2: Have STEM undergraduate students' and graduate students' developed communication skills to promote interdisciplinary science inquiry to middle and high school science teachers and students? | | | |
| University STEM students will develop increased pedagogical knowledge related to interdisciplinary inquiry | Survey at the beginning and end of an academic year of STEM Students' Pedagogical Knowledge | POSTT (Schuster, et al, 2010)<br>ATLAST (Horizon Research, 2008) | *US/BPS ISEP STEM Student Content and Pedagogical Content Knowledge Assessment* |
| University STEM students will develop increased ability to develop collaboratively interdisciplinary science teaching and learning activities | Document analysis at the end of an academic year of interdisciplinary science teaching and learning activities (to be adapted from AAAS Curriculum Materials Evaluation Criteria) | (to be adapted from AAAS Curriculum Materials Evaluation Criteria) | *UB/BPS ISEP STEM Student Questionnaire* |
| University STEM students will effectively tutor middle and high school students | Survey BPS students at the end of an academic year | | *UB/BPS ISEP BPS Student Questionnaire* |

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

| ***Anticipated Outcomes*** | ***Evaluation Design and Data Collection/Analysis*** | ***Instruments and Protocols to be used in development*** | ***UB/BPS ISEP Instrument*** |
|---|---|---|---|
| *Summative Evaluation Question 3: Have To STEM undergraduate students' and graduate students' developed an appreciation of professional learning communities and collaborative skills to actively contribute to the PLCs?* | | | |
| University STEM students will develop increased appreciation of professional learning communities | Survey of STEM students at the beginning and end of each academic year | | *UB/BPS ISEP STEM Student Questionnaire* |
| University STEM students will actively contribute to professional learning communities | Analysis of school activity log<br>Survey of STEM students at the beginning and end of each academic year | | *UB/BPS ISEP STEM Student Questionnaire* |

Appendix B. UB-BPS ISEP Teacher Questionnaire (Summer 2013)

***Targeted MSP: The University of Buffalo/Buffalo Public Schools (UB/BPS) Interdisciplinary Science and Engineering Partnership***
Teacher Questionnaire, Summer 2013

**Default Question Block**

**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 a follow-up to one you completed in June 2012 and 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 June 30.**

**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 do you teach in an average school year?**

***9. Do you currently teach or will you teach science and/or mathematics in the next school year?**

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

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

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

**11. 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 |
|---|---|---|
| **12. Are you a special education teacher?** | ○ | ○ |
| **13. Are you a career/technical education teacher?** | ○ | ○ |

**14. What grades and/or course(s) are you currently teaching? *(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): ______

**15. At your school, besides you, how many other teachers are employed full time to teach at your grade level in…**

| | Number of Teachers |
|---|---|
| a. Science | |
| b. Mathematics | |

**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 2012-2013 school year.
- Yes, during the 2011-2012 school year.
- Yes, during the 2010-2011 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 2011-2012 School Year: | Number of Hours in 2012-2013 School Year: |
|---|---|---|
| Content-related | | |
| Assessment-related | | |
| Curriculum-related | | |
| Pedagogy-related | | |

| | Number of Hours |
|---|---|
| **27a. In 2011-2012 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 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:** | |

## 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 levels 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. | ○ | ○ | ○ | ○ | ○ |

**SciInquiry/Design**

## 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

**37. If yes, please list the type of kits you use (such as SEPUP, FOSS, GEMS, STC, EiE, etc.):**

**Section I**

**38. 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 strongly do you agree that …

| | Strongly Disagree | Disagree | Neutral/ Undecided | Agree | Strongly Agree |
|---|---|---|---|---|---|
| 28. Design/Engineering/Technology has positive consequences for society. | ○ | ○ | ○ | ○ | ○ |

### 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.**

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

| | Strongly Disagree | Disagree | Neutral/ Undecided | Agree | Strongly Agree |
|---|---|---|---|---|---|
| In Grades K–9, truly understanding mathematics in schools requires special abilities that only some people possess. | ○ | ○ | ○ | ○ | ○ |
| The use of technologies (e.g., calculators, computers) in mathematics is an aid primarily for slow learners. | ○ | ○ | ○ | ○ | ○ |
| Mathematics consists of unrelated topics (e.g., algebra, arithmetic, calculus, geometry). | ○ | ○ | ○ | ○ | ○ |
| To understand mathematics, students must solve many problems following examples provided. | ○ | ○ | ○ | ○ | ○ |
| Students should have opportunities to experience manipulating materials in the mathematics classroom before teachers introduce mathematics vocabulary. | ○ | ○ | ○ | ○ | ○ |
| Getting the correct answer to a problem in the mathematics classroom is more important than investigating the problem in a mathematical manner. | ○ | ○ | ○ | ○ | ○ |
| Students should be given regular opportunities to think about what they have learned in the mathematics classroom. | ○ | ○ | ○ | ○ | ○ |
| Using technologies (e.g., calculators, computers) in mathematics lessons will improve students' understanding of mathematics. | ○ | ○ | ○ | ○ | ○ |
| The primary reason for learning mathematics is to learn skills for doing science. | ○ | ○ | ○ | ○ | ○ |
| Small group activity should be a regular part of the mathematics classroom. | ○ | ○ | ○ | ○ | ○ |
| 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. | ○ | ○ | ○ | ○ | ○ |
| Science is a constantly expanding field. | ○ | ○ | ○ | ○ | ○ |
| Theories in science are rarely replaced by other theories. | ○ | ○ | ○ | ○ | ○ |
| 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. | ○ | ○ | ○ | ○ | ○ |

**EndPage**

**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.**

----- Miami University, Oxford, OH 45056. www.MiamiOH.edu. 513.529.1686 -----

Ohio Evaluation & Assessment Center
MATHEMATICS • SCIENCE • EDUCATION

# Evaluation of ISEP

ES-MS Student Questionnaire
Fall 2013

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.

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

# *Evaluation of ISEP*

ES-MS Student Questionnaire
Fall 2013

**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

**Part 1: Please choose the answers that best represent your views and opinions about science and what you do in your science class this year.**

**MY OPINION ABOUT SCIENCE**

| | **Level of Agreement** | | | | |
|---|---|---|---|---|---|
| | **Strongly Disagree** | **Disagree** | **Neutral** | **Agree** | **Strongly Agree** |
| **8.** Please **circle** the response that best reflects how you feel about science. | | | | | |
| 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**

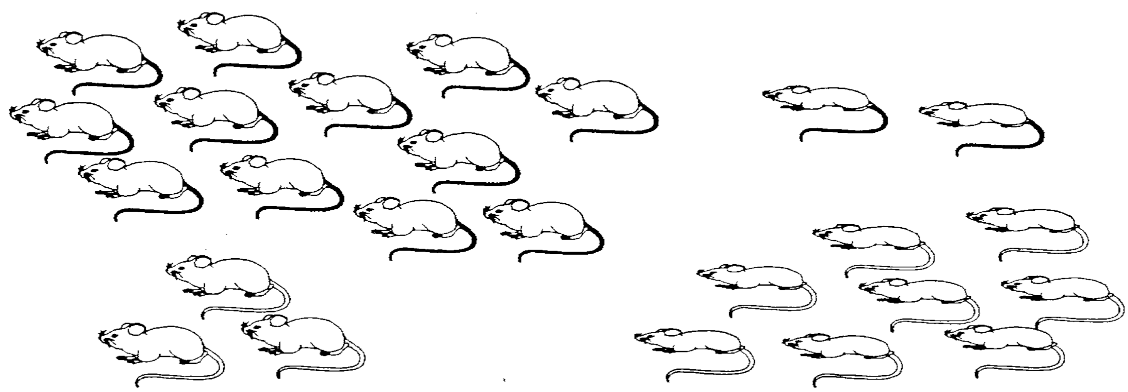
**Instructions:** Please **circle** the response that best reflects how often this happens in your science class **OR** in your home.

| | 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?

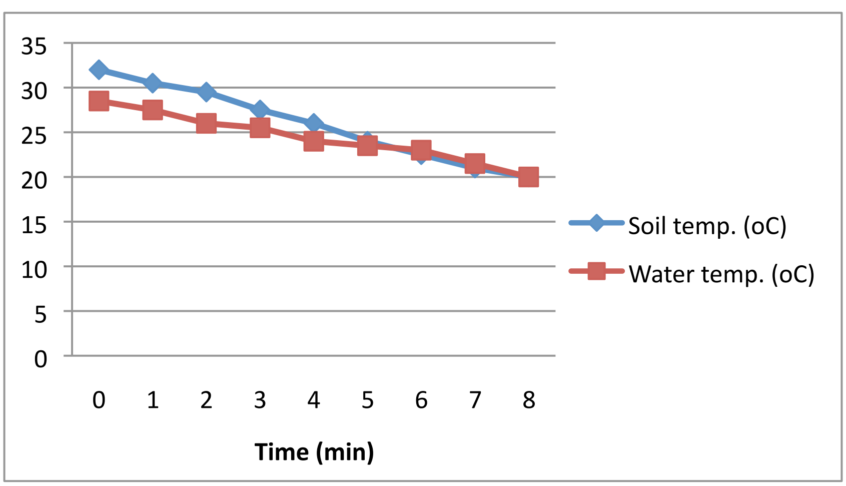
   A. Heat the samples for exactly the same amount of time.
   B. Heat the water sample longer than you heat the soil sample.
   C. Heat the soil sample longer than you heat the water sample.

Your experiment gives you the results shown in this table.

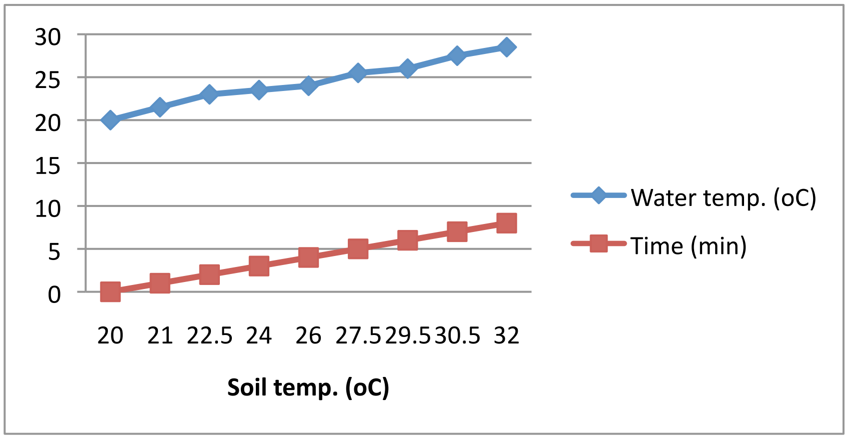
| Time (min) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Soil temp. ($^{o}$C) | 20.0 | 21.0 | 22.5 | 24.0 | 26.0 | 27.5 | 29.5 | 30.5 | 32.0 |
| Water temp. ($^{o}$C) | 20.0 | 21.5 | 23.0 | 23.5 | 24.0 | 25.5 | 26.0 | 27.5 | 28.5 |

6 . Which graph represents the data from your experiment?

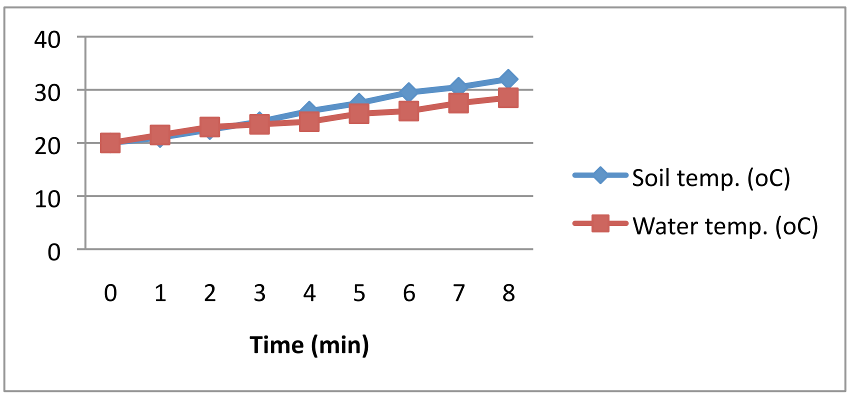
A.



B.

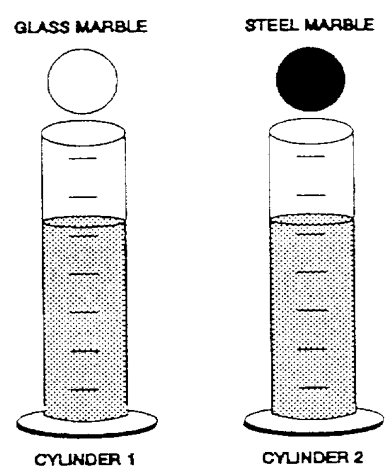



C.




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.

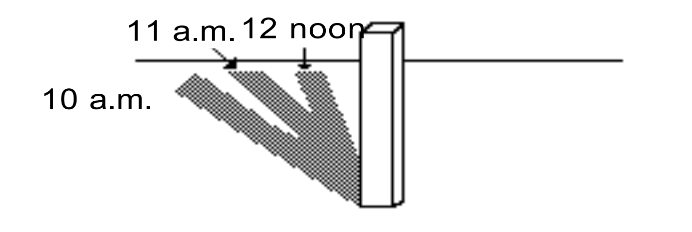
Use the information in this table to answer question 9.

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

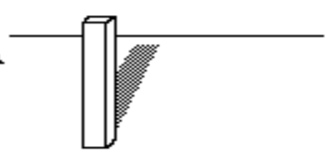
9. According to the information in the table, what should you do to decide whether an unknown powder is Powder X or Powder Y?

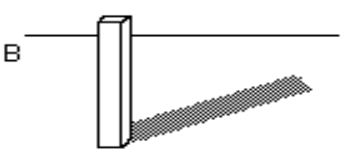
   A. Check the color of the powder.
   B. Measure the melting point of the powder.
   C. Dissolve the powder in water.

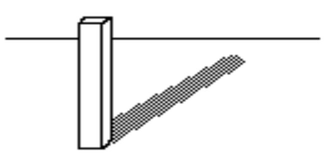
10. You notice that the shadow from a stick you placed in the sunlight changed position during the day. You recorded this information as shown here.




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

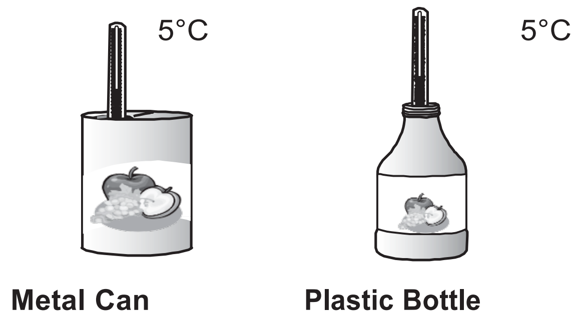
A


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.

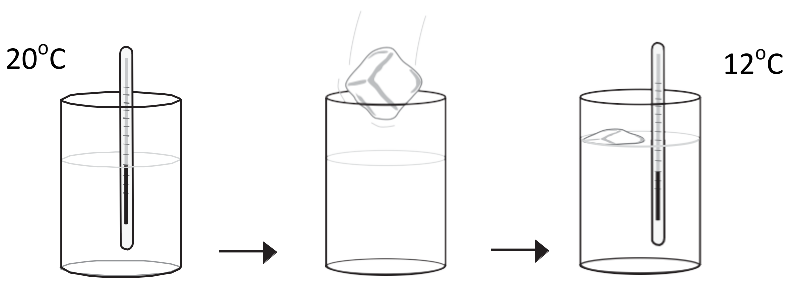



11. Why does the can feel colder than the bottle?

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?

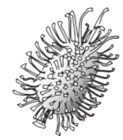
A. The ice cube melts because cold flows out of the ice cube to the water.
B. The ice cube does not melt because cold flows into the ice cube from the water.
C. The ice cube melts because thermal energy transfers to the ice cube from the water.

13. Which seed has structures that allow animals to transport the seed on their fur?

Corn Seed

A. 

Cocklebur

B. 

Maple Seed

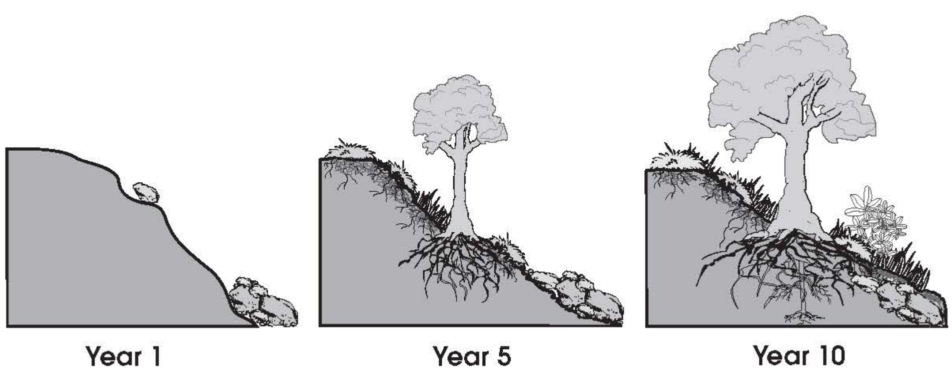
C. 

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?

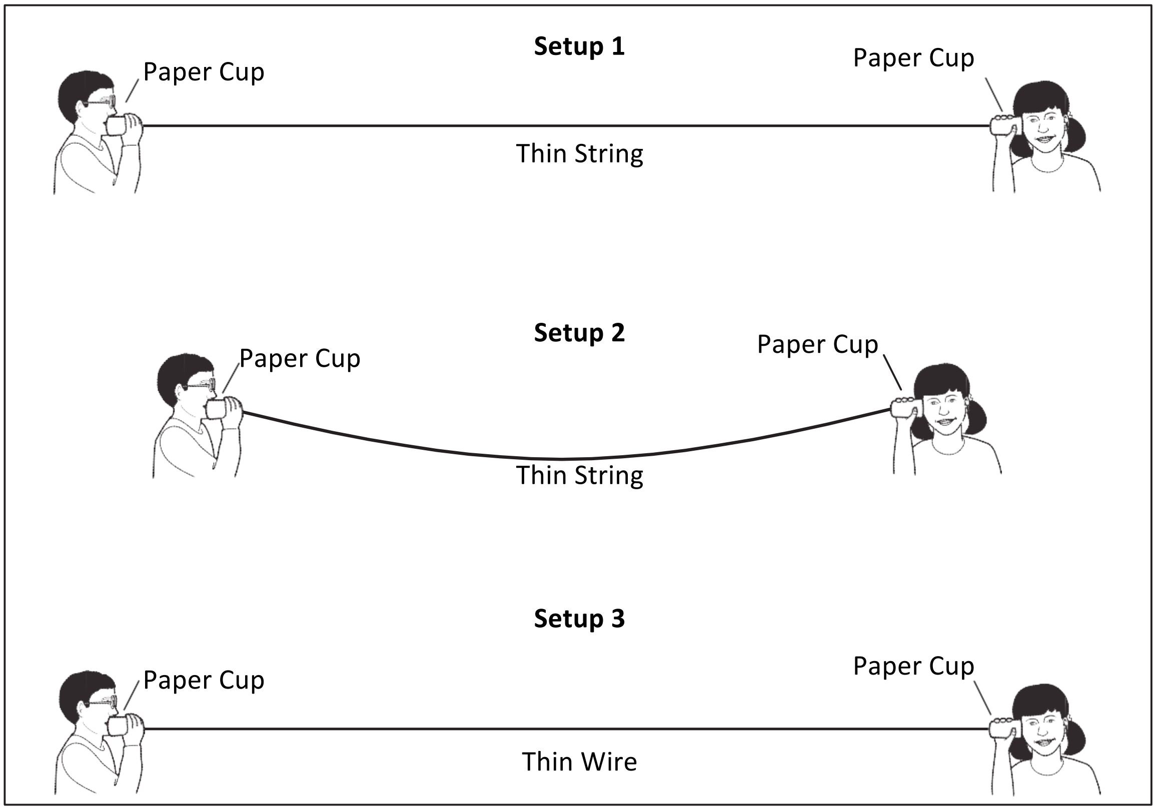
A. Plants absorb water from the wet soil.
B. Plant roots hold soil particles together.
C. Plants decrease moisture evaporation from the soil.

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: Fall 2013* 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.

**Item 16:** Ohio Department of Education. (2007 May). *Ohio Achievement Tests: 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.

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.

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

# *Evaluation of ISEP*

HS Student Questionnaire
Fall 2013

**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

**Part 1: Please choose the answers that best represent your views and opinions about science and what you do in your science class this year.**

**MY OPINION ABOUT SCIENCE**

| | Level of Agreement | | | | |
|---|---|---|---|---|---|
| **8.** Please **circle** the response that best reflects how you feel about science. | **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 (AN), Seldom (Se), Sometimes (So), Often (O), Very Often (VO)

| **10. In this class, I …** | Almost Never | Seldom | Sometimes | Often | Very Often |
|---|---|---|---|---|---|
| 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 |

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## MY OPINION ABOUT MY FUTURE

**Instructions:** Please **circle** the response that best reflects your future plans.

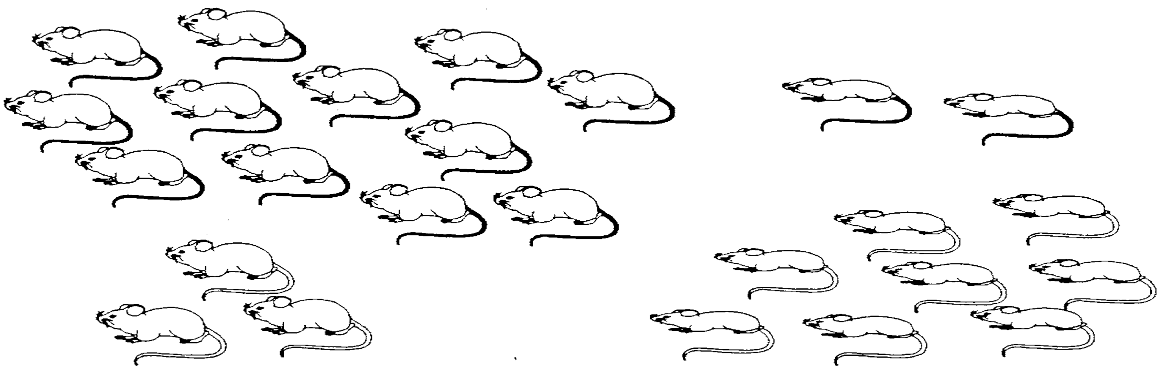
| **12. I plan to . . .** | **Strongly Disagree** | **Disagree** | **Neutral** | **Agree** | **Strongly Agree** |
|---|---|---|---|---|---|
| a. take (or am taking) only the science courses I am required to take in high school. | SD | D | U | A | SA |
| b. take (or am taking) the most challenging science courses offered in my high school. | SD | D | U | A | SA |
| c. take (or am taking) 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 |

Level of Agreement

**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.

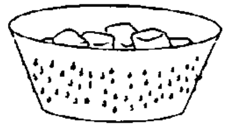
2. Because

   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 mos 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
2 bins
2 thermometers

1 sample of soil
1 sample of water
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. (°C)** | **20.0** | **21.0** | **22.5** | **24.0** | **26.0** | **27.5** | **29.5** | **30.5** | **32.0** |
| **Water temp. (°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?

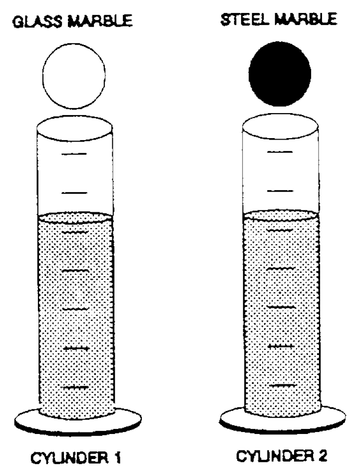
   A. The distance from Earth to the moon changes.
   B. Earth comes between the sun and the moon.
   C. The position of the moon, Earth and sun changes.
   D. The distance from the sun to the moon changes.

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.

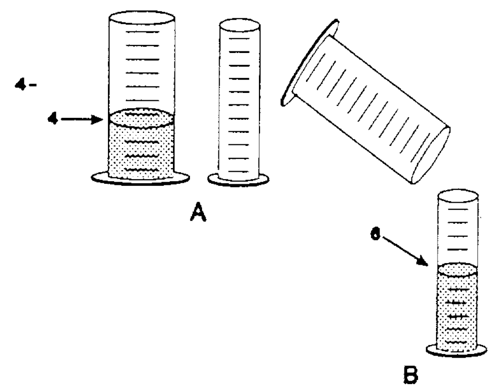
Which is a result of the limited genetic variation in the current cheetah population compared to earlier cheetah populations with more variation?

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

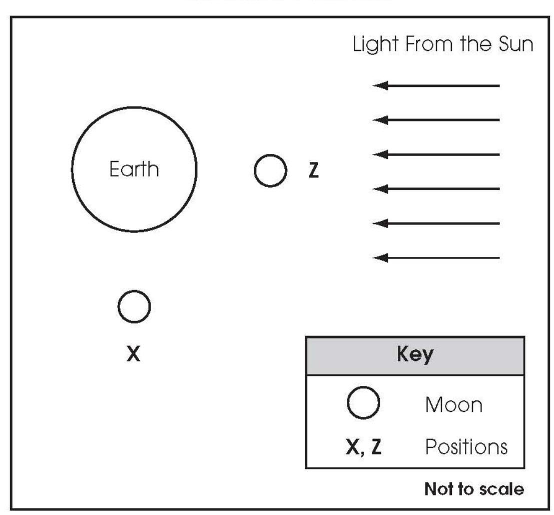
    A. The answer cannot be determined with the information given.
    B. It went up 4 more before, so it will go up 4 more again.
    C. It goes up 2 in the narrow for every 1 in the wide.
    D. It will go up to the same mark as it did before.

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

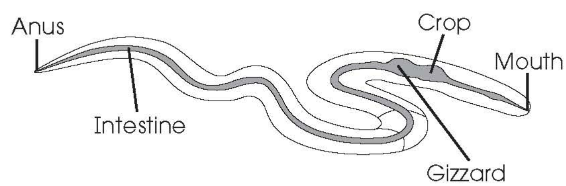
Two Lunar Positions



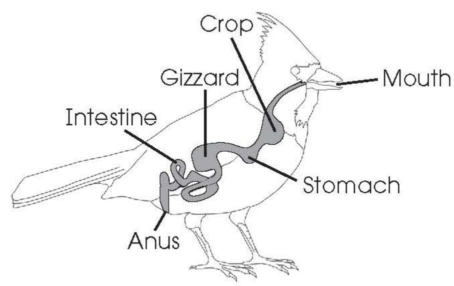
Use the diagrams and information below to answer Question 17.

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**



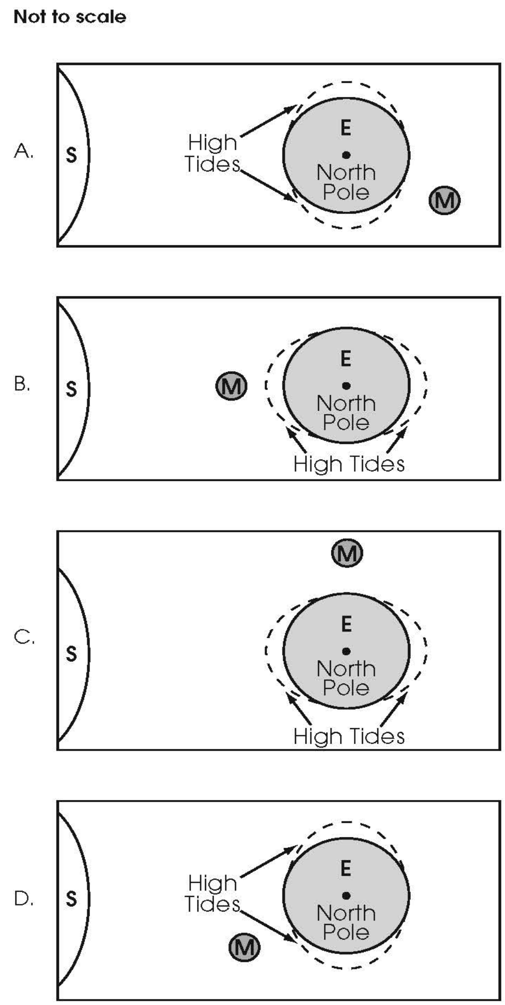

17. Why do earthworms and birds need gizzards but mammals do not?

    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.

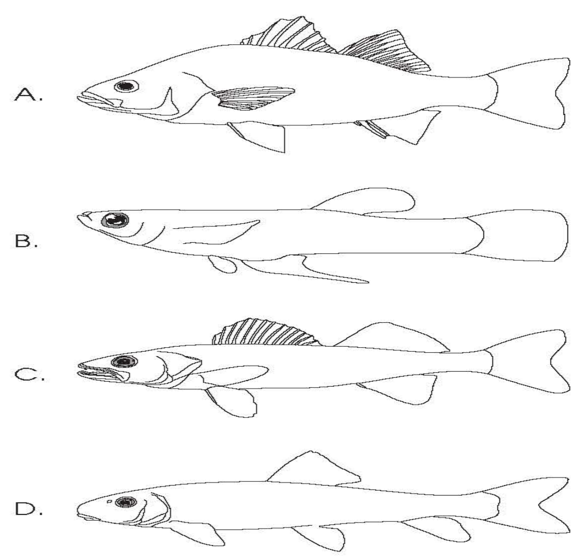
18. You walk from inside an air- conditioned building to stand outside on a sunny, sandy beach. You notice that your face and the bottoms of your feet feel warm. Which statement best describes the thermal energy transfer taking place?

    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: Fall 2013* 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 D. UB-BPS ISEP STEM Student Survey (Fall 2013)

Ohio Evaluation & Assessment Center
MATHEMATICS • SCIENCE • EDUCATION

# *UB-BPS ISEP*
# *STEM Student Questionnaire*
Fall 2013

**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 16.**

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**

| | Strongly Disagree | Disagree | Agree | Strongly Agree |
|---|---|---|---|---|
| C2a. Work on a Team | ○ | ○ | ○ | ○ |
| C2b. Lead a team | ○ | ○ | ○ | ○ |
| C2c. Facilitate group discussions | ○ | ○ | ○ | ○ |
| C2d. Teach STEM concepts and methods | ○ | ○ | ○ | ○ |
| C2e. Develop instructional materials about STEM concepts and methods | ○ | ○ | ○ | ○ |
| C2f. Generate others' interest in STEM research and activities | ○ | ○ | ○ | ○ |
| C2g. Conduct research as part of a collaborative team | ○ | ○ | ○ | ○ |
| C2h. Conduct independent research | ○ | ○ | ○ | ○ |
| C2i. Develop a research and/or technology agenda | ○ | ○ | ○ | ○ |
| C2j. Write papers and reports about my work | ○ | ○ | ○ | ○ |
| C2k. Present my work at a professional conference | ○ | ○ | ○ | ○ |
| C2l. Explain STEM research and concepts to public (non-technical) audience | ○ | ○ | ○ | ○ |
| C2m. Decide a career in education | ○ | ○ | ○ | ○ |
| C2n. Understand science concepts better | ○ | ○ | ○ | ○ |

**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.**

----- Miami University, Oxford, OH 45056. www.MiamiOH.edu. 513.529.1686 -----

## Appendix E. UB/BPS MSP ISEP Parent-Based PLC Questionnaire, Spring 2013

Dear Parent,

The ISEP project is very interested in learning how to better serve BPS students, parents, and the community. This questionnaire asks about your perceptions of this parent-based PLC session and expectations for your child's science education. The information collected by this questionnaire will be used only to improve the project; it will not identify you or your child, and will not be shared with anyone other than ISEP project personnel. It is your decision whether to complete this questionnaire, and there is no consequence or penalty for not doing so. Your input is valued and very important to the success of the ISEP project. Thank you for considering this request.

If you have more than one child attending the ISEP partner schools, please respond for all of your children.

1. Which school does your child attend? (Please check all that apply.)

- ☐ 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

2. What science class(es) is/are your child taking this year? (Please check all that apply.)

- ☐ 3rd Grade Science
- ☐ 4th Grade Science
- ☐ 5th Grade Science
- ☐ 6th Grade Science
- ☐ 7th Grade Physical Science
- ☐ 8th Grade Life Science
- ☐ Regents Biology
- ☐ Regents Earth Science
- ☐ Regents Chemistry
- ☐ Regents Physics
- ☐ Environmental Science
- ☐ AP Biology
- ☐ AP Chemistry
- ☐ AP Physics
- ☐ AP Environmental Science
- ☐ IB Biology Jr. & Sr.
- ☐ IB Physics Jr. & Sr.
- ☐ Advanced Biology
- ☐ Advanced General Chemistry
- ☐ Organic Chemistry
- ☐ Other (please specify):___________________________

3. Does your child's science teacher participate in the ISEP professional development program?

- ☐ Yes
- ☐ No
- ☐ I don't know

1/3

## Appendix E. UB/BPS MSP ISEP Parent-Based PLC Questionnaire, Spring 2013

| After today's meeting, … | Yes | No | I'm not sure |
|---|---|---|---|
| 4. The purpose and goals of the parent-based PLC were explained to me clearly. | | | |
| 5. My questions about my involvement in the PLC were answered completely. | | | |
| 6. I believe my participation in this parent-based PLC will be an effective way to support my child's science education. | | | |
| 7. Based on my understanding of the PLC at this point, I want to continue to participate in the parent-based PLC. | | | |

8. Please explain why you want to or why you do not want to continue to participate in the parent-based PLC.

9. As a parent, what are your short-term (i.e., within the next 1-2 years) expectations for your child's science education?

10. As a parent, what are your long-term (i.e., for the next 3-5 years) expectations for your child's science education?

2/3

## Appendix E. UB/BPS MSP ISEP Parent-Based PLC Questionnaire, Spring 2013

11. What resources or opportunities do you have now to support your child in reaching these expectations?

12. What additional resources or opportunities do you need to support your child in reaching these expectations?

Table F1. *Aggregate Teacher Information for ISEP Partner Schools, 2010-2011 and 2011-2012*

| | | Middle (K-8) Schools | | | | | High Schools | | | | CB/Gates (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 Credential [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% | 3% | 4% |
| % w/ Master's+30 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% |
| % of Core Courses **NOT** Taught By HQT [a] | 2010-2011 | 2% | 12% | 0% | 0% | 0% | 7% | 0% | 4% | 5% | 0% | 9% | 6% | 3% | 5% in high-poverty schools; 0% in low-poverty schools |
| | 2011-2012 | 5% | 0% | 0% | 0% | 0% | 7% | 0% | 3% | 0% | 1% | 1% | 1% | 2% | 2 |
| Turnover Rate of Teachers with Fewer than 5 Years of Exp [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% |
| 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% |
| Number of ISEP Teachers | 2012-2013 | 1 | 0 | 2 | 3 | 2 | 3 | 9 | 6 | 8 | 5 | 4 | 9 | -- | -- |
| Number of Science Teachers | 2012-2013 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 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 and 2011-2012*

| | | 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 |
| % American Indian or Alaska Native | 2010-2011 | 1% | 0% | 2% | 1% | 22% | 1% | - |
| | 2011-2012 | 1% | 1% | 2% | 1% | 18% | 1% | 1% |
| % Black or African American | 2010-2011 | 89% | 88% | 22% | 21% | 39% | 55% | 19% |
| | 2011-2012 | 84% | 69% | 23% | 20% | 36% | 53% | 19% |
| % Hispanic or Latino | 2010-2011 | 4% | 3% | 10% | 10% | 16% | 15% | 22% |
| | 2011-2012 | 6% | 8% | 10% | 13% | 18% | 16% | 23% |
| % 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% |
| % White | 2010-2011 | 5% | 7% | 63% | 64% | 6% | 23% | 50% |
| | 2011-2012 | 7% | 15% | 62% | 60% | 8% | 22% | 48% |
| % Multiracial | 2010-2011 | 1% | 0% | 1% | 3% | 2% | 2% | - |
| | 2011-2012 | 2% | 6% | 1% | 3% | 1% | 2% | 1% |
| % Limited English | 2010-2011 | 0% | 1% | 0% | 1% | 28% | 10% | 8% |
| | 2011-2012 | - | - | - | 1% | 31% | 11% | 8% |
| % Students with disabilities | 2010-2011 | Data were not available on the New York State School Report Card. | | | | | | |
| | 2011-2012 | 27% | 36% | 26% | 28% | 15% | 20% | 15% |
| % Poverty (% free/reduced lunch) | 2010-2011 | 93% | 92% | 77% | 80% | 98% | 79% | 48% |
| | 2011-2012 | 91% | 94% | 81% | 86% | 96% | 77% | 50% |
| % Male | 2010-2011 | Data were not available on the New York State School Report Card. | | | | | | |
| | 2011-2012 | 52% | 52% | 52% | 52% | 52% | 50% | 51% |
| % Female | 2010-2011 | Data were not available on the New York State School Report Card. | | | | | | |
| | 2011-2012 | 48% | 48% | 48% | 48% | 48% | 50% | 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% |
| Grade 8 Science % | 2010-2011 | 50% | 23% | 50% | 51% | 47% | 42% | 72% |
| | 2011-2012 | 57% | - | 39% | 54% | 45% | 40% | 69% |
| Number of ISEP Teachers | 2012-2013 | 1 | 0 | 2 | 3 | 2 | NA | NA |

Table F3. *High School Aggregate Student Demographic and Performance Data, 2010-2011 and 2011-2012*

| | | 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 |
| % 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% |
| % 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% |
| % 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% |
| % 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% |
| % White | 2010-2011 | 3% | 5% | 55% | 15% | 7% | 7% | 40% | 23% | 50% |
| | 2011-2012 | 2% | 5% | 55% | 13% | 8% | 7% | 41% | 22% | 48% |
| % Multiracial | 2010-2011 | 0% | 1% | 1% | 0% | 1% | 0% | 0% | 2% | - |
| | 2011-2012 | 1% | 0% | 1% | 0% | 0% | 0% | 0% | 2% | 1% |
| % Limited English | 2010-2011 | 1% | 4% | 6% | 20% | 2% | 6% | 1% | 10% | 8% |
| | 2011-2012 | 3% | 5% | 6% | 26% | 4% | 10% | 1% | 11% | 8% |
| % Students with disabilities | 2010-2011 | Data were not available on the New York State School Report Card. | | | | | | | | |
| | 2011-2012 | 21% | 21% | 21% | 21% | 21% | 21% | 21% | 21% | 21% |
| % Poverty (% free/reduced lunch) | 2010-2011 | 80% | 80% | 80% | 80% | 80% | 80% | 80% | 80% | 80% |
| | 2011-2012 | 76% | 76% | 76% | 76% | 76% | 76% | 76% | 76% | 76% |
| % Male | 2010-2011 | Data were not available on the New York State School Report Card. | | | | | | | | |
| | 2011-2012 | 47% | 47% | 47% | 47% | 47% | 47% | 47% | 47% | 47% |
| % Female | 2010-2011 | Data were not available on the New York State School Report Card. | | | | | | | | |
| | 2011-2012 | 53% | 53% | 53% | 53% | 53% | 53% | 53% | 53% | 53% |
| 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% |
| Graduation rate - American Indian or Alaska Native[d] | 2010-2011 | - | - | - | - | - | - | - | 47% | 63% |
| | 2011-2012 | - | - | - | - | - | - | - | 52% | 63% |
| 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% |
| Graduation rate - Hispanic or Latino[d] | 2010-2011 | - | - | - | 34% | - | - | - | 41% | 60% |
| | 2011-2012 | - | - | - | 36% | - | - | - | 45% | 63% |
| Graduation rate - Asian or Native Hawaiian/ Other[d] | 2010-2011 | - | - | - | - | - | - | - | 52% | 84% |
| | 2011-2012 | - | - | - | - | - | - | - | 51% | 86% |
| Graduation rate - White[d] | 2010-2011 | - | - | 56% | 33% | - | - | 88% | 61% | 85% |
| | 2011-2012 | - | - | 66% | 38% | - | - | 80% | 65% | 87% |
| Graduation rate - Multiracial[d] | 2010-2011 | - | - | - | - | - | - | - | - | 70% |
| | 2011-2012 | - | - | - | - | - | - | - | - | 80% |
| 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% |
| Graduation rate - Male[d] | 2010-2011 | 36% | 45% | 43% | 23% | 61% | 53% | 83% | 44% | 71% |
| | 2011-2012 | 35% | 32% | 59% | 32% | 58% | 31% | 79% | 50% | 74% |
| % 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% |
| % 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% |
| 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% |
| Regents Physical Setting/Chemistry % | 2010-2011 | - | 10% | 11% | 50% | 64% | - | 42% | 53% | 73% [c] |
| | 2011-2012 | 0% | 44% | 17% | 17% | 40% | - | 51% | 50% | 78% |
| Regents Physics % | 2010-2011 | - | - | - | 0% | - | - | 58% | 57% | 82% [c] |
| | 2011-2012 | - | - | - | - | - | - | 61% | 63% | 79% |
| Number of ISEP Teachers | 2012-2013 | 3 | 9 | 6 | 8 | 5 | 4 | 9 | -- | -- |

## Appendix G
## UB-BPS ISEP Teacher Questionnaire Findings

Table G1. *Respondents' Needs for Professional Development, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012 and Summer 2013*

| Q31. Professional Development Needs | Time | *n* | *M* | *SD* | Wilcoxon Signed Ranks Test *p* |
|---|---|---|---|---|---|
| 1). Help students develop the ability to communicate with others an argument based on evidence. | Pre | 14 | 3.36 | 0.84 | .257 |
| | Post | 14 | 3.14 | 1.10 | |
| 2). Help students develop an understanding of scale, proportion, and quantity as these concepts are used to describe the natural world. | Pre | 14 | 3.43 | 0.65 | .271 |
| | Post | 14 | 3.14 | 0.95 | |
| 3). Help students develop an understanding of the behavior of organisms. | Pre | 14 | 3.29 | 0.61 | .058 |
| | Post | 14 | 2.64 | 1.08 | |
| 4). Help students develop the ability to use mathematics and computational thinking. | Pre | 14 | 3.36 | 0.74 | .763 |
| | Post | 14 | 3.43 | 0.76 | |
| 5). Help students develop the ability to construct explanations and design solutions. | Pre | 14 | 3.79 | 0.43 | .063 |
| | Post | 14 | 3.36 | 0.93 | |
| 6). Help students develop an understanding of chemical reactions. | Pre | 14 | 2.93 | 0.73 | .608 |
| | Post | 14 | 2.79 | 0.97 | |
| 7). Help students develop an understanding of patterns in natural events. | Pre | 14 | 3.64 | 0.50 | .297 |
| | Post | 14 | 3.36 | 1.01 | |
| 8). Help students develop an understanding of the interactions of energy and matter. | Pre | 14 | 3.57 | 0.51 | .161 |
| | Post | 14 | 3.14 | 1.10 | |
| 9). Help students develop an understanding of form and function. | Pre | 14 | 3.29 | 0.61 | .516 |
| | Post | 14 | 3.14 | 0.95 | |
| 10). Help students develop an understanding of the structure and properties of matter. | Pre | 14 | 3.21 | 0.80 | .763 |
| | Post | 14 | 3.14 | 1.03 | |
| 11). Help students develop an understanding of the conservation of energy and increase in disorder. | Pre | 14 | 3.07 | 0.83 | .782 |
| | Post | 14 | 3.14 | 0.95 | |
| 12). Help students develop the abilities needed to do scientific inquiry. | Pre | 14 | 3.79 | 0.43 | .739 |
| | Post | 14 | 3.71 | 0.61 | |
| 13). Help students develop an understanding of the structure of the atom. | Pre | 14 | 2.64 | 0.84 | .679 |
| | Post | 14 | 2.71 | 1.07 | |
| 14). Help students develop an understanding of the molecular basis of heredity. | Pre | 14 | 3.21 | 0.80 | .248 |
| | Post | 14 | 2.93 | 1.00 | |
| 15). Help students develop an understanding of energy in the earth system. | Pre | 13 | 3.46 | 0.78 | .546 |
| | Post | 13 | 3.23 | 1.01 | |
| 16). Help students develop an understanding of the theory of biological evolution. | Pre | 14 | 3.43 | 0.76 | **.035** |
| | Post | 14 | 2.93 | 1.07 | |
| 17). Help students develop the ability to develop and use valid models. | Pre | 14 | 3.21 | 0.89 | .792 |
| | Post | 14 | 3.29 | 0.91 | |
| 18). Help students develop the ability to obtain, evaluate, and communicate information. | Pre | 14 | 3.71 | 0.47 | .763 |
| | Post | 14 | 3.64 | 0.63 | |
| 19). Help students develop the ability to ask questions and define problems. | Pre | 14 | 3.79 | 0.43 | 1.000 |
| | Post | 14 | 3.79 | 0.58 | |

| | | | | | |
|---|---|---|---|---|---|
| 20). Help students develop an understanding of matter, energy, and organization in living systems. | Pre | 14 | 3.57 | 0.51 | .305 |
| | Post | 14 | 3.21 | 1.05 | |
| 21). Help students develop the ability to analyze and interpret data. | Pre | 14 | 3.79 | 0.43 | .527 |
| | Post | 14 | 3.64 | 0.63 | |
| 22). Help students develop an understanding of systems, order, and organization. | Pre | 14 | 3.57 | 0.51 | .335 |
| | Post | 14 | 3.36 | 1.01 | |
| 23). Help students develop an understanding of evidence, models, and explanation. | Pre | 14 | 3.71 | 0.61 | .206 |
| | Post | 14 | 3.43 | 0.94 | |
| 24). Help students develop an understanding of the cell. | Pre | 14 | 3.57 | 0.65 | **.034** |
| | Post | 14 | 2.93 | 1.00 | |
| 25). Help students develop a scientific understanding of the earth in the solar system. | Pre | 14 | 3.07 | 1.14 | 1.000 |
| | Post | 14 | 3.07 | 1.00 | |
| 26). Help students develop an understanding of the interdependence of organisms. | Pre | 14 | 3.64 | 0.63 | .119 |
| | Post | 14 | 3.21 | 0.97 | |
| 27). Help students develop the ability to plan and carry out investigations. | Pre | 14 | 3.79 | 0.43 | .655 |
| | Post | 14 | 3.86 | 0.36 | |
| 28). Help students develop an understanding of change, constancy, and measurement. | Pre | 13 | 3.77 | 0.44 | .083 |
| | Post | 13 | 3.23 | 1.01 | |
| 29). Help students develop an understanding of geochemical cycles. | Pre | 14 | 2.64 | 0.74 | **.034** |
| | Post | 14 | 3.07 | 1.00 | |
| 30). Help students develop a scientific understanding of the origins of the earth and the universe. | Pre | 14 | 2.79 | 0.97 | .206 |
| | Post | 14 | 3.14 | 1.03 | |

Table G2. *Respondents' Familiarity with DET and Perceived Importance of DET, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012 and Summer 2013*

| **DET 1** | **Time** | ***n*** | ***M*** | ***SD*** | **Wilcoxon Signed Ranks Test *p*** |
|---|---|---|---|---|---|
| 1.How familiar are you with Design/Engineering/Technology as typically demonstrated in the examples given above? | Pre | 14 | 3.29 | 1.27 | .546 |
| | Post | 14 | 3.07 | 1.38 | |
| 2.Have you had any specific courses in Design/Engineering/Technology outside of your preservice curriculum? | Pre | 14 | 1.86 | 1.29 | .942 |
| | Post | 14 | 2.00 | 1.18 | |
| 3.Did your preservice curriculum include any aspects of Design/Engineering/Technology? | Pre | 13 | 2.08 | 1.26 | .395 |
| | Post | 13 | 1.77 | 0.93 | |
| 4.Was your pre-service curriculum effective in supporting your ability to teach Design/Engineering/Technology at the beginning of your career? | Pre | 14 | 2.07 | 1.21 | .161 |
| | Post | 14 | 1.64 | 0.84 | |
| 5.How confident do you feel about integrating more Design/Engineering/Technology into your curriculum? | Pre | 14 | 3.57 | 1.28 | .272 |
| | Post | 14 | 3.21 | 1.25 | |
| 6.How important should pre-service education be for teaching Design/Engineering/Technology? | Pre | 14 | 3.86 | 1.29 | 1.000 |
| | Post | 14 | 3.86 | 1.03 | |
| 7.Do you use Design/Engineering/Technology activities in the classroom? | Pre | 14 | 3.14 | 1.61 | .631 |
| | Post | 14 | 2.93 | 1.27 | |
| 8.Does your school support | Pre | 14 | 3.07 | 1.33 | .831 |

| | | | | | |
|---|---|---|---|---|---|
| Design/Engineering/Technology activities? | Post | 14 | 3.14 | 1.51 | |
| 9.Do you believe Design/Engineering/Technology should be integrated into the K-12 curriculum? | Pre | 14 | 4.00 | 1.52 | 1.000 |
| | Post | 14 | 3.93 | 1.44 | |

Table G3. *Teaching DET to Diverse Groups of Students*, *Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012 and Summer 2013*

| **DET 2** | **Time** | ***n*** | ***M*** | ***SD*** | **Wilcoxon Signed Ranks Test *p*** |
|---|---|---|---|---|---|
| 10.Most people feel that female students can do well in Design/Engineering/Technology. | Pre | 15 | 3.93 | 1.03 | .590 |
| | Post | 15 | 3.67 | 1.11 | |
| 11.Most people feel that minority students (African American, Hispanic / Latino, and American Indian) can do well in Design/Engineering/Technology. | Pre | 15 | 3.87 | 1.06 | .389 |
| | Post | 15 | 3.47 | 1.30 | |

Table G4. *Importance of Including DET in Science Curriculum, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012 and Summer 2013*

| **DET 3: As you teach a science curriculum, it is important to include…** | **Time** | ***n*** | ***M*** | ***SD*** | **Wilcoxon Signed Ranks Test *p*** |
|---|---|---|---|---|---|
| 12.Planning a project. | Pre | 14 | 4.43 | 0.85 | .589 |
| | Post | 14 | 4.29 | 1.07 | |
| 13.Using engineering to develop new technologies. | Pre | 14 | 3.93 | 0.83 | .164 |
| | Post | 14 | 3.50 | 1.16 | |

Table G5. *Needs of Teaching DET*, *Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012 and Summer 2013*

| **DET 4: I would like to be able to teach my students to understand the…** | **Time** | ***n*** | ***M*** | ***SD*** | **Wilcoxon Signed Ranks Test *p*** |
|---|---|---|---|---|---|
| 14.Design process. | Pre | 15 | 4.07 | 0.88 | .408 |
| | Post | 15 | 4.27 | 0.59 | |
| 15.Use and impact of Design/Engineering/Technology. | Pre | 14 | 4.29 | 0.61 | .705 |
| | Post | 14 | 4.21 | 0.70 | |
| 16.Science underlying Design/Engineering/Technology. | Pre | 15 | 4.40 | 0.74 | .414 |
| | Post | 15 | 4.27 | 0.70 | |
| 17.Types of problems to which Design/Engineering/Technology should be applied. | Pre | 15 | 4.20 | 0.68 | .705 |
| | Post | 15 | 4.27 | 0.70 | |
| 18.Process of communicating technical information. | Pre | 15 | 4.53 | 0.52 | .194 |
| | Post | 15 | 4.27 | 0.70 | |

Table G6. *Respondents' Motivation for Teaching Science, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012 and Summer 2013*

| **DET 5: My motivation for teaching science is…** | **Time** | ***n*** | ***M*** | ***SD*** | **Wilcoxon Signed Ranks Test *p*** |
|---|---|---|---|---|---|
| 19.To prepare young people for the world of work. | Pre | 15 | 3.93 | 1.03 | .414 |
| | Post | 15 | 3.80 | 1.08 | |
| 20.To promote an enjoyment of learning. | Pre | 15 | 4.33 | 1.05 | .084 |
| | Post | 15 | 3.93 | 1.16 | |
| 21.To develop an understanding of the natural and technical world. | Pre | 15 | 4.67 | 0.49 | .705 |
| | Post | 15 | 4.60 | 0.51 | |
| 22.To develop scientists, engineers, and technologists for industry. | Pre | 15 | 3.73 | 1.10 | .180 |
| | Post | 15 | 3.93 | 1.10 | |
| 23.To promote an understanding of how Design/Engineering/Technology affects society. | Pre | 15 | 4.13 | 0.83 | .317 |
| | Post | 15 | 3.93 | 1.03 | |

Table G7 *Respondents' Perceived Barriers to Integrating DET in Classroom, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012 and Summer 2013*

| **DET 6: Barrier** | **Time** | ***n*** | ***M*** | ***SD*** | **Wilcoxon Signed Ranks Test *p*** |
|---|---|---|---|---|---|
| 24.Lack of time for teachers to learn about Design/Engineering/Technology. | Pre | 15 | 3.27 | 1.58 | .370 |
| | Post | 15 | 3.80 | 1.47 | |
| 25.Lack of teacher knowledge. | Pre | 15 | 3.33 | 1.54 | .721 |
| | Post | 15 | 3.13 | 1.36 | |
| 26.Lack of training. | Pre | 15 | 3.60 | 1.45 | .943 |
| | Post | 15 | 3.53 | 1.60 | |
| 27.Lack of administration support. | Pre | 15 | 3.07 | 1.44 | .877 |
| | Post | 15 | 3.00 | 1.73 | |

Table G8. *Social Effect of DET, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012 and Summer 2013*

| **DET 7** | **Time** | ***n*** | ***M*** | ***SD*** | **Wilcoxon Signed Ranks Test *p*** |
|---|---|---|---|---|---|
| 28.Design/Engineering/Technology has positive consequences for society. | Pre | 13 | 4.38 | 0.51 | .414 |
| | Post | 13 | 4.23 | 0.73 | |

Table G9. *Respondents' Knowledge of DET Standards, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012 and Summer 2013*

| **DET 8: How much do you know about the …** | **Time** | ***n*** | ***M*** | ***SD*** | **Wilcoxon Signed Ranks Test *p*** |
|---|---|---|---|---|---|
| 29.National science standards related to Design/Engineering/Technology? | Pre | 14 | 3.43 | 1.34 | .273 |
| | Post | 14 | 3.07 | 1.38 | |

Table G10. *Attitudes towards Teaching DET, Summer 2012 and Summer 2013 Matched Teachers, UB/BPS ISEP Teacher Questionnaire, Summer 2012 and Summer 2013*

| **DET 9** | **Time** | ***n*** | ***M*** | ***SD*** | **Wilcoxon Signed Ranks Test *p*** |
|---|---|---|---|---|---|
| 30.How enthusiastic do you feel about including Design/Engineering/Technology activities in your teaching? | Pre | 15 | 4.27 | 0.88 | .476 |
| | Post | 15 | 4.00 | 1.20 | |
| 31.How prepared do you feel to include Design/Engineering/Technology activities in your teaching? | Pre | 15 | 3.53 | 1.30 | .786 |
| | Post | 15 | 3.47 | 1.30 | |
| 32.How important is it for you that Design/Engineering/Technology activities are aligned to mathematics state and national standards? | Pre | 14 | 3.71 | 1.07 | 1.000 |
| | Post | 14 | 3.71 | 1.07 | |
| 33.How important is it for you that Design/Engineering/Technology activities are aligned to science state and national standards? | Pre | 15 | 4.20 | 1.01 | .334 |
| | Post | 15 | 4.00 | 0.93 | |

**Appendix H**
**UB-BPS ISEP Student Questionnaire Findings**

Table H1. *Comparisons of Students' Responses by Teacher Participation Status, UB/BPS ISEP Student Questionnaire, Spring 2013, Elementary School Students, Only Schools with Both Control and ISEP Teachers*

| Item | Participation | *n* | *M* | *SD* | *t* | *df* | *p* |
|---|---|---|---|---|---|---|---|
| **Q8. Views of Science** | | | | | | | |
| Q8a. I like science. | Control | 27 | 3.41 | 1.25 | -1.27 | 100 | .209 |
| | ISEP | 75 | 3.75 | 1.18 | | | |
| Q8b. I am good at science. | Control | 27 | 3.37 | 1.28 | -1.34 | 36.14 | .187 |
| | ISEP | 74 | 3.73 | 0.91 | | | |
| Q8c. I would keep on taking science classes even if I did not have to. | Control | 26 | 2.69 | 1.46 | -1.80 | 96 | .076 |
| | ISEP | 72 | 3.26 | 1.36 | | | |
| Q8d. I understand most of what goes on in science. | Control | 28 | 3.46 | 1.07 | -1.45 | 101 | .150 |
| | ISEP | 75 | 3.79 | 0.98 | | | |
| Q8e. Almost all people use science in their jobs. | Control | 27 | 2.37 | 1.04 | -3.03 | 96 | **.003** |
| | ISEP | 71 | 3.10 | 1.07 | | | |
| Q8f. Science is useful for solving everyday problems. | Control | 26 | 2.65 | 1.38 | -1.97 | 97 | .052 |
| | ISEP | 73 | 3.21 | 1.17 | | | |
| Q8g. Science is a way to study and understand the natural world. | Control | 24 | 3.92 | 1.28 | -0.15 | 90 | .879 |
| | ISEP | 68 | 3.96 | 1.00 | | | |
| Q8h. Scientists sometimes disagree about scientific knowledge. | Control | 26 | 3.04 | 1.18 | -2.31 | 91 | **.023** |
| | ISEP | 67 | 3.61 | 1.03 | | | |
| Q8i. All scientists do not follow the same step-by-step method to do science. | Control | 27 | 3.04 | 1.48 | -1.08 | 96 | .284 |
| | ISEP | 71 | 3.37 | 1.30 | | | |
| Q8j. Scientists use their imagination when doing science. | Control | 27 | 2.96 | 1.29 | -0.61 | 96 | .542 |
| | ISEP | 71 | 3.13 | 1.15 | | | |
| Q8k. Science ideas or hypotheses must be supported by evidence. | Control | 27 | 3.41 | 1.31 | -0.75 | 97 | .454 |
| | ISEP | 72 | 3.63 | 1.27 | | | |
| Q8l. Scientific theories can change when new evidence or a new explanation becomes available. | Control | 27 | 3.11 | 1.05 | -2.28 | 97 | **.025** |
| | ISEP | 72 | 3.67 | 1.09 | | | |
| **Q9. In this class, my teacher ...** | | | | | | | |
| Q9a. arranges the classroom so students can have discussion. | Control | 27 | 3.19 | 1.59 | 1.86 | 98 | .065 |
| | ISEP | 73 | 2.63 | 1.21 | | | |
| Q9b. asks questions that have more than one answer. | Control | 25 | 3.40 | 1.22 | -1.19 | 95 | .236 |
| | ISEP | 72 | 3.72 | 1.14 | | | |
| Q9c. asks me to give reasons and provide evidence for my answers. | Control | 27 | 3.89 | 1.19 | -1.38 | 96 | .171 |
| | ISEP | 71 | 4.21 | 0.97 | | | |
| Q9d. encourages me to ask questions. | Control | 27 | 3.15 | 1.38 | -2.33 | 98 | **.022** |
| | ISEP | 73 | 3.78 | 1.13 | | | |
| Q9e. let me work at my own pace. | Control | 26 | 3.15 | 1.57 | 0.57 | 96 | .567 |
| | ISEP | 72 | 2.97 | 1.31 | | | |
| Q9f. encourages me to explain my ideas to other students. | Control | 27 | 2.85 | 1.59 | -2.13 | 33.95 | **.041** |
| | ISEP | 73 | 3.55 | 1.00 | | | |
| Q9g. encourage me to consider different scientific explanations. | Control | 26 | 2.50 | 1.17 | -3.34 | 96 | **.001** |
| | ISEP | 72 | 3.40 | 1.18 | | | |
| Q9h. provides time for me to discuss | Control | 27 | 3.04 | 1.53 | -0.84 | 96 | .402 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| science ideas with other students. | ISEP | 71 | 3.30 | 1.29 | | | |
| Q9i. checks that I have completed my assignments. | Control | 27 | 3.96 | 1.37 | 0.12 | 96 | .907 |
| | ISEP | 71 | 3.93 | 1.21 | | | |
| Q9j. provides meaningful and challenging assignments. | Control | 26 | 3.50 | 1.17 | -0.89 | 95 | .376 |
| | ISEP | 71 | 3.72 | 1.03 | | | |
| Q9k. helps me apply my learning to real life. | Control | 27 | 3.74 | 1.20 | 0.36 | 97 | .719 |
| | ISEP | 72 | 3.64 | 1.27 | | | |
| Q9l. expects me to do well. | Control | 27 | 4.04 | 1.51 | -1.04 | 35.73 | .305 |
| | ISEP | 74 | 4.36 | 1.05 | | | |
| **Q10. In this class, I ...** | | | | | | | |
| Q10a. use information and data to support my conclusions. | Control | 26 | 3.69 | 1.38 | 0.21 | 95 | .836 |
| | ISEP | 71 | 3.63 | 1.17 | | | |
| Q10b. talk with other students about how to do a science task or about how to interpret the data from an experiment. | Control | 25 | 3.20 | 1.35 | -0.61 | 91 | .544 |
| | ISEP | 68 | 3.37 | 1.11 | | | |
| Q10c. learn from other students. | Control | 25 | 3.24 | 1.16 | 0.09 | 89 | .925 |
| | ISEP | 66 | 3.21 | 1.28 | | | |
| Q10d. consider different scientific explanations. | Control | 26 | 2.88 | 1.28 | -1.03 | 93 | .308 |
| | ISEP | 69 | 3.14 | 1.03 | | | |
| Q10e. have a say in deciding what activities I do. | Control | 26 | 2.77 | 1.21 | -0.26 | 94 | .799 |
| | ISEP | 70 | 2.84 | 1.27 | | | |
| Q10f. use a computer or the Internet for science assignments or activities. | Control | 25 | 3.04 | 1.67 | -0.55 | 93 | .587 |
| | ISEP | 70 | 3.21 | 1.25 | | | |
| Q10g. write about how I solved a science task or about what I am learning. | Control | 27 | 3.44 | 1.45 | 0.85 | 95 | .400 |
| | ISEP | 70 | 3.19 | 1.31 | | | |
| Q10h. learn that there are different solutions to science tasks. | Control | 24 | 3.38 | 1.31 | -0.96 | 93 | .337 |
| | ISEP | 71 | 3.63 | 1.07 | | | |
| Q10i. use multiple sources of information to learn. | Control | 25 | 3.56 | 1.19 | -0.01 | 94 | .990 |
| | ISEP | 71 | 3.56 | 1.20 | | | |
| Q10j. develop my skills for doing science. | Control | 24 | 3.58 | 1.14 | -0.23 | 90 | .819 |
| | ISEP | 68 | 3.65 | 1.18 | | | |
| Q10k. learn about how science is important in the real world. | Control | 26 | 3.62 | 1.27 | -0.42 | 92 | .674 |
| | ISEP | 68 | 3.72 | 1.01 | | | |
| Q10l. work on science tasks in a group with other students. | Control | 25 | 3.68 | 1.46 | 0.60 | 92 | .548 |
| | ISEP | 69 | 3.51 | 1.13 | | | |
| **Q11. At least one adult in my home, ...** | | | | | | | |
| Q11a. makes me do my science homework. | Control | 25 | 2.40 | 1.78 | -3.03 | 90 | **.003** |
| | ISEP | 67 | 3.54 | 1.53 | | | |
| Q11b. asks about what I am learning in science class. | Control | 24 | 3.08 | 1.38 | -0.52 | 90 | .607 |
| | ISEP | 68 | 3.26 | 1.51 | | | |
| Q11c. helps me with my science homework. | Control | 24 | 2.63 | 1.69 | -2.28 | 89 | **.025** |
| | ISEP | 67 | 3.46 | 1.49 | | | |
| Q11d. helps me work on my science projects. | Control | 24 | 3.21 | 1.53 | -1.80 | 91 | .076 |
| | ISEP | 69 | 3.81 | 1.37 | | | |
| Q11e. expects me to do well in science. | Control | 26 | 4.04 | 1.37 | -0.80 | 92 | .425 |
| | ISEP | 68 | 4.26 | 1.17 | | | |
| Q11f. expects me to go to college. | Control | 27 | 4.33 | 1.33 | -1.10 | 34.3 | .278 |
| | ISEP | 66 | 4.64 | 0.82 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Q11g. expects me to have a science-related career. | Control | 26 | 3.35 | 1.65 | 1.48 | 93 | .142 |
| | ISEP | 69 | 2.84 | 1.42 | | | |

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

Table H2. *Comparisons of Students' Responses by Teacher Participation Status, UB/BPS ISEP Student Questionnaire, Spring 2013, Middle School Students, Only Schools with Both Control and ISEP Teachers*

| Item | Participation | *n* | *M* | *SD* | *t* | *df* | *p* |
|---|---|---|---|---|---|---|---|
| **Q8. Views of Science** | | | | | | | |
| Q8a. I like science. | Control | 53 | 3.57 | 1.19 | -1.62 | 142 | .107 |
| | ISEP | 91 | 3.88 | 1.07 | | | |
| Q8b. I am good at science. | Control | 51 | 3.59 | 0.96 | 0.09 | 140 | .929 |
| | ISEP | 91 | 3.57 | 1.14 | | | |
| Q8c. I would keep on taking science classes even if I did not have to. | Control | 52 | 2.77 | 1.17 | -2.68 | 140 | **.008** |
| | ISEP | 90 | 3.38 | 1.38 | | | |
| Q8d. I understand most of what goes on in science. | Control | 53 | 3.75 | 0.81 | 0.57 | 130.5 | .573 |
| | ISEP | 90 | 3.67 | 1.04 | | | |
| Q8e. Almost all people use science in their jobs. | Control | 51 | 3.25 | 1.04 | 1.20 | 139 | .233 |
| | ISEP | 90 | 3.03 | 1.06 | | | |
| Q8f. Science is useful for solving everyday problems. | Control | 50 | 3.22 | 1.06 | 0.23 | 135 | .815 |
| | ISEP | 87 | 3.17 | 1.19 | | | |
| Q8g. Science is a way to study and understand the natural world. | Control | 50 | 4.02 | 0.84 | -0.81 | 137 | .417 |
| | ISEP | 89 | 4.16 | 1.01 | | | |
| Q8h. Scientists sometimes disagree about scientific knowledge. | Control | 51 | 3.43 | 1.01 | -0.71 | 137 | .479 |
| | ISEP | 88 | 3.56 | 1.00 | | | |
| Q8i. All scientists do not follow the same step-by-step method to do science. | Control | 52 | 3.27 | 1.17 | 0.98 | 136 | .327 |
| | ISEP | 86 | 3.06 | 1.25 | | | |
| Q8j. Scientists use their imagination when doing science. | Control | 53 | 3.06 | 1.08 | 0.96 | 138 | .339 |
| | ISEP | 87 | 2.86 | 1.21 | | | |
| Q8k. Science ideas or hypotheses must be supported by evidence. | Control | 52 | 3.94 | 0.92 | 0.41 | 133.6 | .680 |
| | ISEP | 89 | 3.87 | 1.29 | | | |
| Q8l. Scientific theories can change when new evidence or a new explanation becomes available. | Control | 52 | 3.85 | 0.92 | -1.29 | 140 | .199 |
| | ISEP | 90 | 4.06 | 0.94 | | | |
| **Q9. In this class, my teacher ...** | | | | | | | |
| Q9a. arranges the classroom so students can have discussion. | Control | 52 | 2.37 | 1.21 | -3.31 | 137 | **.001** |
| | ISEP | 87 | 3.08 | 1.25 | | | |
| Q9b. asks questions that have more than one answer. | Control | 52 | 3.35 | 1.08 | -1.80 | 133 | .075 |
| | ISEP | 83 | 3.67 | 1.00 | | | |
| Q9c. asks me to give reasons and provide evidence for my answers. | Control | 51 | 3.90 | 0.94 | -0.75 | 133 | .453 |
| | ISEP | 84 | 4.02 | 0.89 | | | |
| Q9d. encourages me to ask questions. | Control | 52 | 3.38 | 1.22 | -1.74 | 135 | .084 |
| | ISEP | 85 | 3.76 | 1.25 | | | |
| Q9e. let me work at my own pace. | Control | 49 | 3.53 | 1.21 | 0.03 | 133 | .973 |
| | ISEP | 86 | 3.52 | 1.21 | | | |
| Q9f. encourages me to explain my ideas to other students. | Control | 53 | 2.96 | 1.16 | -1.62 | 137 | .107 |
| | ISEP | 86 | 3.33 | 1.35 | | | |
| Q9g. encourage me to consider different scientific explanations. | Control | 50 | 3.00 | 0.95 | -2.18 | 134 | **.031** |
| | ISEP | 86 | 3.42 | 1.15 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Q9h. provides time for me to discuss science ideas with other students. | Control | 50 | 2.68 | 1.32 | -3.15 | 135 | **.002** |
| | ISEP | 87 | 3.34 | 1.11 | | | |
| Q9i. checks that I have completed my assignments. | Control | 50 | 4.12 | 1.10 | 0.48 | 134 | .631 |
| | ISEP | 86 | 4.02 | 1.15 | | | |
| Q9j. provides meaningful and challenging assignments. | Control | 50 | 3.56 | 1.13 | -0.62 | 135 | .536 |
| | ISEP | 87 | 3.68 | 1.04 | | | |
| Q9k. helps me apply my learning to real life. | Control | 52 | 3.33 | 1.17 | -2.19 | 136 | **.030** |
| | ISEP | 86 | 3.78 | 1.18 | | | |
| Q9l. expects me to do well. | Control | 51 | 4.37 | 0.96 | -0.38 | 136 | .707 |
| | ISEP | 87 | 4.44 | 0.97 | | | |
| **Q10. In this class, I ...** | | | | | | | |
| Q10a. use information and data to support my conclusions. | Control | 50 | 3.62 | 1.10 | -0.42 | 125.5 | .677 |
| | ISEP | 87 | 3.71 | 1.47 | | | |
| Q10b. talk with other students about how to do a science task or about how to interpret the data from an experiment. | Control | 51 | 3.00 | 1.30 | -2.19 | 135 | **.030** |
| | ISEP | 86 | 3.47 | 1.14 | | | |
| Q10c. learn from other students. | Control | 51 | 3.06 | 1.30 | -0.70 | 135 | .487 |
| | ISEP | 86 | 3.21 | 1.17 | | | |
| Q10d. consider different scientific explanations. | Control | 49 | 3.20 | 1.08 | -1.57 | 133 | .119 |
| | ISEP | 86 | 3.52 | 1.17 | | | |
| Q10e. have a say in deciding what activities I do. | Control | 49 | 3.14 | 1.27 | -1.29 | 131 | .199 |
| | ISEP | 84 | 3.43 | 1.21 | | | |
| Q10f. use a computer or the Internet for science assignments or activities. | Control | 50 | 2.46 | 1.27 | -3.29 | 133 | **.001** |
| | ISEP | 85 | 3.20 | 1.26 | | | |
| Q10g. write about how I solved a science task or about what I am learning. | Control | 49 | 3.22 | 1.19 | -1.33 | 131 | .185 |
| | ISEP | 84 | 3.50 | 1.12 | | | |
| Q10h. learn that there are different solutions to science tasks. | Control | 49 | 3.45 | 0.89 | -0.80 | 129 | .424 |
| | ISEP | 82 | 3.60 | 1.10 | | | |
| Q10i. use multiple sources of information to learn. | Control | 49 | 3.53 | 1.04 | -0.45 | 131 | .657 |
| | ISEP | 84 | 3.62 | 1.14 | | | |
| Q10j. develop my skills for doing science. | Control | 49 | 3.49 | 1.00 | -1.75 | 130 | .082 |
| | ISEP | 83 | 3.83 | 1.12 | | | |
| Q10k. learn about how science is important in the real world. | Control | 50 | 3.40 | 1.14 | -3.59 | 133 | **< .001** |
| | ISEP | 85 | 4.05 | 0.92 | | | |
| Q10l. work on science tasks in a group with other students. | Control | 49 | 3.04 | 1.35 | -2.76 | 77.73 | **.007** |
| | ISEP | 86 | 3.65 | 0.99 | | | |
| **Q11. At least one adult in my home, ...** | | | | | | | |
| Q11a. makes me do my science homework. | Control | 49 | 3.76 | 1.42 | 2.17 | 134 | **.032** |
| | ISEP | 87 | 3.16 | 1.59 | | | |
| Q11b. asks about what I am learning in science class. | Control | 50 | 3.10 | 1.39 | -0.80 | 133 | .428 |
| | ISEP | 85 | 3.31 | 1.49 | | | |
| Q11c. helps me with my science homework. | Control | 50 | 3.10 | 1.50 | 0.75 | 134 | .457 |
| | ISEP | 86 | 2.91 | 1.43 | | | |
| Q11d. helps me work on my science projects. | Control | 48 | 3.35 | 1.44 | 0.60 | 132 | .552 |
| | ISEP | 86 | 3.20 | 1.47 | | | |
| Q11e. expects me to do well in science. | Control | 50 | 4.42 | 1.05 | 0.29 | 135 | .775 |
| | ISEP | 87 | 4.37 | 1.01 | | | |
| Q11f. expects me to go to college. | Control | 51 | 4.51 | 0.95 | 1.03 | 136 | .305 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | ISEP | 87 | 4.32 | 1.08 | | | |
| Q11g. expects me to have a science-related career. | Control | 50 | 2.42 | 1.47 | -1.66 | 136 | .099 |
| | ISEP | 88 | 2.85 | 1.47 | | | |

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

Table H3. *Comparisons of Students' Responses by Teacher Participation Status, UB/BPS ISEP Student Questionnaire, Spring 2013, High School Students, Only Schools with Both Control and ISEP Teachers*

| **Item** | **Participation** | ***n*** | ***M*** | ***SD*** | ***t*** | ***df*** | ***p*** |
|---|---|---|---|---|---|---|---|
| **Q8. Views of Science** | | | | | | | |
| Q8a. I like science. | Control | 97 | 3.42 | 1.14 | -1.17 | 370 | .244 |
| | ISEP | 275 | 3.58 | 1.16 | | | |
| Q8b. I am good at science. | Control | 97 | 3.24 | 1.06 | -1.49 | 370 | .138 |
| | ISEP | 275 | 3.42 | 1.05 | | | |
| Q8c. I would keep on taking science classes even if I did not have to. | Control | 96 | 2.92 | 1.25 | 0.47 | 366 | .640 |
| | ISEP | 272 | 2.85 | 1.29 | | | |
| Q8d. I understand most of what goes on in science. | Control | 97 | 3.67 | 0.87 | 0.91 | 369 | .364 |
| | ISEP | 274 | 3.57 | 0.96 | | | |
| Q8e. Almost all people use science in their jobs. | Control | 97 | 3.18 | 1.05 | 0.24 | 370 | .811 |
| | ISEP | 275 | 3.15 | 1.06 | | | |
| Q8f. Science is useful for solving everyday problems. | Control | 93 | 3.31 | 1.00 | -0.33 | 364 | .738 |
| | ISEP | 273 | 3.36 | 1.11 | | | |
| Q8g. Science is a way to study and understand the natural world. | Control | 96 | 4.04 | 0.82 | -0.65 | 366 | .518 |
| | ISEP | 272 | 4.11 | 0.92 | | | |
| Q8h. Scientists sometimes disagree about scientific knowledge. | Control | 94 | 3.71 | 0.90 | -0.98 | 361 | .330 |
| | ISEP | 269 | 3.82 | 0.90 | | | |
| Q8i. All scientists do not follow the same step-by-step method to do science. | Control | 96 | 3.57 | 1.10 | -1.26 | 365 | .207 |
| | ISEP | 271 | 3.73 | 1.03 | | | |
| Q8j. Scientists use their imagination when doing science. | Control | 97 | 3.13 | 1.24 | -1.52 | 366 | .130 |
| | ISEP | 271 | 3.35 | 1.19 | | | |
| Q8k. Science ideas or hypotheses must be supported by evidence. | Control | 95 | 3.96 | 1.02 | -1.46 | 367 | .145 |
| | ISEP | 274 | 4.13 | 0.96 | | | |
| Q8l. Scientific theories can change when new evidence or a new explanation becomes available. | Control | 96 | 4.10 | 0.83 | -1.55 | 368 | .122 |
| | ISEP | 274 | 4.26 | 0.88 | | | |
| **Q9. In this class, my teacher ...** | | | | | | | |
| Q9a. arranges the classroom so students can have discussion. | Control | 92 | 3.18 | 1.16 | -0.95 | 355 | .344 |
| | ISEP | 265 | 3.32 | 1.20 | | | |
| Q9b. asks questions that have more than one answer. | Control | 96 | 3.54 | 1.04 | 0.21 | 361 | .834 |
| | ISEP | 267 | 3.52 | 0.98 | | | |
| Q9c. asks me to give reasons and provide evidence for my answers. | Control | 93 | 4.05 | 1.00 | 0.08 | 360 | .940 |
| | ISEP | 269 | 4.04 | 1.01 | | | |
| Q9d. encourages me to ask questions. | Control | 94 | 4.01 | 1.07 | 1.26 | 356 | .209 |
| | ISEP | 264 | 3.84 | 1.11 | | | |
| Q9e. let me work at my own pace. | Control | 94 | 3.68 | 1.04 | 0.35 | 357 | .729 |
| | ISEP | 265 | 3.64 | 1.04 | | | |
| Q9f. encourages me to explain my ideas to other students. | Control | 95 | 3.40 | 1.06 | 0.24 | 357 | .807 |
| | ISEP | 264 | 3.37 | 1.14 | | | |
| Q9g. encourage me to consider different | Control | 95 | 3.52 | 1.06 | 0.90 | 356 | .369 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| scientific explanations. | ISEP | 263 | 3.40 | 1.14 | | | |
| Q9h. provides time for me to discuss science ideas with other students. | Control | 94 | 3.21 | 1.11 | -0.93 | 358 | .355 |
| | ISEP | 266 | 3.34 | 1.18 | | | |
| Q9i. checks that I have completed my assignments. | Control | 95 | 4.17 | 0.90 | -1.92 | 360 | .056 |
| | ISEP | 267 | 4.37 | 0.88 | | | |
| Q9j. provides meaningful and challenging assignments. | Control | 94 | 3.76 | 0.98 | -2.06 | 357 | **.040** |
| | ISEP | 265 | 3.99 | 0.95 | | | |
| Q9k. helps me apply my learning to real life. | Control | 95 | 3.57 | 1.20 | -1.20 | 359 | .231 |
| | ISEP | 266 | 3.74 | 1.20 | | | |
| Q9l. expects me to do well. | Control | 96 | 4.42 | 0.99 | -0.51 | 363 | .607 |
| | ISEP | 269 | 4.47 | 0.87 | | | |
| **Q10. In this class, I ...** | | | | | | | |
| Q10a. use information and data to support my conclusions. | Control | 97 | 3.90 | 0.97 | -0.09 | 364 | .931 |
| | ISEP | 269 | 3.91 | 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 | 95 | 3.62 | 1.07 | -0.43 | 362 | .667 |
| | ISEP | 269 | 3.68 | 1.08 | | | |
| Q10c. learn from other students. | Control | 94 | 3.43 | 1.09 | -0.94 | 356 | .346 |
| | ISEP | 264 | 3.55 | 1.09 | | | |
| Q10d. consider different scientific explanations. | Control | 97 | 3.34 | 0.97 | -1.01 | 360 | .314 |
| | ISEP | 265 | 3.46 | 1.06 | | | |
| Q10e. have a say in deciding what activities I do. | Control | 96 | 3.07 | 1.12 | 0.28 | 357 | .781 |
| | ISEP | 263 | 3.03 | 1.18 | | | |
| Q10f. use a computer or the Internet for science assignments or activities. | Control | 94 | 3.15 | 1.16 | -0.51 | 197.6 | .610 |
| | ISEP | 267 | 3.22 | 1.42 | | | |
| Q10g. write about how I solved a science task or about what I am learning. | Control | 94 | 3.29 | 1.10 | 0.52 | 359 | .601 |
| | ISEP | 267 | 3.21 | 1.20 | | | |
| Q10h. learn that there are different solutions to science tasks. | Control | 97 | 3.60 | 1.01 | -1.23 | 360 | .219 |
| | ISEP | 265 | 3.75 | 1.03 | | | |
| Q10i. use multiple sources of information to learn. | Control | 97 | 3.63 | 1.00 | -2.03 | 364 | **.043** |
| | ISEP | 269 | 3.86 | 0.96 | | | |
| Q10j. develop my skills for doing science. | Control | 96 | 3.74 | 0.89 | 0.42 | 198.5 | .675 |
| | ISEP | 267 | 3.69 | 1.06 | | | |
| Q10k. learn about how science is important in the real world. | Control | 95 | 3.78 | 1.07 | 0.02 | 361 | .983 |
| | ISEP | 268 | 3.78 | 1.12 | | | |
| Q10l. work on science tasks in a group with other students. | Control | 97 | 3.53 | 1.06 | -2.16 | 363 | **.032** |
| | ISEP | 268 | 3.81 | 1.11 | | | |
| **Q11. At least one adult in my home, ...** | | | | | | | |
| Q11a. makes me do my science homework. | Control | 94 | 3.40 | 1.39 | 2.31 | 360 | **.022** |
| | ISEP | 268 | 3.00 | 1.48 | | | |
| Q11b. asks about what I am learning in science class. | Control | 95 | 3.36 | 1.38 | 3.03 | 361 | **.003** |
| | ISEP | 268 | 2.84 | 1.44 | | | |
| Q11c. helps me with my science homework. | Control | 95 | 2.85 | 1.34 | 3.05 | 358 | **.002** |
| | ISEP | 265 | 2.36 | 1.34 | | | |
| Q11d. helps me work on my science projects. | Control | 93 | 3.08 | 1.34 | 2.94 | 358 | **.004** |
| | ISEP | 267 | 2.58 | 1.40 | | | |
| Q11e. expects me to do well in science. | Control | 95 | 4.41 | 0.89 | 0.93 | 363 | .355 |
| | ISEP | 270 | 4.30 | 1.04 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Q11f. expects me to go to college. | Control | 96 | 4.61 | 0.73 | 0.43 | 211.1 | .670 |
| | ISEP | 268 | 4.57 | 0.93 | | | |
| Q11g. expects me to have a science-related career. | Control | 95 | 2.78 | 1.54 | 0.87 | 360 | .387 |
| | ISEP | 267 | 2.63 | 1.46 | | | |
| **Q12. I plan to . . .** | | | | | | | |
| Q12a. take (or have taken) only the science courses I am required to take in high school. | Control | 94 | 3.63 | 1.30 | 1.28 | 360 | .202 |
| | ISEP | 268 | 3.42 | 1.36 | | | |
| Q12b. take (or have taken) the most challenging science courses offered in my high school. | Control | 94 | 2.84 | 1.17 | -2.48 | 361 | **.014** |
| | ISEP | 269 | 3.23 | 1.36 | | | |
| Q12c. take (or have taken) 4 years of science courses in high school. | Control | 94 | 3.50 | 1.23 | -1.36 | 359 | .175 |
| | ISEP | 267 | 3.71 | 1.32 | | | |
| Q12d. pursue a science-related career. | Control | 93 | 2.83 | 1.26 | -1.18 | 358 | .241 |
| | ISEP | 267 | 3.03 | 1.45 | | | |
| Q12e. go to a 2- or 4-year college. | Control | 94 | 4.16 | 1.06 | -2.02 | 358 | **.045** |
| | ISEP | 266 | 4.41 | 1.02 | | | |
| Q12f. take science courses in college. | Control | 95 | 3.31 | 1.18 | -2.47 | 360 | **.014** |
| | ISEP | 267 | 3.67 | 1.24 | | | |
| Q12g. major in a science field in college. | Control | 93 | 2.90 | 1.23 | -0.92 | 357 | .358 |
| | ISEP | 266 | 3.06 | 1.43 | | | |
| Q12h. major in an engineering field in college. | Control | 94 | 3.31 | 1.16 | 2.17 | 192.3 | **.031** |
| | ISEP | 268 | 2.99 | 1.39 | | | |
| Q12i. major in a science or engineering technical field in college. | Control | 93 | 3.38 | 1.24 | 0.64 | 359 | .524 |
| | ISEP | 268 | 3.27 | 1.39 | | | |

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

# Section 4b: Response to Evaluator's Report

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

**Year 3: 2013 – 2014**

## 4. b. Response to External Evaluation Report

Xiufeng Liu and Joseph A. Gardella, Jr.

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***

Although data on teachers' perceived need for professional development on science inquiry shows a significant increase compared to that in previous year, we agree with the External evaluator that this may suggest that, after participation in the ISEP for a year, teachers realized that conducting science inquiry, particularly interdisciplinary science inquiry, could be more complex than what they initially thought, thus leading them to want to learn more. Related to this, science teachers still felt that they were less prepared to teach engineering design. The evaluation finding also suggested that teachers became more prepared in teaching disciplinary core ideas and crosscutting concepts, two essential components of interdisciplinary science inquiry. In our next year's implementation, more emphasis of teacher professional development should be on developing teachers' science and engineering practices.

The evaluation found that overall teachers did not change significantly their knowledge and understanding of the nature of science. This finding is not surprising given that there is a body of literature suggesting that changing teachers' conceptions of nature of science requires explicit instruction or professional development. In previous years of ISEP implementation, there were no explicitly structured activities targeting nature of science. Instead, developing teachers' understanding of nature of science was implicit in that we expected teachers to develop a better understanding as the result of their experiencing authentic science inquiry at the university.

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 nature of science. We will include new workshop/presentations in academic year professional development as part of ISEP. The new structure of academic year content PD with pending 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. Professor Gardella has developed two case studies, on one the evolution of interdisciplinary science and engineering in tissue engineering and the second in the science and engineering development of solid state electronic devices. We will couple those with a third panel discussion/presentation on interdisciplinary environmental science, engineering and social science.

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 did not obtain enough evidence on the development and effect of PLCs, we were very pleased on the amount of work put into establishing various PLCs over the part year. With the foundation established this past year, we expect that we will see some positive outcomes to emerge in the next two years.

***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 in participating ISEP teachers' classes. This seems to confirm that our approach of teacher professional development and during the academic year wrapping-around activities is effective in achieving this goal.

***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 two years, 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 work with our external evaluator to begin synthesizing 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 4:  2014 - 2015**

# ISEP Year 4 Plan:  July 2014 – July 2015

For Year 4 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

| | July & August | Fall | Spring | June 2014 |
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| **Teacher professional development** | Teachers engaging in research experiences and share projects through PLC's; planning for implementation in upcoming school-year<br><br>12 BPS teachers participating in 3-week Summer STEM Institutes at Buffalo State College<br><br>3 BPS teachers participate in CS Principles Workshop at Buffalo State College<br><br>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)<br><br>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)<br><br>Teacher implementation of inquiry science teaching with support by STEM and STEM education faculty, graduate and undergraduate students as well as retired master teachers<br><br>Teachers nominated/ self-nominated for summer 2014 research experiences and Summer STEM Institute (proposed summer programs finalized by May)<br><br>Faculty/research teams and mentors identified<br><br>Ongoing communication with school and district leadership to align and maximize resources, placements, and opportunities | Placements finalized for research projects and plans;<br><br>Proposed implementation including short and long term inquiry projects and afterschool programs |

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| **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<br><br>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<br><br>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.<br><br>Meet with school based parent group to plan activities.<br><br>Review building supplies and equipment requests.<br><br>GA's and RA's support in-class and afterschool activities and service learning students; in-school and afterschool activities<br><br>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<br><br>Ongoing partner events including family nights at BMS<br><br>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<br><br>Summer research internships made available with application process<br><br>Summer camp enrichment opportunities for participating middle school students |

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| **PLC's** | Communication to invited new member participation in PLCs and initial meeting with participants<br><br>Teachers engaged in summer research prepare products to share through PLC's<br><br>Test social network tools for each PLC | Optimum web interface chosen by PLC members and contributions made by participating teachers, graduate students, partners, and parents<br><br>Scheduled meetings and communication to support PLC's<br><br>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<br><br>Ongoing interactions with DPCC and Parent PLC to encourage parent involvement<br><br>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) |

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| **Evaluation** | Develop and pilot instrument to assess STEM faculty perceptions (ISEP Faculty Questionnaire<br><br>Analyze UB/BPS ISEP Teacher Questionnaire pre/post comparisons<br><br>Analyze BPS ISEP Student Questionnaire data from treatment and comparison students- Spring 2013<br><br>Collect 2013-2014 School/classroom/teacher-level demographic data<br><br>Collaborate with the Research Team to develop and pilot test Teacher Content and PCK Assessment<br><br>Observation and informal interviews of ISEP teacher participants, STEM students, and faculty during summer lab experiences<br><br>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)<br><br>Administer UB/BSU Faculty Questionnaire<br><br>Ongoing collection of data and monitoring of ISEP components and responding to project team needs<br><br>Administer and analyze STEM Student Survey data<br><br>Analyze BPS student summer program experience data<br><br>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)<br><br>Ongoing collection of data and monitoring of ISEP components and responding to project team needs<br><br>Administer and analyze STEM Student Survey Data<br><br>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)<br><br>Administer UB/BPS ISEP Teacher Questionnaire<br><br>Ongoing collection of data and monitoring of ISEP components and responding to project team needs<br><br>Preparing for evaluation of summer research components and final activities in schools and revision of evaluation plan as necessary |

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| **Research** | Participant observation of teachers conducting research at university research laboratories and industrial partner sites during the summer 2013<br><br>Working with the external evaluator to develop standardized measurement instruments on science teachers' interdisciplinary science inquiry content knowledge and pedagogical content knowledge<br><br>Participant observation of STEM graduate students conducting research with teachers, summer 2013 | Observation of teachers implementing interdisciplinary science inquiry in their classrooms<br><br>Supporting teachers in implementation interdisciplinary science inquiry through a monthly seminar<br><br>Periodic interviews of teachers on their changing conceptions of interdisciplinary science inquiry teaching<br><br>Observation of the undergraduate academy seminar on preparation of STEM students to work in schools<br><br>Organizing graduate student orientation sessions to prepare them to work in schools;<br><br>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<br><br>Supporting teachers in implementation interdisciplinary science inquiry through a monthly seminar<br><br>Ongoing activities related to studying graduate student impacts (continuation of fall activities) | Prepare journal articles and other relevant publications to disseminate research findings<br><br>The Research Team will prepare for studying the next round of teachers conducting research at UB and partnering facilities |