Interdisciplinary Science and Engineering Partnership

Annual Report to NSF

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

Year 2: 2012 – 2013

Section 1: Activities and Findings

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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 on five major activities central to the mission of ISEP 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 second year of the NSF support for ISEP include:

- placement of 64 teachers in summer professional development (PD) in 2012, including 49 teachers in research opportunities,
- research results reported in several submitted papers (see references in research review),
- development of subject based PLC's and a special PLC focus on parent participation
- as a result of collaboration in research teams in 2012, and the PLCs, highly focused STEM teaching teams emerge in K-8 schools among middle school science teachers (grades 4-8),
- a significant expansion of participation of Ph.D. Graduate Assistants to connect middle and high schools with similar research themes,
- substantial expansion of undergraduate service learning student participation with the recruitment of students from four area colleges through the WNY Service Learning Coalition,
- additional opportunities for summer high school student research and middle school science camps are added for summer 2013 ***and***
- initial results on classroom implementation in academic year 2012-2013.

The issues that have complicated ISEP progress in year 2 include:

- The appointment of a new superintendent, Dr. Pamela Brown, slowed ISEP access to top leadership, as she had no background in ISEP upon her arrival, and a series of competing partnership issues and opportunities for the District, along with teacher evaluation controversies. Access to Dr. Brown, while less than previous, has been excellent, once collaborations were established.
- The abrupt departure of a key coordinating teacher at one K-8 school during the academic year was complicated by the lack of other teachers involved in ISEP and a new principal. ISEP programs slowed at School 59 from November to April, but ISEP graduate assistants were critical in maintaining science instruction with substitute teachers. Appointment of a veteran teacher to the position at School 59 was important for ISEP as the new teacher is a long time ISEP partner from Buffalo State College.
- Of the sixty four teachers supported last summer, one teacher resigned from ISEP participation in the fall, refusing to deliver his commitments on follow-up implementation. He was dissatisfied with the school based leadership of ISEP.

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)*** offered the initial (2012) summer teacher PD course, taught by coPI Prof. Dan MacIsaac. 15 teachers completed the course and are prepared for summer research in 2013. Further, BSC provided an extensive summer middle school camp for students. A report is offered in the ***appendix*** to this part of the report. Finally, the expansion of participation to the Department of Technology Education was solidified in year 2, with Prof. Clark Greene, Chair of the Department, leading the BSC course in 2013.
- ***Buffalo Museum of Science (core partner)*** continued their support for informal science opportunities, along with the curricular support for School 59. Many events are held regularly at the Museum and planning to optimize the major presentations, such as Body Worlds Vital are complemented by the ongoing renovation of space to make more hands on workstations for use daily by School 59, which is adjacent/connected to the museum, along with other hosted field trips by ISEP schools.
- ***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)*** hosted a middle school teacher in crystal growth research and expanded their summer student research program in computational genetics to ISEP students for summer 2013, both at middle and high school level. 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.

- ***Life Technologies (new supporting partner)*** established their partnership commitments this year and will host one teacher in summer research in 2013. In addition, they have hosted multiple field trips in the past year.
- ***Medaille College (new supporting partner)*** provided over 30 service learning students through leadership of Professor Brenda Fredette to Riverside High School (see next section) and are offering an ISEP supported summer middle school STEM camp which emphasizes STEM based entrepreneurship (another Riverside magnet academic program).
- ***WNY Service Learning Coalition (supporting partner)*** helped recruit Daemen College, Niagara University and Canisius College as new supporting partners and they are exploring specifics of service learning collaboration for their students 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.

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

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

In year 2 of the program, support for the number of graduate assistants was increased, as the ISEP leadership judged that additional help was desired and justified in the schools. 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 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. The graduate assistants in the schools work with teachers, classes and the principal, and meet at Common Planning time to facilitate all teachers participating in wrap around support, including science, technology, mathematics and special education

The participation of undergraduates in service-learning, 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. In year 2, Medaille College in Buffalo committed all students registered in a senior level capstone science based service learning course taught by Professor Brenda Fredette. Professor Fredette has been very active in science based service learning in Buffalo, and agreed to explore and then commit to joining ISEP's project in our schools. The President of Medaille College, Richard T. Jurasek, joined our planning to express his enthusiasm for the collaboration, which is extending further through joint ISEP sponsorship of Medaille's STEM summer middle and high school camp program.

During the past year, the PI completed work on expanding the basic preparatory course for the Service Learning experience at UB, funded via a grant from the American Academy of Colleges and Universities

(AACU) Bringing Theory to Practice program to extend the program to providing a sophomore seminar for UB Academies program. Collaboration with the Academies in service learning brings students from this residential college program registered in specific theme areas, presently, Civic Engagement, Global Perspectives, and Research Exploration. Additional themes are being introduced next year, including Sustainability.

The combination of UB, Buffalo State and Medaille increased the participation in both paid internships and course based service-learning at the undergraduate level from 45 students last year to approximately 80 each semester. In addition, again, several experienced undergraduates from Buffalo State College were identified through our core partner leadership.

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 Partners, VWR Science Kit (now Ward Scientific) continued providing professional staff at School 93, Southside Academy. Life Technologies is currently considering providing staff at the high school level.

Because of the commitment from Medaille College, Riverside High School was able to have 30 students supporting teachers in the school, which is the level that now serves as our goal for every ISEP school.

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

A number of schools organized science nights for parents including School 19 which held the annual Science Fun night March 19st. This event drew approximately 200 participants at a school with an enrollment from K-8 of 450 students. Research surveys of participants at the event are reported by Professor Liu and his student, Brooke Grant. School 93 Southside Academy held a Science Family Night on March 14th, and School 72, Lorraine Academy held their Science and Career Night with considerable Buffalo State faculty involvement, drawing over half of the Lorraine student families.

The Museum of Science will hold the second annual open STEM career event for all ISEP High school students and their parents in late June, 2013.

The ability for schools to schedule field trips continues to be a significant activity which has been expanded in year 2. . The program leadership has continued to negotiate effective discounts to maximize participation of students at middle and high schools. Particularly attractive for schools was a Body Works exhibition at the Museum that has recently opened, with 70 students attending in late May from Bennett High school during opening week. Also, field trips to UB laboratories and to additional community educational facilities (Tifft Nature Farm and the Buffalo Zoo) have were conducted. A great example has been the Bennett High team which took 9th and 10th graders to Hauptmann Woodward Institute and the UB Neurosurgery group, both documented in articles in local media. Field trips expanded in popularity, well aligned with interdisciplinary STEM experiences. A total of 13 high school field trips and 9 middle school field trips were funded by ISEP this past year, compared to 18 total field trips last year.

d. 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 2012

Table 1 below shows the names, schools, placements and faculty support for 59 teachers placed in interdisciplinary research, the Buffalo State College preparatory course, or both. The color coding is noted in the Table title. One teacher in this group declined the appointment because of expected childbirth date during the summer. Six other teachers were supported for curriculum writing project at Lorraine

Academy, at the request of the Principal and Coordinating teacher. Three technology teachers combined the course plus three additional weeks of research applications.

a. Teacher Placement for ISEP Summer PD 2012 and Ongoing Appointments for Summer 2013

For summer 2013, the review of proposals for summer research PD was accomplished by a committee staffed by members of the Executive Committee, chaired by Co-PI MacIsaac, and including four faculty, two who are chairs of departments and two heads of interdisciplinary engineering research programs, plus our contacts at the two research based corporate partners, Praxair and Life Techologies and the Chief Academic Officer at (supporting partner) Roswell Park Cancer Institute. Six teachers were selected for the Buffalo State College course, with the remainder being placed in research positions at the present time. We expect to have a similar number of research placements as 2012. The organization of the teacher placements into these interdisciplinary subject "clusters" has continued this year (Table 2) with slightly different numbers of teachers. Specific placements are being made presently for the summer 2013.

Table 1: Summary of teacher summer **2012** assignments organized by school. Yellow indicates coordinating teachers who spent six weeks in research, green indicates teachers enrolled in the Buffalo State College course and blue indicates teachers in one month research assignments.

SCHOOL	TEACHER	RESEARCH PROPOSAL	COURSE	Grad Students	Cluster	Stem Faculty
Bennett HS	Tanya Johnson	Genetics		Andrew Contronea	BioGen	Dr. Satpal Singh
	Ann Crittenden		X		Course	
	Angel Moses	Forensic Science	X		Course	
	Carl Bish	Aquaponics		Susie, Michelle, etc.	Chem Env	Joe G., Lara Hutson
	Jeffrey Biesinger	Biomedical			Roswell	
	John Nowak	Extreme Events			Eng/EQ Center	Adel Sadek, Salvatore Salamone
	Richard Rittling	Extreme Events			Eng/EQ Center	Adel Sadek, Salvatore Salamone
	Jeffrey Walter	Extreme Events			Eng/EQ Center	Adel Sadek, Salvatore Salamone
Burgard HS	Sara Kszanak	Bioengineering		Ben Wang	Bioengineering	Debanjan Sarkar
	Angelo Muscarella	Earth Science	X		Course	
	Bruce Allen	Magnetic Nanotechnology		Tom Scrace	Physics	Hong Luo
	Julianna Evans	Immune Response		Shannon Clough	Bioengineering	Debanjan Sarkar
	Jason Kolb	Environmental Engineering	X		Course	
	Vicky Walters	Engineering/Extreme Events			Eng/EQ Center	Adel Sadek, Salvatore Salamone
East HS	Patrick McQuaid	Molecular Biology		Amy Zielinski	BioGen	Jim Barry
	Jill Roach	Bioinformatics/Biomedical		Jeremy Bruenn	BioGen	
	Kristen Lieker	Forensics			Chem Env	Frank Bright
Hutch Tech HS	Jill Jakubowicz	Using Restriction Enzymes		Sarina Dorazio	BioGen	Janet Morrow
	Daniel Stumpf (T1)	Physics/CTE	X		Physics	John Cerne
	Jason Mayle (T1)	Science Olympiad	X		Physics	John Cerne
	Jacqueline Nelson	Genetics			BioGen	Jerry Koudelka
	Roger Aumick	Engineering	X		Eng/EQ Enter	
	Robert Merkle (T1)	Physics/CTE	X		Physics	John Cerne
	Mary Ziewers	Computer Science		Lavone Rudolph	Computer Sci	
	Karen Beck	Environment		Susan Mackintosh	Chem Env	Val Frerichs/Luis Colon
	Deanna Rizzo	Living Env/Chemistry		Susie, Michelle, etc.	Chem Env	
Riverside HS	Brad Gearhart	Physics, Praxair, UB, BSC			Phy/Buffalo State	
	Anne Kokolus	Biology		Amber Worrall	Anat/Phys Med	Bob Hard
	Arthur Wager	Anatomy and Physiology		Amber Worrall	Anat/Phys Med	Bob Hard
	Gayle Gritzmacher		X		Course	
	Gregory Vincent	Cell Biology			BioGen	Stephen Free
	John Bihr		X		Course	
	Richard Nagler	Biotechnology/Earth Science		Amber Worrall	Anat/Phys Med	Bob Hard
	Karl Wagner	Changing levels of O2 and CO2			Chem Env	
South Park HS	Kathleen Marren	Renewable Energy Technology		Meghan Kern	Chem	Dave Watson
	Ann Mychajliw	Cancer Diagnosis			Roswell	
	Daniel Hildreth	Nuclear Chemistry			Materials	Sarbajit Banerjee
	Diane Link	Renewable Energy Sources		James Parry	Materials	Hao Zeng
	Adam Hovey	Environmental/Earth Sci		Michael Gallisdorfer	Chem Env	
	Dave Morreale	Social Studies, env,		Alex Ticoalu	Chem Env	

Table 1 (con't.): Summary of teacher summer **2012** assignments organized by school. Yellow indicates coordinating teachers who spent six weeks in research, green indicate teachers enrolled in the Buffalo State College course and blue indicate teachers in one month research assignments.

MST Prep School	Michelle Zimmerman	Bottle Biology		Lara Hutson	Env	Joe G.
	Perka Kresic	Enviromental		Susan Mackintosch	Chem Env	Valerie Luis & Diana Aga & Louis Colon
	Charles Harding	Earth Science		Jonathan Malzone	Chem Env	Joe G. Diana A.
	Lori Nirschel	Special Ed	X		Course	
	Michael Mecca	Living Environment	X		Course	
	Nowel Eloudi	Math	X		Course	
	Christen LaBruna	Earth Science		Jonathan Malzone	Chem Env	
Drew Science Magnet School	Amy Brackenridge	Environmental Engineering		Shannon Seneca	Chem Env	Joe G.
Harriet Ross Tubman School	Steven Indalecio	Diseases and immune system		Ekue Bright Adamah-Brassi	Roswell Pk	
	Dana Cassata	Plant Repair	X		Course	
	Dottie McGavern	Plant Phoyosynthesis	X		Course	
Lorraine Elementary	Sharon Pikul	Life Science/Nutrition			Hauptman WD	Eddie Snell, HWI
	Roseanne Cullis	Medical Careers; Anat/Phys		Amber Worral	Anat/Phys Med	Bob Hard
Native American Magnet Sch	Heather Maciejewski	Biomedical		Amber Worral	Anat/Phys Med	Bob Hard
	Mary Ellement	Environmental		Susie, Michelle, etc.	Chem Env.	Joe G., Lara Hutson
Southside Elem School	Susan Wade	Environmental Science		Susie, Michelle, etc.	Chem Env	Joe G.
	Carlo Casolini	Environmental Science			Chem Env	
	Donna Heavey	Environmental Science			Chem Env	
	Jennifer Sarkees	Science Skills	X		Course	

Table 2: Teacher Research Placement Summary

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	ca. 18	ERIE IGERT, Chemistry, Geology, Geography
Genetics	Living Environment	4-6	Biological Sciences, Pharmacology and Toxicology
Anatomy and Physiology	Living Environment, Medical Careers, Middle Schools	4	Physiology and Anatomy and Pathology (Basic Medical Sciences)
Cancer Research	Living Environment, Middle Schools	4	Roswell Park Cancer Institute, Hauptman Woodward Institute
Materials Chemistry	Living Environment, Chemistry	2	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	2	Bioengineering
Physics	Physics, Technology, Engineering	5	Physics, Praxair

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 to be that described in the strategic plan for the subsequent years of ISEP.

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

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 proposed expansion of the PLC to include additional participants. The primary role of PLC's will be to cultivate mentoring partnerships between middle and high school teachers, but to add in the PLC, 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 2013 school year. Teachers involved in the summer research will identify other STEM, special education and English as Second Language 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 a project website; and through presentations at regional and national meetings. The PLC structure and implementation as well as the learning outcomes achieved will foster 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 Gerber (nee 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 Raymond Delgado (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 2012 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.

The Buffalo Public School District's newly appointed Director of Parent and Family Engagement has also been collaborating with ISEP on initiatives to increase parent involvement overall as well as a specific focus on the ISEP Parent based PLC.

d. Outcomes from 2012-2013 PLC's

Creation of PLC clusters:

Parent/Guardian Based- focusing on to how to actively partner with their child to keep him/her 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.

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

Multi-Stakeholder Based- Parent/guardian, teachers, UB doctoral students, UB STEM faculty-focusing on creating strategies to keep children/students engaged in classroom activities, subject content, and afterschool ISE based activities. (Will begin in fall of 2013)

Middle and High School Teacher Based- focusing on the transition from middle to high school, building on pedagogical content knowledge, strategizing on connecting middle school ISE content to high school ISE content.

School Building Based PLC- Coordinating Teacher will convene during common planning time to share research project, implementation and other ISEP based programs and opportunities. (Will begin in the fall of 2013)

Middle & High School Teacher, Doctoral Student, STEM faculty, Research Based –focusing on specific areas of research those teachers are engaged in through their participation in the ISEP Summer Research component of the grant.

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. (Will begin in the fall of 2013)

The overarching goal of establishing various groups of ISEP PLC's is to present all stakeholders (parents/guardians, teachers, doctoral students, university faculty, school building administration involved with the ISEP Program) with an opportunity to convene to discuss how to keep students engaged in interdisciplinary science education, especially as they transition from middle to high school.

Each PLC will have a specific focus within the larger initiative of student engagement in interdisciplinary science education (ISE).

Additionally, setting up face to face meetings with groups has proved to be the best way to advance this project. Many parents in the district do not have direct access to computers and internet access. While a variety of communication platforms will be explored and piloted including various versions of social networks and blogs; currently , PLC's will utilize a face to face, group meeting mode of communication.

1) **Pilot PLC content/research based PLC** included a diverse cluster of BPS elementary, middle and high school teachers across various science based disciplines. The Environmental Science, Social Science and Engineering (Env Sci/Eng) Group (Table 3) worked with a diverse group of STEM faculty, doctoral students and corporate partners. This Pilot PLC centered on content knowledge. The participating BPS teachers, STEM faculty and doctoral students discussed their respective research focus, shared best practices, PCK, pedagogical approaches to implementing research in classroom. Additionally, the teachers also reflected on the overall research experience including the research proposal process, the research experiences, working with STEM faculty and doctoral students and some of the anticipated challenges of implementing research in the classroom during the fall 2012-spring 2013 school year.

Table 3: Environmental Science, Social Science and Engineering (Env Sci/Eng) Group

Teacher Name	School	Subject	Faculty Collaborator(s)	Graduate Assistants
Perka Kresic	MST	Chemistry	Valerie Frerichs, Luis Colon	
Karen Beck	Hutch	Chemistry	Valerie Frerichs	
Michelle Zimmerman	MST	Living Env.	Lara Hutson	
Amy Brackenridge	Museum 59	Living Env.	Joe Gardella	Shannon Seneca
Sue Wade	Southside 93	Living Env.	Joe Gardella	Angelina Montes
Mary Ellement	NAMS 19	5th grade	Joe Gardella	Angelina Montes
Charles Harding	MST	Earth Sci		Jonathan Malzone
Christen LaBruna	MST	Earth Sci		Jonathan Malzone
Adam Hovey	South Park	Earth/Env.		Michael Gallisdorfer
Dave Morrealle	South Park	Social St/Env	Ling Bian	Alex Ticoalu
Carl Bish	Bennett	Aquaponics	Joe Gardella	Angelina Montes
Karl Wagner	Riverside		Diana Aga	Susie Mackintosh
Deanna Rizzo	Hutch	Living Env.	Diana Aga	Susie Mackintosh
Carlo Casolini	Southside 93		Joe Gardella	Michelle Marchany
Donna Heavey	Southside 93	6th grade	Joe Gardella	Angelina Montes

2) Graduate/Undergraduate Student PLC-

The doctoral and the undergraduate students met to discuss ongoing projects, collaboration between middle and high school students and some of the challenges associated with classroom management, and finally managing their own expectations regarding the level of engagement of the students that they worked with in the classroom. Overall, the doctoral and undergraduate student's experiences with the BPS students were very positive. There were two major collaborations between middle and high school students:

- Hutchinson Technical high school students and UB doctoral students worked with Harriett Tubman middle school students working on a boomilever (a device built to hold a specified weight load at a given distance from a vertical service) project. The high school students presented and assisted the middle school students in building a boomilever.
- Lorraine Academy middle school presented at Burgard High School Health /Science Fair on cancer research. The Lorraine Academy students facilitated six stations and their goal was to familiarize students, teachers, administrators and parents at Burgard with the concept of basic cancer biology as it relates to what they were taught by Mrs. Gilbert in their living environment curriculum (eg. cells to tissues to organs to organ system and organisms).

3) Middle & High School Teachers PLC-

The BPS teachers met in November 2013 to discuss purpose and structure of PLC. This meeting was designed to give all teachers from all of the 12 ISEP schools opportunities to participate in a PLC. Most of the participants had taken part in the summer research. Some of the participants attended to find out more about ISEP and how they could utilize ISEP resources in their school building.

4) Parent PLC-

The parent based PLC have met three times during the spring 2013 school year thus far. Several key themes emerged from the meetings including:

- Parents desire to have a better understanding of what interdisciplinary science is and how it will directly benefit their children academic and future professional opportunities. Parents want to know what types of careers their children will be able to pursue.
- Parents want to have a different experience "walking into a school building" .
- Parents want to have an opportunity to learn more about interdisciplinary science.
- Parents want to spend more time in classroom.
- Parents who are involved are very frustrated with parents who are unwilling to become more engaged.

Table 4: Overview of Professional Learning Communities 2012-2013

Timetable	Participants	Responsibilities	Issue/Concerns	Outcomes
July, 2012-2012-2013 school year	• Participating BPS teachers in summer research • UB doctoral students • UB STEM faculty • BPS Parents	Meet monthly to exchange ideas, best practices, pedagogical approaches, student engagement, parent involvement	• Scheduling time to meet face to face regularly • Parent access to technology • Parents access to transportation	• Initial PLC Clusters were created and implemented • PLC Clusters created opportunities for teachers within school buildings to work together in groups and as a team for upcoming summer 2013 research • Graduate students created collaborative opportunities between middle and high school teachers and students • Parent PLC created opportunities for parents to collaborate with STEM faculty and BPS teachers. Tis June 2013, a parent will be participating on an ISEP panel as part of the 2013 annual WNY *Networking in Higher Education Conference: Building Bridges for a Better Tomorrow"*

e. Moving Forward

Phase two of the PLC clusters will commence during the summer of 2013 and continue throughout 2013-14 school year. The following PLC Clusters will be created and implemented:

- Multi-Stakeholder Based
- School Building Based PLC

- Building Principal Based

Additionally, the existing PLC clusters will continue to meet during the summer 2013 and continue throughout the 2013-14 school year.

As a result of parent input, several programmatic opportunities will be 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.
- STEM faculty and doctoral student led ISEP workshops for parents designed to better aquatint parents with basic interdisciplinary science concepts.
- Parent field trips to high schools, designed to better familiarize parents with ISEP high Schools as they prepare to choose what high school their child/children will attend.
- 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 will be 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.
- Implementation strategies

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), Dr. Vanashri Nargund-Joshi (post-doc research associate), Bhawna Chowdhary (doctoral student research assistant), Brooke Grant (doctoral student research assistant), and Erica Smith (doctoral student research assistant). Following the first-year implementation plan submitted last year, we conducted a series of studies to research teachers' development of pedagogical content knowledge (PCK) on interdisciplinary science inquiry. The preliminary findings were reported at the annual MSP Learning Network Conference in Feb. 2013 and at the annual meeting of NARST – A Worldwide Organization for Improving Science Teaching through Research in April 2013. Six articles based on the above conference presentations have been submitted to academic journals including *Journal of Research in Science Teaching*, *Science Education*, *International Journal of Science Education*, *Journal of Curriculum Studies*, *Journal of Science Teacher Education*, and *School Science and Mathematics (see references)*.

This section describes major research activities we implemented from June 1 2012 to May 31 2013 and major findings we have obtained so far.

5.1 Activities

5.1.1 Pedagogical Workshops

During the academic year, we conducted monthly workshops related to different components of PCK in order to support teachers' implementation and transformation of their summer research experiences into interdisciplinary science teaching and learning in their schools and classrooms. 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. Table 5.1 lists the workshops.

Table 5.1 Monthly Pedagogical Workshops

Month	Focus	Major Activities	# of Attendees
October	Understanding Interdisciplinary Science Inquiry (ISI)	• Clarifying Meanings of ISI • Relevance of ISI to Common Core and the Next Generation Science Standards • Explanations with Examples: Case Studies and teachers' Summer Research Experiences • Introduction of PCK Framework	21
November	Exploring the ISEP Professional Learning Community	• Discuss Professional Learning Communities (PLCs) • Understanding resources available for teachers to implement ISI in the classrooms • Examine exemplary cases of how teachers have collaborated with different partners in the ISEP PLC • Discuss the role of the Research Team in the ISEP PLC	16
December	Conducting Interdisciplinary Science Teaching with Technology	• Applying ISI Teaching Rubric • Experiencing technology based lesson in a group • "Can iPhones Give You Cancer?" ISI Investigation • Sharing Findings • Revising lesson using ISI framework and rubric	10

January	Teaching Strategies for Interdisciplinary Science Inquiry	• Observing human body exhibit from the museum and answering a driving question: What do you know about YOU? • Introduction of Project Based Science Framework • Teaching Strategies Supporting Project-Based Science Teaching and Learning • Understanding role of community resources in project based science learning • Sharing examples from teachers' classroom & thinking ahead	17
February	Understanding Interdisciplinary Science Curriculums	Driving Question: How does your knowledge of standards impact the curricular decisions you make in your planning? • Integration of the Common Core Curriculum Standards • ISI Framework – Implementation and Understanding • Review of ISI Framework and Common Core Connection • Knowledge and Implementation of Curriculum Standards (Next Generation Science Standards) • Understanding other Factors: What do we need to add to create a better picture of the different factors that influence your curricular decisions? • Using the Standards to Create or "Recreate" a Lesson or Unit	11
March/April	Preparing proposals for Next Year-Summer Research	• Overview of ISI Framework and Summer research Types • Examples of different research studies from the first year • Overview of UB 2020 • Sharing teachers' experiences • Questions from teachers	~45
May	Assessing Interdisciplinary Science Learning	• Review of Interdisciplinary Science Inquiry (ISI) framework • ISI Assessment: Maintaining Water Systems • Applications of ISI Assessment Scoring Rubric to the unit • Developing and sharing of a rubric for a unit in use.	11

5.1.2. Research on ISI Conceptual Framework

We interviewed scientists who hosted teachers in conducting summer research. We also observed teachers conducting research with STEM faculty and students in university research laboratories. Finally we interviewed teachers and observed their implementation of interdisciplinary science inquiry.

Specifically, we contacted all the participating scientists via email. Once initial contact with the scientists was established we scheduled interviews with the scientists. The interview questions with scientists had three main sections. Section one focused on understanding how scientists differentiate between interdisciplinary science inquiry from discipline specific inquiry and what kind of examples do they provide. The second section of the interview focused on science and engineering practices and crosscutting concepts involved in the new K-12 science framework. The last section of the interview focused on understanding how scientists guided teachers who worked in their respective laboratories and how do they foresee their teachers implementing this research experience in the classroom. Each interview lasted between 45 minutes to 120 minutes.

Interviews with teachers took place according to their convenience during school year to understand their views about ISI and how do they translate ISI in their classroom. During interview teachers were probed to elaborate upon their thinking about choosing certain activity, resources, handouts or questioning strategy to teach interdisciplinary inquiry in the classroom. Teachers' interviews provided us rich data and allowed us to understand their thinking, reasoning, beliefs and struggles about implementing ISI in the classroom.

Our third data source was observations of teachers' summer sessions. Each teacher was assigned in different laboratories either on the university campus or in the industrial setting. Teachers conducted their research projects for around 6 to 8 weeks under guidance of their mentors. Between team of four researches we conducted multiple observations. We observed each teacher at least once conducting his or her summer research or participating in the lecture session as part of his or her summer research project. The purpose of these observations was to mainly understand how scientists have mentored teachers to develop and conduct their interdisciplinary projects. These observations gave us insight into scientists' understanding of interdisciplinary inquiry at K-12 level.

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

The focus of this research was to understand teachers' Pedagogical Content Knowledge (PCK) toward Interdisciplinary Science Inquiry (ISI). A team of four researchers, i.e., post-doc and doctoral research assistants, collected data through observations and interviews with teachers. Each researcher focused on a different component of PCK framework including: ISI instructional strategies, curricular understanding, teachers' overall orientation toward ISI teaching, and interactions between STEM students and teachers. We used case study approach to analyze teachers' knowledge toward ISI and implementation in the classroom. Case study approach allowed us to understand intricacies of teachers' understanding and factors supporting or acting as hurdle in ISI implementation.

We collected data from various sources, but interviews with teachers and classroom observations served as our main data source to elicit teachers' conceptions towards each component of PCK and overall orientations to implement ISI in the classroom. We developed an interview protocols around different dimensions of ISI and components of PCK. The interview protocol allowed us to understand teachers' conceptions about the each component PCK, as well as overall conceptualization towards interdisciplinary science inquiry teaching and learning. Other data sources included teachers' summer research proposals, observations of their summer research sessions and classroom instruction, and evaluations written by teachers after each professional development session.

5.1.4 Research on STEM Students

Research on STEM students over the year continued to focus on their development of science communication skills in schools and classrooms. We conducted the following activities:
a. Observation of the undergraduate academy seminar, *Continuing Undergraduate Academies Experience Seminar,* taught by PI (Gardella), in both the fall and spring semesters. Guest speakers were invited to speak to students about adolescent development, doing science demonstrations, lesson planning, and informal science activities. Graduate students were also invited to several of these presentations.
b. Artifacts from the course were collected including personal reflection journals, final papers, and presentations
c. All students were given a survey at the end of each semester regarding their preparation, experiences, perceived values of UB/BPS ISEP, Self-Efficacy in Communicating Science, and Background. Surveys were analyzed using descriptive statistics
d. Many students were interviewed regarding their experiences in the Buffalo Public Schools, science communication, and their facilitation of interdisciplinary science inquiry
e. Observations were conducted at several of the Buffalo Public Schools, PLC meetings, and summer research experiences.

5.2. Findings

5.2.1 Summary of Pedagogical Workshop Evaluation

October 2012 Workshop

Please explain how today's workshop influenced your understanding of Interdisciplinary Science Inquiry:

- It was very clarifying and helped shape my understanding, esp. the first activity.
- Finally began to see the big picture behind summer research. We engaged in ISI to help understand to use it in our class.
- Helped clarify what ISI is and gave me at how I can and do practice ISI in classroom.
- Gave a more focused new of how ISI can translate into classroom learning
- Helped me clarify the difference between ISI and multidisciplinary inquiry.
- Clarified my perception of ISI
- Showed me that we are using ISI in our classrooms already. Need to use REAL problems.

Please explain how today's workshop influenced your understanding of the four dimensions of Interdisciplinary Science Inquiry:

- I am now aware of them.
- Never really thought about them before so it was helpful
- Broadened my scope of knowledge- helpful to reflect!!!
- Enhanced understanding of four dimensions and how it can be used in my instruction and what they are composed of.
- Helped me realize the universality of cross cutting concepts among scientific disciplines.
- My awareness has been augmented.
- Expanded my knowledge of the current research.
- I am not sure if I know what the 4 dimensions are—Scientific and Engineering practices- good, Crosscutting good, 3 &4 ??

Prior to this workshop did you make connections to your summer research experiences within the framework of Interdisciplinary Science Inquiry?

- Some because of the summaries we wrote with our education research students.
- As much as was possible with only INTRINSIC construction
- Some- which were doing logs- nice to hear others
- Yes. But in a fragmented way
- I looked at the document that you sent us via email and I made those connections
- I am more away of interdisciplinary importance- seeing the word as a whole (Not just segmented into Physical, Living and chemical)

How do you plan to implement your summer research into your classroom practices?

- Through laboratory experiences
- Developed a classroom ready activity
- Working with students to develop lessons
- Conducting directly and open inquiry on evolutionary selective pressures.
- Has already begun with use of GIS system to stimulate writing types.
- Students will learn about specific labs at Rosewell Park, visit the labs, conduct a scientific interview, videotape it, and present it to the class.
- It was done at much higher level. Not sure how to use in class.
- Try to implement common core strategies into class—especially into the lab work. Not only verbally communicating concepts but being able to write about results.

Overall how have you benefitted from the summer research project?

- Learned new concepts/ sharpened my science skills
- Gave ideas for my classroom
- Operationally defined ISI by actually doing it.
- Gained content knowledge- learned through experiments and sharing with students.
- Provided new tools/ methods to use in practice
- I gained tremendous amount of knowledge about how I can teach using real world scenarios

- I have gained knowledge regarding some common research techniques (i.e. immunochemistry, microscopic visualization, southern blots). I have gained confidence in trying to use such techniques in the classroom.
- Purchased equipment for my class.
- 7/10
- Made me more aware of the way I am teaching.
- Yes, the networking, talking, sharing with people who love not only science, but our students.

November 2012 Workshop

Please explain how today's workshop has influenced your understanding of Professional Learning Communities:

- Just reinforced what I already know
- Actually I was largely unaware of PLCs before today. So, the session introduced me to new material
- Clarified what the overall purpose of them is
- Clarified the roles of the participants
- Gave a better picture of exactly which PLC are possible
- Touched base with others who were working on similar projects
- Clarify the role they play in our current circumstance
- This was an excellent way for us to become comfortable with PLC discussions
- Expanded networking
- Better understanding of the structure
- They are helpful and we can really use the knowledge immediately
- It clarified what they are and what they do

Please describe specifically what aspect of the Professional Learning Community you have been involved in and how it contributed to your professional development experience:

- Summer Research
- In retrospect, I was involved in a research group and it renewed my experience of the scientific method
- I have collaborated with several other teachers in the grant in regards to classroom activities and field trip
- WNYPTA, AAPT
- None yet
- I am a member of the environmental PLC
- Working with teachers from other schools developing ideas for classroom use
- Museum of Science, Biomedical research
- Collaboration with other teachers
- Left Blank – 3

Please list one positive gain in your experience with Professional Learning Communities:

- What others did; related research to mine
- Work with grad students
- Learning what is happening in other schools
- Diverse ideas on implementation

- I have been able to have valuable conversations with Spark teachers which have helped us to develop a more appropriate vertical alignment of grades 6-8 science/math skills
- Using graduate students
- N/A or left blank - 5

Please list one area in need of improvement in your experience with Professional Learning Communities:

- Need more focused project for my secondary ed
- Getting everyone together
- Diverse PLC opportunities
- Better communication on roles of individuals involved
- Use of graduate students
- Maintain open channels of communication
- N/A or left blank - 5

Please describe how Professional Learning Communities have supported your understanding and practice of Interdisciplinary Science Practices in your classroom?

- Has brought my practice much closer to true interdisciplinary inquiry
- Sharing of information and ideas
- Using others to make better experiences for students
- Different backgrounds working together on a single content can bring a diverse variety of approaches that aren't possible for a single person
- New ideas to think about and use in my class
- PLC have strengthened my knowledge of successful implementation in the classroom
- They contribute to the collaboration between the different disciplines
- N/A or left blank - 5

Please share any suggestions you may have for improvement of the ISEP teacher workshops:

- Good as is
- Improve attendance
- So far…so good
- Diet Drinks
- Good Job
- N/A or left blank – 6

<u>December 2012 Workshop</u>

Please explain how today's workshop has influenced your understanding of assessing interdisciplinary science teaching:

- Ipads were a nice "all inclusive" device
- Today's workshop was an excellent way to showcase science inquiry
- Excellent inquiry lesson ideas. I hope I remember.
- Reinforce use of SPARKS in inquiry based learning
- My opinion is that the video was the entertainment

- Having the opportunity to be part of n inquiry lesson (with spark) was excellent. This allowed me to see how various apps can be used together to create such a cooperative learning environment.

Please describe how do you plan to implement interdisciplinary science inquiry in your classroom based on today's workshop:

- Open ended activities
- Will use the technology piece. Look more closely at them
- I will start by posing more research based questions and allow my students to find out more about a specific topic using some of the methods used in this workshop
- Hands on activities to try out
- Already using a variety of PKG lessons and ones I made on SPARKS
- Will use in physics class
- Will use apps for the specific labs
- I would like to explore the apps some more to see which can be used for specific concepts in biology. Having a good foundation with the technology would allow me to come up with good lessons as opportunities arise.

Did today's workshop add any new strategies in your repertoire? If so, how?

- I have been well trained in these methods
- Some- good applications, technology
- Yes, using groups with purpose
- Group swapping
- Prizes are great motivation
- New probeware for Earth science
- Yes, ideas taping the experiment
- Will use apps for student engagement.
- Many apps + how they work together to put the tools for data collection

Please share any suggestions you may have for improvement of the future ISEP teacher workshops:

- ISIOP or RTOP training
- We were a bit rushed, would have liked to have spent more time on inquiry question.
- Pace too fast
- Add more participants.
- More time for inquiry
- More time to "figure things out" in the lesson- enough time to make an excellent product (about 60 minutes)

<u>January 2013 Workshop</u>

Please explain how today's workshop has influenced your understanding of Project-Based Science (PBS):

- Gained ides for implementation PBS- interesting ideas shared 5E

- I have developed my existing knowledge of PBS. I have a new understanding of the priority of a good driving question (relevant, deep, open ended)
- I have several new ideas to how I can integrate this into daily lessons
- It expanded my knowledge of PBS and learned new strategies and ideas
- More current technologies can be brought into the classrooms
- How to integrate PBS techniques into everyday lesson
- It give it "LIFE", the students and teachers will benefit from the experience and get more out of learning experience.
- Engage and explore.
- Just enhanced it. I enjoyed the activities and seeing what the science museum has to offer
- Showed hands on examples
- Provided concrete example and operational definitions
- I now know what it is- veru similar to other instructional strategies
- PBS should contain specific components that are completed in sequence.

Please describe specifically what aspect of PBS you can apply directly within your classroom:

- Will work to have students develop their <u>own</u> questions to explore as opposed to giving project/ experiment to students?
- Student driven questions
- Production of artifacts.
- The "5E model" is really perfect for introducing abstract concepts
- I liked investigative-prediction method
- If we can get the models/technology, the investigation stations. Also, the web quests and model modeling
- 5E, investigation stations, relevance to real life
- 5 E, group work, learning start time
- games
- Will work with ESL staff.
- All of it- inquiry, questioning that asks for students to explore and explain in finding answers
- PEOE
- Group work in laboratory setting and class investigations
- Driving questions, artifact production, collaboration

Please explain how you can utilize the Buffalo Museum of Science as community resource for your students' learning:

- Several exhibits will work for our curriculum. Look forward for bringing students in and/or will ask staff out at the school
- We can continue to bring students to exhibit
- I now know some of the "educational collection" resources available for use in schools (with facilitator)
- I teach older students chemistry, but some demonstrations may be applicable to science/ math topics.
- I would like to have students create a flow chart of what happens at each of the stations and observe how software used(?)
- Bring in the BMS' resource person to participate in students workshops
- Field trip for anatomy and physiology class to reinforce inquiry regarding human body
- Bring in Dough as a resource and lab techniques that may not be available in class (Ex: PCR).
- Classroom units- doing activities

- Museum visits for a large science group XXX
- Field trip actually this year ☺
- Possibility of brining them into the classroom
- I am interested in a field trip for body worlds
- Field trips

Please describe how would you utilize the PBS framework in your classroom to address cross cutting concepts and engineering practices:

- Use engagement and explanation to tie together body systems and health.
- Students will be challenged to create engineering solutions to relevant problems (hopefully students generated)
- Relating "real" life experiences to specific topics, and the solving problems i.e. amount of ions in local water, ion analysis etc.
- Using some actual problems found within the community- apply the concepts to solve the problem
- Work with other departments to design lessons on how current technology and issues impact our culture.
- Patterns, structure and function, stability and heat = homeostasis within body
- Continue to do interdisciplinary lesson and activities that address NGSS and CCLS
- I already have inquiry based units that do this because I use setup
- Choose "large-scoped" activities for students that require multiple parts to place together.

Please share any suggestions you may have for improvement of the ISEP teacher workshops:

- This was great workshop
- Include examples of each science discipline
- Great job
- None- yet! ☺
- Great first time experience
- Great thus far. Loved having the experience the students will have.
- Very well organized- always walk away with a new thought to provide
- Keep them at the museum.
- Not so long- 3 hrs is long when many of us have been up since 5 am. More interactive sessions, lecture form, smart board not very engaging.

<u>February, March and April 2013 Workshops</u>

No evaluation was conducted for these workshops

<u>May 2013 Workshop</u>

Please explain how today's workshop has influenced your understanding of ISI framework:

- "Hands on" participation broadened understanding of project that we xxxx to student understanding of, and inquiry with scientists.
- Learned in depth info on the grading rubric
- Helped coordinate inquiry to activity
- This workshop really made the ISEP concept cohesive forms
- The activity really helped focus the ISI components and made me understand them more.

- Many activities we already use have dimensions of ISI but can be imposed by developing an ISI rubric for the activity.
- Learned how to score and set up rubric
- Helped to deepen my understanding of the evaluation and degree to which an activity is addressing ISI
- Gained a better understanding of how it applies to state assessment and national assessment
- This workshop clarified the 4 dimensions of the ISI application

Describe how this knowledge of ISI will help you in creating assessment that reflects the various aspects of ISI:

- This will help develop several different activities based on methodology
- This lab was wonderful. It could be used for any skill level student
- Improve my labs and develop scoring rubrics
- I can now see when things I have done really do fit into ISEP model.
- The rubric will help me develop my lessons
- The breakdown of dimensional components in the handout will help to incorporate the dimensions during unit development.
- Rubric has all the ISI elements included and used in the activity.
- It will enable me to be the look aspects of ISI to what standards are actually asked to do (rather than what we believe the activity is addressing)
- Will be able to discuss labs and activities if they are hitting 4 sections.
- I will be working with my team of Southside to develop “setup-like” activities for grade 5-6. I will also try to write “dimensions-based” rubrics for the activities/ units teach.

Did today’s workshop help you with an increased ability to assess ISI characteristics?

- Yes
- Because developing an ISI rubric helps to look at activities more completely for ISI dimensions
- Yes, did explain by first paper

Please list the most helpful aspect of today’s workshop:

- Step by step procedure and quality of project
- Seeing the rubric and working with the lab
- Actual doing activity
- Experiencing an ISEP activity.
- Activity with rubric and ISI components
- ISI dimensional breakdown
- ISI paper explanation, application to real situation.
- Small participant population allowed for less “treating water” type down as you wait for people to finish
- Hands on activity and walking through 4 sections and how to interpret the questions
- Working through the actual process of scoring an assessment.

5.2.2 Findings on ISI Conceptual Framework

This study sought to capture the conceptions and experiences of the scientists about discipline specific inquiry versus interdisciplinary inquiry. When asked to compare discipline specific inquiry with interdisciplinary inquiry, three main themes emerged: (1) Nature of problem, (2) Need to answer questions and generating hypothesis and (3) Nature of disciplines. Almost all the scientists when asked about the explanation of the term scientific inquiry or discipline specific inquiry mentioned that scientific inquiry starts with a question or problem. For examples, Dr. Sardar a scientist from Biomedical Engineering mentioned, "*scientific inquiry is to frame a question*". Similarly, Dr. Brown, a Chemist mentioned inquiry as " *to answer question that are related to humanity and that will address points that can benefit humanity*". For majority of scientist the nature of scientific inquiry was complex and they related it with addressing something that is unknown to us and will help mankind.

One of the questions in our interviews focused on understanding scientists' views about disciplinary inquiry. Scientists took different routs while explaining relationship between disciplinary inquiries in comparison with interdisciplinary inquiry. According to Dr. Saagger, discipline specific inquiry needed in-depth knowledge of a subject, but in order to conduct an investigation, every team member needed to have expertise in his discipline along with knowledge of other disciplines in order to converse and progress in the investigation.

All the scientists from all disciplines agreed upon nature of today's science being interdisciplinary and also mentioned how it is driven by the nature of problems, questions and constant development of technology. All the scientists believed that in today's science it is almost impossible to solve any societal issue without integrating more than one discipline. Scientists provided examples from their disciplines to explain, how do they address issues related to environment or develop solutions on some disease or try to develop understanding of a virus or bacteria using variety of techniques, approaches and by collaborating with scientists from different disciplines. The four dimensions of ISI that we define through this research are: (a) Drivers of Interdisciplinary Science Inquiry, (b) Science and Engineering practices, (c) Crosscutting concepts and (d) Disciplinary core ideas. Figure 5.1 shows the conceptions of ISI.

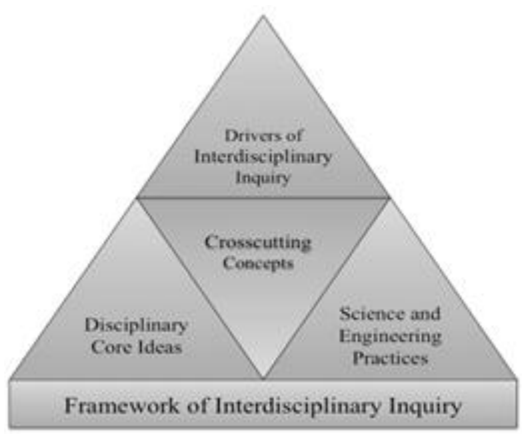

Figure 5.1 Conception of Interdisciplinary Science Inquiry

5.2.3: Findings on Teachers' Development of ISI Pedagogical Content Knowledge:

5.2.3a: Findings on Teachers' Development of ISI Pedagogical Knowledge

The focus of this study was to understand the development of science teachers Interdisciplinary Science Inquiry Pedagogical knowledge and practices. Based on analysis of multiple data sources collected over the year, we concluded three major findings:

1. Teachers' perceptions and conceptions of interdisciplinary science inquiry changed over the year. In their initial proposals teachers demonstrated a fragmented and varied understanding of ISI. For example, some teachers believed that ISI was hands on work and crossed various disciplines. Others believed inquiry was learning by doing and that ISI was a method of teaching that involved cross curricular connections. These initial conceptions of ISI evolved as the teachers engrossed themselves in various research experiences at the university and research settings and pedagogical workshops during the year.

2. The summer university research experience and during-academic-year professional development aided to varying degrees of teachers' interpretations of ISI. Teachers experienced various ISI research experiences during the summer. Each teacher was located within a research setting of their choice. Some teachers explored conceptualization of Earthquake development and wanted to bring the direct experience into his classroom. Other teachers worked on sustainability models and incorporated it into the classroom practices while others explored the local cancer institute and desired to utilize this experience into their classroom practices. There were visible connections to teachers' initial conceptions of ISI as stated in their proposals and the way in which those conceptions were carried into their research experiences. The teachers who came in with a more comprehensive understanding of science inquiry continued to develop along the path of increasing their knowledge further through the summer research experience and were also the ones most interested in continuing to develop their knowledge through professional development workshops. These workshops allowed teachers to channel and hone this knowledge into practical learning experiences for their students.

3. The varied interpretations of ISI impacted the way in which teacher's implemented ISI instructional strategies within their classrooms. For example, some teachers demonstrated their understanding of ISI by conducting a review of science questions as their lesson. It was a teacher centered lesson with no notable characteristics of ISI instructional strategies. Other teachers demonstrated their understanding of ISI through a lesson on the concept of photosynthesis and respiration. The lesson was teacher centered and the role of students was to review science concepts, watch a video on material cycles, followed by a brief discussion on how the lesson connected to his sustainability model. There was little evidence of ISI instructional strategies and practices. Although the teacher understood science content and ISI they were limited in their practices by the beliefs they held about his students' abilities and the requisites required in teaching ISI. Another teacher also had a fragmented understanding of ISI however due to his summer research and experiences and sustained professional development involvement, he was able to translate his knowledge into instructional practices within his classroom. His lesson

exemplified the greatest characteristics of ISI and his emphasis on inquiry practices, high level of science content and a connection to students' lives made his lesson exemplary.

Findings on Teachers' Development of Curriculum Knowledge of ISI

A qualitative study that utilized a descriptive case study approach sought to develop an understanding how in-service teachers' curricular goals, in regards to interdisciplinary inquiry, are impacted as they take part in authentic research experiences. Results showed the following:

Theme #1: To Promote "Buy-In" and Implementation of ISI, Teachers' Research Experiences Must be Aligned with Their Perceived Curricular Goals.

The main conclusion that can be made about how teachers view their summer research experience influencing their classroom practice is that when the research experience matches the proposed goals and interests of the participating teachers, there is more buy-in to developing and using their experiences within the classroom. The beliefs held by the participating teachers regarding their summer experience were directly connected to how they set out to plan and implement aspects of those experiences in their classrooms. When their personal beliefs and knowledge regarding their curriculum matched the research experience, they viewed it as being more beneficial and were therefore more likely to implement it. However, when they interpreted the experience as not matching their school curriculum, their view of that experience was along the lines of it being an interesting opportunity, but was something that they could not do in their classrooms or that their students would be successful with.

Theme #2: Teachers' Understandings of ISI Impacted the Perceived Relevance of Their Summer Research Experience

The participating teachers' views regarding the relevance of their summer experiences were affected by their understanding of what ISI was. Knowledge and beliefs about science curriculum is one of the five components of PCK. Interdisciplinary science inquiry represents a theoretical framework with which to design science learning around and as such represents an aspect of science curriculum that teachers within this project were asked to develop and implement into their classroom practices. The teachers within the study illustrated a wide spectrum regarding their knowledge of ISI. However, what could be drawn from this was that those with a more developed understanding of ISI were those that had a greater sense of how their summer research could be incorporated into their curriculum and classroom practices.

Theme #3: Levels of Use is Directly Connected to How Teachers View their Summer Experience Matching their Curricular Goals

As there is currently no direct measure of interdisciplinary science inquiry curriculum knowledge and practice of that knowledge, the Level of Use scale was used to identify how teachers were implementing their summer research and ISI framework in practice. The teachers in this study demonstrated a varied spectrum of use of both their research experience and the ISI framework. Even though the participating teachers professed to have gained more knowledge of science and skills related to science research, it did not necessarily result in changes in their curriculum or enactment of that curriculum. In many ways, the enactment of their curriculum goals was directly connected to how they viewed their summer research experience fitting with their curriculum.

Theme #4: Cultural and Ecological Factors Get in the Way of Doing ISI in the Classroom

In this study contextual factors were classified as either cultural or ecological. Both types were identified by teachers within the study as impacting their abilities to implement their summer research experiences and interdisciplinary science inquiry into their classroom practices.

The cultural factors identified by teachers included their perceptions about the ability of their students to be involved in interdisciplinary science inquiry and their own abilities to lead activities of that nature. All of the teachers highlighted in this study identified students' academic weaknesses as being a major limiting factor to even conducting basic inquiry investigations in the classroom. The students' weaknesses reached beyond science and encompassed their reading and writing abilities as well as their ability to do basic mathematics.

The main ecological factors that the teachers identified were time and resources. The amount of time that it takes the teachers to plan and set up inquiry experiences, to the time it takes away from teaching other curricular requirements during the school year, to the time is takes for students to successfully complete those inquiry experiences were major stumbling blocks for the teachers. The lack of equipment or improperly functioning equipment at the beginning of the school year had many of the teachers putting off their plans to implement their summer research goals. Another factor identified with regards to the equipment was the inability to use the type of equipment that the teachers had used during their summer research experience in their classrooms or with their students. This inability was identified to be due to the cost and type of equipment that they used over the summer and the need for the equipment to user-friendly for their respective student population.

Findings on Science Teachers' Orientation towards Interdisciplinary Science Inquiry

The purpose of this study was to examine science teachers' conceptions and orientations towards interdisciplinary science inquiry. This study attempts to understand how in-service teachers' develop an understanding of interdisciplinary science inquiry after participating in an authentic inquiry experience of summer research and other professional development opportunities throughout the year with university faculty members and graduate students. We focus on a central component of PCK known as orientations. We define orientations as teachers' conceptions and behavior about science teaching and learning.

We found all the participants developed some insight about various aspects of ISI and could relate their summer laboratory experiences or summer coursework with various dimensions of new framework. Some teachers struggled with understanding and implementing different dimensions of ISI especially crosscutting concepts because they did not see crosscutting concepts as overlap between different disciplines. Some teachers also struggled with discussing and implementing science and engineering skills explicitly with their students, but some teachers implemented them effectively. Majority teachers struggled with the fourth dimension of ISI, i.e. drivers. Teachers did not place their projects, discussions and science topics in the context of students' familiarity and did not make it relevant to students' lives, but after discussing Project Based Science (PBS) framework with them during one of the PD sessions, some teachers could implement ISI effectively by adapting PBS framework and by integrating science, math and ELA in their curriculum. It was also evident that teachers were benefitted by summer research experiences and coursework and managed to adapt their learning experiences to a great extent to their classroom needs. Teachers felt supported with the summer experience by collaborating with their colleagues, STEM faculty members and students. These teachers also felt supported because of resources they gathered by participating in this project. Overall, teachers' conceptions towards each component of PCK were in alignment with ISI dimensions to a great extent.

All the teachers displayed some characteristics of ISI orientation in their understanding and classroom instruction with the help of summer research experience, regular PD sessions and support of STEM students in the classroom. We identified five main orientations for science teaching as: (a) Interdisciplinary science inquiry, (2) Inquiry, (3) Conceptual change, (4) Activity and (5) Traditional. Figure 5.2 presents the five orientations. Teachers held multiple orientations toward science teaching, but one orientation(s) was on the foreground than the others. For example, Mrs. Kale, displayed combination of ISI and conceptual change orientation, but conceptual change orientation was on the foreground.

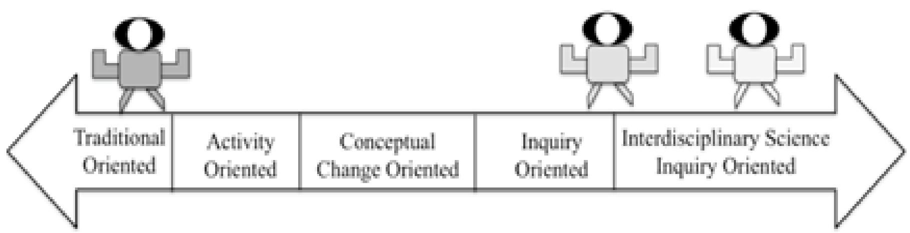

Figure 2 Science Teachers' Orientations toward Science Teaching

Findings on Roles of STEM Students in Teachers' Development of ISI PCK

There were a combination of both graduate PhD students and undergraduate students involved in the partnership. The graduate students were nominated by department chairs and program leaders, and then were chosen based on their research expertise, K-12 experience, financial need, and how well their skill set or expertise matched the needs of the school. As for the undergraduate students, a seminar course was promoted by their advisors and the students signed up for course credit. If they would like to continue after the semester was over, they could do so for internship credit and then for a stipend.

There was not a prescribed formula as to what exactly the university students would be doing in the schools, as the needs were different in all of the settings. Therefore, we set out to find what roles these students were fulfilling in the schools. Surveys were given to all students to find out exactly what types of activities they were engaged in. Table 5.2 presents the descriptive statistics of activities engaged by students.

Table 5.2
Descriptive Statistics of STEM Student Experiences in Schools (n=70)

Activity	Frequency (%)
Assisted teachers in teaching lessons	45 (64.3%)
Assisted teachers in conducting labs	53 (76%)
Developed science labs for class use	21 (30%)
Developed out-of-school science learning activities	10 (14.3%)
Led small group activities/discussions with students in class	51 (72.9%)
Led small group activities/discussions with students after school or during weekend	17 (24.3%)
Demonstrated scientific content, procedures, tools, or techniques to students	49 (70%)
Helped teachers find relevant resources (e.g., science activities)	24 (34.3%)
Presented lessons/lectures to students in class	20 (28.6%)
Tutored students after school or during weekends	7 (10%)
Other	4 (5.7%)

Facilitating Interdisciplinary Science Inquiry Teaching and Learning
In looking at what the university students were doing in the schools, during the summer research, and at PLC meetings, one can see that there was a wide range of levels of participation. Therefore, it is no surprise that there was also variation in the amount of collaboration and facilitation of interdisciplinary science inquiry teaching and learning going on in the schools. In looking at these relationships between university students, teachers, and their classrooms, these relationships can be categorized into three main facilitation levels: Collaborative, Supportive, and Non-Essential.

STEM students as collaborators. When looking at the relationships that were truly transformative, it was in the classrooms that involved the graduate students rather than the undergraduate students.

Teachers in these relationships were observed and spoke about actually changing their curriculum and teaching practices because of the access they had to the content expertise of the graduate students. These are the teachers that spoke about how they would not be able to do certain things, were it not for the facilitation of these STEM students.

STEM students as support. For most of the teachers, their teaching practices or curriculum did not change to incorporate the expertise of the university students. Rather, the students acted more in the role of a "teacher aide;" walking around the room, passing out materials, answering questions, etc. These teachers referred to the students as an "extra set of hands" or "a help" in the classroom. While the STEM students were seen as a great help because they could walk around the room and work with students in smaller groups, the teachers' lessons were not transformed in such a way as above.

STEM students as non-essentials. When asked about the contribution of the STEM students in their classrooms, none of the teachers expressed that they were "no help" or a "hindrance". Most of the teachers felt that they did help in some way, at least by helping to keep students on task. However several of the STEM students, particularly the undergraduate students during the first year of the partnership expressed feeling as if they weren't doing much in the schools. When these students were asked if there was anything that went poorly, the most common answers cited were centered upon the fact that not all teachers fully utilized them in their rooms. They described sitting in the back of the room during lectures, watching films, or doing "busy work" like cleaning test tubes. This issue seemed to improve somewhat this year two however, as many of the teachers who did not utilize students previously, did not get assigned students again.

5.2.4 Findings on STEM Student Development of Science Communication Skills

In visiting the schools and interviewing students, we found that the most common activity that the university students, both graduate and undergraduates, were doing was working with students one-on-one. This included walking around and aiding kids with their assignments, labs, and projects, as well as tutoring one-on-one. University students also tutored and aided students working in small groups.

While aiding students one-on-one or in small groups was the primary activity observed by both the graduate and undergraduate students in the schools, after that, the difference between the graduate and undergraduate roles in the schools became more distinct. The undergraduates helped more with classroom management primarily by trying to keep kids on task, answering questions, and passing out materials. Some also described giving input into lectures, by either commenting on what the teacher was talking about, creating their own mini-lectures, or finding videos that reinforce concepts that the teacher is discussing. Some students also helped with after-school science activities where they primarily worked with students in small groups, or did demonstrations in an after-school science night for students and parents. Some students helped to chaperone field trips or school activities, and some students helped the teacher to find resources such as science articles or websites.

Like the undergraduate students, the graduate students often worked with students one-on-one or in small groups, however besides that, in their interviews they described creating labs and presentations for the students. They were also more involved with administrative-type tasks. The graduate students in the schools served as the liaison between the school and the university. For example, if the schools wanted to order supplies or coordinate field trips through the partnership, these requests went through the graduate students. Also, the graduate students often "managed" the undergraduate students and coordinated which classrooms the undergraduate students went into. One school was very focused on developing curriculum, so the graduate student helped with that. Several graduate students were found participating in after school science clubs and activities where they worked with students in small groups or did science demonstrations for students and parents.

When asked about what went well during their time at the school, the most common answer of both the graduate and undergraduate students was their interactions with the students, either when they helped them with their schoolwork or when they got to know them on a personal level.

While most undergraduate and graduate students felt that their interactions with the students are what went well, after that, their responses were quite diverse. One undergraduate student mentioned that what he thought went well was that he gained skills for working with kids. A graduate student mentioned that a lab she created went well. An undergraduate student mentioned that he was utilized well in the classrooms that he was in. An undergraduate student reflected fondly on a time that he took over the class because there was a sub that did not know what the students were supposed to be doing. Another undergraduate student mentioned that the fact that the partnership had expanded to include more schools went well, and a graduate student mentioned the fact that teachers are starting to embrace a particular science curriculum is something that went well.

Necessary Support

When asked about the support necessary for them to work with adolescents in science, the overwhelmingly most common answer given by both the graduate and undergraduate students was support from the classroom teacher. While teacher support was the most cited answer, the students also mentioned that you need good communication lines, support from your peers or other graduate students involved in the project, funding, supplies, space, and support from administration.
When asked about what could be improved in the program, most of the undergraduate students interviewed mentioned either having more contact in the schools or teachers who better understood the program. These things were not cited by the graduate students however. The graduate student answers varied greatly. Their responses were that the expectations of them should be spelled out more prior to the beginning, teachers who are more open-minded, more consistency in undergraduate students coming into the schools, and better coordination of scheduling.

When asked if there was anything that went poorly, the most common answers cited were centered upon the fact that not all teachers fully utilized the university students in their rooms. They described sitting in the back of the room during lectures, watching films, or doing "busy work". This issue seemed to improve as time went on, somewhat, as many of the teachers who did not utilize students, did not get assigned students again. The other most common answer had to do with time. Some students mentioned their time commitment to the schools interfering with their other academic commitments. Graduate students mentioned difficulties in managing the undergraduates who were assigned to be there a couple of times a week, and dealing with the school schedules that often went on an A-F schedule, whereas colleges often use a Monday through Friday schedule. In regards to time, the undergrads mentioned scheduling, but mostly the short amount of time that they were in the classrooms. Due to the fact that they were taking other classes during the day, they typically went into the schools once or twice per week. Sometimes the undergraduate students were even assigned to two schools, so they were only in each school once per week. Then, since they were taking this as a semester class, they only went into the schools for one semester, although some continued in the program. When factoring in university breaks, school days off, and time at the beginning of the semester to get schedules together, most undergraduate students went into the schools about ten times. Many cited that the shortage of time did not allow them to make as many personal connections with the students as they would have liked. Along those same lines, one undergraduate student mentioned that something that went poorly is that there was a lack of communication and that the program was a low priority in the school.

While the lack of time and lack of being utilized properly were the primary things that the undergraduate students felt went poorly, these students also cited a variety of other things that they think went poorly. For example, one student mentioned that when he was not familiar with the material that was being taught he thought it went poorly. Another mentioned that it was just a difficult setting in general and another said it was difficult to get the students interested in the material.

<u>Benefits for Science Communication</u>

Table 5.3 presents descriptive statistics of student perceived benefits from their experiences in K-12 schools.

Science communication can be broken down into three important principles: define your audience, develop your message, and explain science. When asked about what this experience taught them about communicating science to students, the participants explained a wide variety of things that they learned, of which we are going to discuss in the context of these three principles.

<u>Define Your Audience</u>

An important part of science communication is defining your audience. One must take into account the interest, background knowledge and attention span. Of all three principles, most of the STEM student responses expressed that they realized that you have to know your audience, with the most common answer being that you have to communicate at their level. Besides academic level, students also mentioned that you have to take their backgrounds into account, that you must connect with the students, and that you must hone in on their questions, inquiries, and interest.

Table 5.3
Descriptive Statistics of Student Perceived Benefits from Their Experiences in Schools (n=70)

Statement	Strongly Disagree (%)	Disagree (%)	Agree (%)	Strongly Agree (%)
Work on a Team	1 (1.5%)	9 (13.2%)	46 (67.6%)	12 (17.6%)
Lead a team	1 (1.4%)	11 (15.7%)	43 (63.2%)	13 (19.1%)
Facilitate group discussions	0 (0%)	2 (2.9%)	47 (69.1%)	19 (27.9%)
Teach STEM concepts and methods	1 (2.9%)	11 (16.4%)	36 (53.7%)	18 (26.9%)
Develop instructional materials about STEM concepts and methods	5 (7.5%)	21 (31.3%)	35 (52.2%)	6(9.0%)
Generate others' interest in STEM research and activities	1 (1.5%)	8 (12.1%)	42 (63.6%)	15 (22.7%)
Conduct research as part of a collaborative team	5 (7.5%)	30 (44.8%)	27 (40.3%)	5 (7.5%)
Conduct independent research	6 (9.0%)	30 (44.8%)	28 (41.8%)	4 (4.5%)
Develop a research and/or technology agenda	4 (5.9%)	35 (51.5%)	29 (42.6%)	0 (0%)
Write papers and reports about my work	4 (5.9%)	24 (35.3%)	32 (47.1%)	8 (11.8%)
Present my work at a professional conference	4 (6.1%)	42 (63.6%)	19 (28.8%)	1 (1.5%)
Explain STEM research and concepts to public (non-technical) audience	2 (3.0%)	23 (34.3%)	34 (50.7%)	8 (11.9%)
Decide a career in education	4 (5.9%)	29 (42.6%)	25 (36.8%)	10 (14.7%)
Understand science concepts better	4 (5.9%)	15 (22.1%)	37 (54.4%)	12 (17.6%)

Develop Your Message

In Science Communication scientists must identify their key ideas and/or messages. After identifying the key message(s), the scientist must make many decisions: how much information to share about each of the ideas; how he/she is going to convey the message, and how much time to spend on each of the ideas or messages. In regards to developing a message, few students discussed learning anything in this regard, which makes sense, as when examining what they were doing in the schools, only a minority of the students actually made decisions about curriculum or lesson planning. However, when answering questions, these students still have to develop an answer.

Explain Science

In explaining science, there are many things to consider: the interaction with the audience, presentation modes to use, pause time and time for reflection with the audience, and ways for collecting feedback. In this regard, students mentioned learning that you have to relate the material to something that they know already, you have to vary your instruction, and that one must hone into the questions, inquiries, and interest of the students.

Some students, when asked what they learned about science communication, also spoke in general terms, for example, "*it's difficult", "it's important"* or "*it takes a lot of effort."*

Benefits of K-12 experiences on science communication are also demonstrated on their responses to the survey questions on their future careers. Table 5.4 presents the descriptive statistics of student perceived benefits on their career choices.

Table 5.4
Descriptive Statistics of Student Perceived Impact on Their Future Careers (n=70)

Statement	Strongly decreased	Decreased	Was Unchanged	Increased	Strongly Increased
My interest in conducting research	0 (0%)	3 (4.4%)	42 (61.8%)	17 (25%)	6 (8.8%)
My interest in teaching at the college/university level	0 (0%)	3 (4.4%)	33 (48.5%)	21 (30.9%)	11 (16.2%)
My interest in teaching at the K–12 level	3 (4.4%)	11 (16.2%)	22 (32.4%)	23 (33.8%)	9 (13.2%)
My interest in influencing public policy related to STEM education	1 (1.5%)	0 (0%)	21 (30.9%)	27 (39.7%)	19 (27.9%)

Planned Research Activities: June 1, 2013 – May 31, 2014

During next year, the research team will consist of three doctoral research assistants (RAs) and co-PI (Liu). Two of the RAs will focus on research on teachers and the third RA will focus on research on STEM students.

1. Research on teachers

Following the *Strategic Plan* and the principle of *Evidence-based Design and Outcomes*, research on teachers will continue collecting data to understand the processes and conditions in which science teachers develop interdisciplinary science inquiry knowledge, and how this knowledge may be translated into interdisciplinary pedagogical content knowledge (PCK) that ultimately improves student science learning. Specifically, we will conduct the following research activities:

1.1 Development of a Measurement Instrument on Teachers' ISI Knowledge and Pedagogical Content Knowledge (PCK)

Using the ISI conceptual framework we developed this past year, research is already underway to develop a standardized measurement instrument to measure teachers' ISI knowledge and PCK. A multi-stage process will be followed. The first stage will involve developing ISI case scenarios based on teacher summer research experiences. The research scenarios will be used to frame assessment questions to probe teachers' knowledge about the four dimensions of ISI and how they may implement ISI in their classrooms. Pilot-testing of the instrument will take place with the 2013 cohort of teachers. Constructed response questions will be used at this stage. STEM faculty and students will also be asked to respond to the ISI knowledge questions. The second stage will be developing selected response questions using teachers' and STEM faculty and students' responses to the open-ended questions. A new version of the measurement instrument will then be pilot-tested with participating teachers in Dec. 2013. Both conventional statistical and Rasch analyses will be conducted to examine the item and measurement scale properties. Revisions will be made to the questions. The third stage will be validation of the instrument by field-testing the revised measurement instrument with the 2014 cohort of teachers.

1.2 Science Teachers' development of ISI Knowledge and PCK

Once again, we will conduct ethnographic research studies. Particular focus will be on how continuing teachers grow in their ISI knowledge and PCK from year 1 to year 2. Data collection will include:

a. Participant observation of teachers conducting research at university research laboratories and industrial partner sites during the summer 2013;

b. Observation of teachers implementing interdisciplinary science inquiry in their classrooms during the academic year of 2013-2014;

c. Supporting teachers in implementation interdisciplinary science inquiry through a monthly seminar during both the fall and spring semesters;

d. Periodic interviews of teachers on their changing conceptions of interdisciplinary science inquiry teaching.

Each doctoral research assistant will write (i.e., lead author) at least one article suitable for research conference presentation and/or scholarly journal publication. A collection of cases in interdisciplinary science teaching and engineering design will also be assembled.

2. Research on STEM graduate and undergraduate students

Following the *Strategic Plan* and the principle of *Evidence-based Design and Outcomes*, research on STEM students will focus on the processes of STEM students developing understanding of interdisciplinary science inquiry and abilities to communicate science to middle and high school science teachers and students. Research questions will continue to be:

a. How do STEM graduate and undergraduate students develop an informed understanding of interdisciplinary science inquiry?

b. How do STEM graduate and undergraduate students develop their skills to communicate interdisciplinary science inquiry to middle and high school students and teachers?

c. What are factors facilitating or inhibiting the above development?

The following activities will be conducted during the 2013-2014 academic year:

a. Participant observation of STEM graduate students conducting research with teachers during the summer 2013;

b. Interview of STEM graduate students on their conceptions of interdisciplinary science inquiry and engineering designs during the summer 2013;

c. Observation of the undergraduate academy seminar during the fall and spring semesters on preparation of STEM students to work in schools;

d. Organizing graduate student orientation sessions to prepare them to work in schools;

e. Interview of STEM graduate and undergraduate students on their experiences and perceptions of communicating science to students and teachers;

f. Developing a draft instrument related beliefs and valuing in professional learning communities (PLC).

The doctoral student research assistant will write (i.e., lead author) at least one article suitable for research conference presentation and/or scholarly journal publication. A collection of useful resources on communicating science in schools will also be assembled.

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Submitted papers from ISEP Research

Grant, B., Liu, X., & Gardella, J. (in review). 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.

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.)

Please see the Exhibit below (implementation and goal matrices) which summarize and synthesize our efforts over Year 2 (described above) with ratings of perceived progress and corresponding explanations.

Exhibit 1: Implementation Matrix

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

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

Improve understanding of science and science inquiry teaching.	Activity 1c: Teacher Professional Development: engage teachers in interdisciplinary science research and engineering design with University STEM faculty	• Partnership Driven • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-based design & Outcomes • Institutional Change & Sustainability			✓			
	Activity 1d: External project evaluators administered and analyzed the ISEP Teacher Pre-Questionnaire to collect demographic and perception data and assess teachers' knowledge and skills in conducting inquiry and engineering design	• Teacher Quality, Quantity & Diversity • Evidence-based design & Outcomes	✓					

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

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

	Activity 2d: PLC's: Participating teachers will form and sustain professional learning communities with other teachers in their school and district. Utilizing mentoring models with help from university STEM faculty and graduate students; participants will utilize social media, blogs and hold regularly scheduled face to face meetings.	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes • Institutional Change & Sustainability	✓					Teacher based PLC commenced July 2012 The PLC consisted of the Environmental Cluster (a group of middle and high school teachers form the 12ISEP schools). Initial meetings focused on summer research experience and how to improve on it for the following summer. Additional meetings focused on content specific to the Environmental Clusters focus.
	Activity 2e: External project evaluators collected baseline and Year 1 teacher, student, and school demographic data	• Evidence-Based Design & Outcomes	✓					

Goal 3: **Develop and sustain professional learning communities in urban schools, based on mentoring models, using university STEM faculty and graduate students.**								
Objective 3: The ISEP PLCs are partnership driven and designed to foster collaboration. The ISEP combines novel mentoring approaches and expanded PLC to build leadership and resources for improving science education in high needs/high potential urban schools. The objective of PLC will be to cultivate mentoring partnerships with middle and high school teachers and students; UB and BSC STEM and Education faculty; UB and BSC undergraduate and graduate students; volunteer STEM professionals; and parents.	Activity 3a: Face to face meetings, virtual communication platforms: blogs, electronic professional communications network. ISEP Partners will provide access to their respective interdisciplinary research programs across several communication platforms. ISEP Parent Partnership, The District Parent Coordinating Council (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.	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes • Institutional Change & Sustainability	✓					Currently all PLC's are being conducted face-to-face. Utilizing edWeb.net will commence during 2013-14 school year as a supplemental means of PLC members communication. However the main source of interactions will take place in face to face sessions. Initial PLC Clusters were created and implemented PLC Clusters created opportunities for teachers within school buildings to work together in groups and as a team for upcoming summer 2013 research Graduate students created collaborative opportunities between middle and high school teachers and students Parent PLC created opportunities for parents to collaborate with STEM faculty and BPS teachers. Tis June 2013, a parent will be participating on an ISEP panel as part of the 2013 annual WNY Networking in Higher Education Conference: Building Bridges for a Better Tomorrow"

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

Goal 5: Improve student achievement in science, attitude toward science-technology-society, and interest in pursuing advanced science studies								
Objective 5: Students of participating teachers will continue to experience interdisciplinary science inquiry learning in elementary, middle and high school. Participating science teachers will maintain involvement and STEM faculty and students will be actively involved in activities improving k-12 science education; parents will become more involved in school-based in/after-school programs.	Activity 5a: Teachers implement inquiry and interdisciplinary science inquiry teaching and learning in their classrooms.	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes	✓					
	Activity 5b: The project will place STEM Ph.D. graduate assistants and undergraduate service learning students to support teacher implementation of inquiry science teaching	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes	✓					
	Activity 5c: STEM PhD students lead after-school pportunities for students such as clubs, tutoring, fun nights, etc. to PCK that improves students science learning; how PLC;s support the development of this PCK. The project also will study the impact of associated activities on participating graduate students.	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes	✓					

	Activity 5d: External project evaluators analyzed STEM undergraduate and PhD questionnaire data (Fall 2011-Spring 2013)	• Partnership Driven, • Evidence-Based Design & Outcomes	✓					
	Activity 5e: External project evaluators administered the ISEP BPS Student Questionnaire to treatment and comparison BPS students to assess differences in students' interest in science learning and careers and perceptions of classroom science experiences	• Challenging Courses & Curricula • Evidence-Based Design & Outcomes	✓					

Goal 6: Improve collaboration in student learning among university, school, and parents									
Objective 6: Participating science teachers will maintain involvement and STEM faculty and students will be actively involved in activities improving k-12 science education; parents will become more involved in school-based after-school programs and PLC's. Engage faculty, grad students, undergraduates, UB and BSC STEM faculty, corporate and research partners and parents in PLC's and other programmatic components and leadership structures.	Activity 6a: Engagement of faculty, staff and students, as well as corporate and research partners through informal science activities, both in and out of class.	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes • Institutional Change & Sustainability	✓						
	Activity 6b: Implement The District Parent Coordinating Council into the ISEP program involvement.	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes • Institutional Change & Sustainability	✓						Parent PLC created opportunities for parents to collaborate with STEM faculty and BPS teachers. Tis June 2013, a parent will be participating on an ISEP panel as part of the 2013 annual WNY Networking in Higher Education Conference: Building Bridges for a Better Tomorrow"
	Activity 6c: Create active and constructive interactions amongst the parents and teachers through PLCs.	• Partnership Driven, • Teacher Quality, Quantity & Diversity • Challenging Courses & Curricula • Evidence-Based Design & Outcomes • Institutional Change & Sustainability	✓						Parent based PLC commenced in spring 2013 and will continue to meet during summer of 2013. Parents will be invited to 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 2013. Parent PLC created opportunities for parents to collaborate with STEM faculty and BPS teachers. This June 2013, a parent will be participating on an ISEP panel as part of the 2013 annual WNY Networking in Higher Education Conference: Building Bridges for a Better Tomorrow

	Activity 6d: Developed and administered a parent survey to measure parents' perceptions of the parent PLC and expectations for students' STEM learning	• Partnership Driven, • Evidence-Based Design & Outcomes • Institutional Change & Sustainability	✓					

Section 2: Management Report

University at Buffalo/ Buffalo Public Schools ISEP

Year 2: 2012 – 2013

Overview

With the initiation of interdisciplinary research placements for PD in Summer 2012, and the development and implementation of the research course at Buffalo State College to prepare 15 additional teachers, Year 2 was focused on core activities to lead to the first year of wrap around support for ***implementation*** in academic year 2012/2013. The ISEP management team, led by the PIs (Gardella, Liu, Cartwright, MacIsaac and Baudo (transitioning from Deborah Sykes of BPS)) were supported by Dr. Karen King (who completed her Ph.D. in May 2013) in management planning and decision making and a new hire (part time), Melissa Hagen, handling budget, purchasing and personnel. The addition of Ms. Hagen required the layoff of Mr. Brian Kawaler, who had served as (part time) interim project manager from 2011 in the pilot program through 2012. Ms. Hagen quickly and professionally consolidated personnel operations and budget management for all aspects of ISEP, including NYS Ed supported ISEP PD programs during the academic year. Some changes in the team are reflected in the updated Organizational Chart in Figure 1.

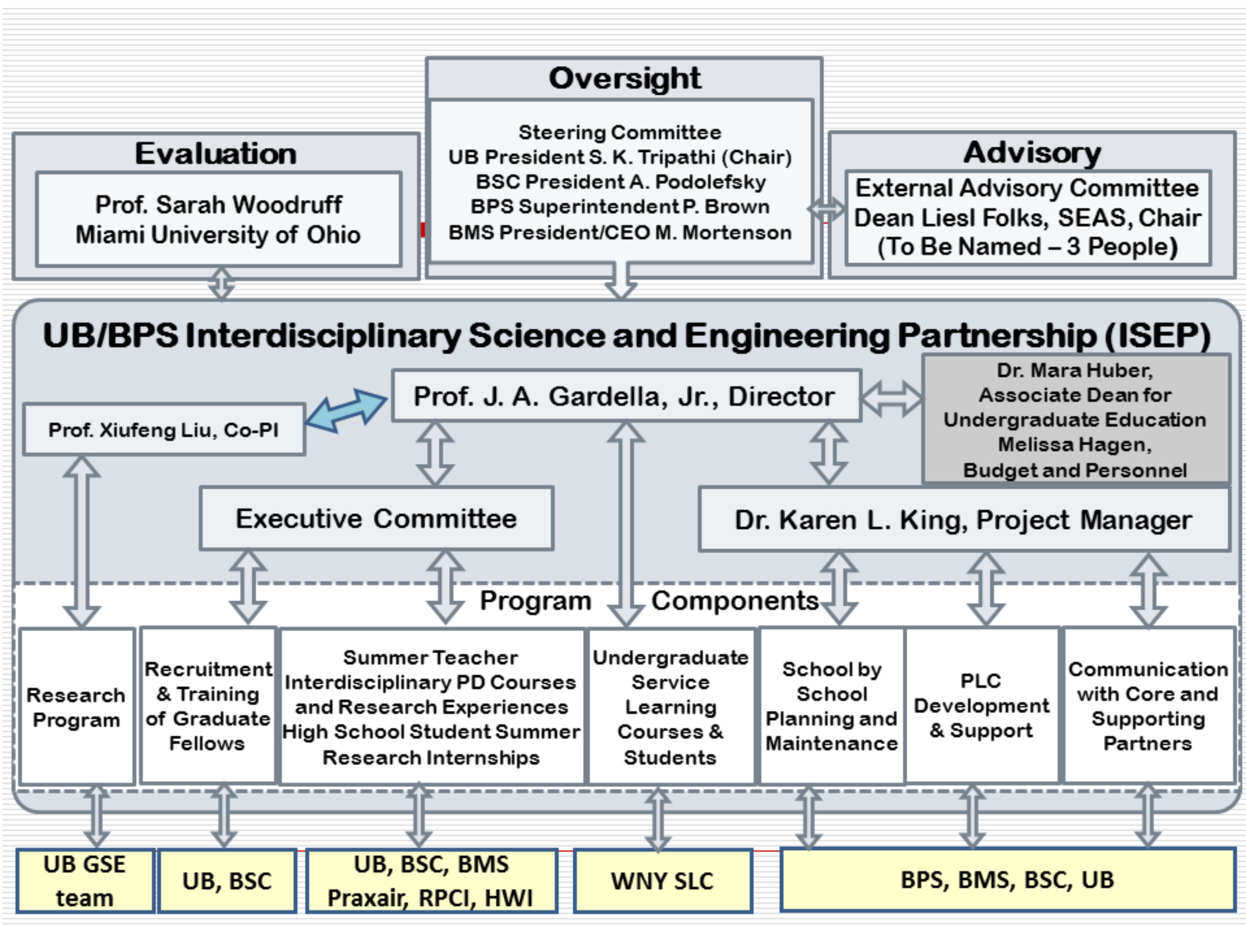

Figure 1: ISEP: Current (2013) Organizational Chart

In particular, Dr. Mara Huber's (Senior Personnel) position was changed to report through the academic leadership. 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. Most importantly was the appointment of Dr. Pamela Brown as Superintendent of the Buffalo Public Schools, following interim Superintendent Amber Dixon. Dr. Brown meets with ISEP leadership quarterly.

CoPI Professor Alexander Cartwright, Vice President for Research and Economic Development, is presently working with President Tripathi to confirm appointments to the Advisory Committee, which is expected to meet in summer 2013 to review the first two years of activities.

Important management activities were both expanded from year 1 and new activities were established, according to the strategic plan in year 2. Executive Committee involvement in key components of the recruitment and evaluation of teachers in ISEP was expanded in year 2 by formation of two subcommittees, one to review and rank teacher applications/proposals for summer research and coursework, chaired by Buffal State coPI Prof Dan MacIsaac and a second, co-chaired by Dr. Mara Huber and Prof. David Watson to review and establish summer middle school science camps and summer high school research opportunities for students in ISEP schools.

Table 1 summarizes school leadership from year 1. Results of the school based theme development are discussed in Activities and Findings.

Core Partner Management and Coordination

Core partner participation in all activities followed 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 Program Manager, as envisioned in the Strategic Plan. The Program 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 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

Following the appointment of Dr. Brown as Superintendent, an detailed and extensive initial meeting has been followed by quarterly meetings are scheduled with the ISEP PI, Joseph Gardella and Dr. Karen King. 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 are a major focus. Dr. Brown attended the first ISEP Teacher poster session in September, 2012, and several ISEP events, including a tour by Dr. John B. King, Commissioner of Education of New York State, at the Math Science and Technology School at Seneca in September 2012. The most recent participation was at a District Parent Coordinating Council (DPCC) Parent event on a Saturday morning, where middle school students from Lorraine Academy presented experiments on microscopy of cancerous tissues and basic cancer biology, coordinated by graduate assistants and help from ISEP teacher summer PD at Roswell Park Cancer Institute.

ISEP leadership expanded collaboration at the BPS leadership levels, by establishing organizational meetings with the 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 Community Superintendents can 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, who was promoted to Community Superintendent from being 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 Community Superintendents (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 now serves 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.

Supporting Partner Development

As noted in section 2, ISEP established new partnerships with additional companies to develop further corporate partnerships, in addition to our established corporate partner, Praxair. These are:

- Life Technologies division on Grand Island, NY,will host one ISEP summer teachers in research, and serves as a tour site for field trips. Leadership from Dr. Mwita Phelps, now a member of the executive committee.
- Lab Aid, Inc., for support of SEPUP development during the summer, donation of SEPUP kit materials
- VWR Science Kit, Tonawanda and Rochester, NY, for staff support of middle school programs and a discount on supplies and equipment.

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 2. 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. The WNY SLC organization led to the addition of four new college partners for service learning collaboration in ISEP. Medaille College (at Riverside High), Daemen College (at South Park High and Southside Elementary), Niagara University and Canisius College (both to be determined, organization underway) have committed through faculty and leadership meetings to participate at multiple levels in ISEP, but initially providing service learning students for classroom support. That brings six schools, UB, Buffalo State, and these four, along with Praxair, VWR and Life Technologies committed to staffing in class and after school support.

Multiple meetings of ISEP leadership with DPCC occur at their regular monthly meetings, a featured presentation at a yearly parent forum, sponsored by DPCC (400 parents attending), interviews on local city cable access TV hosted by DPCC leadership, and collaboration side by side at several school based parent nights shows the strong continued support from DPCC for the ISEP program. DPCC helped with recruitment of parents for the Parent PLC. DPCC participation is at three levels; leadership participation on the Executive Committee, school based participation through parent organizations in each of the twelve ISEP schools, and project participation for parents in the PLC development. As evidenced by the participation of a parent in our team at the 2012 NSF MSP Learning Network Conference: Framing Effective Teaching in STEM, our collaboration with DPCC has emerged as a major strength.

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 page shows ISEP Schools, Research Themes, Coordinating Teachers & STEM Graduate and Undergraduates. Persistent Low Achieving (PLA) schools under Race to the Top funding are indicated by the PLA 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.

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 Susan Mackintosh (1/2 time)	Emily Donovan Matthew Cohen Mathew Gordon	Praxair
Harriett Tubman 31 (K-8)	Steven Indelacio	Biomedical, Environmental Science	Ekue Bright Adamah-Brassi Steve Rogers (1/2 time	Tayler Halter Michael Jacobs Alexandra Murphy	Roswell Park Cancer Institute
Science Magnet 59 (K-8) PLA	Dara Dorsey	Biomedical and Environmental Sciences	Thomas Scrace Michael Habberfield (1/2 time)	Krista Coleman	Museum of Science
Lorraine Academy 72 (K-8)	Sharon Pikul	Medical Careers	Sarina Dorazio Nadine James (1/2 time)	Andrew Burstein Chelsea Dipizio	Mercy Hospital, Trocaire College
Southside Academy 93 (K-8)	Susan Wade	Environmental Science, Link to South Park High	Michael Gallisdorfer Sarah Whiteway (1/2 time)	Steven Coffed Kevin Rushlow Liam Greeson	VWR Science Kit
MST Seneca 197 (Grades 5-12)	Michelle Zimmerman	Environmental Science and Engineering	Jonathan Malzone Sarah Whiteway Susan Mackintosh (1/2 time)	Philip Tucciarone	Praxair
Bennett High 200 (Grades 9-12) PLA	Tanya Johnson	Biomedical, Pharmaceutical Sciences	Alex Ticoalu Mike Habberfield (1/2 time)	Andrew Contronea, Gladys Abrahante, Jacob Brancato, Jordan Little Gary Mana	Retired Teachers
Riverside Tech 205 (Grades 9-12) PLA	Bradley Gearhart	Medical Careers	Shannon Clough Nadine James (1/2 time)	25 students from Medaille College, Alyssa Cederman,2 Nepalese	Medaille College,
South Park 206 (Grades 9-12) PLA	Kathleen Marren	Environmental Science and Social Sciences	James Parry Meghan Kern (1/2 time)	Valerie Goldblatt, Emily Hare, Marissa Walters	
Burgard 301 (Grades 9-12) PLA	Bruce Allen Juliana Evans	Auto Technology,Physics	Katie Hofer Lavone Rodolph (1/2 time)	Darcy Regan Kara Comins Dylan Burrows Eva Nutter.Veronica Sukati	Praxair
Hutch Tech 304 (Grades 9-12)	Jill Jakubowicz	Engineering, Physics, Biochemistry	Ben Wang, Lavone Rodolph and Meghan Kern (1/2 time)	Shohini Sen Eleni Mazur	
East High 307 (Grades 9-12) PLA	Pat McQuaid	Bioinformatics, Forensics	Amy Zielinski Steve Rogers (1/2 time)	Brooke Ayoub, Farhana Hassan, Elizabeth Sidare Hillary Chiarella	

Section 3: Financial Report

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

Year 2: 2012 – 2013

3.1 Status

Spreadsheet projections (below) show just 7% of UB's portion award will be left at the end of the year (August 31, 2013). 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 2013-2014 for five major categories:

- Undergraduate student support
- Supplies

and within the yellow highlighted Participant Support Costs:

- Support for teachers, both in the form of stipends and travel support
- Support for our student research programs, both for high school students and grad student mentoring for middle/high school students
- Parent stipends for participating in committees and meetings

3.2 Background related to shortfalls and justification for use of carryover to 2013-2014.

Teacher participation has increased, as planned. As program participation solidifies, we have formalized work plans for summer research programs, which conclude in late August 2013. An operational change from last year will shift some stipend costs past September 1st, as we are reserving a portion of the stipend will be issued based on the summer PD project conclusion. Evaluations of the projects and implementation are expected to occur in early Year 3, we request to carry over these funds to complete the stipend payments for teachers participating in our summer research programs.

Support for teacher travel is expected to increase as the plans for summer/academic year research programs finalize and teachers are able to focus on planning for travel to professional meetings during Y3. We request to carry over these funds to meet upcoming needs.

Student summer research programming has increased for Summer 2013 with two middle school programs focused on information technology and environmental science; and with four high school offerings with focus on environment and entrepreneurship, genetics, computer engineering, chemistry, physics, and engineering. The support we are extending to Buffalo-area camps and research programs has the potential to reach up to 250 middle and high school students in ISEP schools. With approved carry over funds, we expect to continue programming expansion into the academic year of 2013-2014 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 2013.

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 2 (2012-2013)

Category	Funds Budgeted	Carry Over from Y1	Total Funds Available	Funds Expended	Summer 2013 Committed Funds	Total Expected to Expend	Projected Carryover Funds
Faculty Salaries	$ 43,577.00	$ 6,262.45	$ 49,839.45	$ 9,450.66	$ 38,288.00	$ 47,738.66	$ 2,100.79
Staff Salary	$ 3,693.00	$ (6,985.95)	$ (3,292.95)	$ 53,310.21	$ 6,704.42	$ 60,014.63	$ (63,307.58)
Graduate Students	$ 417,900.00	$ (1,416.75)	$ 416,483.25	$ 434,959.75	$ 114,350.00	$ 549,309.75	$ (132,826.50)
Undergraduates	$ 67,200.00	$ 43,398.93	$ 110,598.93	$ 16,115.00	$ 4,000.00	$ 20,115.00	$ 90,483.93
Fringe Benefits	$ 79,202.00	$ 801.75	$ 80,003.75	$ 88,272.09	$ 33,879.84	$ 122,151.93	$ (42,148.18)
Participant Support Costs							
Stipends							
Teachers	$ 282,000.00	$ 12,150.00	$ 294,150.00	$ -	$ 173,250.00	$ 173,250.00	$ 120,900.00
Middle/High School Students	$ 84,000.00	$ 75,900.00	$ 159,900.00	$ 1,600.00	$ 120,255.00	$ 121,855.00	$ 38,045.00
PT grad assistants	$ 48,000.00	$ 31,000.00	$ 79,000.00	$ 8,852.00	$ 36,100.00	$ 44,952.00	$ 34,048.00
Parents	$ 1,800.00	$ 1,800.00	$ 3,600.00	$ 400.00	$ 250.00	$ 650.00	$ 2,950.00
Travel	$ 48,000.00	$ 45,641.07	$ 93,641.07	$ 654.93	$ 125.00	$ 779.93	$ 92,861.14
Supplies	$ 72,000.00	$ 32,420.03	$ 104,420.03	$ 80,184.45	$ 52,630.39	$ 132,814.84	$ (28,394.81)
Supplies	$ 38,400.00	$ 36,064.44	$ 74,464.44	$ 254.99	$ -	$ 254.99	$ 74,209.45
Tuition	$ 12,876.00	$ (25,332.00)	$ (12,456.00)	$ 66,457.00	$ -	$ 66,457.00	$ (78,913.00)
Travel	$ -	$ (6,251.93)	$ (6,251.93)	$ 2,668.61	$ -	$ 2,668.61	$ (8,920.54)
Total UB Direct Costs	$ 1,198,648.00	$ 245,452.04	$ 1,444,100.04	$ 763,179.69	$ 579,832.65	$ 1,343,012.34	$ 101,087.70
							7.00%

Section 4

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

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

Year 2: 2012 – 2013

Ohio Evaluation & Assessment Center

MATHEMATICS • SCIENCE • EDUCATION

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

Annual Report 2012-2013

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Please cite as follows:

Woodruff, S. B., & Li, Y. (2013). *Evaluation of University at Buffalo/Buffalo Public Schools (UB/BPS) Interdisciplinary Science and Engineering Partnership: Annual report 2012-2013.* Oxford, OH: Miami University, Ohio's Evaluation & Assessment Center for Mathematics and Science Education.

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

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

Project Description

The University at Buffalo/Buffalo Public Schools Interdisciplinary Science and Engineering Partnership project is a National Science Foundation (NSF) Mathematics and Science Partnership project to establish and sustain a comprehensive partnership targeting 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 will engage 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 will also include summer enrichment and university research internships for BPS students.
- Expanded professional learning communities (PLC's) with mentoring relationship between UB STEM faculty members, undergraduate and graduate students, and BPS students and parents.

Additionally, the project will conduct 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 will study the impact of associated activities on participating 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. Primary tasks of the E & A Center include:

a) Design and modify the external evaluation plan and protocols over the life of the project.

b) Advise, as requested, design protocols and instruments to be used by the internal evaluation and research teams.

c) Recommend, develop, and modify evaluation instruments.

d) Test evaluation instrument validity and reliability.

e) Prepare and supply or administer instruments for participants. Instruments may be provided in hard copy or online as requested by project personnel.

f) Collect and analyze quantitative (i.e., questionnaire, content assessment, demographic, performance/achievement) data and qualitative (i.e., written reflections, observations, interview/focus group) data from and regarding project participants and other relevant data to be used for comparison analyses.

g) Conduct focus groups and/or interviews of a sample of project participants.

h) Collect and analyze project artifacts and documents provided by project personnel.

i) Conduct protocol-based observations of a sample of participant teacher classrooms.

j) Integrate and synthesize data from the internal evaluation and research in the creation of annual and final reports.

k) Provide informal interim reports to project personnel as requested to inform project continuous improvement efforts.

l) Prepare and submit to Project PI annual and final project reports for the NSF.

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 2, 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. During Year 3, quantitative data will be triangulated with observation, interview, and written reflection data from project research to provide a more rigorous assessment of project implementation and impact.

The external summative evaluation plan submitted with the project's proposal to the NSF was updated in February 2012 and again 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 evaluation activities between January and July 2013. Activities in green font are completed. Current activities of the E & A Center (in red font) include developing instruments for faculty, BPS students and their parents, and UB STEM students. Current activities of the internal evaluation and research team (in blue font) include developing content assessments for ISE teachers and UB STEM students.

Table 1. *E & A Center Primary Evaluation Activities and Timeline, January – July 2013*

Evaluation Activity	Jan - Mar	Apr - Jun	Jul - Sept
~~Develop PLC reflection subscale~~	X		
~~Develop Faculty Questionnaire~~	X		
~~Develop and test BPS Student Questionnaire~~	X		
~~Develop STEM Student Questionnaire (new version)~~	X		
~~Develop Parent PLC Questionnaire~~	X		
~~Analyze STEM Student Questionnaire (Liu version)~~		X	
~~Administer Parent PLC Questionnaire hardcopy~~	X	X	
Develop/test Teacher/STEM student CK/PCK instrument	X	X	X
Administer BPS Student Questionnaire hardcopy		X	
Collect 2011-2012 Data – School/teacher-level		X	
Administer Teacher Post-questionnaire online		X	
Administer PLC reflection subscale to PLC participants		X	
Administer Faculty Questionnaire online		X	
Analyze pre/post Teacher Questionnaire			X
Administer STEM Student Pre-Questionnaire online (new version)			X
Administer Teacher CK/PCK instrument online			X
Administer STEM Student CK/PCK instrument online			X

During Year 2 of the project, the E & A Center and ISEP Project Team have 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) modifying the external evaluation timeline; (b) recommending and developing and testing evaluation instruments; (c) administering online instruments for teacher participants; (d) administering paper instruments for student participants; (e) collecting school-level baseline demographic data; and (f) preparing and submitting the Year 2 annual evaluation report.

Participants

Participants in the evaluation of the ISEP project are Buffalo Public School middle and high school teachers, their students in Grades 5 through 12, parents of the teachers' students, University at Buffalo and Buffalo State College STEM faculty, undergraduate students, and graduate students. Other key informants may include BPS district and building administrators, ISEP project personnel, and non-participating BPS middle and high school teachers.

Instruments

UB/BPS ISEP Teacher Questionnaire (Summer 2012)

The *UB/BPS ISEP Teacher Questionnaire* was developed with permission from existing instruments previously used in NSF and USDOE MSP projects and in DRK12 projects[1]. This questionnaire was composed of 217 items divided among 6 sections. It collected data from teachers before their participation in project activities beginning in June 2012. The *UB/BPS ISEP Teacher Questionnaire* can be found in Appendix C of the *Evaluation of University at Buffalo/Buffalo Public Schools (UB/BPS) Interdisciplinary Science and Engineering Partnership: Annual Report 2011-2012* (Woodruff & Li, 2012). The following sections were included in the questionnaire.

Comprehensive Demographics

This section contained 33 items asking for comprehensive demographics, including teachers' professional development history, to collect teacher and classroom data; Items in this section were modified with permission from: RMC Research (2009).

Mathematics Preparation

This section contained 6 open-response and 10 items on a 4-point rating scale (with the fifth choice as *not sure*) with responses ranging from *not adequately prepared* (1) to *very well prepared* (4), asking for participants' preparation for mathematics teaching, including the undergraduate and graduate level mathematics coursework (only for those who teach mathematics) and their perceived preparedness for teaching mathematics content. Items in this section were modified with permission from RMC Research (2009).

Science Preparation

This section contained 8 open-response and 8 items on a 4-point rating scale (with the fifth choice as *not sure*) with responses ranging from *not adequately prepared* (1) to *very well prepared* (4), asking about participants' preparation for science teaching, including the undergraduate and graduate level STEM coursework and their perceived preparedness for teaching science content. In addition, this section also contained two subscales. The first one contained 19 items on a 4-point rating scale (with the fifth choice as *not sure*) with responses ranging from *not adequately prepared* (1) to *very well prepared* (4), asking for participants preparedness for various aspects of science teaching. The second subscale contained 30

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[1] Lederman, N. G. (2006). Syntax of nature of science within inquiry and science instruction. In L. B. Flick and N. G. Lederman (Eds.), *Scientific inquiry and nature of science* (pp. 301-317). Netherlands: Springer.
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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.

items on a 4-point rating scale (with the fifth choice as *not sure*) with responses ranging from *not a priority* (1) to *high priority* (4), asking about perceived importance of teaching cross-cutting content in science and inquiry. Items in this section were modified with permission from RMC Research (2009).

Science as Inquiry & Understanding the Nature of Science

This section contained two subscales. The first subscale contained 20 items on a 5-point Likert-type scale with responses ranging from *strongly disagree* (1) to *strongly agree* (5), asking for participants' views of inquiry-based science teaching and learning (SI). The second subscale also contained 20 items on a 5-point Likert-type scale with responses ranging from *strongly disagree* (1) to *strongly agree* (5), measuring participants' understanding of nature of science (NOS). Items in this section were modified with permission from the following: Lederman, N. G. (2006); National Research Council (2000); Liang, L. et al. (2008); and National Science Teachers Association (2000).

Design, Engineering and Technology (DET) Survey

This section contained one *yes/no* item; one open-response item; 14 items on a 5-point Likert-type scale with responses ranging from *not at all* (1) to *very much* (5); 13 items on a 5-point Likert-type scale with responses ranging from *strongly disagree* (1) to *strongly agree* (5); two items on a 5-point Likert-type scale with responses ranging from *not at all important* (1) to *very important* (5); and five items on a 5-point Likert-type scale with responses ranging from *not strong at all* (1) to *very strong* (5), asking for perceived importance of and familiarity with design, engineering, and technology (DET). Items on this subscale were modified with permission from Yasar, S. et al. (2006).

Attitudes and Beliefs about Teaching Science and Mathematics

This section contained one subscale with 27 items on a 5-point Likert-type scale with responses ranging from *strongly disagree* (1) to *strongly agree* (5), asking for participants' attitudes and beliefs about teaching science, mathematics, and engineering design. Items on this subscale were modified with permission from McGinnis, J. R. et al. (2002).

Factor Analysis and Reliability

In Summer 2012, E & A Center evaluators performed factor analyses to establish reliable subscales for the *UB/BPS ISEP Teacher Questionnaire.* Using all the teacher responses received in Summer 2012 (n = 46), 22 factors were established from the six subscales using the principal components method with varimax rotation. The list of subscales, factors, and their reliabilities are shown in Table 2. High internal consistency reliability were found for factors in the "Preparedness for Science Teaching," "Science Professional Development Needs," "Understanding the Nature of Science (NOS)," and "Design, Engineering, and Technology (DET)" subscales, with Cronbach's coefficient alpha values for all factors in these subscales equal to or higher than .80, except factors "Structure of Scientific Knowledge" (.63) and "Teaching DET: Individual Perspective" (.73). Factors in the subscales "Science as Inquiry (SI)," "Attitudes and Beliefs about Teaching Mathematics," and "Attitudes and Beliefs about Teaching Science" had low to moderate reliabilities ranging from .43 ("Beliefs about Mathematics") to .77 ("Role and Responsibilities of the Teacher in SI"). The low reliabilities are likely due to a) the small sample sizes, especially for the "Attitudes and Beliefs about Teaching Mathematics" subscale (n = 10); b) small numbers of items loaded on the factors, and c) the large number of items that required reverse coding. In addition, the original published instrument, from which the "Attitudes and Beliefs about Teaching Science and Mathematics" section was adapted, reported only moderate reliability levels (McGinnis & et al, 2002, p. 721, Table 2).

Table 2. *Reliability of UB/BPS ISEP Teacher Questionnaire Factors, Summer 2012*

Subscale	Total # of Items in the Subscale	Factor	Item	# of Items in Each Factor	Cronbach's Alpha	*n*
S1. Preparedness for Science Teaching	19	F1. Preparation in Foundational Concepts of Science Instruction and Curriculum (RMC: Preparedness for Teaching Science)	Q30a-i, Q30q	10	0.919	39
		F2. Teaching Diverse Populations Using Diverse Methods (RMC: Preparedness to Meet Student Needs)	Q30j-p, Q30r, Q30s	9	0.878	38
S2. Science Professional Development Needs	30	F1. Interdisciplinary Cognitive Skills/Critical Thinking Abilities (RMC: Scientific Method and Inquiry)	Q31_1, Q31_5, Q31_7, Q31_12, Q31_17, Q31_18, Q31_19, Q31_21, Q31_22, Q31_23, Q31_27, Q31_28	12	0.909	39
		F2. Physical Sciences Knowledge (RMC: Atoms, Matter, and Energy)	Q31_2, Q31_4, Q31_8, Q31_10, Q31_11, Q31_13, Q31_15, Q31_25, Q31_29, Q31_30	10	0.880	39
		F3. Life Sciences Knowledge (RMC: Life Science)	Q31_3, Q31_6, Q31_9, Q31_14, Q31_16, Q31_20, Q31_24, Q31_26	8	0.802	39
S3. Science as Inquiry (SI)	20	F1. Role and Responsibilities of the Learner in SI	Q32_1, Q32_2, Q32_3, Q32_4, Q32_5F, Q32_6F, Q32_8F, Q32_12, Q32_13, Q32_15, Q32_16	11	0.635	38
		F2. Requirements and Assumptions of SI	Q32_7F, Q32_9F, Q32_10F, Q32_14, Q32_17F	5	0.501	37
		F3. Role and Responsibilities of the Teacher in SI	Q32_18, Q32_19, Q32_20	3	0.774	40

Subscale	Total # of Items in the Subscale	Factor	Item	# of Items in Each Factor	Cronbach's Alpha	*n*
S4. Understanding the Nature of Science (NOS)	20	F1. Structure of Scientific Knowledge	Q33_1, Q33_2, Q33_3F, Q33_5, Q33_6, Q33_7, Q33_9, Q33_10, Q33_11, Q33_12F, Q33_16	11	0.634	34
		F2. Scientific Experiments and Research	Q33_4F, Q33_8F, Q33_17F, Q33_18F, Q33_19F	5	0.834	39
		F3. Context of Scientific Knowledge	Q33_13, Q33_14, Q33_15, Q33_20	4	0.792	39
S5. Design, Engineering, and Technology (DET)	33	F1. Familiarity with DET	DET1-DET5, DET7, DET8	7	0.861	39
		F2. Importance of DET	DET6, DET9	2	0.839	39
		F3. DET Teaching Priorities	DET14-DET18	5	0.923	38
		F4. Motivation for Teaching Science	DET19-DET23	5	0.841	40
		F5. Barrier in Integrating DET	DET24-DET27	4	0.801	39
		F6. Teaching DET: Individual Perspective	DET30-DET33	4	0.730	40
S6. Attitudes and Beliefs about Teaching Mathematics	10	F1. Beliefs about Mathematics	Q46_aF, Q46_bF, Q46_cF, Q46_e, Q46_fF, Q46_iF	6	0.428	10
		F2. Teaching Strategies to Improve Student Understanding in Mathematics (McGinnis: Beliefs about the Teaching of Mathematics)	Q46_dF, Q46_g, Q46_h, Q46_j	4	0.633	10
S6. Attitudes and Beliefs about Teaching Science	17	F1. Beliefs about Science	Q46_lF, Q46_mF, Q46_pF, Q46_qF, Q46_rF, Q46_tF, Q46_u, Q46_vF	8	0.743	38
		F2. Beliefs about Teaching Science	Q46_k, Q46_n, Q46_o, Q46_s, Q46_w, Q46_z	6	0.630	39
		F3.Attitudes towards Teaching Science	Q46_xF, Q46_yF, Q46_aa	3	0.516	38

The factor analysis and reliability tests yielded reasonable constructs (factors) for the subscales "Preparedness for Science Teaching" and "Science Professional Development Needs." However, for the "Science as Inquiry" subscale, the constructs measured by factors "Role and Responsibilities of the Learner in SI" and "Requirements and Assumptions of SI" are not clearly separated. For example, instead of loading on the "Role and Responsibilities of the Learner in SI" factor together with items such as *inquiry-based learning requires that learners generate and investigate their own questions,* the item *inquiry-based learning requires that learners are engaged in hands-on activities* loaded on the "Requirements and Assumptions of SI" factor. Similarly, for the "Understanding the Nature of Science" subscale, the constructs measured by the three factors "Structure of Scientific Knowledge," "Requirements and Assumptions of SI," and "Context of Scientific Knowledge" were also not clearly defined using these data. Instead of loading on the "Context of Scientific Knowledge" factor, the item *contributions to science are made by people from all cultures around the world* loaded on the "Structure of Scientific Knowledge." Rather than loading on the "Structure of Scientific Knowledge" factor along with other items about the relationship between scientific laws and theories, the item scientific *laws are theories that have been proven* loaded on the "Scientific Experiments and Research" factor together with items such as *scientific experiments are the only means used to develop scientific knowledge* and *basic scientific research is concerned primarily with practical outcomes related to developing technology*. The ambiguity of these constructs is possibly caused by teachers' misconceptions about science as inquiry and the nature of science.

For the subscales "Attitudes and Beliefs about Teaching Mathematics" and "Attitudes and Beliefs about Teaching Science," even though the constructs were identified in a consistent way by the original literature, the items did not load on these constructs (factors) in a consistent way as was demonstrated in the original literature (McGinnis, 2002). One of the reasons could be because these two subscales were analyzed separately using the *UB/BPS ISEP Teacher Questionnaire* data. Only 10 teachers responded to the "Attitudes and Beliefs about Teaching Mathematics" subscale, while almost all teachers responded to the "Attitudes and Beliefs about Teaching Science" subscale. These results suggest that further data need to be collected and analyzed for additional factor analysis and reliability tests. 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 consistent and within an acceptable range.

UB/BPS ISEP Survey of UB STEM Students (2011-2012 & 2012-2013)

The *UB/BPS ISEP Survey of UB STEM Students* collected data from UB STEM graduate and undergraduate students who have participated in project activities in Fall 2011, Spring 2012, Fall 2012, and Spring 2013. The instrument was developed and administered by Dr. Liu, internal evaluator and researcher for the ISEP project. The E & A Center has reviewed the survey and recommends that this survey be administered pre and post each academic year to measure change in UB students' perceptions of experiences and skills in order to respond to relevant research and evaluation questions. The E & Center suggests merging the current STEM student survey (developed and administered by Dr. Liu) with other subscales to collect data at appropriate time points in order to reduce survey fatigue. The revised *UB/BPS ISEP STEM Student Questionnaire* would serve as a comprehensive data collection tool. The revised instrument will be administered online to new and returning UB STEM students by the E & A Center in Fall 2013. The current version of *UB/BPS ISEP Survey of UB STEM Students* instrument contains the following sections and can be found in Appendix B.

Section A: Preparation

This section contained one multiple-choice item asking for students' preparedness for aspects of project activities in schools.

Section B: Experiences

This section contained one multiple-choice item asking for students' self-reported experiences in schools.

Section C: Perceived Value of UB/BPS ISEP

This section contained one 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 for students' perceived value of project experiences.

Section D: Self-Efficacy in Communicating Science

This section contained 20 items on a 5-point rating scale with responses ranging from *nothing* (1) to *a great deal* (5), asking for students' self-efficacy in communicating science.

Section E: Comprehensive Demographics

This section contained five items asking for students' comprehensive demographics, experiential history, and career plan data.

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

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 in Spring 2013. 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 C.

Data Collection

The online version of the *UB/BPS ISEP Teacher Questionnaire* was developed by Ohio's Evaluation and Assessment Center for Mathematics and Science Education using Prezza Checkbox®. The link to the instrument was sent (with an invitation to participate in the questionnaire) to all teachers participating in the ISEP summer institute on June 11, 2012 and the questionnaire remained active online until July 9, 2012. Of the 60 teachers who participated in the summer PD activities, 46 responded to this questionnaire. The response rate is approximately 77%.

The *UB/BPS ISEP Survey of UB STEM Students* was administered by Dr. Liu to undergraduate and graduate STEM students who participated in ISEP at the end of the Fall 2011, Spring 2012, Fall 2012, and Spring 2013 semester. The data were then entered into Excel spreadsheets and sent to the E&A Center for analysis.

The *UB/BPS MSP ISEP Parent-Based PLC Questionnaire* was administered by ISEP project personnel to the parents who participated the parent-based PLC sessions between January 26 and May 30, 2013. Data collected using this instrument were not yet available to the E&A Center for analysis, hence are not reported in this evaluation report.

Data Analysis

UB/BPS ISEP Teacher Questionnaire

Descriptive statistics (e.g., frequencies, percentages, means and standard deviations) were used to report the baseline findings from the *UB/BPS ISEP Teacher Questionnaire* (Summer 2012). No inferential statistical tests were conducted using the Summer 2012 data. 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 neither from the raw scores nor using Item Response Theory (the Rasch Model) at this stage. The *UB/BPS ISEP Teacher Questionnaire* (post) data will be collected again in June 2013. Further factor analysis will be conducted using both the pre- and post-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.

UB/BPS ISEP Survey of UB STEM Students

Descriptive statistics (e.g., frequencies and percentages) were used to report the findings from the *UB/BPS ISEP Survey of UB STEM Students* (2011-2012 and 2012-2013). 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 one year and those who were new to the project.

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

Findings

UB/BPS ISEP Teacher Questionnaire Data, Summer 2012

Demographics

In Summer 2012, about 60 teachers from 12 different schools in the Buffalo Public School District participated in the summer professional development activities of the UB/BPS ISEP project. Forty-six teachers responded to the *UB/BPS ISEP Teacher Questionnaire* before starting the summer activities and 4,755 students were reported to be taught by these teachers. Demographic frequencies were calculated as shown in Tables 3 to 8. Note that not all teachers responded to all items, therefore the total number of responses may not equal 46 in all tables. Table 3 shows that 91% of the teacher respondents were White and 57% were female.

Table 3. Respondents' Race and Gender, UB/BPS ISEP Teacher Questionnaire, Summer 2012

Race/Ethnicity	Female	Male	Total (%)
White, non-Hispanic	23	19	42 (91%)
African American, non-Hispanic	1	0	1 (2%)
Hispanic	0	0	0
Asian/Pacific Islander	0	0	0
American Indian/Alaskan native	0	0	0
Multiracial	0	1	1 (2%)
Other, not indicated	2	0	0
Total	**26 (57%)**	**20 (43%)**	**46 (100%)**

Table 4 shows that all but one teacher were teaching science upon beginning this project. In addition, 11% also were teaching mathematics; 20% were special education teachers; and one teacher was teaching career/technical education. All but one teacher indicated that they were teaching in the areas for which they were credentialed; 96% of teachers reported that they met No Child Left Behind (NCLB) Highly Qualified Teacher (HQT) status (Appendix D).

Table 4. Respondents' Position, UB/BPS ISEP Teacher Questionnaire, Summer 2012

Teaching	*n*	Percent
Currently Teaching Science	45	98
Currently Teaching Mathematics	5	11
Special Education Teacher	9	20
Career/Technical Education Teacher	1	2
Credentialed for Current Teaching Assignment	45	98

As shown in Tables 5 and 6, 89% of teachers were certified to teach science, 13% were certified to teach mathematics, and 20% held a special education certificate, and no teacher was credentialed to teach education.

Table 5. Respondents' Teaching Credential, UB/BPS ISEP Teacher Questionnaire, Summer 2012

Teaching Credential	*n*	Percent
Certified to Teach Science	41	89
Certified to Teach Mathematics	6	13
Hold Special Education Certificate	9	20
Hold Technology Education Certificate	0	0

Table 6. *Respondents' Mathematics and Science Teaching Credentials*, UB/BPS ISEP Teacher Questionnaire, Summer 2012

Fields Certified to Teach Mathematics and Science		*n*	Percent
Mathematics			
Elementary	PreK-6, 5-6	6	13
Middle Grades	5-9, 7-8, 7-9	4	9
High School	7-12	2	4
Science			
Elementary	PreK-6, 5-6	10	22
Middle Grades	5-9, 7-8, 7-9	24	52
High School (7-12)	7-12	35	76
Certification Areas:	Biology	28	61
	Chemistry	7	15
	Earth Science	13	28
	General Science	13	28
	Physics	5	11
Others Fields			
Other	Special Education	9	20
	Technology Education	1	2

When asked about their teaching experience, most teachers reported that they had more than 10 years of K-12 teaching experience. Of the 45 teachers who had science teaching experience, the average experience teaching science was 13 years and over 50% of these teachers had 11 or more years of experience. The average teaching experience in the current school is seven years and more than 50% of the teachers indicated they taught in the current school for six years or more (Table 7).

Table 7. Respondents' Teaching Experience, UB/BPS ISEP Teacher Questionnaire, Summer 2012

Years of Experience	*n*	*M*	*SD*	Minimum	Median	Maximum
Teaching in a K-12 school	46	14	8	3	12	43
Teaching K-12 Math	13	11	9	2	10	35
Teaching K-12 Science	45	13	8	1	11	43
Teaching in Current School	45	7	6	0	6	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 Biology, Earth Science, or Environmental Science.

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

Courses Currently Teaching	*n*	Percent
4th Grade Science	1	2
5th Grade Science	2	4
6th Grade Science	5	11
7th Grade Physical Science	5	11
8th Grade Life Science	5	11
Regents Biology	23	50
Regents Earth Science	12	26
Regents Chemistry	3	7
Regents Physics	2	4
High School Environmental Science	9	20
High School AP Biology	3	7
High School AP Environmental Science	2	4
High School Advanced Biology	1	2

More than half of teachers had previously participated in professional development activities with University at Buffalo (UB) and/or Buffalo State College (BSC) (Appendix D). Most teachers also reported moderate to high levels of participation in professional development activities focused on content or curriculum. In addition, teachers reported that they had participated in an average of 40 hours of professional development activities outside of PD course with UB and/or BSC during each of the past two school years (Appendix D).

Science Preparation

In terms of educational preparation in science content, most ISEP science teachers reported that they took at least four college-level chemistry, two physics, eight life sciences, two earth and space sciences, and one physical science courses, as shown in Table 9. Some teachers also reported taking graduate-level science courses. ISEP teachers felt best prepared to teach life science and middle school science (Table 10).

Table 9. *Educational Preparation for Teaching Science Content*, UB/BPS ISEP Teacher Questionnaire, Summer 2012

Science Course	Course Level	*n*	*M*	*SD*	Minimum	Median	Maximum
Chemistry	Undergraduate	36	3.53	2.32	0	4	10
	Graduate	10	0.20	0.63	0	0	2
Physics	Undergraduate	31	2.39	3.90	0	2	23
	Graduate	10	1.10	2.33	0	0	6
Life Sciences	Undergraduate	40	8.20	6.43	0	8	30
	Graduate	19	3.16	3.47	0	2	10
Earth and Space Sciences	Undergraduate	27	3.70	4.26	0	2	15
	Graduate	13	4.69	9.83	0	1	36
Physical Sciences	Undergraduate	15	0.93	1.10	0	1	3
	Graduate	8	0.13	0.35	0	0	1

Science Course	**Course Level**	***n***	***M***	***SD***	**Minimum**	**Median**	**Maximum**
Engineering	Undergraduate	15	1.13	4.12	0	0	16
	Graduate	8	0.00	0.00	0	0	0
Technology Education	Undergraduate	19	1.47	2.61	0	0	10
	Graduate	11	2.18	4.02	0	0	12

Table 10. Respondents' Perceived Preparedness for Teaching Science Content, UB/BPS ISEP Teacher Questionnaire, Summer 2012

Q29. Science Preparation	***n***	**Not Adequately Prepared**	**Somewhat Prepared**	**Well Prepared**	**Very Well Prepared**	**Not Sure**
		%	**%**	**%**	**%**	**%**
a. Chemistry	33	30	30	21	15	3
b. Physics	31	42	32	13	10	3
c. Life Science	42	0	14	29	**52**	5
d. Earth and Space Science	36	14	39	22	22	3
e. Physical Science	33	9	24	42	18	6
f. Middle School Science	39	0	10	44	44	3
g. Elementary School Science	30	3	20	30	30	17

Table 11 shows ISEP teachers' preparedness for science instruction. More than half of the respondents indicated they were well or very well prepared in all 19 areas related to providing science instruction to students. Teachers reported highest levels of preparedness in providing science instruction that meets appropriate standards (91% well or very well prepared, with *M* = 3.52), teaching scientific inquiry (86% well or very well prepared, with *M* = 3.36), and encouraging participation of females and minorities in science courses (86% well or very well prepared, with *M* = 3.39). Conversely, teachers reported the lowest levels of preparedness for teaching science to students who have limited English proficiency (40% not adequately prepared or somewhat prepared, with *M* = 2.50), teaching students who have a learning disability which impacts science learning, (37% not adequately prepared or somewhat prepared, with *M* = 2.83), and using a variety of technological tools to enhance student learning (28% not adequately prepared or somewhat prepared, with *M* = 2.98).

Table 11. Respondents' Preparedness for Science Instruction, UB/BPS ISEP Teacher Questionnaire, Summer 2012

Q30. Please indicate how well prepared you feel to do each of the following.	*n*	**Not Adequately Prepared / Somewhat Prepared**	**Well Prepared / Very Well Prepared**	**Not Sure**
		%	**%**	**%**
a. Provide science instruction that meets appropriate standards (district, state, or national).	43	7	**91**	2
b. Teach scientific inquiry.	42	14	**86**	0
c. Manage a class of students who are using hands-on or laboratory activities.	43	19	**79**	2
d. Lead a class of students using investigative strategies.	43	28	**70**	2
e. Take into account students' prior conceptions about natural phenomena when planning instruction.	43	26	**72**	2
f. Align standards, curriculum, instruction, and assessment to enhance student science learning.	43	16	**79**	5
g. Sequence (articulation of) science instruction to meet instructional goals across grade levels and courses.	43	33	**65**	2
h. Select and/or adapt instructional materials to implement your written curriculum.	43	16	**79**	5
i. Know the major unifying concepts of all sciences and how these concepts relate to other disciplines.	43	23	**74**	2
j. Understand how students differ in their approaches to learning and create instructional opportunities that are adapted to diverse learners.	43	16	**81**	2
k. Teach science to students from a variety of cultural backgrounds.	43	23	**72**	5
l. Teach science to students who have limited English proficiency.	42	40	**55**	5
m. Teach students who have a learning disability which impacts science learning.	43	37	**60**	2
n. Encourage participation of females and minorities in science courses.	43	9	**86**	5
o. Provide a challenging curriculum for all students you teach.	42	12	**86**	2

Q30. Please indicate how well prepared you feel to do each of the following.	*n*	Not Adequately Prepared / Somewhat Prepared	Well Prepared / Very Well Prepared	Not Sure
		%	%	%
p. Learning the processes involved in reading and how to teach reading in science.	43	28	**70**	2
q. Use a variety of assessment strategies (including objective and open-ended formats) to inform practice.	42	12	**86**	2
r. Use a variety of technological tools (student response systems, lab interfaces and probes, etc.) to enhance student learning.	42	29	**69**	2
s. Teach interdisciplinary science inquiry.	42	21	**74**	5

Prior to participating in ISEP summer activities, teacher participants were asked to prioritize their professional development needs. More than half of the participants indicated moderate or high priority professional development needs in all 30 areas related to providing science instruction to students (Table 12). Teachers reported that helping students develop general understanding and ability to do scientific inquiry-based learning were top priorities. On the other hand, teachers reported lower priority professional development needs related to subject-specific aspects.

Table 12. *Respondents' Needs of Professional Development*, UB/BPS ISEP Teacher Questionnaire, Summer 2012

Q31. Professional Development Needs	*n*	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.	43	14	**86**	0
2. Help students develop an understanding of scale, proportion, and quantity as these concepts are used to describe the natural world.	43	2	**98**	0
3. Help students develop an understanding of the behavior of organisms.	42	10	**88**	2
4. Help students develop the ability to use mathematics and computational thinking.	43	12	**86**	2
5. Help students develop the ability to construct explanations and design solutions.	42	2	**98**	0
6. Help students develop an understanding of chemical reactions.	43	35	**65**	0
7. Help students develop an understanding of patterns in natural events.	42	0	**100**	0
8. Help students develop an understanding of the interactions of energy and matter.	42	12	**88**	0

Q31. Professional Development Needs	***n***	**Not a Priority / Low Priority**	**Moderate Priority / High Priority**	**Not Sure**
		%	**%**	**%**
9. Help students develop an understanding of form and function.	42	14	**86**	0
10. Help students develop an understanding of the structure and properties of matter.	42	21	**79**	0
11. Help students develop an understanding of the conservation of energy and increase in disorder.	42	21	**79**	0
12. Help students develop the abilities needed to do scientific inquiry.	43	5	**93**	2
13. Help students develop an understanding of the structure of the atom.	43	40	**60**	0
14. Help students develop an understanding of the molecular basis of heredity.	43	14	**84**	2
15. Help students develop an understanding of energy in the earth system.	42	19	**79**	2
16. Help students develop an understanding of the theory of biological evolution.	43	9	**88**	2
17. Help students develop the ability to develop and use valid models.	43	7	**93**	0
18. Help students develop the ability to obtain, evaluate, and communicate information.	43	2	**95**	2
19. Help students develop the ability to ask questions and define problems.	43	0	**98**	2
20. Help students develop an understanding of matter, energy, and organization in living systems.	43	2	**98**	0
21. Help students develop the ability to analyze and interpret data.	43	0	**95**	5
22. Help students develop an understanding of systems, order, and organization.	43	0	**98**	2
23. Help students develop an understanding of evidence, models, and explanation.	43	5	**95**	0
24. Help students develop an understanding of the cell.	43	14	**86**	0
25. Help students develop a scientific understanding of the earth in the solar system.	43	26	**74**	0
26. Help students develop an understanding of the interdependence of organisms.	43	9	**88**	2

Q31. Professional Development Needs	*n*	**Not a Priority / Low Priority**	**Moderate Priority / High Priority**	**Not Sure**
		%	**%**	**%**
27. Help students develop the ability to plan and carry out investigations.	43	0	**98**	2
28. Help students develop an understanding of change, constancy, and measurement.	42	7	**93**	0
29. Help students develop an understanding of geochemical cycles.	43	35	**60**	5
30. Help students develop a scientific understanding of the origins of the earth and the universe.	43	21	**77**	2

Science as Inquiry & Understanding the Nature of Science

Table 13 shows teachers' views of inquiry-based science teaching and learning practices. Although teachers demonstrated positive views toward inquiry-based teaching and learning, they revealed misconceptions regarding inquiry-based learning. As examples, the majority of teachers agreed or strongly agreed that inquiry-based learning requires that learners first understand basic, key science concepts prior to engaging in inquiry activities (63%); requires learners to generate and investigate their own questions (65%); requires the use of hands-on or kit-based instructional materials (55%); and engagement in hands-on activities (78%).

Table 13. *Respondents' Views of Inquiry-Based Science Teaching and Learning*, UB/BPS ISEP Teacher Questionnaire, Summer 2012

Q32. Views of inquiry-based science teaching and learning.	*n*	**Strongly Disagree / Disagree**	**Neutral / Undecided**	**Agree / Strongly Agree**
		%	**%**	**%**
1. Inquiry-based learning requires that learners engage in answering a scientifically-oriented question.	41	7	27	**66**
2. Inquiry-based learning requires that learners gather (or are given) data to use as evidence for answering a scientifically-oriented question.	40	3	25	**73**
3. Inquiry-based learning requires that learners manipulate and analyze data to develop evidenced-based explanations, by looking for patterns and drawing conclusions.	40	0	15	**85**
4. Inquiry-based learning requires that learners connect their explanations with explanations and concepts developed by the scientific community.	40	8	25	**68**
5. Inquiry-based learning requires that learners communicate, justify, and defend their explanations.	40	5	18	**78**

Q32. Views of inquiry-based science teaching and learning.	***n***	**Strongly Disagree / Disagree**	**Neutral / Undecided**	**Agree / Strongly Agree**
		%	**%**	**%**
6. Inquiry-based learning requires that learners first understand basic, key science concepts prior to engaging in inquiry activities.	40	15	23	**63**
7. Inquiry-based learning assumes that all science subject matter should be taught through inquiry.	40	48	25	28
8. Inquiry-based learning requires that learners generate and investigate their own questions.	40	10	25	**65**
9. Inquiry-based learning requires the use of hands-on or kit-based instructional materials.	40	13	33	**55**
10. Inquiry-based learning requires that learners are engaged in hands-on activities.	40	3	20	**78**
11. Inquiry, as a process of science, can be taught without attention to specific science content or subject matter.	39	31	21	49
12. Inquiry-based learning assumes that learners build new knowledge and understanding on what they already know.	38	0	26	**74**
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.	39	0	26	**74**
14. Inquiry-based learning assumes that learning is mediated by the social environment in which learners interact with others.	38	8	42	**50**
15. Inquiry-based learning requires that learners take control of their own learning.	40	10	23	**68**
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.	38	3	29	**68**
17. Inquiry-based learning requires more sophisticated materials and equipment than other types of classroom learning.	38	47	21	32
18. Inquiry-based teaching requires that the teacher act as a facilitator or guide of student learning rather than as a disseminator of knowledge.	40	5	13	**83**
19. Inquiry-based teaching focuses more on what the students do, rather than on what the teacher does.	40	3	25	**73**
20. Inquiry-based teaching requires that the teacher have a strong background in the science content related to the inquiry.	40	3	25	**73**

Table 14 shows teachers' understanding of the nature of science. Similar to their views of inquiry-based science teaching and learning, although teachers demonstrated a good understanding of most aspects of the nature of science, they held misconceptions on scientific methods, and the relationship between scientific laws and theories. At least half of the teachers agreed that a universal step-by-step scientific method is used by all scientists (50%); that all scientific laws have accompanying explanatory theories (63%); and that scientific laws are theories that have been proven (59%).

Table 14. *Respondents' Understanding of the Nature of Science*, UB/BPS ISEP Teacher Questionnaire, Summer 2012

Q33. Understanding the nature of science.	*n*	**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.	39	0	21	**79**
2.Scientific knowledge is reliable and durable so having confidence in scientific knowledge is reasonable.	38	13	21	**66**
3.A universal step-by-step scientific method is used by all scientists.	38	16	34	**50**
4.Scientific experiments are the only means used to develop scientific knowledge.	39	49	23	28
5.Contributions to science are made by people from all cultures around the world.	39	0	8	**92**
6.Scientific observations and conclusions are influenced by the existing state of scientific knowledge.	39	3	15	**82**
7.With new evidence and/or interpretation, existing scientific ideas are replaced or supplemented by newer ones.	39	5	15	**79**
8.Basic scientific research is concerned primarily with practical outcomes related to developing technology.	39	36	38	26
9.The principal product of science is conceptual knowledge about and explanations of the natural world.	38	11	32	**58**
10.Scientific laws are generalizations or universal relationships about some aspect of the natural world and how it behaves under certain conditions.	37	11	22	**68**
11.Scientific theories are inferred explanations of some aspect of the natural world.	38	8	16	**76**
12.All scientific laws have accompanying explanatory theories.	38	5	32	**63**

Q33. Understanding the nature of science.	*n*	Strongly Disagree / Disagree	Neutral / Undecided	Agree / Strongly Agree
		%	%	%
13.Scientific conclusions are to some extent influenced by the social and cultural context of the researcher.	39	13	28	**59**
14.Scientific observations are to some extent influenced by the observer's experiences and expectations.	39	10	31	**59**
15.Scientists may make different interpretations based on the same observations.	39	8	18	**74**
16.Scientific theories are subject to on-going testing and revision.	39	0	18	**82**
17.Scientific laws are theories that have been proven.	39	15	26	**59**
18.Cultural values and expectations do not influence scientific research because scientists are trained to conduct unbiased studies.	39	33	28	38
19.Scientists do not use their imagination and creativity because these can interfere with objectivity.	39	**59**	18	23
20.Scientific knowledge is tentative and may be abandoned or modified in light of new evidence or reconceptualization of prior evidence and knowledge.	39	8	26	**67**

Design, Engineering, and Technology (DET)

More than half (54%) of ISEP teachers reported using science kids during science instruction. Among science kits listed, SEPUP was the kits used the most by teachers (Appendix D). But as shown in Table 15, even though the majority of teachers believed that it was important that pre-service education address teaching Design/Engineering/Technology (58%) and that DET be integrated into the K-12 curriculum (74%), the majority also indicated that support for teaching DET was not sufficient. Most teachers indicated that they had very little or no preparation to teach Design/Engineering/Technology, and that their schools support very little or no DET activities.

Table 15. *Respondents' Familiarity with DET and Perceived Importance of DET*, UB/BPS ISEP Teacher Questionnaire, Summer 2012

DET 1	*n*	**Not At All/ A Little**	**Neutral/ Undecided**	**Somewhat/ Very Much**	*M*	*SD*
		%	**%**	**%**		
1.How familiar are you with Design/Engineering/Technology as typically demonstrated in the examples given above?	40	45	15	40	2.85	1.21
2.Have you had any specific courses in Design/Engineering/Technology outside of your preservice curriculum?	40	**70**	15	15	1.98	1.31
3.Did your preservice curriculum include any aspects of Design/Engineering/Technology?	40	**70**	18	13	2.00	1.13
4.Was your pre-service curriculum effective in supporting your ability to teach Design/Engineering/Technology at the beginning of your career?	40	**63**	20	18	2.10	1.17
5.How confident do you feel about integrating more Design/Engineering/Technology into your curriculum?	40	38	18	45	3.17	1.32
6.How important should pre-service education be for teaching Design/Engineering/Technology?	40	23	20	**58**	3.52	1.18
7.Do you use Design/Engineering/Technology activities in the classroom?	39	49	18	33	2.77	1.35
8.Does your school support Design/Engineering/Technology activities?	39	**51**	23	26	2.59	1.19
9.Do you believe Design/Engineering/Technology should be integrated into the K-12 curriculum?	39	13	13	**74**	3.97	1.16

Table 16 shows teachers' beliefs regarding bias toward teaching to diverse groups of students. Close to half (45%) of the teachers disagreed that most people felt that female students could do well in DET and more than half (70%) of them disagreed that most people felt that minority students could do well in DET.

Table 16. *Teaching DET to Diverse Groups of Students*, UB/BPS ISEP Teacher Questionnaire, Summer 2012

DET 2	*n*	Strongly Disagree/ Disagree	Neutral/ Undecided	Agree/ Strongly Agree	*M*	*SD*
		%	%	%		
10.Most people feel that female students can do well in Design/Engineering/Technology.	40	45	15	40	3.63	0.98
11.Most people feel that minority students (African American, Hispanic / Latino, and American Indian) can do well in Design/Engineering/Technology.	40	**70**	15	15	3.68	0.94

As shown in Table 17, the majority of the teachers reported that it was important to include planning a project and using engineering to develop new technologies in science curriculum.

Table 17. *Importance of Including DET in Science Curriculum, UB/BPS ISEP Teacher Questionnaire, Summer 2012.*

DET 3	*n*	Not At All Important/A Little Important	Neutral/ Undecided	Somewhat Important/Very Important	*M*	*SD*
		%	%	%		
12. Planning a project.	40	8	15	**78**	4.27	0.99
13. Using engineering to develop new technologies.	40	8	28	**65**	3.70	0.88

Similarly, as shown in Table 18, the majority of the teachers indicated that they would like to teach their students to understand and apply the design process to solve problems.

Table 18. *Needs of Teaching DET*, UB/BPS ISEP Teacher Questionnaire, Summer 2012

DET 4	*n*	Strongly Disagree/ Disagree	Neutral/ Undecided	Agree/ Strongly Agree	*M*	*SD*
		%	%	%		
14.Design process.	40	3	20	**78**	4.03	0.77
15.Use and impact of Design/Engineering/Technology.	38	3	16	**82**	4.05	0.73
16.Science underlying Design/Engineering/Technology.	40	0	18	**83**	4.15	0.70
17.Types of problems to which Design/Engineering/Technology should be applied.	40	0	18	**83**	4.07	0.66
18.Process of communicating technical information.	40	0	10	**90**	4.30	0.65

The majority of teachers also reported their primary motivation for teaching science was to promote an enjoyment of learning, develop students' understanding of the natural and technical world. Teachers also indicated they desired to prepare young people for the world of work.

Table 19. *Respondents' Motivation for Teaching Science*, UB/BPS ISEP Teacher Questionnaire, Summer 2012

DET 5	*n*	**Strongly Disagree / Disagree**	**Neutral / Undecided**	**Agree / Strongly Agree**	*M*	*SD*
		%	**%**	**%**		
19.To prepare young people for the world of work.	40	5	8	**88**	4.18	0.78
20.To promote an enjoyment of learning.	40	3	3	**95**	4.50	0.78
21.To develop an understanding of the natural and technical world.	40	0	3	**98**	4.60	0.55
22.To develop scientists, engineers, and technologists for industry.	40	10	20	**70**	3.83	0.98
23.To promote an understanding of how Design/Engineering/Technology affects society.	40	5	13	**83**	4.15	0.83

When reflecting on barriers to integrating DET in their classrooms, the majority of teachers reported that lack of time for teachers to learn about Design/Engineering/Technology (63%), lack of teacher knowledge (58%), and training (65%) were strong barriers to integrating DET activities (Table 20).

Table 20. *Respondents' Perceived Barrier in Integrating DET in Classroom*, UB/BPS ISEP Teacher Questionnaire, Summer 2012

DET 6: Barrier	*n*	**Not Strong At All / A Little Strong**	**Neutral / Undecided**	**Somewhat Strong / Very Strong**	*M*	*SD*
		%	**%**	**%**		
24.Lack of time for teachers to learn about Design/Engineering/Technology.	40	25	13	**63**	3.65	1.33
25.Lack of teacher knowledge.	40	30	13	**58**	3.45	1.36
26.Lack of training.	40	23	13	**65**	3.65	1.27
27.Lack of administration support.	39	26	26	49	3.33	1.44

As shown in Table 21, 87% of the teachers agreed that DET has positive consequences for society.

Table 21. *Social Effect of DET*, UB/BPS ISEP Teacher Questionnaire, Summer 2012

DET 7	*n*	**Strongly Disagree / Disagree**	**Neutral / Undecided**	**Agree / Strongly Agree**	*M*	*SD*
		%	**%**	**%**		
28.Design/Engineering/Technology has positive consequences for society.	39	0	13	**87**	4.31	0.69

As shown in Table 22, 51% of ISEP teachers reported that their knowledge of the national science standards related to DET was at a moderate to high level.

Table 22. *Respondents' Knowledge about DET Standards*, UB/BPS ISEP Teacher Questionnaire, Summer 2012

DET 8	*n*	**Not At All/ A Little**	**Neutral/ Undecided**	**Somewhat/ Very Much**	*M*	*SD*
		%	**%**	**%**		
29.National science standards related to Design/Engineering/Technology?	39	36	13	**51**	3.13	1.26

As shown in Table 23, the majority of teachers reported positive views of teaching DET and believed that it was important to align DET activities with mathematics and science standards.

Table 23. *Attitudes towards Teaching DET*, UB/BPS ISEP Teacher Questionnaire, Summer 2012

DET 9	*n*	**Not At All/A Little**	**Neutral/ Undecided**	**Somewhat/ Very Much**	*M*	*SD*
		%	**%**	**%**		
30.How enthusiastic do you feel about including Design/Engineering/Technology activities in your teaching?	40	3	13	**85**	4.20	0.76
31.How prepared do you feel to include Design/Engineering/Technology activities in your teaching?	40	28	18	**55**	3.35	1.25
32.How important is it for you that Design/Engineering/Technology activities are aligned to mathematics state and national standards?	40	8	25	**68**	3.87	0.99
33.How important is it for you that Design/Engineering/Technology activities are aligned to science state and national standards?	40	8	23	**70**	3.95	1.01

Attitudes and Belief about Teaching Science and Mathematics

As shown in Table 24, teachers held positive attitudes and beliefs about teaching science and mathematics in general. Several questions revealed less consensus among mathematics teachers than among science teachers, (i.e., 40% of teachers disagreed that to understand mathematics, students must solve many problems . . .) while 40% of teachers agreed this statement. On the other hand, science teachers demonstrated more neutral views on similar issues, (i.e., 46% of science teachers reported neutral views regarding students must solve many problems).

Table 24. *Respondents' Attitudes and Beliefs about Teaching Science and Mathematics*, UB/BPS ISEP Teacher Questionnaire, Summer 2012

Q46. Attitudes and Beliefs about Teaching Science and Mathematics	*n*	**Strongly Disagree / Disagree**	**Neutral / Undecided**	**Agree / Strongly Agree**	*M*	*SD*
		%	**%**	**%**		
a. In Grades K-9, truly understanding mathematics in schools requires special abilities that only some people possess.	11	**64**	27	9	2.36	0.81
b. The use of technologies (e.g., calculators, computers) in mathematics is an aid primarily for slow learners.	10	**80**	10	10	2.20	0.79
c. Mathematics consists of unrelated topics (e.g., algebra, arithmetic, calculus, geometry).	10	**70**	10	20	2.30	1.06
d. To understand mathematics, students must solve many problems following examples provided.	10	40	20	40	3.00	0.94
e. Students should have opportunities to experience manipulating materials in the mathematics classroom before teachers introduce mathematics vocabulary.	10	20	30	**50**	3.30	1.16
f. Getting the correct answer to a problem in the mathematics classroom is more important than investigating the problem in a mathematical manner.	10	**70**	20	10	2.30	0.82
g. Students should be given regular opportunities to think about what they have learned in the mathematics classroom.	10	10	10	**80**	4.00	0.94
h. Using technologies (e.g., calculators, computers) in mathematics lessons will improve students' understanding of mathematics.	10	10	10	**80**	3.80	0.79
i. The primary reason for learning mathematics is to learn skills for doing science.	10	30	30	40	3.10	0.88
j. Small group activity should be a regular part of the mathematics classroom.	10	0	10	**90**	4.20	0.63
k. Using technologies (e.g., calculators, computers) in science lessons will improve students' understanding of science.	39	10	21	**69**	3.79	0.89
l. Getting the correct answer to a problem in the science classroom is more important than investigating the problem in a scientific manner.	39	**85**	10	5	2.00	0.73

Q46. Attitudes and Beliefs about Teaching Science and Mathematics	*n*	**Strongly Disagree / Disagree**	**Neutral / Undecided**	**Agree / Strongly Agree**	**M**	**SD**
		%	**%**	**%**		
m. In Grades K-9, truly understanding science in the science classroom requires special abilities that only some people possess.	39	**82**	10	8	1.95	0.86
n. Students should be given regular opportunities to think about what they have learned in the science classroom.	39	0	5	**95**	4.36	0.58
o. Science is a constantly expanding field.	39	0	3	**97**	4.51	0.56
p. Theories in science are rarely replaced by other theories.	39	**69**	13	18	2.36	1.09
q. To understand science, students must solve many problems following examples provided.	39	31	46	23	2.85	0.88
r. The use of technologies (e.g., calculators, computers) in science is an aid primarily for slow learners.	39	**82**	8	10	2.00	1.12
s. Students should have opportunities to experience manipulating materials in the science classroom before teachers introduce scientific vocabulary.	39	18	26	**56**	3.51	1.10
t. Science consists of unrelated topics such as biology, chemistry, geology, and physics.	39	**64**	13	23	2.38	1.33
u. Calculators should always be available for students in science classes.	39	21	33	46	3.33	1.13
v. The primary reason for learning science is to provide real-life examples for learning mathematics.	38	**55**	26	18	2.45	1.01
w. Small group activity should be a regular part of the science classroom.	39	0	15	**85**	4.13	0.66
x. The idea of teaching science scares me.	39	**85**	13	3	1.56	0.91
y. The idea of teaching engineering design concepts scares me.	38	**58**	18	24	2.39	1.20
z. I prefer to teach engineering design concepts and science emphasizing connections between the two disciplines.	39	13	**54**	33	3.28	0.89
aa. I feel prepared to teach engineering design concepts and science emphasizing connections between the two disciplines.	39	31	44	26	2.97	1.06

UB/BPS ISEP Survey of UB STEM Students Data, 2011-2012 & 2012-2013

As shown in Table 25, 19 Non-STEM students, 48 STEM undergraduate students, and 20 STEM graduate students (including one master's student and 19 doctoral students) who participated in the UB/BPS ISEP project during the academic years 2011-2012 (Fall 2011 and Spring 2012) and 2012-2013 (Fall 2012 and Spring 2013) responded to the *UB/BPS ISEP Survey of UB STEM Students*. During 2012-2013, three STEM undergraduate and 10 STEM graduate students indicated that they were returning participants with experience participating in the ISEP project in the previous year.

Table 25. *Respondents' Student Status by Participation by Academic Year, UB/BPS ISEP Survey of UB STEM Students, 2011-2012 & 2012-2013*

Academic Year	Student Status	First Year in ISEP?		Total
		No	Yes	
2011-2012	Neither STEM Undergraduate nor Graduate	0	10	10
	Undergraduate	0	25	25
	Graduate	0	7	7
	Subtotal for 2011-2012	**0**	**42**	**42**
2012-0213	Neither STEM Undergraduate nor Graduate	0	9	9
	Undergraduate	3	20	23
	Graduate	10	3	13
	Subtotal for 2012-2013	**13**	**32**	**45**
Total	Neither STEM Undergraduate nor Graduate	0	19	19
	Undergraduate	3	45	48
	Graduate	10	10	20
	Grand Total	**13**	**74**	**87**

Comparing STEM Undergraduate Students and STEM Graduate Students

Of the 68 STEM students participating in the UB/BPS ISEP project, 48 were undergraduate and 20 were graduate students. STEM undergraduate and graduate students' responses were compared using two years of data combined. As shown in Table 26, a small portion of STEM undergraduate and graduate students participated in the UB IGERT project prior to entering the UB/BPS ISEP project.

Table 26. *Respondents' Participation in the UB IGERT Project by Student Status, UB/BPS ISEP Survey of UB STEM Students, 2011-2012 & 2012-2013*

E2. Currently participating in the UB IGERT Project	STEM Undergraduate	STEM Graduate	Total
No	38	14	52
Yes	4	5	9
Total	**42**	**19**	**61**

As shown in Table 27, most STEM undergraduate students (56%) indicated that they had experience working with K–12 students outside of a classroom setting before participating in the ISEP project. Most STEM graduate students indicated that they were teaching or laboratory assistant (70%) or worked or volunteered for social, environmental, or political projects/organizations (65%) prior to joining in the ISEP project.

Table 27. *Respondents' Experience Prior to the UB/BPS ISEP Project by Student Status, UB/BPS ISEP Survey of UB STEM Students, 2011-2012 & 2012-2013*

E4. 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	3 (6%)	0 (0%)	3 (4%)
Volunteered in an elementary, middle, or high school classroom	22 (46%)	8 (40%)	30 (44%)
Tutored K–12 students in STEM	19 (40%)	4 (20%)	23 (34%)
Tutored undergraduate students in STEM	13 (27%)	9 (45%)	22 (32%)
Volunteered or worked with K–12 students outside of a classroom setting	**27 (56%)**	9 (45%)	36 (53%)
Taught at a college or university (2- or 4-year)	0 (0%)	7 (35%)	7 (10%)
Was a teaching or laboratory assistant for undergraduate or graduate courses	7 (15%)	**14 (70%)**	21 (31%)
Worked or volunteered at a science/technology museum, nature center, aquarium, zoo, or similar institution open to the public	3 (6%)	3 (15%)	6 (9%)
Worked or volunteered for social, environmental, or political projects/organizations	18 (38%)	**13 (65%)**	31 (46%)
Published a STEM-related research paper or presented a STEM-related paper or poster at a professional conference	4 (8%)	9 (45%)	13 (19%)
Wrote about or presented STEM content to a non-scientific audience	10 (21%)	2 (10%)	12 (18%)
Participated in an IGERT project	1 (2%)	6 (30%)	7 (10%)
None of the above	5 (10%)	0 (0%)	5 (7%)

Compared to STEM undergraduate students, STEM graduate students reported more concrete plans about their future careers, with 50% indicating interest in pursuing a faculty position with both teaching and research responsibilities, 70% in pursuing college or university faculty position with primarily teaching responsibilities, 85% in pursuing researcher position at a government laboratory or research institution, and 60% in pursuing research/development position in industry or business (Table 28).

Table 28. *Respondents' Career Goals by Student Status, UB/BPS ISEP Survey of UB STEM Students, 2011-2012 & 2012-2013*

E5. Career Goals	STEM Undergraduate (%)	STEM Graduate (%)	Total (%)
College or university faculty position with both teaching and research responsibilities	9 (19%)	**10 (50%)**	19 (28%)
College or university faculty position with primarily teaching responsibilities (greater emphasis on teaching than research)	6 (13%)	**14 (70%)**	20 (29%)
College or university faculty position with primarily research responsibilities (greater emphasis on research than teaching)	8 (17%)	4 (20%)	12 (18%)
College or university faculty position preparing K–12 teachers in science or mathematics education	2 (4%)	2 (10%)	4 (6%)
Researcher at a government laboratory or research institution	10 (21%)	**17 (85%)**	27 (40%)
Researcher/developer in industry/business	12 (25%)	**12 (60%)**	24 (35%)
Non-research position in the government or nonprofit sectors	5 (10%)	8 (40%)	13 (19%)
K–12 science or mathematics teacher	10 (21%)	1 (5%)	11 (16%)
K–12 administrator (e.g., school, district, State-level educational administration)	2 (4%)	0 (0%)	2 (3%)
Other	12 (25%)	0 (0%)	12 (18%)
I am unsure at this time	8 (17%)	3 (15%)	11 (16%)

Of all orientations available to students prior to working in schools, orientation in science communication was reported as the least attended orientation by STEM undergraduate students and STEM graduate students (Table 29). Graduate students, in general, reported participating in fewer orientation experiences than undergraduate students.

Table 29. *Respondents' Preparation for Working in Schools by Student Status, UB/BPS ISEP Survey of UB STEM Students, 2011-2012 & 2012-2013*

A. Preparation for working in schools	STEM Undergraduate (%)	STEM Graduate (%)	Total (%)
Orientation in urban education	**25 (52%)**	4 (20%)	29 (43%)
Orientation in culture and diversity	**27 (56%)**	6 (30%)	33 (49%)
Orientation in teamwork/collaboration	23 (48%)	7 (35%)	30 (44%)
Orientation in science teaching and learning	**24 (50%)**	**10 (50%)**	34 (50%)
Orientation in science communications	5 (10%)	2 (10%)	7 (10%)
Orientation in mentoring	**30 (63%)**	8 (40%)	38 (56%)
Other	7 (15%)	6 (30%)	13 (19%)

As shown in Table 30, both undergraduate and graduate students indicated that their major responsibilities in schools included assisting teachers in teaching lessons, and in 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 (60%) and helped teachers find resources (70%).

Table 30. *Respondents' Experience in Schools by Student Status, UB/BPS ISEP Survey of UB STEM Students, 2011-2012 & 2012-2013*

B. Experiences in schools	**STEM Undergraduate (%)**	**STEM Graduate (%)**	**Total (%)**
Assisted teachers in teaching lessons	**29 (60%)**	**13 (65%)**	42 (62%)
Assisted teachers in conducting labs	**32 (67%)**	**15 (75%)**	47 (69%)
Developed science labs for class use	10 (21%)	**12 (60%)**	22 (32%)
Developed out-of-school science learning activities	5 (10%)	7 (35%)	12 (18%)
Led small group activities/discussions with students in class	**33 (69%)**	**14 (70%)**	47 (69%)
Led small group activities/discussions with students after school or during weekend	8 (17%)	6 (30%)	14 (21%)
Demonstrated scientific content, procedures, tools, or techniques to students	**30 (63%)**	**14 (70%)**	44 (65%)
Helped teachers find relevant resources (e.g., science activities)	10 (21%)	**14 (70%)**	24 (35%)
Presented lessons/lectures to students in class	11 (23%)	8 (40%)	19 (28%)
Tutored students after school or during weekends	5 (10%)	1 (5%)	6 (9%)
Other	5 (10%)	2 (10%)	7 (10%)

When reflecting on reasons for participating in the ISEP project, a majority of students from both groups reported that faculty encouragement, sharing STEM knowledge, gaining new experience, and to enhance C.V. as reasons. Most STEM undergraduate students also indicated that working with school-age students was an important reason. In addition, most STEM graduate students also listed financial support and developing teaching skills, and science communication skills as reasons for participating in this project (Table 31).

Table 31. *Respondents' Reasons for Participating in UB/BPS ISEP Project by Student Status, UB/BPS ISEP Survey of UB STEM Students, 2011-2012 & 2012-2013*

C1. Reasons for participating in UB/BPS ISEP	**STEM Undergraduate (%)**	**STEM Graduate (%)**	**Total (%)**
To gain financial support for my education	3 (6%)	**16 (80%)**	19 (28%)
My faculty advisor or another faculty member encouraged me	**32 (67%)**	**12 (60%)**	44 (65%)
Another student(s) encouraged me to participate	8 (17%)	5 (25%)	13 (19%)
To share my knowledge of science, technology, engineering and/or mathematics	**25 (52%)**	**18 (90%)**	43 (63%)
To work with school-age students	**29 (60%)**	9 (45%)	38 (56%)
I was interested in a teaching career	15 (31%)	7 (35%)	22 (32%)
To have new experiences	**31 (65%)**	**14 (70%)**	45 (66%)
To enhance my C.V. or resume	**30 (63%)**	**12 (60%)**	42 (62%)

C1. Reasons for participating in UB/BPS ISEP	STEM Undergraduate (%)	STEM Graduate (%)	Total (%)
To develop my teaching skills	23 (48%)	**15 (75%)**	38 (56%)
To develop my teamwork skills	15 (31%)	5 (25%)	20 (29%)
To develop my science communication skills	17 (35%)	**13 (65%)**	30 (44%)
To develop my research skills	14 (29%)	3 (15%)	17 (25%)
Other	8 (17%)	3 (15%)	11 (16%)

Table 32 shows the differences in responses about the benefits of UB/BPS ISEP project between STEM undergraduate and graduate students. Compared to STEM undergraduate students, graduate students reported significantly higher levels of agreement that the ISEP experience enhanced their abilities to develop instructional materials about STEM concepts and methods, generate others' interest in STEM research and activities, develop a research and/or technology agenda, and explain STEM research and concepts to public audience. 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 32. *Respondents' Perceived Benefit in Participating in UB/BPS ISEP Project by Student Status, UB/BPS ISEP Survey of UB STEM Students, 2011-2012 & 2012-2013*

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	48	2.92	0.74	32.35	377.00	.355
	STEM Graduate	18	3.11	0.47	36.56		
C2b. Lead a team	STEM Undergraduate	48	3.00	0.71	32.71	394.00	.532
	STEM Graduate	18	3.11	0.68	35.61		
C2c. Facilitate group discussions	STEM Undergraduate	48	3.27	0.54	34.36	390.50	.469
	STEM Graduate	18	3.17	0.51	31.19		
C2d. Teach STEM concepts and methods	STEM Undergraduate	48	3.13	0.57	30.93	308.50	.078
	STEM Graduate	17	3.41	0.51	38.85		
C2e. Develop instructional materials about STEM concepts and methods	STEM Undergraduate	47	2.64	0.67	29.52	259.50	**.007**
	STEM Graduate	18	3.11	0.47	42.08		
C2f. Generate others' interest in STEM research and activities	STEM Undergraduate	47	3.00	0.59	29.68	267.00	**.008**
	STEM Graduate	18	3.44	0.51	41.67		
C2g. Conduct research as part of a collaborative team	STEM Undergraduate	48	2.33	0.78	31.26	324.50	.180
	STEM Graduate	17	2.65	0.79	37.91		
C2h. Conduct independent research	STEM Undergraduate	48	2.40	0.74	32.44	381.00	.658
	STEM Graduate	17	2.47	0.62	34.59		
C2i. Develop a research and/or technology agenda	STEM Undergraduate	48	2.23	0.59	29.60	245.00	**.002**
	STEM Graduate	18	2.72	0.46	43.89		
C2j. Write papers and reports about my work	STEM Undergraduate	48	2.75	0.73	36.71	278.00	**.017**
	STEM Graduate	18	2.28	0.83	24.94		

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)**
C2k. Present my work at a professional conference	STEM Undergraduate	48	2.17	0.56	32.75	396.00	.832
	STEM Graduate	17	2.24	0.75	33.71		
C2l. Explain STEM research and concepts to public (non-technical) audience	STEM Undergraduate	47	2.60	0.68	28.22	198.50	**< .001**
	STEM Graduate	18	3.28	0.46	45.47		
C2m. Decide a career in education	STEM Undergraduate	48	2.60	0.82	33.23	419.00	.841
	STEM Graduate	18	2.61	0.85	34.22		
C2n. Understand science concepts better	STEM Undergraduate	48	2.71	0.92	32.45	381.50	.440
	STEM Graduate	18	2.94	0.80	36.31		

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 33 shows STEM graduate students reported that their interest in teaching at the college/university level and in influencing public policy related to STEM education were increased by their ISEP participation more than did STEM undergraduate students.

Table 33. *Respondents' Perceived Effects of Participating in UB/BPS ISEP Project by Student Status, UB/BPS ISEP Survey of UB STEM Students, 2011-2012 & 2012-2013*

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	48	3.40	0.71	33.25	420.00	.839
	STEM Graduate	18	3.39	0.70	34.17		
C3b. My interest in teaching at the college/university level	STEM Undergraduate	48	3.56	0.74	30.23	275.00	**.014**
	STEM Graduate	18	4.06	0.73	42.22		
C3c. My interest in teaching at the K–12 level	STEM Undergraduate	48	3.38	1.10	34.59	379.50	.431
	STEM Graduate	18	3.17	0.99	30.58		
C3d. My interest in influencing public policy related to STEM education	STEM Undergraduate	48	3.88	0.79	29.94	261.00	**.009**
	STEM Graduate	18	4.44	0.62	43.00		

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 34. Compared to STEM undergraduate students, STEM graduate students reported that they were more effective at communicating science content to students and at working with science teachers to develop science learning experiences. Though not statistically significant, STEM undergraduate students reported more skills in working with students informally and individually than did STEM graduate students.

Table 34. *Respondents' Self-Efficacy in Communicating Science by Student Status, UB/BPS ISEP Survey of UB STEM Students, 2011-2012 & 2012-2013*

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	48	3.85	0.74	31.55	338.50	.147
	STEM Graduate	18	4.17	0.79	38.69		
D2. Understand middle and high school students' interest in science	STEM Undergrad	48	3.85	0.65	30.49	287.50	**.019**
	STEM Graduate	18	4.28	0.57	41.53		
D3. Understand middle and high school students' cognitive abilities	STEM Undergrad	48	3.60	0.76	31.72	346.50	.177
	STEM Graduate	18	3.83	0.51	38.25		
D4. Understand middle and high school students' social and cultural backgrounds	STEM Undergrad	48	3.69	0.93	32.44	381.00	.430
	STEM Graduate	18	3.89	0.76	36.33		
D5. Understand middle and high school students' attention span	STEM Undergrad	48	4.06	0.84	35.72	325.50	.093
	STEM Graduate	18	3.56	1.15	27.58		
D6. Decide what science topics are appropriate to students	STEM Undergrad	48	3.50	0.80	29.81	255.00	**.006**
	STEM Graduate	18	4.11	0.83	43.33		
D7. Decide how much science content is appropriate to students	STEM Undergrad	48	3.23	0.66	30.18	272.50	**.012**
	STEM Graduate	18	3.78	1.06	42.36		
D8. Help teachers find relevant resources (e.g., science activities)	STEM Undergrad	48	3.44	0.97	28.38	186.00	**< .001**
	STEM Graduate	18	4.44	0.70	47.17		
D9. Develop science labs	STEM Undergrad	48	3.04	1.09	27.90	163.00	**< .001**
	STEM Graduate	18	4.33	0.91	48.44		
D10. Develop out-of-school science learning activities	STEM Undergrad	48	3.00	1.13	30.54	290.00	**.034**
	STEM Graduate	18	3.67	0.97	41.39		
D11. Assist teachers in teaching lessons	STEM Undergrad	48	3.90	0.93	31.47	334.50	.139
	STEM Graduate	18	4.28	0.83	38.92		
D12. Assist teachers in conducting labs	STEM Undergrad	48	4.00	0.77	28.44	189.00	**< .001**
	STEM Graduate	18	4.78	0.43	47.00		
D13. Teach science labs to students	STEM Undergrad	48	3.83	0.91	30.46	286.00	.054
	STEM Graduate	17	4.29	0.85	40.18		
D14. Facilitate out-of-school science learning activities	STEM Undergrad	48	3.08	1.03	31.04	314.00	.074
	STEM Graduate	18	3.61	1.04	40.06		
D15. Lead small group activities/discussions with students in class	STEM Undergrad	48	4.02	1.02	32.55	386.50	.486
	STEM Graduate	18	4.28	0.67	36.03		
D16. Lead small group activities/discussions with students after school or during weekends	STEM Undergrad	48	3.02	1.19	33.93	363.50	.494
	STEM Graduate	17	2.82	1.38	30.38		

D. How much I can do in order to...	Student Status	*n*	*M*	*SD*	Mean Rank	Mann-Whitney U-statistics	*p* (2-tailed)
D17. Demonstrate scientific content, procedures, tools, or techniques to students	STEM Undergrad	47	3.96	0.91	30.73	316.50	.094
	STEM Graduate	18	4.39	0.50	38.92		
D18. Teach lessons or give lectures to students in class	STEM Undergrad	48	3.50	1.11	31.54	338.00	.158
	STEM Graduate	18	3.89	0.96	38.72		
D19. Tutor students after school or during weekends	STEM Undergrad	48	3.21	1.25	34.38	342.00	.312
	STEM Graduate	17	2.88	1.22	29.12		
D20. Explain a difficult science concept to students	STEM Undergrad	48	3.81	0.87	30.43	284.50	**.024**
	STEM Graduate	18	4.33	0.59	41.69		

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

Comparing First Year Participants and Returning Participants (STEM Graduate Students)

Of the 20 responses received from STEM graduate students who participated in the UB/BPS ISEP project in academic years 2011-2012 and 2012-2013, 10 were in their first year with this project and 10 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 to this instrument, no pre-post matched comparisons were conducted for testing the changes in perceptions of these returning students. Due to small sample sizes, Mann-Whitney *U*-test 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 one year and who were new to the project.

Compared to first-year STEM graduate student participants, the veteran participants reported less interest in pursuing college or university faculty position with both teaching and research responsibilities and more interest in purposing research/development position in industry or business field (Table 35).

Table 35. *Respondents' Career Goals by Participation Status, UB/BPS ISEP Survey of UB STEM Students, STEM Graduate Students Only, 2011-2012 & 2012-2013*

E5. Career Goals	Not First Year in ISEP (%)	First Year in ISEP (%)	Total (%)
College or university faculty position with both teaching and research responsibilities	4 (40%)	**6 (60%)**	10 (50%)
College or university faculty position with primarily teaching responsibilities (greater emphasis on teaching than research)	**7 (70%)**	**7 (70%)**	14 (70%)
College or university faculty position with primarily research responsibilities (greater emphasis on research than teaching)	3 (30%)	1 (10%)	4 (20%)
College or university faculty position preparing K–12 teachers in science or mathematics education	1 (10%)	1 (10%)	2 (10%)

E5. Career Goals	Not First Year in ISEP (%)	First Year in ISEP (%)	Total (%)
Researcher at a government laboratory or research institution	**8 (80%)**	**9 (90%)**	17 (85%)
Researcher/developer in industry/business	**8 (80%)**	4 (40%)	12 (60%)
Non-research position in the government or nonprofit sectors	4 (40%)	4 (40%)	8 (40%)
K–12 science or mathematics teacher	1 (10%)	0 (0%)	1 (5%)
K–12 administrator (e.g., school, district, State-level educational administration)	0 (0%)	0 (0%)	0 (0%)
Other	0 (0%)	0 (0%)	0 (0%)
I am unsure at this time	1 (10%)	2 (20%)	3 (15%)

As shown in Table 36, first-year graduate student participants indicated that they participated in more orientation in teamwork/collaboration for working in schools than did returning participants.

Table 36. *Respondents' Preparation for Working in Schools by Participation Status, UB/BPS ISEP Survey of UB STEM Students, STEM Graduate Students Only, 2011-2012 & 2012-2013*

A. Preparation for working in schools	Not First Year in ISEP (%)	First Year in ISEP (%)	Total (%)
Orientation in urban education	1 (10%)	3 (30%)	4 (20%)
Orientation in culture and diversity	4 (40%)	2 (20%)	6 (30%)
Orientation in teamwork/collaboration	2 (20%)	**5 (50%)**	7 (35%)
Orientation in science teaching and learning	**5 (50%)**	**5 (50%)**	10 (50%)
Orientation in science communications	0 (0%)	2 (20%)	2 (10%)
Orientation in mentoring	4 (40%)	4 (40%)	8 (40%)
Other	1 (10%)	**5 (50%)**	6 (30%)

As shown in Table 37, returning graduate student participants indicated that their activities in schools were more highly integrated and comprehensive than did first-year graduate students. In addition, more first year graduate students indicated that they presented lessons/lectures to students in class than did the returning participants.

Table 37. *Respondents' Experience in Schools by Participation Status, UB/BPS ISEP Survey of UB STEM Students, STEM Graduate Students Only, 2011-2012 & 2012-2013*

B. Experiences in schools	Not First Year in ISEP (%)	First Year in ISEP (%)	Total (%)
Assisted teachers in teaching lessons	**8 (80%)**	**5 (50%)**	13 (65%)
Assisted teachers in conducting labs	**9 (90%)**	**6 (60%)**	15 (75%)
Developed science labs for class use	**7 (70%)**	**5 (50%)**	12 (60%)
Developed out-of-school science learning activities	4 (40%)	3 (30%)	7 (35%)
Led small group activities/discussions with students in class	**9 (90%)**	**5 (50%)**	14 (70%)
Led small group activities/discussions with students after school or during weekend	3 (30%)	3 (30%)	6 (30%)

B. Experiences in schools	Not First Year in ISEP (%)	First Year in ISEP (%)	Total (%)
Demonstrated scientific content, procedures, tools, or techniques to students	**7 (70%)**	**7 (70%)**	14 (70%)
Helped teachers find relevant resources (e.g., science activities)	**8 (80%)**	**6 (60%)**	14 (70%)
Presented lessons/lectures to students in class	3 (30%)	**5 (50%)**	8 (40%)
Tutored students after school or during weekends	1 (10%)	0 (0%)	1 (5%)
Other	0 (0%)	1 (10%)	1 (5%)

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 38). More returning participants than new participants listed faculty encouragement as one of the reasons for participating in the UB/BPS ISEP project.

Table 38. *Respondents' Reasons for Participating in UB/BPS ISEP Project by Participation Status, UB/BPS ISEP Survey of UB STEM Students, STEM Graduate Students Only, 2011-2012 & 2012-2013*

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	**8 (80%)**	**8 (80%)**	16 (80%)
My faculty advisor or another faculty member encouraged me	**8 (80%)**	4 (40%)	12 (60%)
Another student(s) encouraged me to participate	1 (10%)	4 (40%)	5 (25%)
To share my knowledge of science, technology, engineering and/or mathematics	**9 (90%)**	**9 (90%)**	18 (90%)
To work with school-age students	4 (40%)	**5 (50%)**	9 (45%)
I was interested in a teaching career	3 (30%)	4 (40%)	7 (35%)
To have new experiences	**8 (80%)**	**6 (60%)**	14 (70%)
To enhance my C.V. or resume	**6 (60%)**	**6 (60%)**	12 (60%)
To develop my teaching skills	**7 (70%)**	**8 (80%)**	15 (75%)
To develop my teamwork skills	2 (20%)	3 (30%)	5 (25%)
To develop my science communication skills	**7 (70%)**	**6 (60%)**	13 (65%)
To develop my research skills	0 (0%)	3 (30%)	3 (15%)
Other	0 (0%)	3 (30%)	3 (15%)

Table 39 shows that there were no statistically significant differences between first-year and veteran students' responses about the benefits of the UB/BPS ISEP project.

Table 39. *Respondents' Perceived Benefit in Participating in UB/BPS ISEP Project by Participation Status, UB/BPS ISEP Survey of UB STEM Students, STEM Graduate Students Only, 2011-2012 & 2012-2013*

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	8	3.00	0.53	8.63	33	.391
	Not First Year in ISEP	10	3.20	0.42	10.20		
C2b. Lead a team	First Year in ISEP	8	3.00	0.53	8.63	33	.488
	Not First Year in ISEP	10	3.20	0.79	10.20		
C2c. Facilitate group discussions	First Year in ISEP	8	3.13	0.35	9.06	37	.691
	Not First Year in ISEP	10	3.20	0.63	9.85		
C2d. Teach STEM concepts and methods	First Year in ISEP	8	3.38	0.52	8.69	34	.778
	Not First Year in ISEP	9	3.44	0.53	9.28		
C2e. Develop instructional materials about STEM concepts and methods	First Year in ISEP	8	3.00	0.53	8.63	33	.391
	Not First Year in ISEP	10	3.20	0.42	10.20		
C2f. Generate others' interest in STEM research and activities	First Year in ISEP	8	3.38	0.52	8.88	35	.606
	Not First Year in ISEP	10	3.50	0.53	10.00		
C2g. Conduct research as part of a collaborative team	First Year in ISEP	7	2.71	0.76	9.21	34	.874
	Not First Year in ISEP	10	2.60	0.84	8.85		
C2h. Conduct independent research	First Year in ISEP	7	2.43	0.53	8.43	31	.659
	Not First Year in ISEP	10	2.50	0.71	9.40		
C2i. Develop a research and/or technology agenda	First Year in ISEP	8	2.63	0.52	8.63	33	.423
	Not First Year in ISEP	10	2.80	0.42	10.20		
C2j. Write papers and reports about my work	First Year in ISEP	8	2.25	0.89	9.25	38	.839
	Not First Year in ISEP	10	2.30	0.82	9.70		
C2k. Present my work at a professional conference	First Year in ISEP	7	2.43	0.98	10.00	28	.440
	Not First Year in ISEP	10	2.10	0.57	8.30		
C2l. Explain STEM research and concepts to public (non-technical) audience	First Year in ISEP	8	3.13	0.35	8.13	29	.208
	Not First Year in ISEP	10	3.40	0.52	10.60		
C2m. Decide a career in education	First Year in ISEP	8	2.63	0.92	9.63	39	.923
	Not First Year in ISEP	10	2.60	0.84	9.40		
C2n. Understand science concepts better	First Year in ISEP	8	3.00	0.76	9.88	37	.777
	Not First Year in ISEP	10	2.90	0.88	9.20		

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 40 shows that there were no statistically significant differences in responses about the change in interest level in teaching and research as a result of the UB/BPS ISEP project between first-year and veteran STEM graduate student participants.

Table 40. *Respondents' Perceived Effects of Participating in UB/BPS ISEP Project by Participation Status, UB/BPS ISEP Survey of UB STEM Students, STEM Graduate Students Only, 2011-2012 & 2012-2013*

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	8	3.25	0.46	8.50	32	.425
	Not First Year in ISEP	10	3.50	0.85	10.30		
C3b. My interest in teaching at the college/university level	First Year in ISEP	8	4.13	0.64	9.94	37	.735
	Not First Year in ISEP	10	4.00	0.82	9.15		
C3c. My interest in teaching at the K–12 level	First Year in ISEP	8	3.25	1.04	9.63	39	.925
	Not First Year in ISEP	10	3.10	0.99	9.40		
C3d. My interest in influencing public policy related to STEM education	First Year in ISEP	8	4.50	0.53	9.75	38	.841
	Not First Year in ISEP	10	4.40	0.70	9.30		

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 41 shows that there were no statistically significant differences in students' responses about their level of self-efficacy in communicating science between first-year and veteran STEM graduate student participants, with one exception. Compared to first-year graduate student participants, returning participants reported that they were better able to understand middle and high school students' cognitive abilities.

Table 41. Respondents' *Self-Efficacy in Communicating Science by Participation Status, UB/BPS ISEP Survey of UB STEM Students, STEM Graduate Students Only, 2011-2012 & 2012-2013*

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	8	4.00	0.76	8.38	31	.392
	Not First Year in ISEP	10	4.30	0.82	10.40		
D2. Understand middle and high school students' interest in science	First Year in ISEP	8	4.00	0.53	7.31	23	.070
	Not First Year in ISEP	10	4.50	0.53	11.25		
D3. Understand middle and high school students' cognitive abilities	First Year in ISEP	8	3.50	0.53	6.75	18	**.013**
	Not First Year in ISEP	10	4.10	0.32	11.70		
D4. Understand middle and high school students' social and cultural backgrounds	First Year in ISEP	8	3.50	0.93	7.13	21	.054
	Not First Year in ISEP	10	4.20	0.42	11.40		
D5. Understand middle and high school students' attention span	First Year in ISEP	8	3.25	1.28	8.00	28	.224
	Not First Year in ISEP	10	3.80	1.03	10.70		

D. How much I can do in order to...	Experience in ISEP	*n*	*M*	*SD*	Mean Rank	Mann-Whitney U-statistics	*p* (2-tailed)
D6. Decide what science topics are appropriate to students	First Year in ISEP	8	4.13	0.64	9.19	38	.808
	Not First Year in ISEP	10	4.10	0.99	9.75		
D7. Decide how much science content is appropriate to students	First Year in ISEP	8	3.88	0.99	9.56	40	.963
	Not First Year in ISEP	10	3.70	1.16	9.45		
D8. Help teachers find relevant resources (e.g., science activities)	First Year in ISEP	8	4.38	0.74	9.00	36	.690
	Not First Year in ISEP	10	4.50	0.71	9.90		
D9. Develop science labs	First Year in ISEP	8	4.38	0.74	9.31	39	.882
	Not First Year in ISEP	10	4.30	1.06	9.65		
D10. Develop out-of-school science learning activities	First Year in ISEP	8	4.00	0.76	11.25	26	.194
	Not First Year in ISEP	10	3.40	1.07	8.10		
D11. Assist teachers in teaching lessons	First Year in ISEP	8	4.63	0.52	11.38	25	.147
	Not First Year in ISEP	10	4.00	0.94	8.00		
D12. Assist teachers in conducting labs	First Year in ISEP	8	4.75	0.46	9.25	38	.805
	Not First Year in ISEP	10	4.80	0.42	9.70		
D13. Teach science labs to students	First Year in ISEP	7	4.43	0.53	9.21	34	.872
	Not First Year in ISEP	10	4.20	1.03	8.85		
D14. Facilitate out-of-school science learning activities	First Year in ISEP	8	3.75	0.89	9.88	37	.777
	Not First Year in ISEP	10	3.50	1.18	9.20		
D15. Lead small group activities/discussions with students in class	First Year in ISEP	8	4.25	0.89	9.63	39	.922
	Not First Year in ISEP	10	4.30	0.48	9.40		
D16. Lead small group activities/discussions with students after school or during weekends	First Year in ISEP	7	3.14	1.46	10.21	27	.395
	Not First Year in ISEP	10	2.60	1.35	8.15		
D17. Demonstrate scientific content, procedures, tools, or techniques to students	First Year in ISEP	8	4.38	0.52	9.38	39	.916
	Not First Year in ISEP	10	4.40	0.52	9.60		
D18. Teach lessons or give lectures to students in class	First Year in ISEP	8	4.25	0.46	11.25	26	.168
	Not First Year in ISEP	10	3.60	1.17	8.10		
D19. Tutor students after school or during weekends	First Year in ISEP	7	2.86	1.35	8.86	34	.920
	Not First Year in ISEP	10	2.90	1.20	9.10		
D20. Explain a difficult science concept to students	First Year in ISEP	8	4.13	0.64	7.94	28	.206
	Not First Year in ISEP	10	4.50	0.53	10.75		

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

Summary and Recommendations

Year 2 Findings of Interest

Notable Findings regarding ISEP Teachers

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.

ISEP teachers felt best-prepared to instruct in the life sciences but less prepared to teach physical sciences content. More than half 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 students who have limited English proficiency or those with a learning disability.

Though ISEP teachers reported high levels of preparedness to teach science, more than half indicated moderate or high priority professional development needs in all 30 areas related to providing science instruction to students. 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.

Although ISEP teachers demonstrated positive views toward inquiry-based teaching and learning, they revealed a number of common misconceptions regarding classroom scientific inquiry. 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. ISEP teachers held positive attitudes and beliefs about teaching science and mathematics in general.

The majority of ISEP teachers believed that Design/Engineering/Technology should be integrated into the K-12 curriculum, but the majority also indicated that support for teaching DET 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.

Notable Findings regarding ISEP STEM Students

Most ISEP STEM students indicated that they had experience working with K–12 students prior to participating in the ISEP project. STEM graduate students indicated more experience and a broader range of experiences than did STEM undergraduate students.

Not surprisingly, STEM graduate students reported more concrete plans about their future career, with a large number indicating interest in pursuing faculty positions with teaching responsibilities. Compared to first-year STEM graduate students, veteran ISEP participants reported less interest in pursuing teaching, and more interest in pursuing research positions in industry or business, following the second year of participation in the project.

ISEP STEM undergraduate and graduate students indicated that they managed a number of major responsibilities in schools, both assisting teachers and working directly with students. Returning STEM graduate students indicated that their work in the classroom was more highly integrated and comprehensive, compared to first-year graduate students and to STEM undergraduate students.

ISEP STEM graduate students reported that the ISEP experience improved their 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.

Observations and Recommendations

Based upon the findings of the external evaluation, the E & A Center makes the following recommendations for Year 3:

1. After performing analysis of pre/post *UB/BPS ISEP Teacher Questionnaire* 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.

2. In order to continue to test the psychometric properties of the *UB/BPS ISEP Teacher Questionnaire*, the E & A Center:
   a) Will repeat the factor analyses and reliability tests using all teacher pre and post data to determine if the performance of some subscales is improved and to make recommendations for modification to the instrument, if necessary.
   b) Recommends that the lower performing subscales (i.e., Science as Inquiry, Understanding the Nature of Science) be added to the revised *UB/BPS ISEP STEM Student Questionnaire* in order to provide more data for factor analysis. Evaluators also are interested in exploring whether ISEP STEM graduate students hold the same misconceptions regarding scientific inquiry and nature of science as do ISEP teachers.

3. Evaluators note that the ISEP project continues to develop and enhance partnerships which are critical to the project's mission and goals. Evaluators know this to be a unique feature of this MSP project and would like to partner with the project team to explore and report on the project's strategies that are resulting in successful outreach to and authentic collaboration with a range of STEM faculty and a mutually beneficial and reinforcing partnership with the Buffalo Public Schools, its teachers, administrators, parents, and the community. Evaluators believe that dissemination of information about this aspect of the project could be highly important to the field and to the MSP Program.

4. 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 look forward to these observations to collect supplementary qualitative data that can contextualize evaluation quantitative data during the next project year.

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 (Years 1-5) ANOVA	POSTT (Schuster, et al, 2010) 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) (Years 1-5) Rubric scored ANOVA	Teacher Views of NOS and SI (Crawford, Capps, & Woodruff, 2008) based on VNOS-Form C (Lederman et al, 2002) Teacher Survey of Design, Engineering, and Technology – Importance of DET and Familiarity with DET subscales (Yasar, et al, 2006) 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) Protocol-based observations of teacher classrooms (Years 2-5) Rasch modeling Hierarchical linear modeling (growth models) when quality of data and sample size are sufficient.	OMSP CPE Teacher Needs Assessment (Woodruff & Zorn, 2010) OMSP CPE Teacher Instructional Practices Questionnaire (Woodruff, 2010) based on Local Systemic Change teacher questionnaire (Horizon Research, Inc) Fossil Finders Teacher Views of NOS and SI (Crawford, Capps, & Woodruff, 2008) based on VNOS-Form C (Lederman et al, 2002) Local Systemic Change	*UB/BPS ISEP Teacher Questionnaire* *UB/BPS ISEP BPS Student Questionnaire*

		Classroom Observation Protocol (Horizon Research, Inc) What Is Happening in This Class (WIHIC) Questionnaire (Aldridge & Fraser, 2000) 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 Science teacher population diversity will increase 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) Descriptive statistics disaggregated by race/ethnicity and gender Chi-square analysis and/or Qualitative categorization	District HR data OMSP CPE Teacher Needs Assessment (Woodruff & Zorn, 2010)	*UB/BPS ISEP Teacher Questionnaire* *UB/BPS ISEP School-level Data (2009-2014)* *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) Descriptive statistics and ANOVA	School Culture Assessment Questionnaire (Sashkin, 1995) 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 (Years 1 and 5) 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) ANCOVA	District or classroom data regarding student district and/or state standardized test scores	*UB/BPS ISEP School-level Data (2009-2014)* *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) Rasch modeling and ANOVA	Science, Technology, and Society Attitude Scale (Attitude Domain) (Enger & Yager, 2000) 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) Pre- and post-questionnaire administered to participating teachers and principals (Years 1-5)	Tracking sheet of parent participation at school or classroom level (TBD by project team) 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) Repeated measures, post-questionnaire administered annually to teachers (Years 1-5) 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) Repeated measures, post-questionnaire administered annually to STEM students (Years 1-5) Rasch modeling Hierarchical linear modeling (growth models) when quality of data and sample size are sufficient	Faculty Questionnaire (E & A Center)	*UB/BPS ISEP Faculty Questionnaire* *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) 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) 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) 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) 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 Survey of STEM students at the beginning and end of each academic year		*UB/BPS ISEP STEM Student Questionnaire*

Appendix B. UB/BPS Interdisciplinary Science and Engineering Partnership (ISEP)
Survey of UB STEM Students

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

In order to…	**How Much Can You Do?**				
	Nothing	**Very Little**	**Some Influence**	**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	☐	☐	☐	☐	☐

Section E: Background

E1. Are you currently a STEM undergraduate or graduate student? Choose one of the following:

☐ No
☐ Yes (please further choose one of the following):

☐ Undergraduate ☐ Master's ☐ Doctoral

E2. Are you currently participating in the UB IGERT Project?
☐ No
☐ Yes

E3. Which of the following disciplines are most closely aligned with what you are currently studying at UB? *(Rank up to 2, with 1 being your primary discipline of study.)*

Discipline	*Rank*
☐ 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 (please specify)	________
☐ Social Sciences	________
☐ Other (please specify):	________

E4. Before participating in the UB/BPS ISEP Project, did you ever 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

E5. 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)

☐ Other (please specify): ________________________

☐ I am unsure at this time

______________________________THE END ______________________________

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Appendix C. 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

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

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?

Appendix D. Findings from UB/BPS ISEP Teacher Questionnaire Data, Summer 2012

Demographics

Table D1. *Respondents' Race and Gender, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Race/Ethnicity	**Female**	**Male**	**Total (%)**
White, non-Hispanic	23	19	42 (91%)
African American, non-Hispanic	1	0	1 (2%)
Hispanic	0	0	0
Asian/Pacific Islander	0	0	0
American Indian/Alaskan native	0	0	0
Multiracial	0	1	1 (2%)
Other, not indicated	2	0	0
Total	**26 (57%)**	**20 (43%)**	**46 (100%)**

Table D2 *Respondents' Position, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Teaching	***n***	**Percent**
Currently Teaching Science	45	98
Currently Teaching Mathematics	5	11
Special Education Teacher	9	20
Career/Technical Education Teacher	1	2
Presently Teaching in an Area for Which Teachers Hold a Certificate/License	45	98

Table D3. *Respondents' Highly Qualified Teacher Status, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Meet NCLB Requirements for Highly Qualified Teacher Status	***n***	**Percent**
No	1	2
Unsure	1	2
Yes	44	96
Total	**46**	**100**

Table D4. *Respondents' Teaching Credential, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Certification	***n***	**Percent**
Certified to Teach Science	41	89
Certified to Teach Mathematics	6	13
Hold Special Education Certificate	9	20
Hold Technology Education Certificate	0	0

Table D5. *Respondents' Teaching Experience, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Years of Experience	***n***	***M***	***SD***	**Minimum**	**Median**	**Maximum**
Teaching in a K-12 school	46	14	8	3	12	43
Teaching in K-12 Math	13	11	9	2	10	35
Teaching in K-12 Science	45	13	8	1	11	43
Teaching in Current School	45	7	6	0	6	31

Table D6. *Grade(s) Taught by Respondents,, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Grade Level Currently Teaching	**Science (%)**	**Math (%)**
Grade 4	1 (2%)	0
Grade 5	2 (4%)	0
Grade 6	5 (11%)	3 (7%)
Grade 7	6 (13%)	1 (2%)
Grade 8	7 (15%)	0
Grade 9	27 (59%)	0
Grade 10	25 (54%)	1 (2%)
Grade 11	21 (46%)	0
Grade 12	18 (39%)	0

Table D7. *Subject Area Taught by Respondents, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Courses Currently Teaching	***n***	**Percent**
3rd Grade Science	0	0
4th Grade Science	1	2
5th Grade Science	2	4
6th Grade Science	5	11
7th Grade Physical Science	5	11
8th Grade Life Science	5	11
Regents Biology	23	50
Regents Earth Science	12	26
Regents Chemistry	3	7
Regents Physics	2	4
High School Environmental Science	9	20
High School AP Biology	3	7
High School AP Chemistry	0	0
High School AP Physics	0	0
High School AP Environmental Science	2	4
High School IB Biology Jr. & Sr.	0	0
High School IB Physics Jr. & Sr.	0	0
High School Advanced Biology	1	2
High School Advanced General Chemistry	0	0
High School Organic Chemistry	0	0

Table D8. *Respondents' Mathematics and Science Teaching Credentials, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Fields Certified to Teach Mathematics and Science		***n***	**Percent**
Mathematics			
Elementary	PreK-6, 5-6	6	13
Middle Grades	5-9, 7-8, 7-9	4	9
High School	7-12	2	4
Science			
Elementary	PreK-6, 5-6	10	22
Middle Grades	5-9, 7-8, 7-9	24	52
High School (7-12)	7-12	35	76
Certification Areas:	Biology	28	61
	Chemistry	7	15
	Earth Science	13	28

	General Science	13	28
	Physics	5	11
Others Fields			
Other	Special Education	9	20
	Technology Education	1	2

Table D9. *Respondents' Previous PD Experience, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Previous PD with UB or BSC	*n*	Percent
2011-2012	21	46
2010-2011	14	30
No	19	41

Table D10. *Respondents' Amount of PD Activities, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Number of Hours	Year	*n*	*M*	*SD*	Minimum	Median	Maximum
UB/BSC Related PD							
Content	2010-2011	12	22	22	3	12	65
	2011-2012	14	17	22	0	10	75
Assessment	2010-2011	5	5	5	0	5	11
	2011-2012	8	8	15	0	0	40
Curriculum	2010-2011	8	19	18	5	12	60
	2011-2012	10	10	13	0	7	40
Pedagogy	2010-2011	6	9	5	0	10	15
	2011-2012	10	7	8	0	4.5	20
Non-UB/BSC PD	2010-2011	35	43	56	0	25	250
	2011-2012	36	41	48	0	23	200

Mathematics Preparation

Table D11. *Numbers of Mathematics Courses Taken by Respondents, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Mathematics Course	Course Level	*n*	*M*	*SD*	Minimum	Median	Maximum
College Algebra	Undergraduate	6	1.17	0.75	0	1	2
	Graduate	2	0.00	0.00	0	0	0
Geometry	Undergraduate	3	0.33	0.58	0	0	1
	Graduate	2	0.00	0.00	0	0	0
Statistics	Undergraduate	4	0.75	0.50	0	1	1
	Graduate	2	0.00	0.00	0	0	0
Calculus	Undergraduate	3	0.33	0.58	0	0	1
	Graduate	2	0.00	0.00	0	0	0
Integrated Mathematics	Undergraduate	3	1.00	1.00	0	1	2
	Graduate	2	1.00	1.41	0	1	2

Table D12. *Respondents' Preparedness for Mathematics Content, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Q27. Mathematics Preparation	*n*	Not Adequately Prepared	Somewhat Prepared	Well Prepared	Very Well Prepared	Not Sure	*M*	*SD*
		%	%	%	%	%		
a. Algebra	7	14	43	0	29	14	2.50	1.23

b. Algebra II	7	**57**	0	0	29	14	2.00	1.55
c. Geometry	7	29	29	29	0	14	2.00	0.89
d. Statistics	7	43	29	14	0	14	1.67	0.82
e. Pre-calculus	7	**57**	14	14	0	14	1.50	0.84
f. Calculus	7	**57**	0	14	0	29	1.40	0.89
g. Integrated Mathematics	7	0	43	29	0	29	2.40	0.55
h. Middle School Mathematics	7	0	29	14	43	14	3.17	0.98
i. Elementary School Mathematics	7	0	29	0	**57**	14	3.33	1.03

Science Preparation

Table D13. *Numbers of Science Courses Taken by Respondents, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Science Course	Course Level	*n*	*M*	*SD*	Minimum	Median	Maximum
Chemistry	Undergraduate	36	3.53	2.32	0	4	10
	Graduate	10	0.20	0.63	0	0	2
Physics	Undergraduate	31	2.39	3.90	0	2	23
	Graduate	10	1.10	2.33	0	0	6
Life Sciences	Undergraduate	40	8.20	6.43	0	8	30
	Graduate	19	3.16	3.47	0	2	10
Earth and Space Sciences	Undergraduate	27	3.70	4.26	0	2	15
	Graduate	13	4.69	9.83	0	1	36
Physical Sciences	Undergraduate	15	0.93	1.10	0	1	3
	Graduate	8	0.13	0.35	0	0	1
Engineering	Undergraduate	15	1.13	4.12	0	0	16
	Graduate	8	0.00	0.00	0	0	0
Technology Education	Undergraduate	19	1.47	2.61	0	0	10
	Graduate	11	2.18	4.02	0	0	12

Table D14. *Respondents' Preparedness for Science Content, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Q29. Science Preparation	*n*	Not Adequately Prepared	Somewhat Prepared	Well Prepared	Very Well Prepared	Not Sure	*M*	*SD*
		%	%	%	%	%		
a. Chemistry	33	30	30	21	15	3	2.22	1.07
b. Physics	31	42	32	13	10	3	1.90	1.00
c. Life Science	42	0	14	29	**52**	5	3.40	0.74
d. Earth and Space Science	36	14	39	22	22	3	2.54	1.01
e. Physical Science	33	9	24	42	18	6	2.74	0.89
f. Middle School Science	39	0	10	44	44	3	3.34	0.67
g. Elementary School Science	30	3	20	30	30	17	3.04	0.89

Table D15. *Respondents' Preparedness for Science Instruction, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Q30. Please indicate how well prepared you feel to do each of the following.	*n*	**Not Adequately Prepared / Somewhat Prepared**	**Well Prepared / Very Well Prepared**	**Not Sure**	*M*	*SD*
		%	%	%		
a. Provide science instruction that meets appropriate standards (district, state, or national).	43	7	**91**	2	3.52	0.63
b. Teach scientific inquiry.	42	14	**86**	0	3.36	0.73
c. Manage a class of students who are using hands-on or laboratory activities.	43	19	**79**	2	3.31	0.78
d. Lead a class of students using investigative strategies.	43	28	**70**	2	3.14	0.84
e. Take into account students' prior conceptions about natural phenomena when planning instruction.	43	26	**72**	2	3.10	0.91
f. Align standards, curriculum, instruction, and assessment to enhance student science learning.	43	16	**79**	5	3.20	0.72
g. Sequence (articulation of) science instruction to meet instructional goals across grade levels and courses.	43	33	**65**	2	3.07	0.87
h. Select and/or adapt instructional materials to implement your written curriculum.	43	16	**79**	5	3.22	0.73
i. Know the major unifying concepts of all sciences and how these concepts relate to other disciplines.	43	23	**74**	2	3.19	0.80
j. Understand how students differ in their approaches to learning and create instructional opportunities that are adapted to diverse learners.	43	16	**81**	2	3.31	0.75
k. Teach science to students from a variety of cultural backgrounds.	43	23	**72**	5	3.10	0.83
l. Teach science to students who have limited English proficiency.	42	40	**55**	5	2.50	1.01
m. Teach students who have a learning disability which impacts science learning.	43	37	**60**	2	2.83	0.94
n. Encourage participation of females and minorities in science courses.	43	9	**86**	5	3.39	0.67
o. Provide a challenging curriculum for all students you teach.	42	12	**86**	2	3.34	0.69
p. Learning the processes involved in reading and how to teach reading in science.	43	28	**70**	2	3.02	0.84
q. Use a variety of assessment strategies (including objective and open-ended formats) to inform	42	12	**86**	2	3.32	0.69

practice.						
r. Use a variety of technological tools (student response systems, lab interfaces and probes, etc.) to enhance student learning.	42	29	**69**	2	2.98	0.82
s. Teach interdisciplinary science inquiry.	42	21	**74**	5	3.15	0.77

Table D16. *Respondents' Needs of Professional Development, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Q31. Professional Development Needs	*n*	**Not a Priority/ Low Priority**	**Moderate Priority/ High Priority**	**Not Sure**	*M*	*SD*
		%	%	%		
1). Help students develop the ability to communicate with others an argument based on evidence.	43	14	**86**	0	3.21	0.68
2). Help students develop an understanding of scale, proportion, and quantity as these concepts are used to describe the natural world.	43	2	**98**	0	3.37	0.54
3). Help students develop an understanding of the behavior of organisms.	42	10	**88**	2	3.20	0.60
4). Help students develop the ability to use mathematics and computational thinking.	43	12	**86**	2	3.31	0.68
5). Help students develop the ability to construct explanations and design solutions.	42	2	**98**	0	3.60	0.54
6). Help students develop an understanding of chemical reactions.	43	35	**65**	0	2.74	0.82
7). Help students develop an understanding of patterns in natural events.	42	0	**100**	0	3.45	0.50
8). Help students develop an understanding of the interactions of energy and matter.	42	12	**88**	0	3.29	0.74
9). Help students develop an understanding of form and function.	42	14	**86**	0	3.10	0.62
10). Help students develop an understanding of the structure and properties of matter.	42	21	**79**	0	3.00	0.86
11). Help students develop an understanding of the conservation of energy and increase in disorder.	42	21	**79**	0	2.90	0.79
12). Help students develop the abilities needed to do scientific inquiry.	43	5	**93**	2	3.55	0.59
13). Help students develop an understanding of the structure of the atom.	43	40	**60**	0	2.63	0.87
14). Help students develop an understanding of the molecular basis of heredity.	43	14	**84**	2	3.19	0.74
15). Help students develop an understanding of energy in the earth system.	42	19	**79**	2	3.22	0.82
16). Help students develop an understanding of the theory of biological evolution.	43	9	**88**	2	3.40	0.67
17). Help students develop the ability to develop	43	7	**93**	0	3.28	0.67

and use valid models.						
18). Help students develop the ability to obtain, evaluate, and communicate information.	43	2	**95**	2	3.64	0.53
19). Help students develop the ability to ask questions and define problems.	43	0	**98**	2	3.67	0.48
20). Help students develop an understanding of matter, energy, and organization in living systems.	43	2	**98**	0	3.44	0.55
21). Help students develop the ability to analyze and interpret data.	43	0	**95**	5	3.71	0.46
22). Help students develop an understanding of systems, order, and organization.	43	0	**98**	2	3.62	0.49
23). Help students develop an understanding of evidence, models, and explanation.	43	5	**95**	0	3.65	0.57
24). Help students develop an understanding of the cell.	43	14	**86**	0	3.37	0.73
25). Help students develop a scientific understanding of the earth in the solar system.	43	26	**74**	0	2.95	0.98
26). Help students develop an understanding of the interdependence of organisms.	43	9	**88**	2	3.43	0.67
27). Help students develop the ability to plan and carry out investigations.	43	0	**98**	2	3.67	0.48
28). Help students develop an understanding of change, constancy, and measurement.	42	7	**93**	0	3.36	0.62
29). Help students develop an understanding of geochemical cycles.	43	35	**60**	5	2.63	0.92
30). Help students develop a scientific understanding of the origins of the earth and the universe.	43	21	**77**	2	2.93	0.87

Science as Inquiry & Understanding the Nature of Science

Table D17. *Respondents' Views of Inquiry-Based Science Teaching and Learning, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Q32. Views of inquiry-based science teaching and learning.	*n*	**Strongly Disagree / Disagree**	**Neutral / Undecided**	**Agree / Strongly Agree**	*M*	*SD*
		%	%	%		
1.Inquiry-based learning requires that learners engage in answering a scientifically-oriented question.	41	7	27	**66**	3.66	0.83
2.Inquiry-based learning requires that learners gather (or are given) data to use as evidence for answering a scientifically-oriented question.	40	3	25	**73**	3.82	0.68
3.Inquiry-based learning requires that learners manipulate and analyze data to develop evidenced-based explanations, by looking for patterns and drawing conclusions.	40	0	15	**85**	4.05	0.60
4.Inquiry-based learning requires that learners connect their explanations with explanations and concepts developed by the scientific	40	8	25	**68**	3.72	0.78

community.						
5.Inquiry-based learning requires that learners communicate, justify, and defend their explanations.	40	5	18	**78**	3.95	0.78
6.Inquiry-based learning requires that learners first understand basic, key science concepts prior to engaging in inquiry activities.	40	15	23	**63**	3.57	1.11
7.Inquiry-based learning assumes that all science subject matter should be taught through inquiry.	40	48	25	28	2.75	1.15
8.Inquiry-based learning requires that learners generate and investigate their own questions.	40	10	25	**65**	3.72	0.88
9.Inquiry-based learning requires the use of hands-on or kit-based instructional materials.	40	13	33	**55**	3.55	0.88
10.Inquiry-based learning requires that learners are engaged in hands-on activities.	40	3	20	**78**	3.93	0.69
11.Inquiry, as a process of science, can be taught without attention to specific science content or subject matter.	39	31	21	49	3.23	1.18
12.Inquiry-based learning assumes that learners build new knowledge and understanding on what they already know.	38	0	26	**74**	3.97	0.72
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.	39	0	26	**74**	3.90	0.64
14.Inquiry-based learning assumes that learning is mediated by the social environment in which learners interact with others.	38	8	42	**50**	3.53	0.80
15.Inquiry-based learning requires that learners take control of their own learning.	40	10	23	**68**	3.78	0.89
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.	38	3	29	**68**	3.76	0.68
17.Inquiry-based learning requires more sophisticated materials and equipment than other types of classroom learning.	38	47	21	32	2.79	1.12
18.Inquiry-based teaching requires that the teacher act as a facilitator or guide of student learning rather than as a disseminator of knowledge.	40	5	13	**83**	4.05	0.88
19.Inquiry-based teaching focuses more on what the students do, rather than on what the teacher does.	40	3	25	**73**	3.88	0.82
20.Inquiry-based teaching requires that the teacher have a strong background in the science content related to the inquiry.	40	3	25	**73**	3.88	0.72

Table D18. *Respondents' Understanding of the Nature of Science, UB/BPS ISEP Teacher Questionnaire, Summer 2012*

Q33. Understanding the nature of science.	*n*	**Strongly Disagree / Disagree**	**Neutral / Undecided**	**Agree / Strongly Agree**	*M*	*SD*
		%	%	%		
1.Science is a systematic way to gain an understanding of the natural world using naturalistic methods and explanations.	39	0	21	**79**	4.00	0.65
2.Scientific knowledge is reliable and durable so having confidence in scientific knowledge is reasonable.	38	13	21	**66**	3.61	0.82
3.A universal step-by-step scientific method is used by all scientists.	38	16	34	**50**	3.45	0.89
4.Scientific experiments are the only means used to develop scientific knowledge.	39	49	23	28	2.79	0.95
5.Contributions to science are made by people from all cultures around the world.	39	0	8	**92**	4.28	0.61
6.Scientific observations and conclusions are influenced by the existing state of scientific knowledge.	39	3	15	**82**	4.00	0.69
7.With new evidence and/or interpretation, existing scientific ideas are replaced or supplemented by newer ones.	39	5	15	**79**	3.95	0.76
8.Basic scientific research is concerned primarily with practical outcomes related to developing technology.	39	36	38	26	2.92	0.84
9.The principal product of science is conceptual knowledge about and explanations of the natural world.	38	11	32	**58**	3.58	0.83
10.Scientific laws are generalizations or universal relationships about some aspect of the natural world and how it behaves under certain conditions.	37	11	22	**68**	3.70	0.85
11.Scientific theories are inferred explanations of some aspect of the natural world.	38	8	16	**76**	3.79	0.74
12.All scientific laws have accompanying explanatory theories.	38	5	32	**63**	3.71	0.77
13.Scientific conclusions are to some extent influenced by the social and cultural context of the researcher.	39	13	28	**59**	3.54	0.91
14.Scientific observations are to some extent influenced by the observer's experiences and expectations.	39	10	31	**59**	3.56	0.88
15.Scientists may make different interpretations based on the same observations.	39	8	18	**74**	3.72	0.69
16.Scientific theories are subject to on-going testing and revision.	39	0	18	**82**	4.05	0.65
17.Scientific laws are theories that have been proven.	39	15	26	**59**	3.51	0.94
18.Cultural values and expectations do not influence scientific research because scientists	39	33	28	38	3.08	0.98

are trained to conduct unbiased studies.						
19.Scientists do not use their imagination and creativity because these can interfere with objectivity.	39	**59**	18	23	2.54	1.19
20.Scientific knowledge is tentative and may be abandoned or modified in light of new evidence or reconceptualization of prior evidence and knowledge.	39	8	26	**67**	3.72	0.79

Section 4b: Response to Evaluator's Report

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

Year 2: 2012 – 2013

4. b. Response to External Evaluation

Xiufeng Liu and Joseph A. Gardella, Jr.

The external evaluation provides us with useful information to reflect on the activities we conducted this past year and to plan activities for the coming year. Specifically, we propose the following activities that are informed by the external evaluation findings:

1. Teacher Preparedness in Science Content: Table 10 indicates that many teachers felt that they were not well prepared to teach physical science content (i.e., chemistry and physics). Thus, when placing teachers for this year's (2013) summer research, we will intentionally expose more teachers to physical science research. While teachers may not necessarily indicate their preference in their research proposals for physical science research, it is possible to incorporate physical science content through interdisciplinary science and engineering research projects that are within teachers' comfort zones.

2. We also are writing a request to the Dreyfus Chemical Sciences program that would focus more laboratory resources for equipping middle school teachers for chemistry topics. This Letter of Inquiry is being submitted June 5, 2013.

3. Teacher Preparedness in Science Instruction: Table 11 indicates that many teachers identified teacher professional development related to teaching science for students with limited English and disabilities, and incorporating technology to be top priorities. We are funding a project summer 2013 that links the research based PD of three coordinating teachers to English as a Second Language (ESL) teachers for application to improving participation of English Language Learners (ELL). ELL students in Buffalo, because of the INS resettlement program for refugees, require support from ESL teachers in 79 languages and dialects, one of the most diverse ESL situations in any school district in the US. Presently, eight teachers are planning with two experienced undergraduate student assistants to support them, including a UB Honors student who speaks seven languages, including Bengali and Nepalese, and a Nepalese refugee whos is a student at Buffalo State College.

4. ESL and Special education topics will be included in the monthly teacher pedagogical support workshops next year. Similarly, Table 12 indicates a number of other science topic specific areas that teachers identified as their top priorities for PD, which should be used to guide planning for next year's monthly pedagogical support during the academic year.

5. Design, Engineering and Technology (DET): Table 15 indicates that many teachers reported their lack of background in DET, thus do not feel confident in incorporating DET in science teaching. While the Buffalo State summer course in 2013, which will be an engineering and technology instruction focus, will be helpful in addressing this need, for those teaches who will not take the course will still need support in this area. We will creat a Professional Learning Community specifically devoted to this topic so that knowledgeable and experienced teachers can mentor less knowledgeable and less experienced teachers on this topic.

6. STEM students: Table 29 indicates that there is still need to provide STEM students with orientations in science communications and team work. Next year, while we may continue providing the workshops we conducted this past year, we can also consider offering more specific science communication topics and team working workshops, such as organizing a science club, organizing a family night, tutoring students, and cooperative learning in school.

In consideration of the recommendations made by the external evaluator, we make the following responses:

Recommendation #1: We agree that a pre- and post-survey of participating teachers is necessary in order to find out changes in the measured constructs. For the 2012-2013 cohort of teachers, the 2012 summer survey can be considered as the pre-survey, and the 2013 survey to be completed can be considered as the post-survey. Since some of this year's cohort of teachers may not continue in this coming year, we should still require them to complete the survey in summer 2013.

Recommendation #2: We agree that continuing validation of the measurement scales in the Teacher Questionnaires with additional data to be collected is necessary. However, we are not sure if asking STEM students to answer the *Inquiry Understanding* and the *Nature of Science* sub-scale questions and merge their responses with teacher responses is appropriate. Practicing science teachers and STEM students are two different populations; combining their responses will make psychometric claims and interpretations unclear. We would like to recommend using Rasch measurement to further validate the sub-scales because item and scale properties based on Rasch measurement models are theoretically not sample dependent.

Recommendation #3: We support the idea of disseminating project activities and findings widely. Although we have been and will continue disseminating project activities through the project web site, new media, presentations at academic conferences (e.g., the NARST annual conference), and submitting articles to scholarly journals, we can also publish practical and less theoretical small pieces on teacher orientated magazines (e.g., *Science and Children*, the *Science Teacher*). We should also gradually publish findings based on summative evaluations.

Recommendation #4: We welcome regular visits by the external evaluator to collect qualitative data. We can also share with the external evaluator the large data sets of qualitative and quantitative data being collected by the research team. Close collaboration between the research team and the external evaluator will continue and be enhanced whenever possible.

Recommendation #5: We agree that a study of the expansion of ISEP partnerships is worthy of development between the Evaluation team and UB ISEP leadership. We will work with Dr. Woodruff to develop ways to research and evaluate the structure of ISEP.

Section 5: Implementation Plan

University at Buffalo/ Buffalo Public Schools ISEP

Year 3: 2013 - 2014

ISEP Year 3 Plan: July 2013 – July 2014

For Year 3 we anticipate full implementation of core activities detailed in grant application and in 5-year plan including the following categories. Please note, new activities added are highlighted with Bold/Italics. Current plans 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
Teacher professional development	Teachers engaging in research experiences and share projects through PLC's; planning for implementation in upcoming school-year 12 BPS teachers participating in 3-week Summer STEM Institute at Buffalo State College Identify continuing and new graduate and undergraduate students to work with teachers during the upcoming school-year through consultation with district and school leadership Orientation for grad & undergrad students	***Monthly pedagogical workshops on inquiry and interdisciplinary inquiry teaching (with graduate credit option from Graduate School of Education)***	***Monthly pedagogical workshops on inquiry and interdisciplinary inquiry teaching (with graduate credit option from Graduate School of Education)*** ***Teacher implementation of inquiry science teaching with support by STEM and STEM education faculty, graduate and undergraduate students as well as retired master teachers*** Teachers nominated/ self-nominated for summer 2013 research experiences and Summer STEM Institute (proposed summer programs finalized by May) Faculty/research teams and mentors identified Ongoing communication with school and district leadership to align and maximize resources, placements, and opportunities	Placements finalized for research projects and plans; Proposed implementation including short and long term inquiry projects and afterschool programs

School-based wrap-Around supports	Reflect on summer research activities and curriculum plans; explore related school needs and collaboratively plan for in-school activities for upcoming year ***Examine results of students from each school in summer research opportunities or middle school summer camps and identify follow up academic year activities for continuing emphasis on student development*** ***Develop student focused leadership and STEM activities to develop mentoring and academic success in STEM with measures reflecting Common Core standards***	School meetings to review building plans and activities; identify ongoing needs and changes; assess viability of plans and assign GA/RA and undergraduate support. Meet with school based parent group to plan activities. Review building supplies and equipment requests. GA's and RA's support in-class and afterschool activities and service learning students; in-school and afterschool activities Ongoing purchasing of STEM related equipment as determined through collaborative discussions and planning with school and district leadership	Ongoing activities (begun in fall) with extensive communication between all parties to ensure benefit and alignment with grant and school/district planning Ongoing partner events including family nights at BMS Announcement of summer camps for middle school students and summer research internship opportunities for high school students	Complete school year with regard to graduate and undergraduate students placed in schools and prepare for summer research programs Summer research internships made available with application process Summer camp enrichment opportunities for participating middle school students

PLC's	Preliminary communication regarding PLC pilot and initial meeting with participants Technology interfaces developed and tested Teachers engaged in summer research prepare products to share through PLC's ***Test new social network tools for each PLC***	***Optimum web interface chosen by PLC members and contributions made by participating teachers, graduate students, partners, and parents*** Scheduled meetings and communication to support PLC's Develop new interfaces and PLC's as needed/ warranted	Ongoing monitoring of PLC activity; communication and meetings to encourage participation and alignment with ongoing STEM related activities associated with ISEP Ongoing interactions with DPCC to encourage parent involvement Ongoing interactions with core partners to encourage their participation in support of ISEP goals	Plan to incorporate new research activities and new teachers, graduate students, researchers, parents, and teachers in PLC's (existing and evolving)

Evaluation	Develop and pilot instrument to assess STEM faculty perceptions (UB/BPS ISEP Faculty Questionnaire) ***Analyze UB/BPS ISEP Teacher Questionnaire pre/post comparisons*** ***Analyze BPS ISEP Student Questionnaire data from treatment and comparison students- Spring 2013*** ***Collect 2011-2012 School/classroom/teacher-level demographic data*** ***Collaborate w/the Research Team to develop and pilot test Teacher Content and PCK Assessment*** ***Observation and informal interviews of ISEP teacher participants, STEM students and faculty during summer lab experiences*** ***Develop and administer instrument to assess BPS student summer program experiences*** ***Meet w/ ISEP Project Team on site***	***Administer pre-intervention instruments to measure changes in BPS students' perceptions of science and engineering (UB/ BPS ISEP Student Questionnaire)*** ***Administer UB/BSU Faculty Questionnaire*** ***Ongoing collection of data and monitoring of ISEP components and responding to project team needs*** ***Administer and analyze STEM Student Survey data*** ***Analyze BPS student summer program experience data***	Administer and analyze fully developed instruments measuring content knowledge and pedagogical content knowledge (UB/ BPS ISEP STEM Teacher Content Knowledge & Pedagogical Content Knowledge Assessments) ***Ongoing collection of data and monitoring of ISEP components and responding to project team needs*** ***Administer and analyze STEM Student Survey Data*** ***Meet with ISEP Project Team on site***	***Administer post-intervention instruments to measure changes in BPS students' perceptions of science and engineering (UB/ BPS ISEP Student Questionnaire)*** ***Administer UB/BPS ISEP Teacher Questionnaire*** ***Ongoing collection of data and monitoring of ISEP components and responding to project team needs*** ***Preparing for evaluation of summer research components and final activities in schools and revision of evaluation plan as necessary***

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