Partnerships across Academic and Geographic Boundaries: A Technology-Driven Transformation of 3^{rd} – 7^{th} Grade STEM Learning Communities

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Abstract

This experience connects world-traveling college students with elementary and middle school students currently in traditional classroom settings. The purpose is to spark excitement for science, technology, engineering and mathematics (STEM) using a non-traditional approach. The focus of the program is to strengthen STEM learning in K-7 students while also strengthening the academic value of college trips. Active curricular participation and collaboration between traveling college students and K-7 classrooms make this a transformative educational process.

During winter and spring breaks, U.S. college students travel around the world to gain a global perspective on many issues; however, their experiences are rarely shared. The developing model is designed to break the current mold by including K-7 students, teachers, and parents in the college academic trip experience using a inquiry-based exchange of ideas, theory, and hands-on activities and incorporating guided student mentoring.

Currently available technology is used to develop a variety of unique learning communities to enhance and extend the environmental science curriculum in K-7 classrooms, especially underserved and underrepresented groups, by providing inquiry-based activities and by connecting those classrooms with real-world environmental studies around the globe. Our approach helps to broaden the current educational structure through the introduction of a collaborative exchange of ideas among college faculty, college students, K-7 teachers, K-7 students and environmental professionals via 21st century technology. Our principal objective is to demonstrate that this technology-driven collaboration will enhance science learning as well as interest in STEM careers among K-7 students.

Keyword: STEM, K-12, inquiry-based, learning communities, student travel

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Introduction

"Partnerships" is a developing model that takes advantage of an innovative, technology-driven environmental science and engineering shared program between K-7, specifically 3^{rd} - 7^{th} grade students, and college students from across disciplines and class standing. [Note: Choice of grade level based on literature review as well as timing of statewide standardized assessment (i.e., 4^{th} and 8^{th} grade), Pennsylvania System of School Assessment (PSSA)] Breaking the mold of the traditional college semester-break trips, our program not only connects 3^{rd} -7^{th} grade students and college students, but also teachers, parents and a diverse group of community partners in the college academic experience. Important to note is that there is little to no cost to associates of the program through the use of publicly available and college-sponsored technology and low cost support equipment (e.g. web cams). The semester-break trip is the project focal point in which inquiry-based exchanges of science ideas, theories, and experiences take place between elementary and middle-school learners, their teachers, and their college faculty/student partners. This model is made possible by Information and Communications Technology (ICT) activities that motivate and actively engage learners as well as educators. It will better prepare 3^{rd} -7^{th} grade students for future academic and work-force endeavors in STEM disciplines as well as demonstrate many practical applications of 21^{st} century technology.

Specifically, the model includes collaborative curriculum planning between elementary, middle school and college faculty as well as mentoring/pedagogy development exercises for college students. Inquiry-based instruction, hands-on activities and data collection on a global scale are key elements of the program. Learning through shared experiences is the link that brings the elements together and works to spark an almost endless supply of energy that drives the program. To further enhance 3^{rd} -7^{th} grade student learning and understanding, active involvement of parents, community leaders from local agencies and individuals working in STEM fields is included. This diverse group of involved participants serves to create several combinations of "learning communities". Transformative aspects of the project are (1) providing real-time, interactive, real-world science experiences which convert hands-on K-7 classroom activities into deep inquiries into the nature of the world and (2) developing the college students into STEM educators by allowing them to lead the 3^{rd} -7^{th} grade students in STEM activities and outreach projects related to science and engineering field work.

Principles that Guide the Design of the Developing Model

A variety of studies and indicators have demonstrated that the United States educational system continues to fail to prepare many students for a knowledge-based, technology-driven society. For example, a 2007 study published by the National Governors Association (NGA)[1] indicated that three out of 10 first-year college students are placed immediately into remedial courses. NGA further pointed out that in the workforce, employers noted common applicant deficiencies in math, computer, and problem-solving skills[1].

A major problem facing the advancement of STEM instruction in pre-collegiate classrooms, especially at the elementary school level, is that teachers often feel that they are not adequately prepared to teach science. K-6 teachers are usually certified in "elementary education" as opposed to a specific discipline and often lack content knowledge, time to research and prepare grade-appropriate hands-on activities, and confidence in their ability to teach STEM subjects. In the 2000 National Survey of Science and Mathematics Education, *Status of Elementary School Science Teaching*, Fulp[2] noted that "elementary school teachers do not feel equally qualified to teach all academic subjects, with preparedness to teach science paling in comparison to mathematics, language arts, and social studies." The literature indicates that the issue of inadequate teacher knowledge of science content and appropriate teaching methods is a nationwide problem[3]. As summarized by Subotnik et al.[4] "Without adequate teacher preparation, it is impossible to improve the number of students who may take an interest in STEM subjects." The present project intends to facilitate communication between content experts (college professors and students) and K-7 teachers to improve the teachers' content knowledge and, in turn, their confidence in STEM subjects.

Another critical reason for students' poor performance in STEM subjects is the manner in which STEM content knowledge is typically taught. Many K-7 science programs emphasize memorization of textbook material without providing the higher-order thinking skills required to truly understand and apply STEM concepts. In contrast, inquiry-based instruction has been shown to have several important positive effects at the K-12 level[5,6,7,8], including higher levels of achievement in science, greater motivation to engage in science activities, and an increased interest in science careers. Our model capitalizes on an inquiry-based instruction approach that utilizes teaching/mentoring relationships to fuel an interactive learning environment between college and K-7 students over five months.

Based on concerns identified by the National Science Foundation (NSF) an important issue that this project addresses is student attitudes toward STEM learning. Although males are included in the study, the specific concern will be females and minorities; those who are underrepresented in STEM disciplines as identified by NSF. In a 2004 study, Zacharia and Barton[9] determined that urban students and students of color had far more negative attitudes toward science and their future in the scientific field than did white students and nonurban students. Further, various studies have found that gender differences, when considering attitudes of student interests in science, remain an issue of concern, particularly in the domain of technology. Nicholson et al.[10] concluded that males and females begin school with a similar interest in technology. However, Butler[11] noted that students between kindergarten and fifth grade start to develop a gender-based technology gap which peaks at the eighth-grade level; females lose interest in technology as reflected in their levels of computer usage. Similarly, Cady and Terrell[12] found that girls as young as 10 years old began to have negative self-attitudes with regard to computers and technology. However, by incorporating technology in the science curriculum, the girls developed higher levels of confidence in their ability to use technology and also raised their view of the importance of using technology. Finally, Sun, Lin, and Yu[13] found that the integration of technology into the science curriculum had a very positive impact on all participants. The results indicated that using technology met the learning needs of all students regardless of their learning styles and that 75% of students in the study strongly preferred using the web-based lab to using traditional learning methods. By incorporating technology into the curriculum, we will accommodate a range of learning styles and address gender-related issues at a critical point in students' academic development.

A key element in the proposed project is the idea that interest and achievement in science can be best cultivated through the establishment of relationships between K-7 students and their college student mentors. Basu and Barton[14] point to the "funds of knowledge" that urban, high-poverty students bring to science learning and the development of a sustained interest in science. They found that "youths developed a sustained interest in science when: (1) their science experiences connected with how they envisioned their own futures; (2) *learning environments supported the kinds of social relationships students valued*; and (3) science activities supported students' sense of urgency for enacting their view on the purpose of science." The proposed model intends to meet the prescribed ingredients that Basu and Barton[14] identified as important elements of a sustainable program. It will tie global and local issues together so that students can make direct connections between them and, in turn, develop a better understanding of STEM concepts. Most importantly, mentoring relationships between K-7 and college students—enabled by increasingly available cybertechnologies (email, webcam, and videoconferencing)—will be the catalyst to make this comprehensive pedagogical mix happen. As such, the project draws heavily on a Vygotskian model[8] of guided participation, in which the learner's growing competence takes place within the context of "collective transactions" between novices and those who are more expert. By partnering college and 3rd -7th grade students in collaborative endeavors in which "ideas are mutually negotiated," we expect to see greater responsibility and enthusiasm for learning STEM in young students, and benefits to the experts, as well[15].

Goals and Objectives of the Program

Our goals and objectives for the overall program are as follows:
Goal 1: To develop a cyber-learning program model and curriculum that enhances STEM learning for 3rd-7th grade students, including those from underrepresented populations. This includes:

a. Professional development for in-service teachers in teaching and inquiry-based science curriculum supported by technology.
b. Connecting 3rd-7th grade students with college students on interim STEM-based field trips through guided experimentation and collaborative study.

Objectives

- Improve 3rd-7th grade student and teacher knowledge of environmental science and STEM content.
- Increase amount of inquiry-based science in 3rd-7th grade STEM classes linked to state standards.
- Develop new hands-on, inquiry-based activities as well as enhance existing activities.
- Develop STEM cyber-mentoring relationships between college undergraduates and 3rd-7th grade students.
- Engage 3rd-7th grade students in cyber-learning experiences that introduce students to cyber-communication (email, videos, Wiki's, blogging, twittering), an interactive website, and technology-based research tools (Google Earth, remote sensing, telemetry data collection).
- Provide opportunities for 3rd-7th grade and college students to observe how scientists, engineers and others apply science and mathematics to address real-world needs.

Goal 2: To enhance attitudes about STEM among 3rd-7th grade students, 3rd-7th grade teachers, parents, college students, college faculty, and institutional partners.

Objectives

- Improve 3^{rd}-7^{th} grade student, college student, and teacher attitudes toward STEM programs and careers, particularly in environmental science.
- Increase parents' involvement in and knowledge of STEM learning.
- Increase 3^{rd}-7^{th} grade student and teacher awareness of skills needed for STEM employment.
- Identify characteristics of the program model that are influential in improving 3^{rd}-7^{th} grade student attitudes about STEM fields, technology, and environmental science.

Goal 3: To disseminate the model.

Objectives

- Share the model with other interim trip programs across the country.
- Make regional and national presentations on research findings relevant to STEM education.
- Create a website and post information, lesson plans, and samples of student work.
- Put links on partner websites to project materials.

Based on the goals and objectives outlined a formative and summative evaluation is planned. Formative evaluation will document the roles and activities of project participants: 3^{rd}-7^{th} grade students, parents, and teachers; college students/mentors and faculty; parents and school administrators as well as the roles of project partners (e.g., Da Vinci Discovery Center, US Naval Academy) before, during and after the trips. Summative evaluation activities will focus on assessing the impact of exposure to the distance field science activities and the accompanying support activities on for 3^{rd}-7^{th} grade students and teachers, college students and project partners.

Development of the Model

Our developing model consists of the following components: (1) collaborative curriculum planning between teachers and professors, (2) mentoring/pedagogy skill development for college students, (3) globally-driven, inquiry-based instruction for all participants, (4) precollegiate and college students using cutting edge technology integral to STEM activities to collaboratively explore environmental science, environmental engineering topics as well as environmental issues and stewardship efforts, (5) parental involvement, and (6) workforce partnership to help 3^{rd} -7^{th} grade students realize career potential as well as academic connections to STEM curriculum. Environmental engineering was targeted in our developing model based on the expertise of faculty involvement; this is not meant to limit program involvement to any engineering or non-engineering discipline. One will note that in the development of the mentoring component of the model, science experts as well as mechanical and electrical engineering play key roles.

Our interactive team is currently in the process of collaboratively designing and testing the model. Included are three elementary classes (20-25 students/ 1 teacher/classroom) and three middle school classes (25-30 students/ 1 teacher/classroom) from Spring Cove School District (SCSD) and the Easton Area, Easton, PA, and control classes matching each study class. Therefore, based on 1 college trip in year one, 2 college trips in year two and 3 college trips in year three, the number of students impacted during the design, testing and evaluation of the model at the K-7 level will consist of 120 elementary students, 150 middle school students and 6 3^{rd} -7^{th} grade teachers (i.e., 270 3^{rd} -7^{th} grade students and 6 teachers at a minimum). At the college level, 8-30 students and 1-2 college professors per trip will participate; therefore at a minimum, 48 college students and 3 professors will be impacted. Partner organizations include the College of Holy Cross, DeSales University, the US Naval Academy, the Da Vinci Science Center (a non-profit organization in Allentown, PA that promotes learning about science, math, and technology through hands-on problem solving (http://www.davinci-center.org/)), and Environmental Resource Management (ERM) (a global environmental consulting firm).

It is important to point out that school districts chosen were based on demographics of student population. We believe we will see varying results of our study based district location as well across grade levels. SCSD is a district which exceeds a 28% rural population and Easton Area School District (EASD) student base is 43% urban population and 44% minority population. Also important to note, curriculum was integrated into existing curriculum, therefore "extra" time was for course material was not an issue.

The spirit, rigor, depth and strength of this program are the result of the positive, collaborative discussions between all members. We have crafted our program so as to incorporate strategies and ideas similar to programs such as the UTeach program offered through University of Texas at Austin (uteach.utexas.edu) and the JASON project (jason.org/public/whatis/start.aspx). Keeping in mind programs such as UTeach and JASON, the selection of team members has been key to the developing model. Unique to our program are our partnerships with the United States Naval Academy (USNA) of Annapolis, Maryland and Da Vinci Science Center of Allentown, Pennsylvania. The STEM Center at the Naval Academy and has reached thousands of minority students from across the country via programs such as the USNA Summer STEM camps and weekend camps. USNA midshipmen serve in leadership roles in these activities and have provided training and direction in development of 3rd -7th grade teaching tools and modules with the Lafayette faculty and students. The Da Vinci Science Center (davinci-center.org/mission.html) is an institution that not only promotes interactive STEM activities throughout the year, but also provides workshops for K-12 teachers. Our partnership with colleges that provide teaching programs such as DeSales University and Holy Cross provides access (and depth) to teaching. And finally, our connection to ERM, a global environmental consulting company, provides a *very* unique link to professionals tied to the STEM field.

<u>*Collaborative curriculum planning*</u>: In 2002, the PA State Board of Education established the *Academic Standards for Science and Technology* which detail eight assessment anchors and *Academic Standards for Environment and Ecology* which outline nine assessment anchors. The purpose of the anchors is to articulate essential and assessable <u>content elements</u> to provide clarity for instruction[16]. Both Spring Cove and Easton Area School Districts use the Full Option Science System (FOSS) program, a series of pre-packaged kits (developed with NSF support) with the supplies required to conduct experiments and address the required content elements.

Interim session (i.e., semester break) trips are typically scheduled a year in advance of an actual trip. At that time conversations between the 3rd-7th grade and the college faculty begin so that a collaborative working environment will be established. As partner, Mrs. Traci Shoemaker, has attested, a relationship based on trust where all parties can exchange ideas in a constructive manner is a very important element of success for such a project from the eyes of teachers at all levels of K-12. Based on outcomes of past programs active planning with respect to course content begins about six months prior to the start of a semester. Elements addressed at this time are - state standards, reviews from previous years' (i.e., student reports and course outcomes), and collection of course materials, and compiling of resources, such as databases of trade books covering the identified topics (appropriate to age and reading levels of the students) and quality, user-friendly websites. Topics of investigation have included wetlands; green buildings; stormwater control and water treatment/quality; flora, fauna, and habitat loss; wastewater/solid waste; energy; climate change and glaciation; geologic role in the natural environment; ocean pollution; and geo-hazards. These topics correspond to the national and state science standards and fit well with the proposed interim session trips: New Zealand (Lafayette), Grand Canyon (Holy Cross), and the Florida Everglades (DeSales), each of which will have an environmental science theme. Lafayette College will have a combined environmental science and engineering theme.

Summer workshops involving all project partners will provide training in inquiry-based teaching methods, assistance in adapting and incorporating the new materials in the precollegiate classes, and the requisite background information to enable the teachers to develop a "comfort level" for teaching science. Our program also includes onsite one-on-one training by partner Shoemaker during the school year. Information sharing among participants will occur via our project webpage, email, and periodic internet conferences using a multipoint interactive conferencing service such as Nitle (www.nitle.org) or Elluminate (www.elluminate.com).

Mentoring/pedagogy Skill Development for College Students: College students participating in this project will be provided with several forms of support to enhance their mentoring and teaching skills. At the beginning of the academic year, they will receive readings describing the cognitive and social skills of elementary- and middle-school aged children. A special focus will be on the nature of scientific thinking and problem solving in these age groups. In addition, college students will receive selected readings (i.e., *Organizing instruction and study to enhance student learning*[17]) and a seminar class based on guidance from education experts. Throughout the project, college students will have electronic access to education experts at Holy Cross and DeSales, as well as the 3rd-7th grade teachers and college faculty participating in the project, who will provide feedback and answer questions about effective mentoring and teaching. The outcome will be a cohesive program where, guided by faculty, college students will mentor/teach their 3rd-7th grade partners, helping them develop research questions and problem-solving strategies while encouraging them in the use of 21st century technology (see section titled *Technology*).

Globally Connected Learning Communities: Lafayette, DeSales, and Holy Cross will each partner with one elementary school (ES) class and one middle school (MS) class from participating schools. The pre-collegiate and college students will be divided into groups. Each group will consist of students from one college and one pre-collegiate school (i.e., Easton or Martinsburg); specifically, two or three elementary students and two or three middle school students will be paired with two or three college students from one college. From October through February, each group will study one of the designated environmental topics through an inquiry-based approach. The colleges will work with a set of up to 10 environmentally focused topics, but not necessarily the same topics because of the diversity of expertise within our core structure. This format presents methodological issues with respect to controlled evaluations.

Therefore, each college/3rd-7th grade class grouping will be paired with a corresponding control class throughout the study (i.e., one ES control class to one ES engaged class, and one MS control class to one MS engaged class).

Demonstration of Student Interactions and Roles of Participates

An example of a how a particular topic (water quality) has been planned to play out from start to finish between 3rd graders and college students on the New Zealand trip is outlined in Table 1. At the 7th grade level age/grade appropriate material would be substituted where needed.

Table1: Timeline Detailing Parallel Activities for 3rd Grade and College Students in the Water Group

Third Grade Students	*College Students*
October - *Creating a common experience*	
*Common project such as building an ROV (SEAPerch) is introduced to excite, engage, teach students about STEM applications. *It also gives 3rd grade and college students a common experience to help build relationships. * Students blog about their experiences with their college partners, using a secure site developed for this purpose.	*Common project (building of an ROV, SEAPerch) is introduced to excite, engage, and teach students. *This common project also helps college students to develop mentoring skills and teaching strategies under the direction of the college education and science faculty. *Students prepare short videos demonstrating various aspects of ROV construction and scientific principles, such as buoyancy and density, for their third grade partners. These are posted on the project website.
November - *Beginning the inquiry together*	
*Environmental topics are introduced; students choose research topic. *Students view project website to see partners. *Students begin web-based search related to water, create collage of images to help understand the topic. *Images then spark focus questions such as: *What is a water treatment plant? How does water get from lakes, streams, oceans to my house? How can we use our water resources more wisely?* *Questions are recorded in science notebooks. *Students continue to blog with questions, ideas.	*College students choose the environmental topic that they will research while on trip to New Zealand. *Students post their pictures and a brief bio on a secure website developed for this project. They will use site to communicate with 3rd grade partners. *Students begin web-based searches and work with faculty to begin to understand the topic of water quality. *Students email and blog with their 3rd grade partners to plan how they are going to explore their topic of water quality. *Students develop a proposal outlining how they will examine the topic while on the trip.
December - *Research Begins*	
*College faculty work with CoPI Shoemaker to demonstrate water quality concepts, how to use tools (pH/conductivity meter) lent to SCSD by Lafayette College.	*College faculty work with college students to demonstrate basic concepts of water quality and how to use tools such as a pH/conductivity

*Students read literary sources (including <u>Magic School Bus at the Waterworks</u>) about water treatment plants, the water cycle, and how water gets to their homes. *Students record notes in their science notebooks. *Students make posters of water treatment plant processes. *Students continue their research on the web.	meter in a meaningful way. *Students brainstorm water quality activities that can be used with 3^{rd} grade students.
January - *Collaboration Continues via Blogs and Web*	
*Students in group continue to read a variety of books on water, water pollution, how water travels, etc. *Students conduct pH, turbidity, conductivity testing of local water sources as suggested by college partners. *Students create charts, graphs showing results, write conclusions to share with their college partners via blog. *Students participate in water activities provided by Blair Conservation District such as a drama about our watershed address, an Enviroscape model to demonstrate effect of pollution on water sources, and identifying bugs to test water quality. Notes are added to science notebooks and shared with partners. *Students conduct web-based research on how to use water wisely, then survey classmates to see which water conservation idea they would try at home. *Students participate in on-going blogs and scheduled webcasts with college partners to compare research findings in Martinsburg with partners' findings in New Zealand.	*College faculty provide information and instruction for college students to help develop examples and explanations for third grade partners re: water quality: what is pH, turbidity, conductivity, and water quality? *College students send water testing activities to 3^{rd} grade partners to conduct in class. *College students conduct water testing (using the same equipment as 3^{rd} graders) at various sites in New Zealand, graph results, share via blog and webcast with 3^{rd} grade partners. *College students share research on water quality, the New Zealand water shed address, how New Zealanders work to conserve water resources. *Students suggest other activities for their partners such as estimating daily water usage and brainstorm water conservation methods.
February - *Final Presentations: It is all about Stewardship* *Face-to-face visit with our partners*	
*Students take information gathered about water quality; create PowerPoint (PP) presentations for partners and parents (i.e., results of water testing from local water sources, examples of pollution, and how we can work together to improve water quality and conserve this natural resource). The overarching theme for all is stewardship: what can we do to help take care of our environment? *Lafayette students travel to Martinsburg to meet their partners in person. The water	*College students take info gathered about water quality in New Zealand, create presentation for 3^{rd} grade partners and parents (showing water sources in New Zealand, results of water testing, examples of how to alleviate pollution, and how we can work together to improve the quality of water and conserve this natural resource). *College students use content to create a board game for 3^{rd} grade partners that reinforces concepts of water quality and resource usage. *Lafayette students deliver games, activities,

group prepares a Reader's Theater (Reading parts are divided among students) on water cycle and our watershed address as a special presentation.	computer simulations personally to their Martinsburg partners.

<u>Lessons Learned:</u> From our first pilot study, we determined that more interactive, globally-connected activities were needed to create an academically significant experience between the two groups. Therefore, in our second pilot study, we emphasized hands-on learning activities that could be globally connected. A recent Maori partner connection was a result of specifically targeting globally-driven, technology-based learning activities. Based on NSF review comments our third iteration (2009-10) has incorporated a mentoring development module.

Future trips will promote a general theme of environmental stewardship and sustainability in watersheds, connecting our environmental topics via a watershed perspective both in the US and other global sites. Table 2 demonstrates how the interaction of our ITEST team will unfold in a given Project Year. Table 3 provides personnel information as well as explicit roles of various partners.

Table 2: Perceived Interactive Roles of ITEST Participants Throughout a Project Year		
Role before the trip	*Role during the trip*	*Role after the trip*
Participants – *College Faculty (Lafayette, DeSales, and Holy Cross)*		
*Meet with college students *Develop mentor/pedagogy skills *Set course expectations (coordinated with ES and MS school curriculum), include scientific research on a chosen topic, interactions with elementary school aged students, other course requirements *Provide model for deliverables (activities, games, computer simulations.)	*Facilitate students' discovery/learning *Facilitate students' communication to grade school/middle school partners *Provide expertise for all participants as needed	*Collect and grade students' reflections on trip and final hands on activity projects *Oversee, coordinate final video conference with partners' PP presentations to share what was learned *Post-trip visit to grade school/middle school
Participants – *Elementary and Middle School Faculty*		
*Collaborate with college professors on content (specific topics), coordination with local/state STEM standards *Teach and review the scientific method *Introduce inquiry method of learning *Introduce use of notebooking *Coordinate and schedule outside agencies and experts to come in to speak to the class (for example: Blair Solid Waste, Blair Conservation District, Altoona	*Continue to incorporate FOSS kit content and other activities *Introduce/teach multiple technology skills: e-mail, image search, using word docs, web-based information search, PowerPoint slide show *Introduce ten topics, help students brainstorm research questions *Facilitate student learning by providing books, internet sites, and other resources	*Help students practice PowerPoint presentations *Organize and coordinate final presentations with college students, parents, administrators and community *Evaluate presentations and implement other related content assessments *Prepare Reader's

Water Authority, etc.) *Incorporate content and activities from FOSS kits and other developed hands-on activities which correspond with interim trip goals and elementary/middle school's STEM curriculum	*Encourage home/school connection by assigning students to find at least two outside sources on their topic	Theater (to show what they have learned about stewardship for the earth) and other items for college students' visit
Participants – *Da Vinci Science Center, Naval Academy, ERM*		
*Help develop/enhance hands-on activities to promote student learning *Field-test activities *Provide teacher training in the implementation of activities (FOSS Kits, etc) *Plan career awareness activities and school to work connections to be implemented in schools	*Refine/enhance activities (FOSS) *Assist with teacher implementation of activities /provide expertise to participants as needed *Provide presentations on workforce connections	*Evaluate effectiveness of activities *Continue work force connection to learning
Participants – *Web/Software designer, videographer*		
*Develop awareness of topics to be covered and prepare story boards for videos *Prepare web site to house project information/interactivity capabilities *Provide teacher training in use of web page and other technology tools	*Film and edit various aspects of interim trip activities *Upload films/pictures for participants' use *Update/refine web page as needed *Provide technical support as needed	*Disseminate films/pictures to all participants *Update/revise web page as needed

Table 3: Project Personnel

Name	Affiliation	Position	Area of Specialty	Role
Dr. Arthur Kney	Lafayette College	Assoc. Professor	Environmental Engr.	Lead PI
Role: (1) Co-Manage project (2) Develop college trip module (2) Lead Lafayette College trip				
Traci Shoemaker	Spring Cove SD	3rd Grade Teacher	K-12 Teaching	CoPI
Role: (1) Co-Manage project (2) Lead elementary teacher at Spring Cove School District (3) Develop elementary module (4) Lead training session during workshop and during semester				
Dr. Joe Colosi	DeSales University	Assoc. Professor	Biology	CoPI
Role: (1) Adapt to DeSales interim course (2)disseminate via workshops/publications (3) Provide feedback				
Dr. Danuta Bukatko	College of Holy Cross	Professor	Developmental Psychology	CoPI
Role: (1) Provide seminar, readings, and on-going support to college students on how to tutor/mentor K-7 students (2)Explore degree to which college student participants express interests in entering STEM teaching careers (3) Adapt model to Holy Cross interim course				

Dr. Angela Moran	U.S. Naval Academy	Professor	Mechanical Engr.	CoPI
Role: (1) Provide support/collaboration in developing project based learning, success-oriented curriculum involving engineering technology with real world applications; Perform trial run modules at Naval Academy camps (2) Provide mentoring/training at elementary, middle school, college and teacher levels				
Mr. Rodney Green	Spring Cove SD	Superintendent	K-12 Administration	Partner
Role: (l) Liaison at Spring Cove School District (2) Advisor for teacher development				
Mr. Tom Ganssle	Easton Area SD	Assoc. Dir of Science	K-12 Science	Partner
Role: (1) Solicit 4 EASD teachers for project (and 4 control teachers) (2) Liaison between teachers, principal, central administration (3) Provide support and resources for teacher involvement and success .				
Dr David Smith	Da Vinci Center	Dir. of Prof. Dev.	K-12 Teaching/Geology	Partner
Role: (1) Develop project based learning, success-oriented curriculum involving engineering technology with real world applications (2) Develop summer workshop program (3) Teacher development				
Mr. Mark Snyder	Spring Cove SD	7th Grade Teacher	K-12 Teaching	Partner
Role: (1) Lead middle school teacher at Spring Cove School District (2) Develop middle school module				
Dr. John Squarcia	Lafayette College	Instructor	Education	Partner
Role: (1) Lead mentoring/pedagogy workshops for college students scheduled for October				
Dr. David Husic Mr. Mike Smull	Lafayette College Big Pixel Studio	Web designer, in coop. with Big Pixel Studio	Info. & Communications Technology (ICT)	Partner Partner
Role: (1) Design/Develop/Maintain secure website to enhance STEM learning through active learning and collaboration between students, teachers, professors, parents (2) Provide methods and procedures for access/storage, blogging, photo galleries, videos, video conferencing, games that provide competition and rewards (3) Ensure web technology is consistent curriculum with Lafayette's recommended standards.				
Mr. Toby Maynard	PICRO	Videographer	ICT	Partner
Role: (1) Produce series of short narrated documentaries to serve as an instructional aid to newly enrolled schools, explaining process , providing examples and explanations of projects and applications (2) Provide support and instruction on use of video cameras, produce initial short video clips (students on location, student projects uploaded regularly) for scientists in training;				
Ms. Kristen Tull	ERM	Staff Engineer	Environmental Science	Partner
Role: bridge gap between academic side of program and career side, help students understand careers related to education in environmental science/ related fields, serve as mentor and facilitate other ERM staff as mentors for students.				

Role of Technology

The most powerful driver of this project is the interaction between the precollegiate students and their college partners. What propels the project is the extent to which 21^{st} century technology makes global connections available quick and easy. At minimal cost, the 3^{rd} -7^{th} grade partners have access to email, video conferencing, blogging, real-time sharing of pictures and video, data and curriculum sharing through a centrally available and project specific webpage with security capabilities and direct connection to an endless supply of academically viable STEM websites and software. Thus, the majority of student research, communication, and presentation will utilize various forms of current and cutting-edge technology. The technology will close the distance gap among the school/college partners, as well as the college student mentors and their 3^{rd} -7^{th} grade partners. The technology-driven approach will also enhance inquiry-based instruction and address the gender and social-class gaps in technology use referenced earlier in the proposal.

Connections to partnering groups will occur primarily though the internet. Students (3^{rd} -7^{th} grade and college) and faculty will communicate virtually, through a secure, interactive website developed specifically for this program with capabilities for storing data, blogging, wikis, defined hands-on, one-on-one activities, educational games, pictures, and informative videos and links. The website for the program will be developed based on w3c.org recommended standards to ensure future portability and consistency within current standards. This will include HTML, CSS, JAVA SCRIPT and DHTML. Further research will be performed to determine the standards for blogging, wikis, videos, and data capture. Children's security will be of primary concern.

The website will be designed for ease of use based on age group (i.e., links will be distinguished by pictures for the younger group and text for the older group). It will be secure with a login required. 3^{rd} -7^{th} grade faculty will be provided additional informational sections unavailable to other users. Approved users will be able to download videos or enter project results. Topic searches will be available.

Although webcams provide an excellent way to videoconference between two or more parties, demonstrating activities does not always provide the intended outcome because of the poor quality of streaming images. This issue, combined with slow internet connections (based on experience during our pilot trips), time differences, and time-specific US classroom activities create a number of troublesome issues when plans include real-time, hands-on activities. Therefore, when hands-on activities are conducted in the field, video clips will be used to relay information. Clips will be uploaded to our website in less than 24 hours, providing clear imaging, timely interactions, and a more informative message. For our 2009-10 trip we also experimented with a portable, low cost, satellite connection such that we can provide real-time field activities with partnering 3^{rd} -7^{th} graders. A professional videographer assisted students and faculty in the creation of informative video clips (i.e., timeless documentaries) on the various interim trip topics. In the future we envision that the videographer will also work with DeSales University communications students to develop training videos on various aspects of the project in order to develop a library that teachers can use to learn about enhancing program connections.

As a way to gain expert feedback with regard to our use of technology in the proposed model a steering committee composed of technology experts will be put in place.

Parental, Professional and Community Involvement

Parental involvement (about 50 – 75% over the test years) through explicit school-home connections involving homework, projects, parent/teacher meetings, and active involvement in key events: During our pilot programs, parent involvement was encouraged. Class newsletters and student journals kept parents informed. Parents frequently asked questions and commented about how amazed they were at what their children were learning at such a young age. They also demonstrated overwhelming support during a final two-hour video conference in which our 3rd - 7th grade and college students gave multi-media presentations on a range of environmental topics with well developed "take home messages." After the event, follow-up questions during parent/teacher conferences substantiated that parents were not only interested and involved in the program (more so than other activities) due to the global nature and mentoring activities, but they themselves also learned about the subject matter and various types of technologies. We plan to increase parental involvement through regular, direct communication.

Active involvement of work-force partners to help students realize career potential as well as academic connections to STEM curriculum: Through our pilot study, we have begun to understand not only the value and importance of the 3rd -7th grade /college student mentoring relationships but also how to effectively incorporate the mentoring participation of local experts, global consultants, and governmental agents. By directly connecting STEM theory and practical workforce applications to environmental issues and stewardship (which we did during the pilot with the assistance of the Blair County Solid Waste Management and Blair Conservation District), we believe a deeper appreciation and understanding takes place.

To provide career awareness and to help translate classroom learning to real-world work situations, representatives from *Environmental Resources Management* (ERM), a leading global provider of environmental, health and safety, risk, and social consulting services, has agreed to partner with us. Representatives will visit classrooms, attend career fairs, participate in educational activities, and discuss careers opportunities and personal experiences in environmental and related fields. ERM job sites will also serve as real-world-classrooms. For example,

- 3rd -7th grade and college students will go on field trips to select ERM job sites, incorporating classroom concepts into the field trip.
- While on their interim trips, the college students will visit ERM job sites and relay the experience to the 3rd -7th grade students.
- ERM staff will videotape field work and job activities. Classroom activities will be structured around the video material. Either ERM staff or others involved will lead the related discussions.

ERM staff will also serve as mentors to students (college and 3rd -7th grade students) via email, videoconferencing, phone, and classroom visits. ERM's participation will be closely coordinated with the curricular program to contribute toward the overall transformative educational process and provide a better understanding of how classroom knowledge can be applied to the workplace. While ERM will be our primary work-force partner, others (i.e. Blair County Waste Solid Waste Management and Blair Conservation District) will be invited to participate.

Potential Side Benefits of the Project

While the central objective of the project is to enhance K-7 science education and awareness we believe there are several important and meaningful ancillary benefits that will accrue for project participants. (As a note, we believe that curriculum in grades 8-12 may be too restrictive to accommodate such a program. This is still under consideration.)

First, we believe that meaningful civic engagement will occur as students, precollegiate and collegiate, apply knowledge of science to address community need. For example, in our first iteration the waste disposal group found that recycling is not mandatory in Martinsburg, it is up to the individual or institution to arrange recycling. The 3rd graders' suggestion prompted the school to initiate a program.

Second, we anticipate that the precollegiate students' knowledge of geography and, to some extent, culture will increase with the focus on interim destinations. For example, as we have developed the semester break trip to our current New Zealand location, we have begun to enhance cultural interactions and connections to a global view of watershed assessment as demonstrated by our partner, Anthony Olsen, Secretary to the *Ngati Umutahi ki Tiepataua Marae Trust, New Zealand.* In a recent letter of support for our project, he directed comment to a shared program with Maori youths and a globally linked hands-on water quality assessment activity throughout the Tarawera River Watershed. These were added to our 2009-10 interim program.

Third, we believe the project enhances the academic value of college interim trips by creating an engaged, collaborative learning community among colleges, 3rd -7th grade institutions, and environmental companies. Furthermore, our model builds on the premise lauded by Lancor and Schiebel[18] "…that you never really learn a subject until you teach it." In our first iteration, the 2008 pilot program, not only did the college students enhance the learning experience of the 3rd graders through their regular communications, they also strengthened their own learning by contemplating how to best explain concepts and ideas to their young partners. The following two examples illustrate this idea:

Kathleen Miller, Parent of 3rd Grader Martinsburg student "….I, as a parent, saw interest and educational growth in Trevor as a result of the experience."

Jackie Zapotoczny, Parent of 3rd Grader Martinsburg student "Wyatt has never been a fan of school, but the Sea Perch and the glacier work is something that he talks about often. I am really proud of him for getting up in front of the parents tonight, something I thought he would have a hard time doing. You have definitely made a big impact on him and these projects are awesome."

Jason Mills, Lafayette '09, Electrical Engineering **"**When first starting this trip I was a little skeptical of the whole idea of creating a presentation and webcaming with 3rd graders while on the trip. But I was totally wrong; the kids brought a whole new side and excitement to the trip. While on the trip the kids were emailing us constantly asking questions and wondering what they could do to help the environment. ***My kids*** put on a great presentation about ocean pollution and I think we learned a lot about ocean pollution from each other."

Brittany Downham, Lafayette '08, Biology "…I really appreciated being forced to communicate advanced scientific knowledge to the 3rd graders in a way that they could understand and learn the material. This was one of the most educational parts of the trip for me and I believe is a great experience for the future of our science workforce. It transfers over to the scientific community being able to communicate knowledge to the general public."

Finally, we noted during our pilot study the importance of family and community in K-7 education. As Smith[19] points out, development and implementation of intentional parental involvement strategies positively influences the level of parental involvement. In the Martinsburg/Lafayette pilot program, parents and community were connected through technology tools. This program will work to capitalize on family and community so that the sharing of scientific knowledge and ideas flows freely.

Anticipated Results

The anticipated project will be a fully tested model that can be adopted by colleges/universities and K-7 grade partner institutions. Specifically this project will result in the following outcomes:

1. model documentation with fully developed STEM curriculum tied to real world connections,
2. STEM attitudes
    a. Learning skills associated with hands-on activity tools
    b. Academic value of the mentoring experience from both global and one-on-one perspectives
    c. Cyber learning experience
    d. Job market perceptions,
3. verification of model performance with institutes beyond Lafayette and Spring Cove SD,
4. fully developed, interactive website containing activities, demonstration tools, video, links.

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