Creating Partnerships between the University and Secondary Schools

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Project STEP (Science and Technology Enhancement Program) is a joint effort between the Colleges of Engineering and Education at the University of Cincinnati to partner with schools in the Cincinnati Public School system. Project STEP connects engineering graduate students (Fellows) with middle and high school science educators to help bring authentic learning activities into the classroom. The project is funded through the NSF GK12 program to enhance science education.

The project had two primary goals; 1) to produce scientists, engineers, and secondary science and mathematics educators who are experienced in developing and implementing authentic educational practices into current secondary science and mathematics curricula and 2) to design, develop, and implement hands-on activities and technology-driven inquiry-based projects, which relate to the students' community issues, as vehicles to authentically teach science, technology, engineering and math (STEM skills). The partnerships with the schools created the context and setting for accomplishing these goals. Fellows were initially trained in lesson planning and teaching techniques, and then were paired with cooperating teachers in the participating schools to develop and implement the hands-on activities.

Fellows completed an Instructional Planning course prior to teaching in the schools. This gave them instruction and practice in lesson planning. They were then paired with teachers to develop ideas for the classes they would be working with. Depending on the needs of the particular class, they would develop lessons that would enrich or sometimes replace instruction the teacher was using. Fellows would teach the lesson in entirety or work with the teacher in presenting the material. Fellows and teachers have implemented over 20 different activities in classes covering physics, math, biology, chemistry and environmental science. These activities involve authentic, inquiry based learning and are posted at the project website, http://www.eng.uc.edu/STEP/overview. Some activities were individual lesson plans and others were modules that consisted of several lessons.

Over the course of the first two years of the three-year program, STEP has involved 8 graduate and 4 undergraduate Fellows working with 23 teachers distributed throughout 7 schools in the Cincinnati area. The graduate Fellows were students in the colleges of engineering and education; 3 were doctoral students in education, 3 were doctoral students in engineering and 2 were masters' students in engineering. One of the education graduate Fellows served as the evaluation Fellow to assist in developing and executing the evaluation. This Fellow did not participate in the implementation of activities in the classroom. The undergraduate Fellows were all seniors in engineering. The participating teachers represented a variety of STEM disciplines; 5 in biology, 2 in engineering, 4 in math, 1 in environmental education, 1 in physics, 3 in general science/science education and 7 in other fields. Their teaching experience ranged from 2-30 years with an average of 12 years. The classrooms ranged from 7^{th} grade to 12^{th} grade and included biology, math, chemistry and physics.

This paper first discusses the development and implementation of the evaluation plan. The paper then focuses on some of the lessons learned in the first two years of implementing this project, based on data collected from the Fellows and teachers regarding their experiences with the project and ways in which it might be improved. Also discussed are some of the gains thus far particularly in the context of Goal 1 and the impact on the Fellows. The documentation of the activities at the project website indicates the gains made towards Goal 2 at this point. Recommendations are offered for others planning to implement similar partnerships to enhance science learning in K through 12.

Development and Implementation of the Evaluation Plan

To assess the ongoing effectiveness of the project implementation and the overall impact, an evaluation plan was developed by the evaluation Fellow and the Co-Primary investigator assigned to evaluation. The plan included formative and summative components and was driven by the goals and objectives of the project.[3] The constituents of the grant were identified as the faculty, Fellows, teachers, middle and high school students, the university, and the state board of education. A sample of the evaluation plan and its components is in Appendix 1. As can be seen in the chart it includes objectives, constituents, key questions, instruments, timeline, person(s) responsible and feedback. This was also organized into a timeline that mapped instruments and measures to the goals and objectives. A portion of the timeline can be seen in Appendix 2. This allowed for a tracking of what instruments need to be administered, when this should be done and which objectives the data would support.

Instruments were identified for each goal or objective as can be seen in the evaluation chart. Qualitative instruments included reflections, focus groups, written observations and portfolios.[2] Quantitative instruments were primarily Likert scale ratings measuring attitudes, confidence levels, and satisfaction and feedback levels about project implementation.[4]

The formative evaluation offered the opportunity to create feedback loops for ongoing improvement in the implementation of the grant. The analysis of the formative data led to the creation of lessons learned and, where possible, adjustments to implementation activities. Lessons Learned were discussed with principal investigators and revisions were made to the implementation plan where applicable. For example, Fellows indicated they needed more instruction about assessment of learning strategies so these were incorporated into the subsequent training. Summative data is still being collected and will be complete after the final year of the grant. However, focus group data collected thus far gives indication of the overall impact of the program especially on the Fellows (Goal 1).

The online lesson plans document the progress towards Goal 2. Summative data is being collected by the Fellows about the impact of these lesson plans and activities on student learning and student's attitudes towards science and math. This impact will be presented in the project's final report. However, Fellows have considered feedback from students as they have presented plans and used this feedback to make adjustments to new lessons. The assessment of the lesson plans was an area of significant development. Fellows were given a guide to aid in the development of their modules (Planning Modules – Measuring Effectiveness/Student Satisfaction, Appendix 3). Additionally, Fellows were required to post lesson plans and assessment information at the project website.

Feedback from the various constituents was gathered in a number of instruments considered in this report. This feedback represents data from the first two years of the project. The primary source of information comes from the Fellows.

Lessons Learned

Feedback on Instruction. Formative data included feedback from Fellows about instruction. In the Fall quarter of the first year, Fellows completed an Instructional Planning course to prepare for their work in the classroom and the development of their activities and lessons. The course evaluation revealed that 100% of the Fellows agreed that the course provided useful information about best teaching practices and instructional approach, content focused on educational methods and concepts, and opportunities to develop lesson plans using a variety of the techniques. Areas for improvement were indicated by low agreement rates. 37% agreed that assessment strategies were adequately addressed and 20% agreed that they had an opportunity to discuss current topics in education with middle and high school science teachers. Subsequent courses were designed to address these concerns. Following their teaching experience in the first year, Fellows also completed a survey to determine their level of competency on a variety of teaching skills. Table 1 shows the self-ratings of competency expressed by the Fellows in some key areas.

Table 1. Fellows self-ratings of competency after Year 1 instruction

Fellows Teaching Skill	average competency score (scale = 1 lowest-5 highest)	% competent (n=9)
Able to use a variety of methods to assess learning	3.9	77%
Relate standards to teaching objectives	3.6	55%
Connect science standards to lesson plans	3.7	55%
Develop authentic learning activities	4.6	100%
Demonstrate the effectiveness of a lesson plan	3.9	66%
Adapt activities to student's needs	4.4	77%
Incorporate technology to support learning	4.3	77%

Based on the competency scores and the percent who felt competent, this indicated that instruction should focus more on standards and demonstrating effectiveness of a lesson plan. The instruction was reasonably effective in the other areas and succeeded in helping the Fellows develop authentic learning activities, the main focus of Goal 2 of the grant. In this survey the Fellows also identified the areas as most helpful in developing their lesson plans and where they need additional assistance (Table 2).

Table 2. Fellows feedback on instruction

Fellows Year 1 Feedback	
Most helpful activities and experiences	**Need additional assistance**
Knowledge of classroom environment/culture	Use of technology
Strategies to capturing student interest	Specific Expectations
Teacher expectations	Feedback from peers
Use of technology	
Collaboration with others	
Practice lessons	

Expectations of the Fellows was an issue that was helpful but also needs more attention. The same was true of the used of technology. Fellows also recognized the importance of knowing how to engage students in learning

Preparing for Implementation. In the first year, the Fellows were trained instructional planning, worked in classrooms and piloted some projects. The second year was considered full implementation. These first year experiences were assessed in a variety of ways, including observation by the grant coordinator who was also the instructor for the Instructional Planning course. Individual projects included other forms of assessment such as tests and papers to determine impact on student learning and the perceptions of the activities by the students. These are addressed in other publications focusing specifically on these activities. Overall, impressions developed from the coordinator observation demonstrate ongoing progress towards meeting the goals of the project. Some of the common themes that emerged from the coordinator's feedback to the Fellows are included in Table 3.

Table 3. Themes from coordinator feedback on Year 1 activities

Gains by the Fellows: • Acknowledged weaknesses, builds on experience • Presented at the National Council of Mathematics Teachers Conference • Used examples to teach concepts and make them relevant • Demonstrated good teaching skills • Addressed classroom management issues • Created good quality lesson plans • Communicated well with urban students • Offered effective feedback to students Lessons learned /areas for improvement • Communication skills - be explicit and clear in presentations • Use questioning techniques • Relate the activities to students' experience • Be more outgoing at the schools • Attend a science or math teacher's conference • Incorporate more engineering applications and models • Utilize more effective classroom management techniques • Engage students in problem solving

The coordinator focuses on the need to engage students in learning, relate learning to students experience and develop classroom management techniques. These areas became central to the ongoing implementation of the lesson plans. Gains made by the Fellows indicated they were ready for Year 2 implementation and supported the Fellows self assessment of the effectiveness of the course in preparing them for teaching.

Overall Year 1. Several survey instruments were developed to collect formative data from the various constituencies in the project after Year 1. These included Team evaluation surveys, Year 1 Feedback Survey and an Open House survey. An Open House was held at the end of the first year to showcase the activities and progress made on the grant. A list of lessons learned was compiled by grouping the feedback from the comment sections of these surveys asking respondents to list barriers to meeting goals, concerns about the project and/or suggestions for improvement. The respondents on all the surveys included representatives from the teachers, Fellows and PI's. This feedback was grouped into the following categories; communication, roles/expectations, assignment and training of Fellows, time management and student issues/needs. A list of lessons learned was developed in each of these categories (see Table 4).

Table 4. List of lessons learned Year 1

Communication
- Better communication between graduate, undergraduate Fellows and teachers
- Better communication between PI's and Fellows
- Improve structure and attendance for meetings
- More voice for Fellows on implementation
- Fellows to be together more often to share ideas and collaborate

Roles/expectations
- Ensure common goals and approaches for all
- Clarify roles early
- Develop common theme for activities, similar goals
- Communicate different roles for undergraduate and graduate Fellows

Assignment and training of Fellows
- Fellow to teacher ratio is important
- Principal needs to be well informed of the role of the Fellow
- Fellows need more experience with technology.
- Make sure activities are standards based.
- Learn how to do internet web design and use graphic software.

Time management
- Address time needed to meet and plan
- Have realistic expectations of time needed to execute lessons

Student issues/needs
- Include more information about applications of theory in student's daily lives
- Find ways to engage students in answering questions
- Be clear about instructions for activities
- Relate lessons to engineering
- Promote student involvement as much as possible
- Implementing hands-on activities is important to keeping students engaged
- Consider problems with student attendance and motivation

Feedback Year 2. In Year 2 the Fellows began full implementation of lesson plans in the classrooms. They used some of the activities from year 1 and developed several new ones. At the completion of this year, the PI's wanted to know how the Fellows had been impacted thus far. This included determining changes in their attitudes towards teaching science and their own level of competency in the skills required. Additionally, it was determined that the use of focus groups would be a good way to get more comprehensive feedback from the Fellows about their experiences and what they had gained from their involvement. They could also offer ideas about areas for improvement.

Two focus groups were conducted separately with the graduate Fellows and the undergraduate Fellows. The interview guide was developed around the goals and objectives of the grant (see Appendix 4). The transcripts of the sessions were coded to determine common themes. These were broken into two categories; Lessons Learned and Project Gains. Table 5 identifies some of the gains made towards the project goals and objectives as expressed by the Fellows in these focus groups. Both the graduate and undergraduate Fellows experienced positive gains in each of the areas listed with two exceptions. The graduate Fellows indicated gains in integrating concepts and familiarity with standards which the undergraduate Fellows did not. In the area of Project Gains; the focus groups identified some major themes. These are:

- Understanding of teaching profession, specific experience in teaching
- Fellows impact on students as role models
- Connect practice and theory in classroom
- Awareness of student learning styles and impact on teaching
- Connect science education to professional goals
- Firsthand experience with making science more relevant to students

Table 5. Gains towards Project Goals and Objectives

Goals and Objectives	**Gains**
	Themes
Produce scientists, engineers, science and math educators	-Valuable teaching experience -Professional development -Personal development
Fellows realize connections between education, research and professional experience and relate to career success	-Networking opportunities -Value goal setting in professional development -Relate teaching to career options -Realize connections between learning and practice -Help students connect learning with careers -Fellows as role models
Engage Fellows in meaningful, productive and educational instruction	-Effective Instructional Planning -Valuable lesson planning practice
Guidance in instructional approaches, best practices and direct teaching experiences	-Experience with lesson plans -Familiarity with standards -Knowledge about students/student issues -Realize various learning levels/styles -Awareness of classroom/school cultures -Make learning relevant for students -Integrate concepts
Develop and implement authentic inquiry based learning activities	-Created numerous hands-on activities -Help students relate to material -Resource for teachers -Impact student learning/interests -Enhance classroom dynamics and learning
Incorporate technology and develop computer modules using multimedia web based tools	-Bring tools and engineering applications to classroom -Incorporate technology

Table 6 is a list of lessons learned from Year 2 and some specific implementation strategies developed to address these.

Table 6. Lessons Learned Year 2

Lessons Learned		
Goals and Objectives	Themes	Implementation Impact
Produce scientists, engineers, science and math educators	-Connect personal goals and program objectives -Realize impact on major program –longer time needed	-Develop communication with major advisor
Fellows realize connections between education, research and professional experience and relate to career success	-Utilize PI knowledge/resources	-PI's offer overview of professional background and research interests
Engage Fellows in meaningful, productive and educational instruction	-Offer Instructional Planning earlier – before work in schools -Reconsider summer practicum -Inconsistent experiences in coursework/training -Provide more practical experiences -Address conflicts with program courses	-Change to summer course Address in school assignments
Guidance in instructional approaches, best practices and direct teaching experiences	-Training on dealing with student issues/classroom management -Address student lack of interest in learning -Guidance on how to integrate concepts	-Add to Instructional Planning course -engage through hands-on activities -increased focus on standards in lesson planning -improve communications with teachers via coordinator -project coordinator reviews lesson plan drafts prior to implementation
Develop and implement authentic inquiry based learning activities	-Determine time required for activities -Ensure Fellow/ teacher goals consistent -Address compatibility between Fellows/teachers -More Fellows per school -Define modules/expectations	-incorporate into lesson planning -review at opening meeting -review when making assignments -reduce number of schools -give Fellows definition and expectations
Incorporate technology and develop computer modules using multimedia web based tools	-Lack of resources in school	-fellows find probes where possible -synchronize lesson plans with computer availability -save website on CD's to bring

	-More training on technology	to classroom -work with school to arrange computer access for students where possible -fellows train students on computer use in context of lesson -revise technology training plan
Effective team dynamics	-Encourage Fellows to work together -Provide clear expectations -Better teamwork/ more involvement from PI's -Undergrad Fellows as second class -More social time to build relationships	-collaboration meetings -develop and review guidelines for Fellows before going into schools -increase meeting and social time -review role of undergrad Fellows -increase meeting and social time

The lessons learned offered additional formative data to make revision to the grant implementation. Some of these had already been addressed based on other feedback, such as:

- Fellows work collaboratively rather than being "individual acts of genius"
- Fellows work with no more than 2 teachers
- Better communication between graduate, undergraduate Fellows and teachers
- Better communication between PI's and Fellows; PI's as a resource
- Clarify roles and expectations for Fellows
- Address time constraints in planning and executing lessons

The focus groups identified some additional lessons learned including:

- More social time for Fellows to build team
- Make better connection between Fellows' goals and project goals
- Be realistic about impact on length of time to complete graduate program
- Role of undergraduate Fellow needs to be assessed
- More training in technology

Attitudes towards teaching science. Over the course of their two year involvement, Fellows were surveyed for their perceptions about and attitudes towards science education. This was accomplished through the use of a skills/confidence inventory and attitude survey[1] which were administrated before their involvement in any training and at the end of Year 2. Changes in the Fellows' assessment of the importance of science teaching skills and their own confidence levels with these skills show some progress towards the project goals. Fellows' attitudes towards teaching science and math showed less conclusive results.

Table 7 shows the results for the attitude survey about teaching math and science. Fellows rated a series of statements on a scale of 1 (strongly disagree) to 5 (strongly agree). One might have expected the overall agreement with all the statements below about teaching math and science to have increased. However, all but the statements about the use of manipulatives (9), calculators (28) and small groups (30) decreased. Likewise the average scores in these other areas decreased. The statements about Fellows' attitudes towards teaching math and science did move in the direction expected for three of the four statements. Fellows showed less agreement and a lower rating score for the statement referring to the use of connections between math and science in teaching. This is of some concern because one of the objectives of the project is to show the importance of making these connections in science education. This might be due to small sample size. Further follow-up of this data will be explored in Year 3.

Table 7. Fellows attitudes and beliefs about teaching science

Fellows beliefs about teaching math and science

Statement	change in agreement	change in score
9. Students should have opportunities to experience manipulating materials in the mathematics classroom before teachers introduce mathematics vocabulary.	5.6%	-0.10
11. Students should be given regular opportunities to think about what they have learned in the mathematics classroom.	-13.9%	-0.58
12. Using technologies (e.g., calculators, computers, etc.) in mathematics lessons will improve students' understanding of mathematics.	-19.4%	-0.83
14. Small group activity should be a regular part of the mathematics classroom.	-2.8%	-0.56
16. Using technologies (e.g., calculators, computers, etc.) in science lessons will improve students' understanding of science.	-16.7%	-0.45
19. Students should be given regular opportunities to think about what they have learned in the science classroom.	-2.8%	-0.24
26. Students should have opportunities to experience manipulating materials in the science classroom before teachers introduce scientific vocabulary.	-11.1%	-0.15
28. Calculators should always be available for students in science classes.	2.8%	-0.34
30. Small group activity should be a regular part of the science classroom.	22.2%	0.17

Fellows' attitudes towards teaching math and science

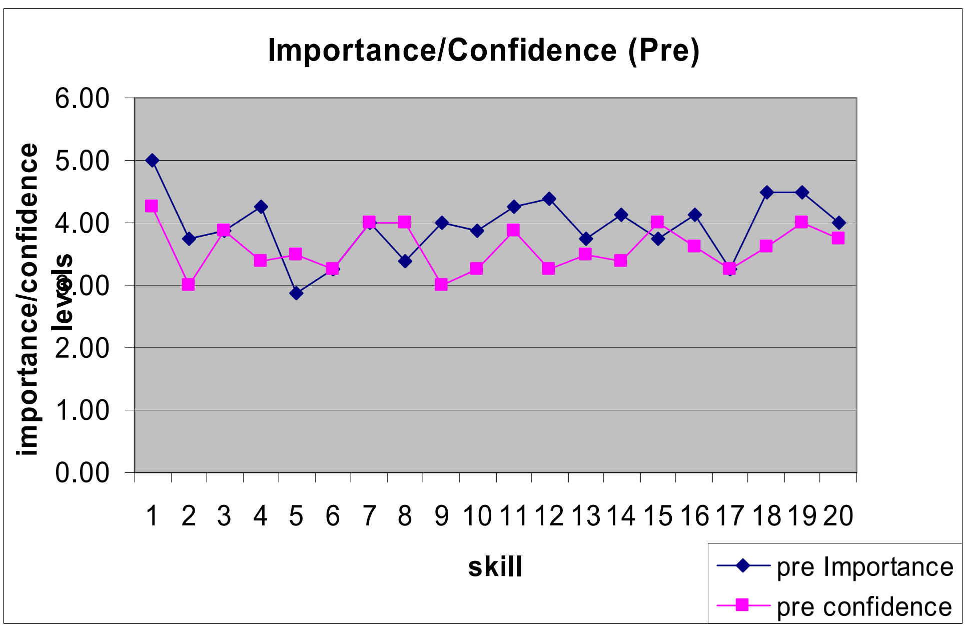
33. The idea of teaching science scares me.	-13.9%	-0.63
35. I prefer to teach mathematics and science emphasizing connections between the two disciplines.	-13.9%	-0.73

36. The idea of teaching mathematics scares me.	-33.3%	-0.92
38. I feel prepared to teach mathematics and science emphasizing connections between the two disciplines.	2.8%	0.00

In the skills confidence inventory, Fellows rated the importance (scale of 1 - not important to 5 - very important) of specific teaching methods and practices in science and their relative confidence (scale of 1 - no confidence to 5 - very confident) in using these. This was administered before their participation in the Instructional Planning course and at the conclusion of their work in the STEP program (two years later). Appendix 5 lists the skill areas rated by the Fellows. The following graphs (Figures 1-4) show the results of these ratings.

In Figure 1, a comparison is made of the Fellows ratings of importance of teaching skills versus confidence at the start of the study prior to beginning teaching. The results indicate that the Fellows tended to rate the importance of the skills they were teaching higher than their confidence in being able to use these skills. Hence, prior to beginning teaching, in all but three skills, the Fellows rated the importance of the skills as being higher than their confidence in using the skill.

Figure 1. Comparisons of Fellows Ratings of Skills Importance and Confidence Prior to Teaching



In Figure 2, a similar comparison is made of the Fellows rating of importance versus confidence; however this is at the end of two years of teaching. Two findings are of interest. First, the overall ratings of both importance and confidence are higher, indicating that the Fellows see these skills as having even more importance in the teaching and practice of science and their confidence in using these have increased. Second, the ratings of skills and confidence are more closely matched indicating the Fellows are most confident on skills they rate as most important.

The confidence patterns seem follow the importance patterns more consistently in the post survey, although there were still some skills that Fellows saw as important but showed less confidence with then compared to other skills. For example Fellows showed the least amount of confidence with 9, the use of Blooms taxonomy; 17, identifying appropriate replication outcomes; and 18 relating student motivation to internal learning processes. However, the only area where the Fellows' level of confidence went down was in the use of Bloom's taxonomy. Overall, Fellows seemed to rate their confidence levels more closely to the importance levels in the post survey.

Figure 2. Comparisons of Fellows Ratings of Skills Importance and Confidence after Two Years of Teaching

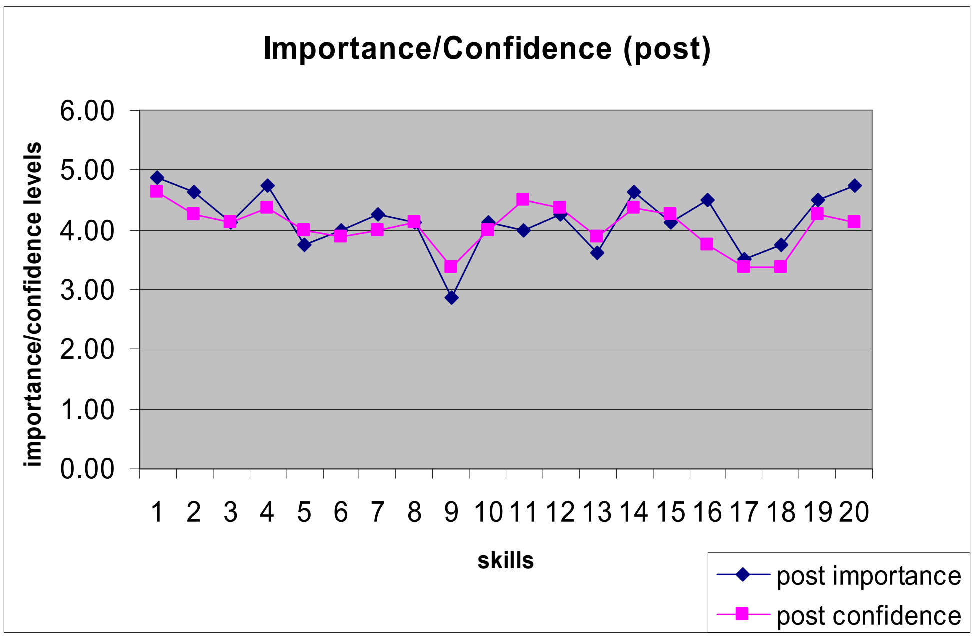


Figure 3 shows the change from pre to post test for the Fellows' rating of the importance of skills. With few exceptions, the majority of skills are rated as similar or more important after they have taught for two years. This indicates that the Fellows consider the skills to be similarly important over time. One exception to this pattern is the difference in the importance of using Bloom's taxonomy which decreased by over a point in the post survey. The Fellows' limited understanding and/or appreciation of this concept and lack of integration into the lesson plans may explain this decrease.

Figure 3. Comparison of Pre and Post Test Ratings of Importance of Skill

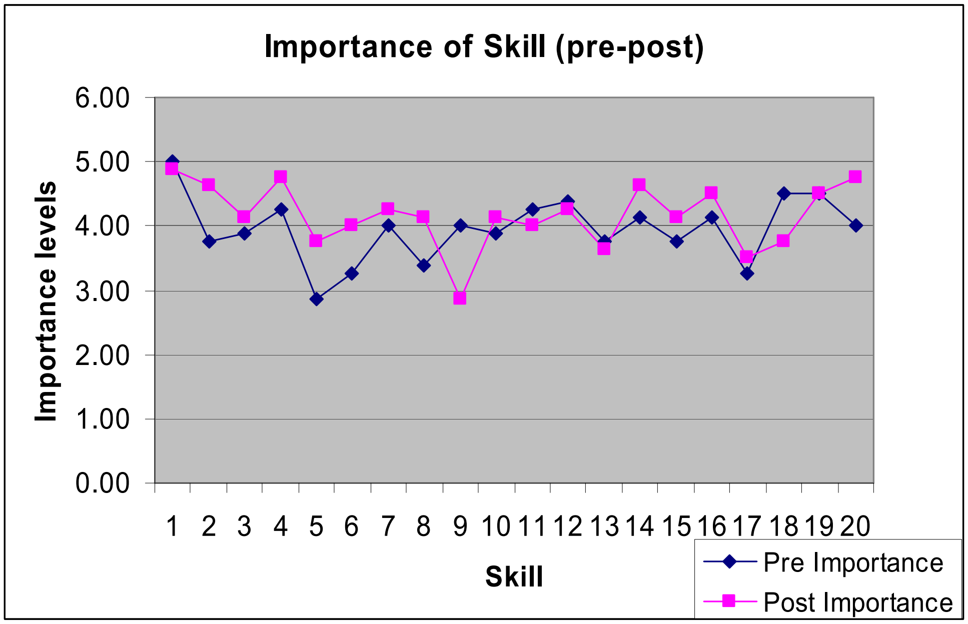
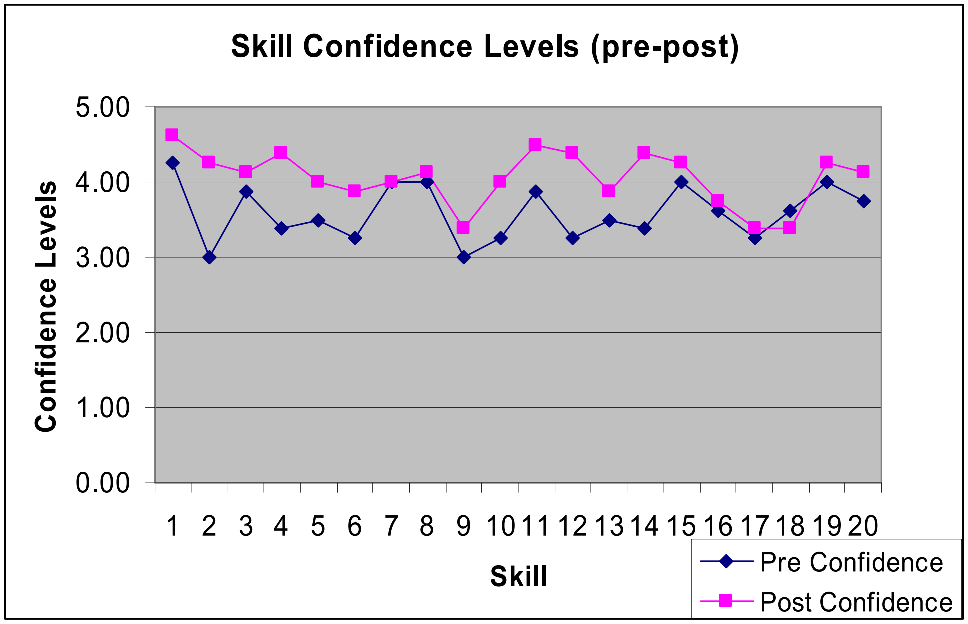


Figure 4 demonstrates that the confidence levels consistently went up for nearly every skill with the exception of 18 (relate student motivation to internal learning processes). These increases are an indication of positive outcomes for the grant. The Fellows are showing increased confidence levels after designing and implementing authentic learning activities in the science and math classrooms. This especially indicated by the change in 2 (design and implement inquiry based lesson plans) and 4 (design and implement hands-on activities). The largest gains in confidence were in the areas of 2 (design and implement inquiry based lesson plans), 4 (design and implement hands-on activities), 12 (design standards-based goals and objectives), and 14 (focus on learner-centered instruction).

Figure 4. Comparison of Pre and Post Test Ratings of Confidence Levels for Teaching the Skills



Conclusions and Recommendations

After the first two years of project STEP, data collected supports progress towards the project goals. Goal 1, to produce scientists, engineers, and secondary science and mathematics educators who are experienced in developing and implementing authentic educational practices into current secondary science and mathematics curricula, is evident in the feedback offered from the Fellows, teachers and PI's. It is especially made clear in the focus group data where the Fellows make repeated references to their work in the classrooms and how this has impacted their understanding and ability to teach science. While many of these references indicate that further development is needed, they do show progress towards this goal. The feedback from teachers and PI's support this progress. Goal 2, to design, develop, and implement hands-on activities and technology-driven inquiry-based projects, which relate to the students' community issues, as vehicles to authentically teach STEM skills, is best supported by the documentation of the lesson plans developed by the Fellows. However, the feedback from the coordinator, teachers, PI's and focus group data from Fellows also support the progress towards this goal. Relating to both goals, the Fellows showed an increase in their confidence in teaching though the skills confidence inventory, instructional planning course evaluation, focus groups, and Year 1 feedback data. Final summative data will be used to demonstrate how the project met its' two main goals.

The formative data is most significant at this point in the project as it is used to provide for continuous improvement. This data has provided a list of lessons learned that have helped the principal investigators guide the ongoing implementation of the project. This has been used in the design of the instructional component of the project (what course to offer, course content and timing), the placement of the Fellows (ratio of teachers to Fellows, number of schools involved), communication strategies (meeting structure, times and agenda, the use of weekly feedback reports, monthly Fellow/PI meetings) and the importance of team building (clear roles and expectations and social interactions). Based on these lessons learned and revised strategies, the project offers several recommendations for other partnerships. These include the following:

- Create structure that supports effective communication between all constituents.
- Define clear roles and expectations with expected outcomes for all constituents.
- Create a manageable structure that supports effective collaboration between the university and schools (don't spread people to thin).
- Create regular team building activities that include opportunities for Fellows to collaborate and social interactions.
- Develop Fellow training program that addresses the following components
    - Fellows have an understanding of student needs and issues.
    - Identify techniques for classroom management.
    - Incorporate the use of technology into lesson plans.
    - Discuss Fellows/teacher relationship and communication issues.
    - Identify pedagogy that engages students in learning.
    - Offer time management skills and techniques.

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Biographies

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Appendix 1. Evaluation Plan Excerpt

Objectives	Constituencies	Key Questions	Instruments	Person(s) Responsible for Instruments	Timeline	Feedback
Demographic analysis of **constituents**	Fellows, teachers, students, faculty	What characteristics define the constituent groups involved in the project?	demographic surveys with consistent questions for all groups	Suzanne	entry into project; September each year	N/A
Improve **teacher's and student's** attitudes about science and science education	Fellows, students, teachers	What beliefs/attitudes are held by the constituent groups in the project and how does involvement in the project affect those belief/attitudes?	attitudinal surveys	Suzanne	pre/post; entry into project and completion of involvement; end of first year	Assess impact on first group of students and teachers and use their input to revise where appropriate and possible
Engage **Fellows** in meaningful, productive and educational instruction	Fellows	Were instructional components of the project meaningful, productive and educational?	course evaluations (18-SEC-511, 18-CI-523, technology courses)	Ted, Suzanne	December, March, June	Use course evaluations to update course content, activities
	Fellows	What significant lessons were learned by Fellows in the practicum and school experiences?	evaluations of modules in Spring seminar by faculty, Fellows and teachers	Suzanne	course completion and year-end, project completion	Use evaluations to make course and project revisions

Appendix 2. Evaluation Timeline Excerpt

Month	**Instrument**	**Constituent**	**Goal/ Objective**
Ongoing	*Document time and activities	all	i, iii, J,N,P
September	*demographic survey *attitudinal surveys *skills/confidence levels *document curriculum projects secondary students' plan survey (N/A)	all Fellows, teachers, students Fellows teachers students	A B, D, K iii, E II,O i
October	*Fellows portfolios	Fellows	iii, D, F
November			
December	*Course evaluations *Course assessment of Fellows learning	Fellows Fellows	C E
January			
February			
March	*Course evaluations *Course assessment of Fellows learning	Fellows Fellows	C E
April			
May	*Document teacher involvement secondary students' plan exit survey (N/A)	Fellows, teachers students	I i
June	*Course evaluations *Course assessment of Fellows learning *Module evaluations *SMET standards assessments (partial) *Document module activities	Fellows Fellows Fellows, faculty, teachers Fellows teachers, students	C E C, E,F,G F ii, J,M,N

Appendix 3. Planning Modules – Measuring Effectiveness/Student Satisfaction

Develop an evaluation plan

A. Identify goals and objectives of the modules
    1. Goal: Integrate math and science - show how the module did this
    2. Objective: Students can make connections between math and science as a result of the module activity
    3. Rubrics can help represent the goals and objectives as they relate to the activities' effectiveness
    4. Use standards to measure project effectiveness
B. Develop evaluation questions – using a manageable list
    1. Best demonstration of effectiveness
    2. Determine formative and summative components
    3. Identify stakeholders and audiences;
       Students, Fellows, faculty, teachers
    4. Create a list of questions
    5. Prioritize questions based on importance, logistics and stakeholder – what questions can be reasonably measured with the resources and time given – where can the greatest impact be demonstrated
C. Match questions with appropriate techniques
    1. What is the most suitable data collection method

Quantitative	**Qualitative**
Questionnaires	Observations
Tests	Interviews
Databases	Focus Groups
Measurements	Journals

    2. How can the data be collected most effectively
    3. Which method gives the most useful information about the question asked
D. Collect data.
    1. Consider how data will be tabulated/recorded
    2. Consider environment, participant needs
E. Analyze data
    1. Formative – how does data impact ongoing implementation
    2. Summative – how does data demonstrate project effectiveness
F. Provide information to interested audiences
    1. Papers, presentations
    2. Feedback to participants

Sample Plan

Step Project Goal: Motivate students through real world experiments, observations and measurements to study problems that affect their daily lives.

Module: Building Bridges
Module Goal: Integrate science and math
Module objective: Students will gain an appreciation for the way in which math and physics are used in bridge building.
Standard: Use mathematical models to predict and analyze natural phenomena.
Rubric component:

	Exceeds expectation	Meets expectation	Below expectation	Unsure/not known
Student connects appreciation for integration of math and science in bridge building with module activity	Responses exceed level of expectation; student makes connections beyond expectation	Responses meet level of expectation; student makes connections as expected	Responses below level of expectation; student not able to see how activity connected math and science	Student not able to respond to question

Evaluation Question:

1. Did students show an increased appreciation for how math and science were integrated?
2. Were students able to see how the activity related this concept?
3. Did students participate in the aspect of the project that emphasized this connection?
4. Did students find this aspect of the activity fun and challenging?

Methodology:
Students' ability to relate math and science; Likert Scale rating, learning portfolios.
Students' response to this part of the project: opinion surveys. Likert Scale, observation of classroom activity, focus groups.

Formative versus summative:
What did you learn about the students' response to the project that would influence the development of other projects in this module?

How does the data show that students were able to make connections between math and science as a result of participating in this project?

Appendix 4. Interview Guide for Fellow focus groups.

Interview Guide
Purpose: To get input from Fellows involved in Project STEP and determine impact of their participation on their educational and career plans.

Questions
A. Project Goal II
Produce scientists, engineers, science/math educators who are experienced in developing and implementing authentic educational practices into secondary science/math curricula
Objective D
Fellows realize connections between education, research and professional experience and how this relates to their career success.

1. How has the program impacted you and your professional pursuits?
2. What contributions do you think you have made to your teachers and students? Give some examples.
3. Explain the ways in which you were able to fulfill or not fulfill your role in the program.

B. Objective C
Engage Fellows in meaningful, productive and educational instruction.
Objective E
Provide Fellows guidance in instructional approaches, best practices and direct teaching experience.

1. Explain how the instructional component of the programs prepared you for your work with teachers and students. In what ways could it be improved?

C. Objective F
Fellows develop and implement authentic inquiry based learning activities based in technical expertise and knowledge.
Objective G
Fellows are trained to develop computer modules using multimedia and web-based tools.
Objective P
Create effective team dynamics to develop and implement the modules.

1. How did the projects you developed incorporate authentic learning and technology?
2. How did the project support you in developing authentic learning modules that integrated technology? What barriers existed to doing this?
3. To what extent do you feel part of a team and how did this impact your involvement in the project?

General
What was the most valuable thing you learned from this experience?
What advice would you give future Fellows?
Is there anything else you would like to say?

Appendix 5. List of teaching skills rated by Fellows in pre-post skills/confidence inventory.

1. Knowledge of relevant content
2. Design and implement inquiry based lesson plans
3. Design and implement procedural lesson plans
4. Design and implement hands-on activities
5. Use of computer based presentations
6. Use of multi-media web resources; ie internet, interactive media
7. Design and implement inductive lesson plans
8. Design and implement deductive lesson plans
9. Use of Bloom's taxonomy
10. Use Cooperative learning strategies
11. Incorporate real world experience
12. Design standards-based goals and objectives
13. Teach proficiency test material
14. Focus on learner centered instruction
15. Incorporate career information
16. Focus on concepts and functional relationships
17. Identify appropriate replication outcomes
18. Relate student motivation to internal learning processes
19. Use of appropriate questioning strategies
20. Use levels of understanding to design teaching units