AC 2007-2384: USING SERVICE-LEARNING TO DEVELOP A K-12 STEM SERVICE AND EXPERIENTIAL LEARNING SITE

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Using Service-Learning to Develop a K-12 STEM Service and Experiential Learning Website Site

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Abstract

This paper will discuss a National Science Foundation grant project that has been designed to provide a mechanism to inform a significant group of science, technology, engineering and mathematics (STEM) educators of the strategies available to incorporate service-learning and experiential learning into their curriculum. The goal of the project is to identify, evaluate, classify and distribute resources (via a web site) for STEM educators (grades K-12) wishing to incorporate community service or hands-on learning into their curriculum in order to encourage students to pursue careers in these fields. By helping students to "make the connections" between STEM subjects and real-world issues, these strategies are expected to increase student interest in STEM disciplines, enrich learning experiences for students, and enhance the skills of STEM educators on the content and application of STEM subjects. In addition the experiential learning that has taken place during the development phase of the website will be discussed. During this phase, a cross functional student team selected the web project as a result of taking a project course.

Introduction

The demand for workers in the U.S. who are educated in the STEM (Science, Technology, Engineering and Mathematics) fields continues to increase at a rate that outpaces the supply. There is a significant gender gap that persists despite continued efforts to address the root causes and to address educational inequities that contribute to its continuance. A study of employment data from 1983 to 2003 shows an increase in the number of women holding jobs in the natural and social sciences, yet there has been no corresponding increase in the field of engineering. The fields of mathematics and computer science have actually experienced a decrease in the number of women holding jobs over this same period of time.[1]

Many studies support the belief that efforts to achieve a more diverse workforce for STEM related disciplines must start by encouraging K-12 students from under-represented groups (including girls) to become interested in science and math and pursue that interest when making career choices.[2] Encouragement toward these disciplines can come in many forms including teaching methods that make science and math exciting and fun, and at the same time stimulating students to become more actively involved in their own learning.

In 2000, Jones studied the attitudes and perceptions of 437 girls in the six grades. The findings suggest that young women are more likely to gravitate toward fields that they perceive to be the "serving" or "helping" fields such as health sciences, social sciences and biology and steer away from careers pertaining to the physical sciences. The study goes on to suggest that young females have a perception that the physical sciences destructive or "war-like". This misconception of the STEM fields amazingly enough exist and assuming it holds true for the majority of six graders could suggest that the gender gap within these fields may continue to exist with little or no hope of changing. An alternative to breaking down these misconceptions is to expose young female students (and male students) to the STEM fields through service and experiential learning techniques.[3]

Service-learning and experiential learning methods, when integrated into STEM curriculum, result in positive attitudes towards these fields and increase the likelihood of students pursuing further education in this area. There are many programs available for STEM educators but Even though the benefits of incorporating service and experiential learning into the curriculum has many benefits, the avenue for teachers to gain information and resources regarding service and experiential learning is one that is less paved. Currently, with the use of the internet, there are a variety of experiential learning activities available. However, there is little consistency between grade levels, required content/curriculum or available resources. This program utilizes a pool of educators to evaluate a website that classifies and composes most easy to use, inexpensive and effective methods for introducing K-12 students to the STEM fields.

Service and Experiential Learning

Service-Learning

The concept of *service* learning has gotten national attention. The American Society for Engineering Education (ASEE) has recognized the need to attract more women and minorities into the field of engineering. They have made a strong commitment toward service leaning by recognizing the connection between engineering careers and humanitarian activities as being the critical key toward closing the gender gap.[4] Programs such as Engineers Without Borders, "Connecting the World to Engineering", New Faces of Engineering" and "Introduce a Girl to Engineering Day" are all examples of the efforts made to expose young women to the diversity within the field itself.

Experiential Learning

Experiential learning has proven to be a powerful tool for educators in gaining student interest in STEM topics. Innovative hands-on, inquiry based activities that augment science and math experiences make these subjects more appealing to students and active discovery has been found to promote interest in mathematics in girls. Informal science education programs have also been shown to increase the participation of women and minorities in STEM fields. These programs rely on intensive one on one interaction with peers and teachers and acquisition of specific practical skills. Alternative teaching methods that involve cooperative learning and group discussion have been shown to be especially effective with girls. The use of these different learning environments and

techniques can also improve girls' preparation to enter the STEM fields. Presenting STEM topics along with real world application entice students to want to learn more. Additionally, experiential learning can often be used to target areas of the curriculum that have traditionally been difficult for teachers to explain using current classroom methods.

Project Overview

In May of 2006, The University of Dayton was awarded a National Science Foundation (NSF) grant entitled, "Making Connections: Resources for K-12 Service-learning and Experiential Learning in STEM Disciplines". The goal of this project was to provide a system for K-12 educators to incorporate service learning into their curriculum. There are several objectives that the project is to accomplish:

1. Promote the entry of women and minorities into the STEM fields
2. Increase the potential pool of engineers and scientists in the United States
3. Contribute to the development of STEM educators
4. Enhance cultural sensitivity, ethics and social responsibility in future STEM workers.

This system is designed to ultimately increase the familiarity of humanitarian acts associated with the STEM disciplines to young women which may foster an increase in the participation of women in the STEM fields. There are several benefits from students receiving this type of exposure. However, our task was to focus upon two; First, that service learning has a positive impact of students' perception of science and produced a corresponding increase in their interest in pursuing further education and careers in the STEM fields. Second, that the new curriculum integrates social responsibility, diversity and ethics into the classroom environment. Exposure to these elements in addition to the STEM topics not only increases female interest but also forms a better student that may be better prepared for life in the real world.

The project aims to develop an easily accessible resource for (K-12) STEM educators designed to make available programs and projects that will either connect community service or humanitarian causes to STEM curriculum or connect STEM experiential learning projects to relevant, real-world applications. It is not enough to make the lessons engaging and entertaining. The lessons must be content-based and tied to the world outside the classroom. Students are more likely to pursue additional coursework and entertain alternative career possibilities when they care about the topics and issues that are associated to material taught in class. Student learning and engagement can only be fully experienced when the topics are relevant to their personal sphere of experience.[5] By continually expanding this sphere of experience through service and experiential learning, students will broaden their potential career choices to include STEM fields. By developing a central repository for these educational resources and designing it to be user-friendly and easily assessable, educators are more likely to implement them into their curriculum thus influencing or even persuading young women to pursue careers in the STEM fields.

General Approach

A plan was developed which included several elements to complete the site. Elements included were; identification of appropriate resources, and curriculum materials, development of advertising brochures for website promotion, website development, pilot testing, assessment and evaluation of site, revisions and final presentation of resources to a national audience. Included in the identification of appropriate resources was a plan to integrate this project into a course that would involve service and experiential learning. Thus, we explored the possibility of involving college students in the development of the website in order to engage them in the experiential and service learning process. A project management course seemed to pose as the ideal setting for the assignment. More detail regarding the team's approach will be discussed later in this document.

Resources

We developed a cross functional committee comprised of several representatives from the STEM fields from the University of Dayton and the Dayton Metropolitan areas. Participants from the faculty at the Univerivsity of Dayton helped with identification of appropriate service and experiential learning content, structure of the modules that will be contained in the site and the evaluation of the prototype website. These faculties were not only recruited from the Science, Mathematics, Engineering and Engineering Technology Departments but also from the School of Education. Committee members outside the University included the Assistant Superintendent of the Montgomery County Educational Service Center (serving 16 school districts) and 20 STEM (K-12) educators interested in participating in the training and evaluation of the prototype site and its contents. All of which contributed willingly.

Curriculum Materials and Module Information

While there are several sites that present service-learning projects of all types, there are few STEM topic-related projects and identifying them is difficult and tedious. Existing service-learning and experiential STEM curriculum enhancements appropriate for grades K-12 have been identified by the committee and segregated into the STEM disciplines. Examples of sites that contain material appropriate for inclusion see "Service-learning: Education Beyond the Classroom", www.servicelearning.org/ and www.paservicelearning.org/.

The committee used the following criteria to evaluate the usefulness of the models.

- Age and culturally appropriate
- Curriculum specific
- Academically challenging
- Transferable
- Inexpensive
- Easy to Implement
- Either community service oriented or hands on and relevant to real world experience

For consistency and ease of use for our users, the same format for each module developed was utilized. Each module would include:

- Title of the Service/Experiential Learning Module
- URL link
- Curriculum Topic
- Target Grade Level
- Project Overview
- Anticipated Time Required
- Project Structure
- Suggested Community Partners
- Supplies Needed
- Estimated Cost to Implement
- Project Implementation
- Student Assessment Tools
- Additional Resources

STEM Logo and Advertising Brochures

UD Department of Public Relations coordinated the production of the brochures to advertise the website. These brochures incorporate introductory and background information explaining the positive impact this type of curriculum enhancement can have on students interested in STEM subjects. Examples of website content will be included and the ease of use will be stressed. If the site is not easy for educators to use, then they will not use it. These brochures are the main method of contact to disseminate the information about the website. The development of the STEM logo for the site incorporates the disciplines of Science, Technology, Engineering and Mathematics and the statement, "Enhancing professional development through service learning". The logo is as important as the content of the modules. Educators and students should be able to recognize the logo easily and associate it with the STEM disciplines. A copy of the logo is shown in Figure 1 below.

Figure 1: Logo developed for the project

Utilizing Experiential Learning in Project Management

Website Development

Originally the website development was to be completed by a professional marketing and communications firm. However, it was decided to integrate service learning into the site development by having a student team develop the site. Students who were selected

were required to participate in a client sponsored project. The course is designed to give students experience conducting a project from start to finish with a community sponsored client. Recently, projects for the course have been solicited by the instructor by developing contacts within the local community. Projects were solicited that will enable students to get out of their proverbial environment/comfort zone and interact with various types of people. Many projects have been selected that integrate the students with the local community. For example, we have completed projects for the City of Dayton, Dayton Metro Libraries, Greater Old North Dayton Business Association and Montgomery County's Mental Retarded, Developmental Disabilities Center and the STEM Committee for the National Science Foundation.

At the beginning of the course, students are presented with several project descriptions and they select their top three choices. Team selections are based upon student interest (which aids in motivation), class profile (technical disciplines that are represented) and student performance history. The STEM student team was comprised of six cross-cultural, multi-disciplined engineering technology undergraduate students. They were a very diverse team that possessed many interests and talents. The students met with their clients in order to develop a project proposal that would meet their client's needs. Elements included in the project proposal were; letter of transmittal, project scope, project deliverables, logistics, support, general approach, schedule complete with Gantt chart and budget. After the client approved their proposal, the student team developed a survey for local teachers regarding the information that would like to have in a website design. The results of the survey are shown in the Appendix Section of the report. Once the students evaluated the data from the local teacher survey, they began to develop their site. They purchased software, located and scheduled training courses in order to learn how to use the software, and began to design the site. Once the prototype site was complete, they met with their client to review the design of the site. As a result of that meeting, the committee wanted to include the ability to search the site by subject for information, at any page on the site. Thus, students needed to investigate a variety of search engines that were available to handle the task. Finally, the team scheduled a meeting with the STEM committee to review and evaluate the content, design and ease of use of the prototype site. During the meeting the team gave a brief tour and explanation of the features of the site which included; the homepage, service learning explanation, place for photos, search engine, additional links and STEM modules for grade school (K-5), middle school (6-8) and high school (9-12). In addition, the students included a survey for the committee to complete regarding the information contained in the prototype site. The committee was able to rate the site's aesthetics, content, organization, the length, clarity and ease of navigation. The URL for the link is http://stemstem.ifastnet.com. See Figure 2 below.

Figure 2: STEM Website Homepage

Student Learning as a Result of this Project

The service and experimental learning component provided an effective means to learn the material taught through connecting actual deliverables to a client. As stated above, students experience higher motivation levels when they can see the usefulness of what they are learning and when they can use that information to do something that has an impact on others. ** In engineering technology, developing a deep understanding of the engineering fundamentals (project management fundamentals) and practice are vital to professional development and growth. Service and experiential learning provides an excellent environment to foster this transformation. Experimental learning provides students with the opportunity to work with people, develop communication skills (written and oral), develop presentation skills, handle constraints, develop contingencies, recognize their limitations, challenge their abilities and become familiar with all the other "messy" issues that are part of the reality of running a project.

Professional Evaluation

There are multiple types of data that will be tracked to measure the effectiveness of the pilot program. The initial feedback regarding the site came from the STEM committee and modifications were made to the site. The second set of data will be collected from a test group of professional educators. The professional educators group is comprised of a small group of about twenty male and female, science and math educators. Information has been distributed to the area Catholic Schools and the County Public Schools which collectively represent students of every socioeconomic status (disadvantaged as well as affluent) and multiple cultural backgrounds. This cross-section of student populations is critical for an effective assessment and evaluation process. The team is responsible for attending the workshop, implementing at least one activity in their classroom, asses the site and attend a closing discussion to share ideas and experiences. A picture of the workshop environment is shown below.

Figure 3 – Educator Workshop

The feedback which will be used to modify changes required to enhance the usefulness of the site. The workshop was conducted on Saturday, January 20, 2007. An example of the evaluations for the workshop and the site are in the Appendix Section of the report. Additionally, the implementation meeting will be held on May 19, 2007. These results will be discussed during the presentation of the paper in June.

Summary and Conclusion

The project results are two fold. First, this project provided a simple mechanism to inform a signification group of STEM educators (K-12) of the strategies available to incorporate service learning and experiential learning into their curriculum in order to encourage students to pursue careers in these fields. By developing a central repository for these educational resources, and making this resource user-friendly, easily accessible, educators are more likely to implement them. Second, this project has provided college level students with the opportunity to apply project management theory and tools to a real project that will help others in the community. By helping students…all students, "make the connections" between STEM subjects and real-world issues, these strategies are expected to increase student interest in STEM disciplines, enrich learning experiences for students and enhance the skills of STEM educators on the content and application of STEM subjects.

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Appendix
STEM Committee Survey

STEM

Science Technology Engineering Math

UNIVERSITY OF DAYTON

This page represents the outcome of the surveys that were collected.

1) What is the order of importance? (1 being the highest)

Attractive	3
Fast to Download	4
Easy to Navigate	1
Rich in information	2

2) What is the order of interest? (1 Being the highest)

Amount of Material	3
Quality of Material	1
Types of Material	2

3) What do you look for in an educational site?

	Percentage of total
Video Clips	21.74
Search Engines	26.09
Forum	13.04
Links	39.13

4) What are the most challenging subjects for your students to comprehend?

	Percentage of total
Physics	29.41
Calculus	11.76
Biology	0
Trigonometry	17.65
Chemistry	23.53
Other	17.65

5) Would an educational website be something you would use to help in the development of your own teaching material?

	Percentage of total
YES	90
NO	10

6) Would you like to see on a site:(Check all that apply)

	Percentage of total
Pictures	28.125
Diagrams	28.125
Data Sheets	21.875
Lessons	21.875

7) What type of navigation do you prefer?

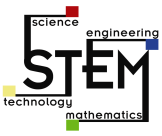
	Percentage of total
Pull down	44.44
Click buttons	55.56

8) Would a search engine be of use to you when searching a site?

	Percentage of total
YES	100
NO	0

9) What website or resources do you currently use as teaching tools?

http://www.ohiodigitalclassroom.org/chalkwaves/
http://www.quia.com
http://www.nctm.org
http://www.ohioctm.org
(ODE) http://www.ode.state.oh.us/GD/Templates/Pages/ODE/ODEDefaultPage.aspx?page=1
www.howthingswork.com
www.math.com
www.webmath.com
www.slidermath.com
star.corn
I search concepts by name using various search engines. I look for websites that can be used as a virtual lab activity.
www.IEEE.org
www.howthingswork.corn
Robotic programming books



STEM Website Evaluation Form

Name:_____ **School:** _____

Please rate the STEM Website based upon the following scale;

0 – Strongly Disagree 2 – Disagree 4 – Neutral 6 – Agree 8 – Strongly Agree

Site Aesthetics – The appearance

1. _____ The homepage of the site is inviting.
2. _____ The colors of the site are pleasing.
3. _____ The pictures on the homepage are appropriate.
4. _____ The site appearance is professional.

Comments regarding Aesthetics:_____

_____

_____

Content – The subject matter

1. ____ The homepage provides suitable information regarding service–learning
2. _____ The homepage provides suitable information regarding experiential learning.
3. _____ The operation of the site is easily understandable.
4. _____ The information provided is at an appropriate level of understanding.
5. _____ The content of the modules is appropriate for clasroom implementation.
6. _____ The module format is suitable.
7. _____ The curriculum topics were correctly categorized.
8. _____ The student groups were appropriately divided.

Comments regarding Content:_____

_____

_____

Navigation – Finding Information

1. _____ Site is easily navigated.
2. _____ Information is easily accessible.
3. _____ Search Engine is helpful.
4. _____ Added website links provided helpful information
5. _____ Website navigation tools took you where you wanted to go.

Comments regarding Navitagtion:_____

_____

_____

Utilization – Helpfulness of the site

1. _____ The site enhanced traditional course content.
2. _____ The site was beneficial when planning lessons.
3. _____ Module content was appropriate.

Comments regarding Utlization:_____

_____

_____

Module Effectiveness – Usefulness of Information

1. _____ Content modules were fun and exciting
2. _____ Modules increased student interest
3. _____ Modules increased student learning

Comments regarding Module Effectiveness:_____

_____

Additional Comments - Please use the space below to provide us with additional comments.

_____

_____

_____