University Faculty Commitment and Involvement in an Outreach Program: Instrumental in Program Success

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Abstract

WISE Investments (WI) is an National Science Foundation-funded program which is designed to encourage more females in middle, high school, and community college to pursue engineering and related careers. A major component of the program are two, two-week summer workshops which introduce middle, high school, and community college teachers and guidance counselors to engineering. These teachers are then charged with integrating what they learn in the workshop into their classrooms. The counselors are charged with incorporating engineering information in their career counseling and developing and implementing an outreach program to encourage students to consider engineering. This has the effect of introducing students as young as 12 years old to engineering as a career option.

The summer workshops include eight hands-on labs on different disciplines of engineering. Arizona State University College of Engineering and Applied Science faculty members present the labs. These eight faculty members have committed time and effort into developing and presenting labs that bring engineering to a pre-college level, and that model gender-inclusive instruction techniques.

The teachers have 16 hours to brainstorm ideas on how to integrate this information on engineering into their current curriculum and to develop applications to implement in the classroom. The engineering faculty work with the teachers for about half of this time to help them find ways to do this. The faculty make suggestions on how to make the labs less expensive, easier to do, shorter, etc. The faculty also help to break down the engineering labs into basic math and science theories that need to be taught in the classroom. This way, the teachers are not adding additional information into the curriculum. They are just presenting the required information in a different -- more engineering-oriented -- way.

Many faculty, teachers, and counselors form a bond that continues into the school year. Faculty work with teacher teams who are each charged with preparing a Saturday Academy based on one area of engineering. The Academies are attended by approximately 40 middle and high school girls. Faculty are sometimes present during the academies to assist the teacher teams, host activities in their own labs, or simply to act as role models for the girls.

The process of cooperation established between the engineering faculty, the teachers, and the counselors is discussed. Examples of lab projects, collaboration, and resulting teachers' lesson

plans will be given. Anecdotes from teachers participating in the program will be presented to show how the university faculty helped them to succeed in the program.

Introduction

Research suggests that middle school is a crucial intervention point for encouraging students to pursue math- and science-related fields. Between sixth to twelfth grade, there is an overall decline in both male and female students' liking and enjoyment of math [1]. Students report that math becomes more and more anxiety provoking over time, math becomes more difficult, and they receive less support from parents, teachers and peers for studying math. Moreover, even though female and male students mathematical ability was approximately equal, female students reported that math was more difficult than did male students, and they rated themselves as more anxious in quantitative situations than males [2]. In fact, as early as the seventh grade, boys plan to study more math while girls show less interest in doing so [3]. High school girls perceive math to be less useful than boys do [4], and value it less than boys do [5]. Research supports the idea that the factors that keep minorities from entering these fields are largely the same as those responsible for the under representation of women [6].

Studies of science and math classrooms have found that teachers interact differently with males than with females, resulting in more contact and more critical feedback for male students [7]. A recent study found that teachers are concerned about gender inequity, but are unaware of the possible causes, and are unaware of the effectiveness of an equity conscious curriculum [8]. In fact, many teachers feel that attempting such "interventions" is a form of reverse discrimination [9].

The Women in Applied Sciences and Engineering (WISE) Program was established at Arizona State University (ASU) in 1993 under the auspices of the College of Engineering and Applied Sciences' (CEAS) Associate Dean of Student Affairs and Special Programs, to recruit and to retain more women into engineering and construction fields. In order to recruit more young women, WISE determined that partnerships and working relationships with local science and math teachers, as well as counselors, was imperative. A "WISE Investments" (WI) Program was established, designed to: Provide teachers with a hands-on introduction to a variety of engineering fields; Teach them the engineer problem-solving approach; Enable them to create gender and culture-inclusive engineering applications for the math and science classes they currently teach; Give them a working knowledge of what engineers do in various settings; and Provide them with an understanding of what skill sets are needed for an engineer or student pursuing an engineering major. By infusing engineering problem-solving concepts and applications into math and science curricula, students would be provided with a context for the material they are learning. Furthermore, demonstrating that engineers use math and science to solve real-world problems that help people is designed to be particularly appealing to female and minority students. A case in point, one study found that young women planning careers in science were drawn to them because of a desire to promote the well being of society [10].

Although the ASU WISE Program spearheads the WI initiative, the program is the product of a unique collaboration of the ASU CEAS, ASU College of Education, six school districts, three community colleges, and eight industry partners. At the heart of this collaboration are the engineering faculty members who are instrumental in the education of the teacher participants.

Program Description

WISE Investments (WI) is an National Science Foundation-funded program which is designed to encourage more females in middle, high school, and community college to pursue engineering and related careers. A major component of the program are two, two-week summer workshops which introduce middle, high school, and community college teachers and guidance counselors to engineering. These teachers are then charged with integrating what they learn in the workshop into their classrooms. The counselors are charged with incorporating engineering information in their career counseling and developing and implementing an outreach program to encourage students to consider engineering. This has the effect of introducing students as young as 12 years old to engineering as a career option. Further, by allowing students to see the real-world applications of math and science to creative problem solving involving people and the environment it is hypothesized that the WI program will particularly interest young women who are prone to dismiss the value of math and science during their middle and high school years.

Summer Workshop

Initially, WI brought 30 middle, high school, and community college math and science teachers to the ASU campus for two, two-week intensive summer engineering workshops in 1999. For the first week of the program, counselors also joined each pre-college school's team, preferably a Math teacher and a Science teacher from the same school. During the workshops, the teacher participants were exposed to eight fields of engineering (Biomedical, Chemical, Civil/Environmental, Computer Science/Systems, Electrical, Industrial, Materials, and Mechanical/Aerospace) through hands-on labs facilitated by ASU engineering faculty.

The following list includes examples of activities included in each lab:

- Chemical Engineering - created personal care products based upon the properties of chemicals.
- Bio-Engineering - examined how the angle of your knee changes the forces placed on the knee joint.
- Computer-Science Engineering - modified an existing program to change the direction, gait, and speed of a robot.
- Industrial Engineering- modified the parameters on a catapult to identify the best design for distance control.
- Civil Engineering- Geotechnical Lab: performed sieve analysis, plasticity, liquification, and dilatancy experiments.
- Electrical Engineering: predicted outputs of circuit design, then built circuits to test prediction.

During the summer workshops, engineering career information was also supplied through two workplace industry tours and a series of lunch-time keynote speakers from engineering-related industry partners. Teachers also received training on establishing a gender- and culture-inclusive classroom. In addition, they received training on e-mail and the internet and explored resources relevant to engineering and education available on the World Wide Web. Counselors participated in some of these activities, but also had their own sessions to help build their skills

on how to advise underrepresented students who are talented in math and science, and how to design and to implement outreach programs about math, science and engineering fields for underrepresented students on their own campuses.

During the second week of the workshops, teacher participant teams worked together to brainstorm and to plan the engineering applications they would introduce into their classrooms for the upcoming year. Engineering faculty served as consultants during this development process. During the last two days of the program, each team of teachers presented their engineering application ideas to the other teams.

Engineering Industry Internships

After the two-week summer workshops, participants had the opportunity to complete a one-week "internship", or job shadowing experience, at one of the WI program's industry partner's facilities. The internships allowed teachers and counselors an opportunity to understand the role of an engineer in various settings on a day-to-day basis. Participants took an active part in engineering-related activities, gaining hands-on experience in a real-world setting.

Saturday Academies

Teachers were assigned to teams which were each responsible for presenting a Saturday Academy for approximately 40 middle and high school girls. Each team was assigned an area of engineering to present and teams worked with the engineering faculty member from that area to design their Academy. Faculty were often present for the Academies themselves, allowing for hands-on activities or demonstrations in their labs.

The Saturday Academies provided a group of middle and high school girls with a single-sex opportunity to explore the many facets of engineering. Further, the Academies provided a mechanism for teachers to gain feedback about their engineering applications. In particular, this feedback allowed the teachers to determine how well the activities were likely to be received by their female students.

The following are agendas for two of the Saturday Academies, planned by the teacher teams and their corresponding engineering faculty:

	Material Science Academy (September 18th, 1999)
9:00-9:10	Welcome
9:10-9:25	Tacoma Bridge Video
9:25-9-30	Pre-test on Material Science Engineering.
9:30-9:45	What do Material Science Engineering do for us?
9:45-10:45	Group A: Bridge Building Activity
9:45-10:45	Group B: Four mini stations at the Undergraduate Material's Science Lab (Silly Putty, Sputtering Machine, A metal fracture under the optical microscope, a bug and pieces of metal under the electronic microscope).
10:45-11:45	Group B: Bridge Building Activity
10:45-11:45	Group A: Four mini stations at the Undergraduate Material's Science Lab

11:45-12:00	Best Bridge design award and prize ceremony and post-test.

	Industrial Engineering Academy (October 9th, 1999)
9:00-9:10	Welcome
9:10-9:25	What do Industrial Engineers do?
9:25-9:45	Video Clip of Apollo 13
9:45-9:55	Mary Kay Keller, Counselor chat
9:55-10:10	Mouse Traps
10:10-10:55	Catapults
10:55-11:05	Break
11:05-11:15	Result of Catapults
11:15-11:45	Human Factor, What's Ergonomics?
11:45-11:50	Closure Video of Apollo 13
11:50-12:00	Questions, comments, feedback.

Academic Year Follow up Activities

In order to provide ongoing support to teacher participants, the teachers participated in two, half-day follow-up sessions. These sessions took place at ASU and included focus groups to determine participants' perceptions of the program, training on assessment relative to the engineering applications, and opportunities to problem-solve or to develop further engineering applications.

Each teacher was also paired with an engineering mentor from a WI industry partner. Mentors communicated with teachers to answer questions about working in engineering. Additionally, each mentor visited the teachers' classrooms to provide their students with an engineering role model.

Participants were encouraged to communicate with each other and project staff via an electronic listserv. This means of communication provided additional support to program participants throughout the year and inspired collaborations and brainstorming among project participants.

End of Year Forum

To celebrate each participant's achievements, an end of the year forum and banquet has been organized for participants, their principals, district representatives, and WI advisory committee members, including engineering faculty members. In order for participants to learn about the various applications developed and implemented throughout the year, a poster-session type exchange will take place this May, 2000. Each teacher team will create a display explaining their efforts to date. From this exchange, one team will be selected to receive sponsorship from the program to travel to a regional or national education conference to report on the program and their engineering applications.

Faculty Member Responsibilities

The eight faculty members involved in the project each represent one area of engineering: Bioengineering, Chemical, Civil/Environmental, Computers, Electrical, Industrial, Materials, and Mechanical/Aerospace. Each faculty member is responsible for developing a four-hour lab that brings their area of engineering to a pre-college level and that models gender-inclusive instruction techniques. Because the teacher participants are split into two groups that rotate through the labs, each lab block is offered two times during their workshop and two more times during the community college workshop. This results in 16 hours of total lab time, plus time for preparation and in some cases modification if feedback from participants indicate that the lab has missed its target.

The engineering faculty work with the teachers during their brainstorming and application development time of the workshop to assist them in their efforts. Participants have roughly 16 hours slotted for these activities and faculty are present for approximately half of this time. The faculty make suggestions on how to make the labs less expensive, easier to do, shorter, etc. The faculty also help to break down the engineering labs into basic math and science theories that need to be taught in the classroom.

Throughout the year, faculty work with teacher teams who are each charged with preparing a Saturday Academy based on one area of engineering. The Academies are attended by approximately 40 middle and high school girls. Faculty work with their assigned team to varying degrees, but on average spend six hours helping their team prepare for their Academy. Faculty are sometimes present during the academies to assist the teacher teams, host activities in their labs, or simply to act as role models for the girls. The Academies each last for three hours and faculty that attend these events are typically there throughout the entire time.

The eight faculty members working with this project have been involved from the beginning, helping to shape its development. The faculty continue to serve as advisory committee members, attending meetings on a roughly twice-a-year basis.

The faculty's various responsibilities result in a time commitment of roughly 35-45 hours each year.

Faculty Member Recruitment, Benefits and Training

When the idea for the WISE Investments project was first developed it was presented to those faculty members who had previously worked with the WISE Program. These faculty had offered labs and other activities in the past during WISE outreach programs. In many cases these same faculty members volunteered to participate in WISE Investments. In other cases they were able to recommend other faculty members within their department to approach. In only one case was it necessary to contact the department chair and ask for assistance in recruiting a representative faculty member. It should also be said that once the chair did so a faculty member was immediately forthcoming and that individual has been an eager supporter of the program since that time.

It was remarkably easy to recruit the engineering faculty to volunteer for this project. What is even more remarkable is that we were initially unable to commit any summer salaries for participating faculty. Fortunately during the pilot year, when no external funding was available for summer salaries, the CEAS Dean's office provided the funding. Presently, this funding is available through the NSF grant. All but two of the eight faculty members receive two weeks summer salary based on their academic year salary rates. The two remaining faculty members are on 12-month appointments and therefore are paid through the CEAS.

Faculty who self-selected to participate in the WISE Investment project are all very education-oriented. Still, it was not assumed that they would automatically be able to transfer their excellent college teaching abilities to the responsibilities called for by the WI project. To assist in this process, participating faculty initially attended 8 hours of training offered by Dr. Dale Baker, a faculty member in the College of Education who specializes in the area of gender equity in science teaching methods. Dr. Baker assisted faculty with developing gender-equitable teaching strategies to model during the labs. She also provided them with guidance with regard to making the engineering activities relevant to the curriculum that the teacher participants would be bringing to the table.

During the pilot year, faculty continued to modify their labs to better meet the goals of being gender-equitable and curriculum-relevant. Prior to the second year of summer workshops faculty participated in additional curriculum coaching by Dr. James Middleton, another faculty member from the science education department of the College of Education. Dr. Middleton especially focused on how the engineering activities being introduced during the labs should meet new national and state science standards, therefore providing teachers with a means of meeting a job requirement instead of adding a new one.

Program Evaluation

The WI project collects summative data for numerous outcomes relevant to the project goals (e.g. increase in knowledge of engineering and gender equity by teacher participants; increase in interest in engineering by teachers' students; etc). However, for faculty members, formative data collected by the project has immediate relevance.

Faculty members received feedback on the summer workshop from participants via questionnaires, end of program evaluations, and interviews conducted during focus groups. This feedback provides valuable information on how faculty can continue to improve their labs and better assist participants throughout the year. This feedback has generally been extremely positive. Answers to their experience in the specific engineering lab sessions included comments such as: "I loved the Civil Engineering lab. Everything for the department head's discussion to the lab was perfect"; "The computer Science lab was interesting for me, Dr. Urban was very helpful and personable"; "The Industrial Engineering lab was easy to follow and fun. Dr. Rollier was very encouraging and willing to help. We saw so much math application with this lab"; " Dr. Wells has a wonderful background. She gave us so much to use in our class. Great!!". Teachers expressed their appreciation for faculty involvement in their overall evaluation comments. Here are some sample quotes: "I really liked having the professor there and their willingness to want to work with us. They were just so friendly', "What awesome people the professors are to give their time and expertise".

Two highlights resulting from the faculty-teacher collaborations follow:

Dr. Joe Urban, Computer Science and Engineering Department, visited his team of three teachers in their classrooms. The teachers invited him to listen to their students give oral presentations about different disciplines of engineering.

Dr. Dwayne Rollier, Industrial Engineering Department, contributed 100 catapults to the teachers participating in WISE Investments. These catapults were given to the teachers to use in their classrooms to demonstrate various math and science theories.

Conclusion

Faculty, as content experts, provide the WI teachers with great guidance: They share information about educational associations and web sites devoted to their particular field of engineering; They give teachers suggestions on specialized equipment and material acquisition; They try to give suggestions so the teachers can easily replicate some of the lab activities back in their schools; They provide real life examples of engineering projects that affect our every day life; and, They have the answers to the question: How can an engineer from your field of expertise make our life better? The answer to this question is a key to motivate students to consider engineering as a career path.

The collaborative nature of the WISE Investment project has brought together the expertise of members from the engineering and education professions in order to provide pre-college students with exposure to a rewarding career they might otherwise never have the opportunity to pursue. The goal of the project is to ultimately increase the number of underrepresented students participating in engineering. However, the project has already produced a marriage between previously theoretical math and science pre-college curriculum and their logical applications to problem solving. To accomplish this the teachers had to learn about engineering, but also, the faculty had to learn much more about education.

For more information, see our web sight at: www.eas.asu.edu/~wise/wise_inv.html

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