

Implementing a Project-based Technology Program for High School Women

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Abstract The Tech Prep Consortium at Bristol Community College is at the forefront of collaborative education initiatives with its development and implementation of a Women In Technology (WIT) Project-Based Learning Program in High Tech Manufacturing. A Special Populations Grant in 1996 encouraged interested educational institutions to develop a program that would address the need to get high school students involved in careers in which one gender was underrepresented. Bristol Community College's Tech Prep Program responded and was awarded the funding necessary to implement a series of activities to address the need for young women to get involved in the various fields of engineering and technology. Crucial to the WIT Program's success was the establishment of strong partnerships with industry, government, and education. The Bristol Tech Prep Consortium, with the support of educators from area high schools and the leadership and resources of local businesses, recruited female high school students to participate in project-based learning at local plants. In 1997, the Bristol Community College Tech Prep Program implemented its first WIT Project-Based Experience at Texas Instruments, Incorporated (TI) in Attleboro, Massachusetts for 12 students. At TI, students acted as junior engineers as they developed designs and devices that addressed real-world problems. Every year since, the program has grown significantly and has had a positive effect on the lives of approximately 300 students. In 2000, Leach & Garner Company in North Attleboro, Massachusetts joined the WIT Program. Since then additional partnerships have included Sapphire Engineering, Foxboro-Invensys, Rika Denshi as well as students, businesses and educators from Swansea, South Carolina and Skaget-Island Prep Works Consortium in Washington State. As many as 110 students have participated in this WIT technology initiative per year. The results have been impressive. One study noted that 65% of the graduates from the 1997-98 WIT Program had gone to college to pursue an engineering or computer technology major. Also noteworthy are the devices and designs completed by the students on each site. Many of these have been adopted and showcased both locally and nationally. Businesses too have benefited from this partnership because they are the direct recipients of student projects that reduce time, labor, and related costs to industry. As a result of the WIT Program success, the College has received four National Science Foundation grants totaling over 2.2 million dollars since 2001. The Bristol Tech Prep Consortium's WIT Program was also the recipient of the first place Bellwether Award in 2002 as well as the WEPAN Award in 2004. The WIT Program clearly demonstrates that integration of academic disciplines within a combined content and contextual framework can foster widespread success for students, schools, industry, and communities.

Bristol Community College (BCC) in Fall River, Massachusetts is the home of the Women In Technology Program (WIT) developed by the College's Tech Prep Consortium. Bristol is the first college in Massachusetts to design a program to recruit high school women for a project-based learning experience in the engineering and technology fields. This paper will address the

challenges faced by the Bristol Community College Tech Prep Consortium and identify the process, strategies and timelines developed to create such a program. The focus will be on the recruitment of participants; the separate responsibilities of businesses, schools, and students; the resources needed; and the many positive outcomes for all involved.

The main goal of Bristol's Tech Prep initiative was to develop a seamless connection among secondary schools, the community college and universities, and business/industry in order to prepare young women for careers in engineering and technology. To achieve that seamless connection, the Consortium first had to recruit advocates from the high schools and have an open dialogue with community college officials and faculty. Implicit in the discussions was the need to align curriculum between high schools and postsecondary schools, so students could receive between three and nine college credits if they had a B or better in their articulated coursework at participating high schools. By tapping into the Massachusetts Department of Education Special Populations program, we at Bristol were also able to arrange conferences for secondary and postsecondary faculty to address issues related to shortages in the workplace. In addition, targeted students and support personnel were asked to participate in Women of Work (WOW) workshops led by a diverse group of dynamic and highly successful women whose work positions ranged from airplane mechanics to managers in Fortune 500 companies. Each described their individual journeys to achieve success in male-dominated professions, and each presentation created a heightened awareness of the issues faced by women in the marketplace. With these insights shared among participants and with the appropriately focused partnership established between high schools and colleges, it became increasingly easy to identify the cohort that was necessary in order to achieve a WIT agenda for area educators.

The second challenge to be addressed was linking participating educators and students to the workplace. These links were initiated by phone calls to area businesses. The first WIT project began with a phone call from Bristol's Tech Prep Coordinator to the human resources manager at Texas Instruments Incorporated, a high tech manufacturer in Attleboro, Massachusetts. Bristol's Director made the suggestion that a group of approximately twelve young women from a combination of academic and vocational high schools (three) take and complete one real life project at Texas Instruments, Incorporated (TI). An additional requirement was that these young women be treated as junior engineers at Texas Instruments Incorporated with timelines, expectations and a completion date by early May. TI executives agreed to the partnership almost immediately. Educators then met with engineering and Human Resources officials at the plant to discuss projects that were needed yet could be completed over an eight-month period. Three projects, ranging from easy to complex, were identified. Educators and advocates concluded that a moderate project would be best suited for the project-based experience.

Recruitment of High School Women

Having established a team of educators, advocates and business/industry leaders, the next challenge for Bristol's Tech Prep Consortium was: how do we recruit young women for this WIT program, and where do we begin? By developing a support network of individuals from the Massachusetts Department of Education, Bristol Community College, area businesses, and local high schools, the Consortium was able to recruit and retain young women by offering them a variety of activities and experiences. These activities took place at the high schools and included the following: gender equity days, guest speakers from nontraditional fields, team-building

camp for young women, and a summer WIT program at UMass Dartmouth. Women were encouraged to explore technical careers, participate in field trips to colleges and businesses, and attend leadership and team building skills workshops. In addition, they were expected to shadow Texas Instruments professionals and attend a summer engineering and technology camp held at University of Massachusetts – Dartmouth and Bristol Community College. The final commitment to this program would be an eight-month project-based learning experience at Texas Instruments for those schools and students who agreed to participate in this demanding endeavor. The initial training and support workshops were critical for many of the WIT students because they needed to know what engineers do as well as the variety of engineering fields available to them in the market place. And these women needed the confidence, insights, and skills that such experiences would provide.

Project-Based Timelines

The project-based learning experiences in this design model required students complete an engineering project that would be sustained over an eight-month time period. Each student assignment would begin on site in October, continue through April, and end by the first or second week of May, with a student presentation identifying the results of the project.

In the past seven years, projects have taken place with the following companies: Texas Instruments, Leach & Garner, Sapphire Engineering, Rika Denshi, and Foxboro-Invensys. The average number of students participating in each project was eight. High schools participating in the WIT Program are: Attleboro High School, Bristol-Plymouth Regional Vocational Technical High School, Dartmouth High School, Dighton-Rehoboth Regional High School, Foxboro High School, Greater New Bedford Regional Vocational Technical High School, New Bedford High School, and Southeastern Regional Technical Vocational High School.

The schedule for WIT students participating at worksites consists of attending meetings two days per month and working 2 to 3 hours during the school week. Some projects are considered part of a classroom grade. Team members visit each other's schools where they observe or assist their peer partners in the development of the components needed for the team project. Typically, four students from an academic high school are paired with four others from a vocational school. All students are required to maintain their current grade level, keep a portfolio of their projects, and sign a non-disclosure statement. All are expected to adhere to the following engineering phases:

- Conceptual Design and Prototype Phase: October through November,
- Preliminary Prototype Phase: December through January,
- Critical Design and Testing Phase: February through April, and
- Acceptance of Design and Presentation Phase: May.

Additionally, a manual and web site are developed throughout the duration of the work-based assignment to clarify the nature and progress of the project. At Texas Instruments the manual becomes part of the TI Resource Center.

Businesses and Their Responsibilities

It is very important to research area businesses thoroughly to target those best qualified for this school/community/industry partnership. After identifying an appropriate business, program administrators should meet with business representatives, human resource professionals, and engineers to build a team of individuals who are willing to dedicate their time to work closely

with all parties involved in the project. The next step is to have businesses identify engineers interested in selecting and working on projects with students. Our WIT program utilizes both male and female engineers who work side by side with the students.

Each business partner has a variety of responsibilities. The business should arrange for worksite dates and locations for the team to meet. The business must also gather all the necessary materials the participating students will need to understand and complete their project. Some of our projects are with teams from other parts of the country; therefore, it is up to the business to arrange for all video conferencing. Additionally, business partners are required to maintain communications with all relevant team personnel in the workplace. Businesses should also provide lunch for all students and school personnel working at the site. Finally, it is up to the business to keep students and the secondary school faculty on the timeline.

A key component to successful project-based learning is the assurance that the business/industry partner will provide a comprehensive on-site orientation to students as they begin their project. Students need instruction and support for issues related to teamwork, safety regulations, and security procedures. Texas Instruments provides a team building exercise for all of the WIT students on the first day of the work-based learning experience. Most of these young women have never met one another before and need to develop relationships among themselves. These activities are designed to bring the young women together as a team. The business partners are also responsible for identifying any and all safety and security policies that will relate to these student participants while on site.

Responsibilities of Schools and Students

The schools are responsible for certain tasks in order to insure the success of the program. They must identify student advisors/advocates. These individuals have the job of coordinating and organizing the program at their school. These advisors/advocates identify faculty who can work with students on the project. They also provide school administrators with the timeline of the project and arrange all transportation needed. They become the link between the faculty and administrators at the school and help to select the students who want to enter the program.

The young women who enter the program are required to possess both hard and soft skills. Some of the hard skills required are a math background in trigonometry and/or algebra as well as some knowledge of technology principles, applied physics, machine technology, electronics, drafting, computer-aided design, and computer programming. Additional understanding of web site development, sheet metal fabrication and/or heating, ventilation and air conditioning principles may also be appropriate depending on the project's nature and design.

The soft skills needed are a good attitude, strong interpersonal skills, and an interest in becoming a team player. They should also be able to think outside of the box and be analytical. Information on the appropriate soft skills for these students was based on the Massachusetts Work-Based Learning Plan.

Additionally, all students must register as College Tech Prep Students with their Site Coordinators. This allows the Bristol Community College Tech Prep Consortium to enter them into the state database to make it easier to assess their progress and compile the data necessary

for future analysis. Once registered, the women also receive all the benefits of being a Tech Prep student. They will earn articulated credit with the college, take field trips to the Bristol Community College site for career and campus exploration days, and participate in other programs and opportunities that Tech Prep has to offer.

Students who want to be considered for participation in WIT must complete an application discussing the nature of the project, identifying what they can offer the program, and what is expected of them during the eight-month period. The students eligible for this program are in their sophomore, junior or senior year of high school. Ideally, WIT students should begin program participation no later than their junior year in high school to allow them to serve as mentors for new students in next year's project. Not only do these seniors become invaluable resources for the younger students, but also they become far more confident and sophisticated as they navigate the work site a second time to complete a particular project. These veterans basically know the timelines, the expected behaviors, and the appropriate resources when they repeat the experience.

The students must also adhere to a zero tolerance policy, which consist of dressing for business, conducting themselves in an appropriate work manner, and maintaining an acceptable grade level. If they do not adhere to this policy, they are terminated from the program. All these conditions are necessary in order to create an atmosphere that will allow the students to see what is expected in the workplace. More importantly, the Consortium is interested in seeing students succeed not just in their work-based project, but in the real world marketplace they are being trained to navigate.

Orientation to the business site is crucial to the success of WIT. Students must participate in any and all such exercises offered by businesses. Typically, they must participate in a team building exercise that is crucial to bridging differences between themselves and their teammates from other schools. (Advocates, advisors, and mentors are required to understand teaming concepts as well.) A communication tree is provided that lists e-mail addresses, telephone and fax numbers, and participants' addresses, so everyone can share information. Students become familiar with safety and security procedures and also tour the plant to speak with employees who use the equipment that students will be redesigning. The students are introduced to the high tech manufacturing culture and in the process learn a whole new vocabulary. As students learn the procedures of the work at their designated sites, one key responsibility is driven home to them from advocates and mentors: students themselves must complete all the work. The teachers and facilitators then step back to encourage the independence required for these students to succeed.

When the project culminates in early May, students are responsible for a final presentation to business partners, secondary and postsecondary personnel, fellow students, parents, and civic and political leaders from the student's community. Another important aspect of the program is the development of a web site. An additional team is formed that compiles photos of all the participants and information about the projects. All teams put together a PowerPoint presentation, which describes the steps the students had to take to complete their project. Each young woman takes a turn in presenting components of her project, thus building confidence in presenting information to the public. Although all the projects have been presented to a wide range of audiences, students are bound by proprietary rights issues not to disclose some of the

essential features of the machinery that they have built. WIT students have taken this component of their experience very seriously, with close adherence to company policy.

Resources and Funding

In order to complete a successful project/work-based learning experience, a considerable amount of resources are required. These resources include partnering with federal, state, and business agencies in order to seek financing, mentoring, and equipment needs.

A substantial portion of the financing for WIT came from Special Populations Funding under the Perkins Grant. This type of funding was needed in order to sustain and maintain growth of Bristol's expanding program. Secondary schools who have access to professional development and Perkins Funding used this money to pay for advocates and teachers who had to work in some cases after school in order to ensure that projects were completed within the required timeline. School systems also used much of their own funding to pay for substitute teachers. Each secondary school had to organize the scheduling of these young women in a way that minimized absence from many of their other classes. When this could not be avoided, advocates and educators from these schools talked with teachers who had these young women in class to request that students be allowed to make up tests as well as any other related course work. Initially, problems did surface with these issues. However, when newspapers and school committees began to report of the success of this program, teachers began to see themselves as partners in this experience and accommodated WIT students' needs in very positive ways.

Although the financial maintenance of this program can be a daunting task, with careful and ongoing planning and the juggling of a variety of resources, a comprehensive program can be funded successfully. An annual budget between 20 and 30 thousand dollars a year can sustain a program like WIT. This budget also provides for a weeklong summer engineering camp for approximately 25 students and at least one day of leadership camp training for approximately 90 students in a fiscal year.

In addition, the Bristol Community College Tech Prep Consortium received very strong support from the College's Grant Writer and its Foundation. These administrators regularly provided the Director of the College Tech Prep Program with new grant opportunities and financial resources in order to enhance the development of the program. BCC's Engineering Division also supported the project by allowing engineers to visit each site, providing advice to students and secondary school faculty, and redesigning curriculum that would allow these high school women to receive three college credits if they decided to become a student at Bristol Community College. The Assistant Dean of Engineering, Math and Science submitted monthly reports on the activities of the WIT Program to the College's President, John J. Sbrega, PhD, who also became a strong advocate of the program. Dr. Sbrega attended all WIT presentations and summer camp activities and always sought to leverage resources to maintain BCC's direct involvement in the program. His presentations on the state and national level for the program have allowed the consortium to receive additional funding from the Workforce Investment Board, private donations, and scholarships from Texas Instruments and Foxboro-Invensys. These scholarships are earmarked for WIT students and distributed through the BCC Foundation.

Business and industry have provided essential resources and support to maintain project-based learning program for WIT students at their various work sites. Participating companies allowed engineers and human resource professionals to spend time away from their everyday responsibilities in order to serve as facilitators and mentors. Many of the engineers have also volunteered to go to the schools and see the progress of the design models being completed by the students. In some instances, engineers have worked evenings with WIT students and advocates in order to provide the extra support necessary to meet project deadlines.

Another cost that is absorbed by business partners is the video conferencing component that allows students in the WIT Program at Bristol Community College to network with students working on similar engineering projects in other states. At Texas Instruments it is common for engineers and subcontractors to talk everyday to other engineers from around the country via videoconferencing. It has been recommended that WIT students experience the same business climate, one that replicates the importance of the global village. Such a network was established in 1999-2000 with the joint efforts of Cisco Photonics and Kaye K. Shaw, Director of Central Midlands Career Partnership in Swansea, South Carolina. In addition to the personnel provided by these partners, Texas Instruments provided its video conferencing facility as well as technicians on a monthly basis to ensure that communication between all parties took place.

Presentation on a national/state level has also exacted a strong commitment and ongoing financial support from our partners in business and industry throughout this endeavor. Texas Instruments paid for the expenses of its former human resources manager, now consultant, to make presentations on the WIT program in Dallas, Texas; Chicago, Illinois; Pittsburgh, Pennsylvania; Okalahoma; Washington State; North and South Carolina, New Orleans, Louisiana; Orlando, Florida; Kansas City, Missouri; Bristol, Rhode Island and throughout Massachusetts. As a result of this effort, international program expansion in Brazil is currently being taken under consideration. In summer of 2004 BCC's WIT program presented to the US Conference of Community Colleges in Beijing, China.

Project-Based Learning Highlights

From 1997 to present, WIT has served approximately 300 young women. During the past seven years, WIT students have successfully completed over 25 projects including three new web sites. Without question, the student projects have been diverse, creative, and meaningful for business and industry. Students working on each site completed innovative projects that have impressed everyone in a variety of arenas, from the classroom to the workplace, both locally and nationally.

One noteworthy Texas Instruments project developed was a Multi-Station Circuit Breaker Test Station that substantially reduced the labor cost and production time at the local plant. This design was so successful it was adopted globally by other TI sites.

Another project, a Cable Bracket Wiring Template, was completed through the collaborative efforts of students at Texas Instruments in Attleboro in conjunction with a team at Cisco Photonics, Inc. This project developed a template useful in the fiber optics industry. Also noteworthy is the networking process used by the WIT students involved with this design. Massachusetts and South Carolina teams used video conferencing, faxes, and e-mail to complete this project.

During the 2000-2001 school year students working with Texas Instruments and Leach & Garner Company developed a Gapping Saw Fixture. This was a redesign of an existing fixture used in the jewelry plant. The student model succeeded in reducing repetitive motion stress, a costly health concern for employees and management at the plant. Some other projects developed this year at these sites included a Mechanical Pin/Pad Staking Station, a Dual Device Motor Protector for heating and air conditioning systems, and a Flexible Thread Check Sensor for automotive systems.

In 2003, Foxboro-Invensys Company, in conjunction with Bristol Community's Information Technology department and partnering high schools, developed a very successful IT based project for one team of WIT students. The young women designed and implemented a database on which the companies' employees could place and track all project documentation as well as search for information using different query methods.

Only a sampling of the WIT projects is highlighted here. For a more comprehensive discussion of the full range of projects, please visit the following web sites:

www.tauntonschools.org/thu/wit/index.html and www.angelfire.com/ma3/wit/index.html

Benefits to All Participants

The WIT Program at Bristol Community College has had a positive impact on everyone involved, from the teams of high school students to the educators, administrators, and business partners who have promoted and participated in this initiative.

WIT students are provided with exposure to careers in engineering thus seeing a reason to continue their education. A survey conducted by the Tech Prep program revealed that of the WIT seniors who enrolled in the program from 1997 to 1998, 65% of the graduates have gone to college either in an engineering or computer technology field. Twenty-five percent of those entered the workforce, and ten percent attended college in other majors.

The Bristol Tech Prep Consortium's WIT program clearly demonstrates that integration of academic disciplines within a combined content and contextual framework can foster success for both students and industry at the same time. WIT students acquire a sense of ownership over the devices that they have designed. They are given open-ended problems to solve and see that the knowledge gained at school can be directly applied to the culture of high-tech engineering and technology fields. WIT students see a new world of possibilities when they present at national conferences. Many of these students have presented in Dallas, Texas; Chicago, Illinois; New Orleans, Louisiana; Charlotte, North Carolina and other states to audiences ranging from 20 to 140 people. Noteworthy is the opportunity afforded to the teams of students who created a Cable-Bracket Wiring Template for Cisco Photonics, Inc. These students were invited to present at the National Tech Prep Network Employer to Employer Conference in Chicago, Illinois. Their success locally and the national publicity of both the design and networking process used to achieve that success resulted in the current expansion of the project-based learning experience with students from La Conner High School and Anacortes High School from Skagit-Island Prep Works Consortium in the state of Washington.

Educators on both the secondary and post-secondary level also benefit from their participation in the WIT Program. They experience the world of engineering first hand and then apply this information to other topics such as physics, automation, electronics, machining, and computer assisted drafting concepts in their own classrooms. As representatives of their respective schools, the advisors, teachers, and advocates also feel a sense of pride and ownership in student accomplishments because the devices that their students have designed and built are used everyday by employees at partnering companies. Educators have also commented on the value of this experience because it took them out of the classroom and provided them with real world, hands-on experience. Their participation at local work sites can be viewed as an externship during classroom time, one that benefits both their schools and the respective employers involved. School Committee personnel who have attended the WIT presentations are eager in many instances to have their students present in front of the entire school committee or on the local cable television channels to communicate the impressive results that occur when educators develop partnerships with industry.

Businesses have also benefited from this partnership because they are the direct recipients of devices and designs that have been developed to reduce time, labor, and costs at their sites. Some projects focused on devices that are ergonomically sound to eliminate the repetitive hand motion stress that affects many of their employees. The cost savings is appreciable in that these devices have reduced both employee absences and additional health care costs for their employees. Business can also claim ownership of the program as they are asked to speak on a national level at various National Tech Prep Network or Association for Career and Technical Education conferences.

The Bristol Community College Tech Prep Program and the College itself have reaped many benefits from this innovative program. In October 2000, the College was awarded the second place Exemplary Worksite Learning Award from Caterpillar Corporation in Charlotte, North Carolina. In February of 2002, Bristol Community College was the recipient of the Bellwether Award in Workforce Development at the 2002 Community College Futures Assembly sponsored by the University of Florida and The National Council of Occupational Education in Orlando, Florida. In June 2004, BCC became the first Community College to win the WEPAN program award.

These awards have allowed the College to leverage itself to successfully pursue additional grants to build and expand its academic support base for technology training for residents of Southern New England. In summary, this program has provided a win-win partnership for all the participants and their respective communities.

Conclusion

Bristol Community College's Tech Prep Women In Technology Program is still in a state of dynamic evolution. One of the ongoing challenges is to identify businesses, large and small, to provide our WIT students with the direct experiences in the fields of mechanics, electronics, manufacturing, and other areas of technology and engineering that correlate with our high school students' backgrounds and interests. In addition, the WIT Program must develop a system of reaching young women in the elementary and middle schools by providing experiences that will interest them in the same or related fields.

To ensure continued success and to validate the use of resources for this program, data will continue to be collected and analyzed. A study of the graduates from 1999 through 2004 will commence in the summer of 2004. Survey questions will be refined and plans are being examined to develop a longitudinal study of graduates from the time they enter their freshmen year in college to the time they enter the job market.

In order to sustain the growth of the WIT Program, the Bristol Tech Prep Consortium must remain in communication with its teams of teachers, advocates, and engineers. They will be able to provide discussions about other experiences not only with students but also with other schools who are interested in developing a similar program. In addition, strong administrative support is required from both secondary and post secondary leaders.

Given the past and current success with the WIT Program, the partners in this initiative including educators, advocates, administrators, business leaders, and engineering mentors, have nothing but optimism for the program's continued growth and success. Positive feedback has resulted from the innovative collaboration of schools and businesses that has led to such meaningful project-based, real world learning experiences for both students and industry. Certainly, the Bristol Tech Prep Consortium looks forward to building on the foundation that all these partners have established to ensure that more under-represented populations have the opportunity to succeed in the marketplace.

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