Implementing a Software Engineering Technology Program within the Context of Experienced-Based Learning

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Abstract

The Department of Engineering Technology and Multimedia Design (ETMD) within the School of Computing and Engineering Sciences at Eastern Washington University (EWU) has implemented a new program in the emerging discipline of Software Engineering Technology (SET). An experience-based learning model was used in the SET program design. This paper describes both the implementation process and the model around which the program was based.

The principal components of the SET program implementation process include:

- An “experience-based learning” approach that depends on industry and community partnerships and gives equal importance and attention to service learning as well as industrial collaboration.
- Participation from a broad cross section of the communities EWU serves, creating an opportunity to improve both workforce diversity and the number of individuals pursuing an education.
- A recruitment and retention model for underrepresented students with the potential to be replicated in other technology and engineering programs at other institutions.
- The design of a curriculum that bridges software and hardware technologies including: team-based projects, experience-based learning and extensive laboratory hands-on experience.
- The formation of an SET Program Advisory Board comprised of actively involved individuals with diverse backgrounds in the development and maintenance of software intensive systems from industry and government.
- The development of an SET program Assessment Plan to meet the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC of ABET) criteria.

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Introduction

The SET program was designed around an overriding concept: Experience-based Learning including both service learning and industrial collaboration. SET students are provided the necessary fundamentals that allow them to solve technical problems in both industry and society. This includes a curriculum designed utilizing student projects acquired from local and regional industry and nonprofit community organizations. This concept is incorporated with an innovative retention and recruitment effort for minority, under-privileged, and nontraditional students.

After reviewing materials from the U.S. Bureau of Labor Statistics [1] and the American Electronics Association [2] it became clear that an innovative software intensive engineering technology program was needed. As a result, the SET program was conceived largely on the basis of three major factors: industrial demand within the region and state, the small number of qualified graduates available to enter the workforce, and the increasing pool of potential students. It is Eastern Washington University’s goal to provide a timely and high-quality SET program that includes a thorough understanding of theory and design combined with the variety of practical skills needed today.

A study of all existing SET programs was undertaken and site visits were made to the Oregon Institute of Technology [3], Arizona State University [4], and University of Southern Mississippi [5]. The Department of ETMD determined the best practices found in these programs and collectively imported them into its SET program. Most notably these were industrial collaboration, project centered and student retention. It was further determined that presenting students with a series of real problems to solve was the best approach to attract, retain, motivate, and encourage students in a mathematically intensive curriculum. The resulting SET program focuses on an “experience-based learning” model that provides students with the necessary fundamentals to be able to solve technical problems for industry and society thoroughly engaging students in this process.

The SET curriculum design was prepared, reviewed, and approved by the faculty of the ETMD and Computer Science (CS) Departments and by the University’s undergraduate affairs council. Curricular goals identified by the Advisory Board with members from both local and regional industries were also incorporated in the design. These included integrating new learning strategies and problem solving techniques, obtaining active local and regional industry participation in the program, and creating a recruitment and retention plan for underrepresented students.

Specific accomplishments included:

- Formation of an SET Program Advisory Board comprised of actively involved individuals with diverse backgrounds from industry, the community and government;
- Development of an SET program Assessment Plan;
- Creation of SET program brochures, informational CD and website;
- Development of an SET Dissemination Plan with revisions in advertising planned for the implementation phase;
• Continued work with industry, community and government agencies by the SET faculty to establish experience-based learning opportunities through mentorships, internships and co-operative programs.

• Identification of new equipment required for the digital circuits, networking, Linux, PC, and Unix laboratories scheduled for delivery during the implementation phase.

A new state-of-the art facility to host the recently formed School of Computing and Engineering Sciences (consisting of the Department of Engineering Technology and Multimedia Design, Computer Science and Physics Departments) will house the SET program. The building was designed to accommodate the additional space requirements for the Software Engineering Technology program. The new facility, housing 15 classrooms (three wired for distance education) and 21 laboratories, with many spaces designed for interaction and collaboration between departments, will open in 2005. Additional information on the new facility and the programs provided by the EWU School of Computing and Engineering Sciences can be found at http://www.ewu.edu/newtech/.

Significance of the SET Program

The significance of the EWU Engineering Technology and Multimedia Design Department’s SET Program derives from three interrelated elements:

• SET is an emerging area within the technology and engineering arena and a niche exists for training and employment.

• A best-practices approach integrating “experience-based learning” defined as both service learning and industry collaboration, throughout the curriculum was used and serves as the cornerstone of the program.

• The program attracts participation from a broad cross section of the communities EWU serves, creates an opportunity to improve both workforce diversity and the number of individuals pursuing an education, and provides a model that can be replicated.

The SET program emphasizes the application of engineering principles to solutions of practical problems within the contexts of understanding, developing, operating and maintaining software and software intensive systems. The program bridges software and hardware technologies by establishing a close alignment between the ETMD and Computer Science (CS) Departments. Not only are faculty and courses shared but both departments will be housed in the new School of Computing and Engineering Sciences facility to increase collaboration. As a result, students who graduate with a Bachelor of Science in SET enter the workforce as software engineers or technologists, application engineers, systems engineers, test engineers, systems analysts, and programmer/analysts.

The SET program has been designed in line with the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC of ABET) program guidelines [6]. Graduates of this type of program are currently in demand and obtain jobs with engineering firms, consulting agencies, governmental agencies, and manufacturing facilities where they work with engineers and computer programmers to optimize computer procedures and processes for many types of engineering projects. While typically engineers design systems and programmers produce software, there is also a need to interface engineering projects with software controls to
avoid the gap created by the current separation of these processes. The software engineering technologist bridges this gap, as he/she learns the fundamentals of engineering design as well as software engineering.

Implementation

Funds from the National Science Foundation (NSF) helped facilitate the development process for this program and allowed for thoughtful consideration and thorough evaluation of curriculum, laboratory needs, and recruitment and retention strategies.

During the Software Engineering Technology program development phase the following tasks were accomplished [7]:
- Existing SET programs were studied and critiqued,
- Three active SET programs were visited and evaluated,
- An Advisory Board was formed and actively participated,
- A tentative curriculum (with 186 quarter credits) was defined,
- Laboratory equipment needs were determined, and
- A student recruitment and retention plan was drafted.

Now that the planning and development phase has been completed the implementation of the SET program has begun.

During the implementation phase of this program, there are four major objectives:
- **Objective 1.** Establish a recruitment/retention infrastructure.
- **Objective 2.** Create and implement an experience-based learning model.
- **Objective 3.** Finalize and implement SET coursework and program requirements.
- **Objective 4.** Upgrade existing laboratories and provide new laboratory instrumentation.

**Objective 1. Establish a Recruitment/Retention Infrastructure**
This objective consists of establishing a solid recruitment and retention program for underrepresented students in the SET program and is an outgrowth of initial efforts conducted under a previous NSF planning grant. It is in direct response to a comprehensive campus diversity initiative focused on developing an institution wide plan to enhance and increase the level of support and services provided to underrepresented faculty and students at the University. It is a fundamental and crucial component of the overall SET program development, drawing on the concept that SET is an emerging area which invites participation from a broad cross section of the communities EWU serves.

The principal rationales for a recruitment and retention component in this implementation program are threefold:
1) it is an opportunity to address what has been in the past a significant limitation to the improvement of workforce diversity and to the number of individuals pursuing an education in the engineering sciences,
2) it has the potential to provide a successful model that can be replicated in other technology and engineering programs and at other institutions, and
3) it aligns appropriately with the core curriculum goals for this project and with the mission statement of the University.

Current demographic data from the Washington State Office of the Superintendent for Public Instruction indicates that Washington has an increasingly broad pool of potential non-traditional students. The challenge is to develop effective contact, communication strategies and programming that meet the needs and desires of these students.

The University wide activities with support and involvement of the SET faculty include:

- Developing an in-depth and holistic admissions review criteria including, but not limited to, community service activities, leadership records, and interviews that may be considered with grade point average and standardized test scores (with the goal of determining the student’s potential to be successful at EWU given their background and the services available to them once on campus);
- Expanding the performance-based transfer competency program being piloted with Spokane Community Colleges to community colleges within the state with high enrollments of underrepresented students;
- Obtaining institutional approval to create faculty development plans (required for tenure and promotion) in which faculty get credit for mentoring and retaining underrepresented students in their departments;
- Expanding outreach to K-12 schools and organizations supporting the educational development of nontraditional students; and
- Students can apply for residence in a new experimental wing of Brewster Hall, a living-learning environment for science, technology and mathematics students. The residence hall will provide appropriate technologies, such as wireless Internet access, a high-tech classroom, and a computer lab. On-site support and programming will include a dedicated Academic Advisor/Career Counselor, tutors and cluster classes, where students from all over campus can come to take classes. Housing Scholarships will be offered to students who demonstrate academic potential and financial need.

The ETMD Departmental level activities include:

- Identifying industry mentors and establishing culturally relevant internships for underrepresented students (i.e., minority owned businesses, businesses located in the student’s home community, etc.);
- Expanding traditional recruitment activities such as site visits, advertisements, multimedia CDs, hardcopy information and Internet web pages describing the SET program in conjunction with EWU’s Student Affairs recruitment team;
- Working with high school guidance counselors in ethnically and culturally diverse areas to develop a formal school to university relations and transitions program for SET;
- Developing or expanding working relationships with the region’s Gear-up, Upward Bound, Talent Search, MESA (Math, Engineering, Science Achievement) and HAAP (Hispanic Academic Achievers Program) programs to develop initiatives that peak student interest and participation in SET;
- Offering to review curricula and identify areas where junior and high school math and science courses can be modified to align to SET program entry requirements;
• Partnering with industries to assist in developing specialized educational programs (such as those provided by Micron. Inc. [8]) that lead to better academic preparation in science and engineering at all levels and to better workforce skills;
• Training and supporting upper classmen and women to be effective mentors and counselors.

In order to be successful, an infrastructure was created that utilizes the cooperative effort of the faculty along with other areas of the University. These units include the: Admissions Office, Academic Advising, African American Studies, American Indian Studies, Chicano Education and the College Assistance Migrant Programs, Women’s Studies and the campus TRIO programs (Student Support Services and McNair Scholars).

Objective 2. Create and Implement an Experience-based Learning Model
The SET program was built around an “experience-based learning” approach that gives equal importance and attention to service learning as well as industrial collaboration. Providing students with the necessary fundamentals to be able to solve technical problems in industry and society drives the curriculum. Current pedagogical evidence shows that community involvement is important both in the technical and civic aspects of the curriculum.

This “experience-based learning” approach is facilitated and validated by the numerous requests faculty receive for help with engineering related problems. Such requests translate into real world problems that can be addressed by students in the SET courses and laboratories. For example, the City of Cheney, Washington, has received funding to upgrade the infrastructure of the broadband network but is without the expertise to accomplish this work. The students would take on this project by interviewing the city council to determine the needs, identifying the scope of the project, designing the system, submitting the working drawings, and preparing the written and oral reports for the City Council.

In the SET program, service learning involves designing and implementing projects and solutions for a given community and for the public good (see City of Cheney example above). Students are expected to address and resolve both the technical components and the human aspects of the problem. A cost versus benefit analysis must be completed by the students requiring them to think critically about the community, their professional philosophies and how the project related to their coursework and goals. Upon completion, a postmortem study of the project must be conducted and serves as a self-evaluation for both the student and the SET program. Students consider what aspects of the project were difficult and why, what aspects of the project they were unprepared for, and what could have been done differently or better.

Information derived from the surveys of existing SET programs and obtained during the site visits was evaluated, synthesized and used to both validate EWU’s SET coursework and guide the future development of curriculum and laboratories. New and updated learning strategies and problem-solving techniques were integrated into the curriculum. Brief descriptions of these include the following.

Laboratory-oriented experience-based learning. An intrinsic difference between software engineering and SET is the amount of laboratory experience the student participates in.
throughout the program. The SET program stresses laboratory-oriented learning, while not straying off the theoretical background necessary to understand the systems at hand. Laboratory experiences are thorough and comprehensive. To this end, the laboratory capabilities are being expanded in the new facility that houses the School of Computing and Engineering Sciences. Industry-supplied problems are implemented in all SET laboratories. An example project from last year involved helping a local company with a software/hardware problem. A device was being designed to measure fetus heartbeat, but special detection techniques were needed for the case of twin fetuses. The company provided the heartbeat data files and system that could detect and measure each of the separate heartbeats was designed and built. The system was tested, documented and the results were shared with the company.

Team-based learning. Current trends in the field of technology indicate that team based projects are increasingly more beneficial to the learning experience than individual ones. Software engineering technologists often work as a member of a team, especially when engineering interfaces between hardware and software systems. As a result, the department utilizes multi-disciplinary, problem-oriented team projects. This approach allows students from different programs and departments to work together on projects that simulate real working scenarios. Group projects and assignments stressed throughout the program culminate with a team senior project and a capstone design class.

Direct involvement of industry. Industrial representatives are given the opportunity to provide input into curriculum, laboratory refinements and to identify skill sets required in the SET work environment through the advisory board. These relationships have helped identify a series of industry related problems that exemplify current and cutting-edge trends and related workforce preparation needs that have been addressed in the classroom.

Assign industry/service problems to students. Industry and community partners are presented with the opportunity of using SET classes (faculty and students) to tackle real problems on their behalf. Area and regional technology companies, community non-profit organizations, governmental agencies along with non-technical businesses propose projects or assignments with an expected outcome to the ETMD Department. The faculty evaluates the proposals for compatibility with the curriculum, ensuring that they provide a problem-solving approach to learning, and a potential for a favorable outcome within a reasonable timeframe. Once a proposal is accepted, an appropriate representative from the company or organization must commit time to the project at the University, serve as a mentor, member of the advisory board, or guest lecturer, oversee an internship, or participate in some other role that contributes to the SET program. These assignments are expected to encompass a wide variety of industry-related theoretical and practical problems.

Implementing experience-based and service learning. In order to incorporate the projects suggested from industry, community groups, non-profit organizations and government agencies into the SET program a number of courses were affected. They were modified to allow for a different project each time the course was offered or to allow a project to continue on from a previous course. This added a whole new degree of freshness and flexibility to these courses. Listed in Table 1 are the courses that were implemented along with their sample projects.
Table 1. Courses that Utilize Experienced-based and Service Learning

<table>
<thead>
<tr>
<th>Class Name</th>
<th>Current Projects/Experiments</th>
<th>New Experience-based and Service Projects</th>
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<tbody>
<tr>
<td>Freshman Design (TECH 197)</td>
<td>Bridge bashing</td>
<td>• Design of parking lot layout for new construction.</td>
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<td></td>
<td></td>
<td>• Website development for non-profit organizations and local communities (i.e. recycling center, child</td>
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<td></td>
<td></td>
<td>ren care center, museums, etc.)</td>
</tr>
<tr>
<td>Digital Circuits I (ENGR</td>
<td>Traditional lecture</td>
<td>• Design of intrusion detection systems for University buildings.</td>
</tr>
<tr>
<td>160)</td>
<td></td>
<td>• Expansion of traffic light system for City of Cheney.</td>
</tr>
<tr>
<td>Digital Circuits II (ENGR 2</td>
<td>Vending machine. Elevator system.</td>
<td>• Improvement and implementation of systems designed in Digital Circuits I.</td>
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<td>50)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microprocessors I (TECH 27</td>
<td>Traditional laboratory experiments.</td>
<td>• Design and software simulation for efficient greenhouse energy management.</td>
</tr>
<tr>
<td>6)</td>
<td></td>
<td>• Design a microprocessor-based router switching system.</td>
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<td></td>
<td></td>
<td>• Card reader access security system for campus and public buildings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Card reader system for parking meter payment.</td>
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<tr>
<td>Microprocessors II (TECH 3</td>
<td>Traditional laboratory. Projects have included: DC motor</td>
<td>• Projects involve improving and hardware implementation of projects designed in Microprocessors I.</td>
</tr>
<tr>
<td>77)</td>
<td>control system, digital clock design, AD/DA converters, etc.</td>
<td></td>
</tr>
<tr>
<td>Programming Principles I/ II</td>
<td>Traditional laboratory exercises.</td>
<td>• Source code security analysis, to eliminate potential security vulnerabilities at source code levels,</td>
</tr>
<tr>
<td>Data Structures I (CSCD</td>
<td></td>
<td>as used in industry.</td>
</tr>
<tr>
<td>225/205/226/326)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Communications</td>
<td>Web based correspondence course.</td>
<td>• Design and develop of network protocols currently used in industry.</td>
</tr>
<tr>
<td>(TECH 416)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software Design I/II (CSCD</td>
<td>Traditional laboratory exercises.</td>
<td>• Projects continue the designs started in CSCD 226/326, but must work in an integrated development</td>
</tr>
<tr>
<td>350/351)</td>
<td></td>
<td>environment (IDE) such as .NET, XML, etc.</td>
</tr>
<tr>
<td>Database Management Systems</td>
<td>Traditional laboratory exercises.</td>
<td>• Secured databases and information security assessment.</td>
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<tr>
<td>(CSCD 425)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software Engineering I/II</td>
<td>Applied projects including ASEWU (Association of Students of</td>
<td>• VP Net (Virtual Possibility network). Establish a broadband digital network which ultimately promote</td>
</tr>
<tr>
<td>(CSCD 450/451)</td>
<td>Eastern Washington University) electronic voting system.</td>
<td>collaboration with industry and other universities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Multiagent AI-based intrusion detection systems.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Network security visualization.</td>
</tr>
</tbody>
</table>

**Freshman Design Experience.** A new course for freshman is currently being developed to give them experience in the engineering design process. This class is project-based with the projects.
selected to match the students’ technical knowledge. Example projects include working with the facilities engineering department to layout the parking spaces for the parking lot for new buildings, web page design for special pages of the ETMD Department website, programmable robots projects, competitions such bridge/tower building and egg dropping, and very basic computer drafting projects.

Mentoring. Local representatives have been identified by the faculty (with the assistance of the advisory board) to serve as mentors to SET students with regard to career opportunities and senior projects. A list of mentors with professional background descriptions has been created and is continually updated and expanded. Students are provided the opportunity to work with mentors on special projects subject to the approval of a faculty member to ensure that the scope and the level of difficulty of the project are commensurate to the class needs. Mentors are matched with students with attention given to the backgrounds and compatibility of the student and mentor along with the career goals of the student.

Internships. Working closely with local and regional industry in the development of the SET program, internship positions are available and more are being identified. Students completing internships through these businesses obtain practical experience and credit toward their academic degree, while opening the door for future permanent employment. Attention is given to the backgrounds and compatibility of the student and the internship supervisor, the location of the internship and the ability of the placement to meet the needs of the student (workforce diversity, flexible hours, employment potential, etc.).

Objective 3. Finalize and Implement SET Coursework and Program Requirements.
The SET curriculum bridges software and hardware technologies by incorporating courses from both the Engineering Technology and Multimedia Design and Computer Science Departments. This collaboration between departments prepares students to understand, design and implement the entire system whether it is hardware or software intensive.

This curriculum is also based on a series of existing lower division prerequisite courses in the humanities, mathematics, physics, and general education requirements. The upper division core includes both existing courses and new courses along with laboratory revisions in both the Engineering Technology and Multimedia Design and Computer Science Departments.

The program was designed to meet the TAC of ABET criteria [6]. TAC of ABET provides a set of program standards that must be met including a minimum number of program instructors (two full-time), a minimum number of credits (186), certain curriculum elements, assessment criteria (i.e. the student must be able to design experiments, communicate effectively, etc.), advisory board formation, administration criteria, etc. All curriculum planning, including the identification of program objectives and outcomes was conducted with this final goal in mind.

The 4-year Software Engineering Technology program curriculum has been implemented and is presented in Table 2. Hardware related courses (with prefixes of TECH and ENGR) are taught by faculty from the Engineering Technology and Multimedia Design Department while the software related courses (with prefixes of CSCD) are taught by the Computer Science Department faculty.
Table 2. 4-Year Software Engineering Technology Curriculum Plan

<table>
<thead>
<tr>
<th></th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>English Composition II (ENGL 201)</td>
<td>Calculus I (MATH 161)</td>
<td>5</td>
</tr>
<tr>
<td>Freshman</td>
<td>Digital Circuits I (ENGR 160)</td>
<td>Technical Writing (ENGL 205)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Precalculus II (MATH 106)</td>
<td>Programming Principles I (CSCD 225)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Computer Literacy II (CPLA 101)</td>
<td>Programming Principles I Lab (CSCD 205)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Total 15</td>
<td>Total 15</td>
<td>Total 16</td>
</tr>
<tr>
<td>Sophomore</td>
<td>Microprocessors I (TECH 276)</td>
<td>GECR</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Total 17</td>
<td>Total 14</td>
<td>Total 18</td>
</tr>
<tr>
<td></td>
<td>Software Design (CSCD 350)</td>
<td>Data Structure I (CSCD 326)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Software Design Lab (CSCD 351)</td>
<td>Data Structure II (CSCD 327)</td>
<td>4</td>
</tr>
<tr>
<td>Junior</td>
<td>Total 17</td>
<td>Total 18</td>
<td>Total 16</td>
</tr>
<tr>
<td></td>
<td>C Programming Language (CSCD 229)</td>
<td>Databases (CSCD 425)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Total 17</td>
<td>Total 18</td>
<td>Total 16</td>
</tr>
<tr>
<td></td>
<td>Discrete Mathematics (Math 301) or Foundations of Mathematics (Math 225)</td>
<td>Data Communications (TECH 416) or Introduction to Networks (CSCD 333)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Elective 3</td>
<td>Total 12</td>
<td>Total 14</td>
</tr>
<tr>
<td>Senior</td>
<td>Computer Architecture (TECH 425)</td>
<td>Software Engineering II (CSCD 451)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Software Engineering I (CSCD 450)</td>
<td>Technical Elective</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Fundamental of Network Security (TECH 421)</td>
<td>Technical Elective</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Elective 4</td>
<td>Senior Elective</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Total 12</td>
<td>Total 14</td>
<td>Total 14</td>
</tr>
</tbody>
</table>

In order to implement this new SET curriculum a number of existing Engineering Technology and Computer Science courses had to be revised along with new ones developed. The courses that have either been revised or developed are:
Freshman Design (TECH 197). A course with introductory level projects to introduce the student to the discipline of Engineering Technology, with a portion of the class dedicated specifically to SET. In previous years, TECH 197 consisted of introductory topics in Engineering Technology, invited speakers, and a final project. Under the newly developed structure, it keeps its previous content, while including a biweekly service learning project designed to intrigue, motivate, and challenge the students.

Digital Circuits (ENGR 160). Digital Circuits is the first of a two-course sequence. Traditionally this class has included lecture only as the preferred pedagogical method. ENGR 250 provides the laboratory component of the sequence. While this structure is maintained, an experience-based project design is now implemented throughout the class, with a formal project report due at the end of the course.

Digital Hardware (ENGR 250). This class currently offers the laboratory component of Digital Circuits (ENGR 160). The revised version includes the hardware implementation of the project designed in the precedent class with the traditional lecture and laboratory experiments.

Microprocessors I (TECH 276). The first of a two-course sequence on Microprocessors, TECH 276 is a traditional lecture/laboratory based class focusing on assembly language. The basics of it were not modified, however, an experience-based final project was included.

Microprocessors II (TECH 377). As a continuation of TECH 276, this course focuses on hardware MCU components. The project started in TECH 276 is refined, improved and implemented. At the end of the course, a working prototype must be developed, shown and demonstrated to the industrial/community partner.

Introduction to Network Security (TECH 421). This is a new class introducing practical topics in network security, such as malicious code, intrusion detection, prevention, response, etc. It incorporates an industrial collaboration project.

Data Communications (TECH 416) or Introduction to Computer Networking (CSCD 333). This class covers the theories of constructing and administering computer networks. It was revised from a web correspondence course to a traditional format with a final service learning project.

Software Design I/II (CSCD 350/351). In addition to the traditional software design content, these classes present a comprehensive introduction to integrated development environments (IDEs).

Database Management Systems (CSCD 425). This class was changed to replace the final project with an experience-based project. The content remains the same.

Software Engineering I/II (CSCD 450/451). The content is the same, but experience-based projects have replaced the traditional academic exercises.
Senior Capstone (TECH 490). The senior capstone class models a team-based industrial environment, where students with a variety of academic and skill backgrounds unite to design and implement a given project. Due to recent revisions, this class needs no further revisions.

Senior Development Project (TECH 491). An end-to-end design and implementation of an experience-based project is completed by students, guided by a professor and/or industrial mentor. Formal progress and final reports are required, and thorough design techniques must be investigated and applied. No modifications are required for this class.

Objective 4. Upgrade Existing Laboratories and Provide New Laboratory Instrumentation. The ETMD Department has developed three new labs and renovated two existing labs to meet the curriculum objectives of the SET program. The three new labs are the Unix lab, Linux lab, and Networking lab. The two labs undergoing renovations are the PC lab and the Digital lab. Each provides the necessary hardware and software resources to incorporate the experience-based learning method. The SET laboratories include:

Network laboratory. The new networking lab contains routers, servers, firewalls, and a network core that enables students to work with various computer configurations. In addition, network security products such as hardware encryption tools and antivirus techniques are included as well. This lab is utilized by several courses related to networking such as CSCD 333 (Introduction to Computer Networks), TECH 416 (Data Communications), and TECH 421 (Introduction to Network Security). Students learn about the configuration and setting up of network environments, analyzing network speed and performance, investigating security problems, etc. Students also are provided with the hands-on experiences required in network certification exams such as Cisco Certified Network Associate (CCNA) and Cisco Certified Network Professional (CCNP). Note that our curriculum is not modeled after the Cisco Academy, but includes material needed to manipulate and program routers. This lab supports experience-based learning projects such as network-intrusion visualization for industry or AI based intrusion detection systems, both mentioned in Table 1.

Unix laboratory. The new Unix lab contains HP Servers and HP Workstations to be used for courses such as CSCD 228 (Introduction to Unix), CSCD 350 (Software Design), C programming language (CSCD 229), Software Engineering I/II (CSCD 450/451), etc. Students learn the Unix system and receive hands-on experience in designing software under the Unix environment. Students requiring flexible lab time are allowed to access the network remotely. This lab, as well as the Linux lab (see below), have its resources available 24 hours a day to all students based on remote access. This lab also supports experience-based learning projects such as IDE (integrated development environment) software design.

Linux laboratory. Many PCs with the Linux environment are available in the new Linux lab. Classes such as Computer Architecture and Design (TECH 425), Programming principles I/II (CSCD 225/226), Data Structures I (CSCD 326), Software Engineering I/II (CSCD 450/451), and Databases (CSCD 425) utilize the Linux lab. Students learn the Linux operating system and how to design software using it. This lab is also used to support experience-based learning projects, such as “Multimedia-based webpage development for regional industry and community.”
Digital laboratory. The current Digital lab is in the process of being renovated and/or updated with new equipment such as Logic Analyzers, Digital Oscilloscopes, Network analyzers, Frequency counters, and Multisim software. Microprocessor boards, Function generators, Digital multimeters, Power supplies, and Pulse generators are being replaced by new ones. This lab is utilized by various classes such as Microprocessor I/II (TECH 276/377), Digital Circuit I/II (ENGR 160/250), Senior Development Project (TECH 491), and Data Communication and/or Introduction to Networks (TECH 416 and/or CSCD 333), etc. In this lab students learn about microprocessor applications, digital design theory and receive extensive hands-on experience. This lab provides hardware resources to perform projects such as the “efficient greenhouse energy management” system (refer to Table 1).

PC laboratory. The current PC lab is also being renovated with the latest PCs and software resources. In addition, it is used as an open lab to all students in the SET program. This lab supports several courses such as C programming language (CSCD 229), Programming Principles I/II (CSCD 225/226), Senior Development Project (TECH 491), Senior Capstone (TECH 490), Computer Architecture and Design (TECH 425), Data Structures I (CSCD 326), Software Engineering I/II (CSCD 450/451), and Databases (CSCD 425), etc. It is also utilized as an open lab by the students for a variety of course related tasks. Students learn about software design, programming languages and data structures in this lab.

SET Program Assessment Plan

In accordance with the standards of the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC of ABET) [6] a comprehensive assessment plan has been created for the Software Engineering Technology Program that meets their criteria.

It can be briefly summarized as: 85% of students will demonstrate the ability to analyze, design, and implement software systems; apply project management techniques to software systems; and utilize statistics, probability, transform methods, discrete mathematics, or applied differential equations in support of software systems. Students will also exhibit hands-on abilities in the application of electrical circuits, computer programming, software applications, analog and digital electronics, microcomputers, operating systems, and local area networks to computer and software systems. In addition, 85% of students will be able to independently solve complex real world problems in Software Engineering Technology as demonstrated in their senior projects.

Conclusions, Reflections and the Future

The SET Program at Eastern Washington University has been implemented and is now up and running. Information gathered through surveys and site visits was utilized to create an innovative and state of the art SET Program. By using an experience-based service learning model, working closely with industry and the community, and applying a new recruitment and retention model for underrepresented students the program is poised for success.
Work for the future includes increasing the collaboration with industry and the community to explore additional partnerships to allow expansion of the project into the Mechanical Engineering Technology, Electronic Technology and Construction Technology majors.

Bibliography

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