A Web-Based Approach for Outcomes Assessment

Lyle B. McCurdy, Ph.D., Douglas B. Walcerz, Ph.D., William H. Drake, Ph.D.
California State Polytechnic University at Pomona /
Enable Technologies, Inc. / Southwest Missouri State University /

Abstract

The Electronics and Computer Engineering Technology (ECET) program at Cal Poly Pomona and the Industrial Management (IM) program at Southwest Missouri State University (SMSU) are designing and implementing an outcomes assessment process in order to continuously improve their programs and to prepare for upcoming accreditation visits. Both programs contracted with Enable Technologies, Inc., to conduct a pilot study using EnableOA, which is a Web-based, software-driven outcome-assessment process. The study involved two courses at each university, covering all levels from freshmen to seniors. The study was conducted during the fall quarter of 2000 at Cal Poly Pomona and the fall semester of 2000 at SMSU.

Results of the study show that the EnableOA process was relatively easy to learn for instructors and students. Instructors spent approximately four hours incorporating their first course into the assessment process, and less than half that time incorporating a second course. They anticipate that in the future only one hour of preparation per course will be required. Students were introduced to the process, which involved the creation and maintenance of an electronic portfolio, in a single class period or, in one case, via Email. Student participation in the process was voluntary, however, response rates were relatively poor. In two courses, a nominal grade incentive tied to student responses was used as a participation motivator.

Approximately two thirds of 84 eligible students in four courses participated. The quality of the material that students submitted was, in general, good or moderate quality; however, students had difficulty associating their educational experiences to appropriate educational outcomes. The data and reports that were automatically generated by EnableOA were judged to be very useful for continuous improvement and accreditation, with the caveat that students must improve their ability to select appropriate outcomes. Both universities are planning to continue their assessment processes using EnableOA.

1. Introduction

In theory, educational research shows that measurement of educational outcomes can be used to improve curricula by providing information about which educational goals are being met and which are not. Research also shows that in practice, the measurement of educational outcomes is often difficult and expensive, the results are often ambiguous or statistically unsound, and the positive impact of continuous improvement on the curriculum is difficult to prove[i].

Regardless, TAC/ABET has recently adopted a new set of criteria, typically known as ET2K, that now mandates that all future accreditation activities include both *outcomes assessment* and *continuous improvement* of the courses and/or curricula associated with any accredited program. These new standards include eleven outcome-based criteria, as well as a requirement for continuous improvement of program quality. Both specifications are given below:

TAC/ABET's Eleven Outcome-Based Criteria

*An engineering technology program must prepare graduates who: **a.** demonstrate an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines; **b.** apply current knowledge and adapt to emerging applications of mathematics, science, engineering, and technology; **c.** conduct, analyze, and interpret experiments and apply experimental results to improve processes; **d.** apply creativity in the design of systems, components, or processes appropriate to program objectives; **e.** function effectively on teams; **f.** identify, analyze, and solve technical problems; **g.** communicate effectively; **h.** recognize the need for and possess the ability to pursue lifelong learning; **i.** Understand professional, ethical, and social responsibilities; **j.** recognize contemporary professional, societal, and global issues and are aware of and respect diversity, and **k.** have a commitment to quality, timeliness and continuous improvement.*

TAC/ABET's Requirement for Continuous Improvement

Programs must have written goals that, as a minimum, focus on the student body served, employer expectations, resource allocation, and other factors affecting the program. Programs are required to have plans for continuous improvement and evidence that the results are applied to further development and improvement of the program. Each program is required to demonstrate achievements through various methods including student outcomes assessment and employer feedback. Typical evidence may consist of student portfolios including project work and activity based learning; results of integrated curricula experiences; nationally-normed subject content examinations; recent graduate surveys that demonstrate graduate satisfaction with employment including career development activities, mobility opportunities, and appropriate job title; and employer surveys that demonstrate satisfaction with recent graduates. Programs also must demonstrate that their graduates are readily accepted into the workforce and are prepared for continuing education.[ii]

With the adoption of these new requirements, engineering technology educators must develop new ways of evaluating their courses and/or programs. Although there may be many ways to meet these new requirements, whatever method is developed should include the following characteristics:

    a. be easy to learn and use, with minimal faculty time commitment,
    b. allow faculty to easily write appropriate educational objectives based upon the new eleven criteria for their courses,
    c. encourage students to write meaningful outcomes of true learning, based upon the eleven new criteria,
    d. provide tabular and graphical information that can be used to validate that the instructor's educational objectives have been met or not, and
    e. be timely, so that continuous course improvement can occur rapidly as needed.

As such, work was initiated at two separate programs at two separate institutions to utilize the new TAC/ABET criteria within their courses, and to begin the continuous-improvement process. In order to simplify and automate the process, both programs desired to use some form of computerized approach for these activities.

Unbeknown to either, Dr. McCurdy at Cal Poly Pomona and Dr. Drake at Southern Missouri State University, independently contracted with Dr. Walcerz at Enable Technologies, Inc., to conduct separate pilot studies during the fall quarter/semester of 2000 utilizing EnableOA, the company's web-oriented software "tool." Both McCurdy and Drake selected EnableOA because it was designed for faculty use in continuous course improvement and was based upon the new outcomes-based criteria mandated by EAC/TAC of ABET. In addition, both faculty members separately agreed to co-author a paper with Dr. Walcerz to document the findings of their studies.

Over time, both faculty learned of each other's research through their mutual contact, Dr. Walcerz. Eventually, it was decided to pool our efforts together into a single paper, based upon our use of the same software tool, EnableOA, while still highlighting the separate approaches taken for course improvement at the two different institutions.

2. Purpose of the Study

This paper will discuss the use of a web-based software tool, and how effective it was for continuous course improvement based upon the newly-mandated TAC/ABET criteria. In particular, this study will address the following hypothesis statement:

The EnableOA software tool will provide a mechanism that is substantially better than existing methods for developing instructor intentions, garnering student input, presenting results a real-time graphical format, and providing for continuous course improvement, all while utilizing the eleven TAC outcome criteria.

Within this framework, this report will address each of the following:

1. An overview of the steps necessary for setting up and using the EnableOA software,
2. How to write instructor intentions, based upon the eleven TAC outcomes criteria, and some examples thereof,
3. how to obtain student feedback of what is actually being *learned* by students on a "real-time" basis in each on-going course, and to ascertain whether or not that feedback is *meaningful*, and
4. how to obtain tables and/or graphs of instructor intentions and student outcomes on a "real-time" basis in each on-going course, and to ascertain whether or not those tables and graphs are *meaningful*.

3. Programs and Courses that Participated in the Study

3.1. Electronics and Computer Engineering Technology at Cal Poly Pomona. This program is housed in the Department of Engineering Technology. This program consists of a rigorous integrated four-year curriculum, designed to prepare graduates for technical careers on the "engineering team." The program currently enrolled about 375 students at the time of this study.

At Cal Poly Pomona, two courses participated in this study during fall quarter 2000. These were:

ETE 310 Applied Network Analysis/Lab (3/1). This was an upper-division math-intensive technical course for juniors that included Laplace transforms, transfer functions, the s-plane, stability, and time/frequency response of second-order electrical networks. The course met three hours per week during the day, enrolled traditional full-time students, and included a three-hour lab once per week. Thirty-six students were enrolled in this course during fall quarter 2000.

ETE 401 Technical Communications for Engineering Technology/Lab (3/1). This was a technical writing course for seniors that included topics in technical writing, senior project proposal, and project management. This course met three hours per week during the day, enrolled traditional full-time students, and included a three-hour lab once per week. Eleven students were enrolled in this course during fall quarter of 2000.

3.2. Industrial Management at Southwest Missouri State University. This program is housed in the Department of Technology at Southwest Missouri State University (SMSU), Springfield. The department offers a BS in Industrial Management with concentrations in CADD, Construction, Electronics, and Manufacturing. The program enrolls about 300 students.

At SMSU, two courses participated in this study during the fall semester of 2000. These were:

TEC 110, Fundamentals of Engineering Drafting. This was a typical freshman-level drafting course in which CAD skills, sketching skills and orthographic and isometric drawing techniques were practiced. There were two lecture and two lab hours per week, mainly populated by traditional, full-time students. Eighteen students were enrolled in this course during the fall semester of 2000.

TEC 250, Industrial Safety. This course emphasized management of occupational safety programs. This was a sophomore-level course that met one evening each week for three hours, and was populated mainly by young adult students with full-time jobs. Nineteen students were enrolled in the course during the fall semester of 2000.

4. Software-Utilization Contract

Both programs, the ECET program at Cal Poly Pomona and the IM program at SMSU separately contracted with Enable Technologies, Inc. to run a pilot assessment study using the EnableOA process and software. Each department paid $250 for temporary software licenses. Enable Technologies, acting as an Application Service Provider, established application Web sites for both departments on the Enable Technologies Web server.

Neither department was required to buy additional hardware or software. Once the licensing was established, the respective faculty at each institution and their students were able to access the software tool via on-line connections to the Enable Technologies Web server.

5. Overview and Use of the Software Tool

5.1. Overview of EnableOA

EnableOA, developed by Enable Technologies, Inc. , utilizes a web-based, software-driven outcomes assessment process. This process has been designed to be consistent with the nine Principles of Good Practice for Assessing Student Learning[iii] published by the American Association of Higher Education (AAHE), and the Program Evaluation Standards[iv] approved by the American National Standards Institute (ANSI).

The EnableOA tool[v, vi] is designed to be easy to use while being powerful enough to provide meaningful course-improvement data appropriate for EAC/TAC reports. In general, the tool is designed to allow course coordinators to enter the eleven TAC outcome objectives directly into the system for later selection by students.

It is also designed to allow faculty to enter their course intentions (educational outcomes) directly into the system. Typically, these course intentions are developed from existing course objectives, with selected outcomes from the eleven TAC outcomes utilized as appropriate.

In addition, the tool is designed to allow students to enter written descriptions of what they have learned in a given course, and to correlate that learning with respect to the eleven TAC outcome criteria. If desired, the students could also attach electronic copies of their actual work, such as formal reports, PowerPoint presentations, CAD files, spreadsheets, programs, digital pictures of design projects, etc., to their descriptions (e.g., electronic portfolio or resume). The usefulness of this extended electronic resume is the primary motivation for students to participate in the assessment process. A second purpose is to be able to aggregate student descriptions for a specific course or set of courses to see if students perceive and report the intended educational outcomes specified by their course instructors.

And, most important, the tool is designed to generate various different reports of tabular and graphical data on a "real-time" basis that highlight the coursework and educational outcomes that are being obtained by the students -- information that is useful for on-going course improvement, planning and evaluation. These reports may also be useful for curriculum planning and evaluation as well.

5.2. General Steps Followed to Work with EnableOA

Step 1. Entering the ET2K course criteria. These were based upon the eleven criteria specified by TAC. They were entered manually into the system using the EnableOA webpage with Dr. Walcerz's help. Both institutions used the eleven TAC criteria as a basis for the pilot study, and worked with Enable Technologies Inc., to enter these into their software. (Note -- These had to be entered into the software system so that they could be utilized later as the students entered their outcomes and selected the desired criteria that they felt correlated to those outcomes.) SMSU, which is accredited by the National Association of Industrial Technology (NAIT), elected to use the ET2K outcomes because they reasonably addressed the desired outcomes for NAIT accreditation and there was no comparable list available from other sources.

Step 2. Entering student names and numbers. Since this was a pilot study using EnableOA's web server, this data had to be entered manually into the system. Drs. McCurdy and Drake provided Dr. Walcerz with spreadsheets containing the names of the courses, instructors, and students who participating in the pilot study. Dr. Walcerz then imported the data into the software and established accounts for the instructors and the students involved.

Step 3. Entering instructor-generated course intentions. This was the most difficult part of the pilot study, and required the greatest amount of thought on both instructor's parts. Both instructors wrote their instructor intentions based upon the eleven ET2K criteria and each course's existing course objectives.

5.2.1. Writing instructor intentions at Cal Poly Pomona. Dr. McCurdy wrote his instructor intentions for ETE 401 first because this course included a large number of subjective course topics, and because he was adding project management topics to the course for the first time, which made the task even more difficult. Overall, he spent about twenty hours or so writing his final set of instructor intentions for the course. In particular, the most difficult part was writing the intentions that related to the subjective-oriented ET2K criteria such as**: *an ability to communicate effectively; a recognition of the need for and the ability to pursue lifelong learning***; *an understanding of professional, ethical, and social responsibilities; a recognition of contemporary professional, societal, and global issues and awareness of and respect for diversity***; and** *a commitment to quality, timeliness, and continuous improvement*. Since the Instructor Intentions for ETE 401 are rather long, they are listed in Appendix A.

After writing the instructor intentions for ETE 401, writing them for ETE 310 was much easier. Also, Dr. McCurdy chose to write them directly into the EnableOA system from the course objectives listed on his course syllabus. This process went smoothly, and took about two hours to complete. Dr. McCurdy's Instructor Intentions for ETE 310 are shown in Figure 1.

1. **An appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines.** Students in ETE 310 will solve switched-mode RC and/or RL circuits in the time domain. They will work with ideal op-amp building blocks including inverters, inverting summers, non-inverting amps, and simple integrators and differentiators.

2. **An ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering, and technology.** Students in ETE 310 will use modern engineering software tools including the latest versions of PSpice, Program CC and/or MATLAB etc. to verify their analysis and/or design work, as appropriate.

3. **An ability to conduct, analyze, and interpret experiments and apply experimental results to improve processes.** Students in ETE 310 lab will use typical laboratory equipment to measure and verify circuit response. Students will connect typical passive and op-amp circuits and use test equipment to measure circuit parameters. Students will validate their measurements with theoretical calculations.

4. **An ability to function effectively on teams.** Students will work in teams in ETE 310 lab. They will work together to connect circuits, take measurements, record data, analyze data, run computer simulations, and write lab reports. Each student is expected to work effectively on those teams. The other team members are given the responsibility and authority to formally inform the instructor via written documents if and when a student does not "pull his/her weight."

5. **An ability to communicate effectively**. Students in ETE 310 lab will write semi-formal and formal lab reports. To receive an A grade for each lab, students will write a formal lab report documenting their understanding of the circuit and characteristics and behavior. The design equations are also required, typically placed in an appendix.

6. **A recognition of the need for and the ability to pursue lifelong learning.** Students in ETE 310 will appreciate the need for, and the utilization of engineering fundamentals for the analysis and design of electronic circuits and systems throughout their technical career.

===
Figure 1. -- Instructor-Generated Course Intentions for ETE310

5.5.2. Writing instructor intentions at SMSU. Dr. Drake composed his Instructor Intentions for TEC 110 and TEC 250 with help from Dr. Walcerz. They discussed the objectives that were intended for the students taking the course, and compared them with the TAC/ABET standards previously listed.. One example of an intended outcome is that students were expected to learn to utilize computer aided design (CAD) software. This has a match with the standard " *demonstrate an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines."* Another objective of the TEC 110 course was to develop sketching skills, which also address this same standard. Working in small groups to check each other's drawings before final submission was also encouraged.

The TEC 250 Industrial Safety course addressed standards that were significantly different from those of the Engineering Graphics course. The six outcomes for this course were:

- an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines,
- an ability to function effectively on teams,
- an ability to communicate effectively,
- a recognition of the need for and the ability to pursue lifelong learning,
- an understanding of professional, ethical, and social responsibilities
- a recognition of contemporary professional, societal, and global issues and an awareness of and respect for diversity.

In one instance, Dr. Drake was able to take advantage of the global safety officer for General Electric fractional horsepower motor plants, who had just returned from a visit to a new manufacturing plant is India. As an interesting aside Dr. Drake learned that in India, the method for transferring concrete is significantly different than the concrete pumps used in the United States; there, women were used to move concrete. They carried the concrete up ladders balanced, in baskets, on their heads. This addressed the ET2K standard; *recognize contemporary professional, societal, and global issues and are aware of and respect diversity.* Working in groups to develop reports and providing many written reaction papers address the standards of communication and working in groups. Communication with Blackboard software and associated e-mail techniques gave another example of *mastering modern tools techniques and skills.*

Dr. Drake felt that the process of working through course objectives and comparing them to the standards gave a much better perception of how those objectives fit into the overall scheme of providing, in SMSU's campus vernacular, "an educated person." The process of developing these objectives and associating them with the ET2K standards took about one hour for each course. This involved reviewing the course syllabus and textbook to identify what the outcome objectives were. The ET2K standards were used because they were already developed and they addressed the learning outcomes of interest for the university's Industrial Technology program.

5.3. Obtaining Student Outcome Data using EnableOA

5.3.1 Obtaining student outcome data at Cal Poly Pomona. Dr. McCurdy logged onto the EnableOA website as a "student" at the beginning of the fall 2000 quarter and soon realized that some form of instruction document would be needed by the students in order to utilize the software tool effectively. As such, an instruction document was developed and distributed to each student in both courses about the second week of the quarter. A copy of this document is shown in Appendix B.

As that time, the students were also informed that a departmentally-approved pilot study was underway to assess the functionality of a web-based course assessment tool, in preparation for the department's next TAC/ABET re-accreditation visit. The importance of the study and student responses was stressed. About thirty minutes of course time was allocated to discussing the study, the eleven ET2K criteria, and how to use the software tool, according to the instruction sheet.

The students in ETE 310 were asked to enter their responses into the EnableOA system on-line at home, or at one of the general-purpose computer labs available throughout the campus because of the large enrollment in the course. An example of a student response for ETE 310 is shown in Figure 2.

I learned the general characteristics of the second order parallel RLC circuit connected to the feedback loop of an op-amp, learned how to compute the damped frequency of oscillation, zeta, peak value, overshoot in percent, current feedback. We learned the general characteristics of an RC circuit response to frequency and time, tau, and its corner frequency, db and phase angle, high and low and band pass filter, low and high pass filter and allows only frequency in the midband to pass. We also learned the general characteristics of the second order RLC circuit. The relationship of Wn and Wd, Wn represents the system's undamped natural frequency, and Wd is the system's natural radian frequency. We learned the difference between the non-inverting 0p-amp and the inverting op-amp. The difference was which side went to ground and so on.... I learned the 6 different characteristics of an ideal op amp, learned how to plot the op-amp thru the pspice sofware. I learned how to use Laplace transform technique to find the capacitor voltage with respect to time and inverse Laplace transform technique to determine the voltage across the capacitor in the time domain. Overall, I learned many things in this ete310 course.

Criteria Covered
- an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines.
- an ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering, and technology.
- an ability to conduct, analyze, and interpret experiments and apply experimental results to improve processes.
- an ability to apply creativity in the design of systems, components, or processes appropriate to program objectives.
- an ability to function effectively on teams.
- an ability to identify, analyze, and solve technical problems.
- an ability to communicate effectively.
- a recognition of the need for and the ability to pursue lifelong learning.
- an understanding of professional, ethical, and social responsibilities.
- a recognition of contemporary professional, societal, and global issues and are aware of and respect diversity.
- a commitment to quality, timeliness, and continuous improvement.

===
Figure 2. A typical ETE 310 student response, obtained from EnableOA.

Note that this student's text response is relatively detailed, it lists most of the topics that were given on the course's syllabus. Note also that the student selected all eleven ET2K criteria as being applicable to his/her response. Evidently, this student felt that he/she learned a lot in ETE 310. However, there is little evidence to support what this student said he/she *learned*, and little or no information to support the selection of all the outcome-criteria items indicated.

The ETE 401 students were able to enter their experiences into the system during a regularly-scheduled lab time in a small computer lab because it's enrollment was considerably smaller. A typical ETE 401 student response obtained from the EnableOA system is shown in Figure 3.

ETE 401 is a class that deals with the organization and writing of technical papers. The class involved writing and organizing a, research, proposal and a project mangement paper. The research paper was a good lesson in researching a topic and putting the information in a paper in an organized manner. The research involved going to the library and finding information which was relevant to the subject. I believe this was a good exercise in researching and organizing information. The second project was a project proposal. The basis of the proposal was to take information from the research paper and come up with a product that could be manufacutred and sold. The proposal outlined the product, giving specific cost paramenters, time constraints and techinal outcomes. This project was beneficial because it related to a real world situtation in industry. The last project was a project managment paper. The project was to come up with a new idea and write a detailed account of everthing from building the building, budget constraints, personnell, manufacturing, and time frame. This project, just like the one before, was beneficial because it modeled a real world scenario. All together this class was beneficial in helping me understand how a techinal paper in industry comes together.

Criteria Covered **-- As selected by the Student via EnableOA**

- an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines.
- an ability to function effectively on teams.
- an ability to communicate effectively.
- a recognition of the need for and the ability to pursue lifelong learning.
- an understanding of professional, ethical, and social responsibilities.
- a recognition of contemporary professional, societal, and global issues and are aware of and respect diversity.
- a commitment to quality, timeliness, and continuous improvement.
==

Figure 3. A selected ETE 401 student response, obtained from EnableOA.

Notice that this student's written response is relatively detailed about what he/she learned with respect to the entire course, along with some nice supporting detail of what he/she actually did. Note also that this student selected seven ET2K criteria as being applicable, mostly subjective types, which can make for a nice metric for these types of outcomes. Although the seven criteria selected were discussed during the project management phase of the course, some supporting detail would have been appropriate. Overall, this student seems to be reporting that that he/she learned a lot in ETE401 with respect to writing for industry.

Discussion of the Student Responses at Cal Poly Pomona. At Cal Poly Pomona, the student responses for both courses were reviewed during the 8th week of the quarter, and a number of problems were noted. Most of their responses were poorly written, and omitted the necessary supporting text of what they actually <u>learned</u> in their respective courses. Also, most students selected too many of the eleven possible criteria options for their responses. And, most importantly, only one student of the thirty-six students in ETE 310 had responded up to that time.

Dr. Walcerz recommended that the benefits of the study be re-emphasized to the students, making special note of the *on-line student portfolio* aspect of the system and how it would be of great benefit later on as an "extended resume" during job interviews etc. The was done at the eighth week of the quarter. Also, as an additional motivator, Dr. McCurdy informed the students in both courses that responding to the system would count toward their homework grades. By the tenth week, the response rate in ETE 310 increased significantly. Apparently, grade motivators helped!

5.3.2. Obtaining student output data at SMSU At SMSU, the assessment software was presented in two different ways. In the TEC 110 class, the combination lab/lecture format allowed presentation as a laboratory exercise. After the first major test the students were provided a set of instructions that directed them through help menus in the EnableOA software. The students reported that these instructions were easy to follow and after reading the introductory material several asked if they should then go ahead and make entries in the software. They then proceeded to work on making entries. Later analysis indicated that they were not all successful in this process.

The second class, TEC 250, met only once a week and did not have an associated lab. Because of other professional responsibilities, Dr. Drake was called out of town during two consecutive class meetings. On the second of these meetings the same instructions used with the TEC 110 class were distributed to the TEC 250 class via e-mail and the Internet using Blackboard software. Later discussion with a sampling of students indicated that the process was easy to follow.

However, later analysis with the software indicated that only a little over fifty percent of the students successfully submitted entries. Speculation was that students had failed to complete the submission process by missing the last step, i.e., not clicking on the software's *Submit* button. Follow-up with select students after the semester ended indicated that the submission oversight might be the reason for the less than expected response rate. As of this writing, a follow-up survey of those participating students is underway to try and determine why entries were missed.

The development of instructor intentions was found to be a relatively easy process while working with Dr. Walcerz. The process took about one hour of direct work and involved using the course syllabus and text to identify intentions and correlate those intentions with the ET2K goals. The process provided some unexpected insight into what was being accomplished with the course. Later analysis also showed that some of the expected outcomes were not achieved as well as had been assumed. Students found the process to be straightforward and easy to use.

Overall, a total of 84 students in four courses were encouraged to participate in the assessment process, and 52 of them did so by submitting at least one experience to their electronic portfolios. In general, about one third of the students did not participate at all, one half submitted a single experience, and a sixth submitted more than one experience. Dr. Drake suspects that the lack of participation in his courses may be related to not clicking on the software's *submit* button as entries were made. The reports that can be generated by the EnableOA process is discussed next.

5.4. Obtaining Reports from EnableOA

EnableOA provides a number of modes for viewing faculty intentions, student participation, and analysis of student narratives with respect to the eleven TAC/ABET criteria in both graphical, tabular and textual form. Some of the various graphs are illustrated below.

5.4.1 Student Participation in the Assessment Process

Figure 4 shows participation broken down by course and number of experiences submitted. Note that the percentage of students who submitted at least one experience in TEC 110, TEC 250, ETE 310, and ETE 401 was 44 percent, 68 percent, 64 percent and 73 percent respectively. Note also that about 18 percent of the students in ETE 401 submitted three or more experiences for this course.
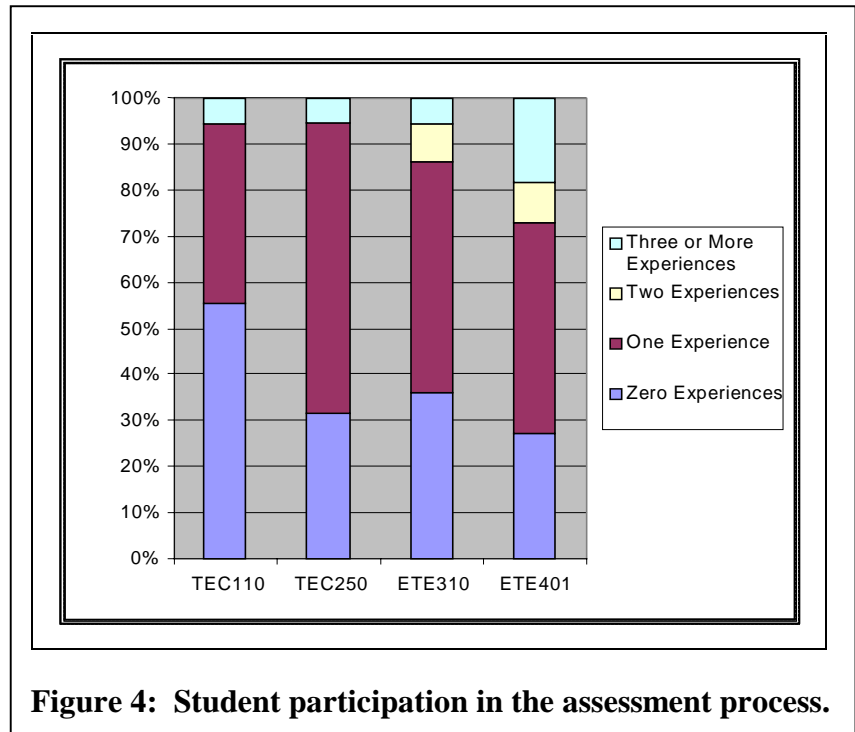

Figure 4: Student participation in the assessment process.

5.4.2. Quality Analysis of Student Narratives

Discussion. In order to participate in the assessment process, students had to compose narrative statements of their classroom experiences, focusing on concrete descriptions of what they had done rather than conclusions about what they had learned.

A total of 75 narratives were submitted, and all were analyzed for quality. Good narratives were written in first person, described the student's work in good detail, and dealt with a single experience or a group of thematically related experiences. Moderate narratives were written in first person, didn't have enough detail, and sometimes included a collection or unrelated experiences. Poor narratives were either too short, e.g., a single three-word phrase, or talked about what the student learned instead of what he or she did. Poor narratives also included an evaluation of the course and/or the instructor.
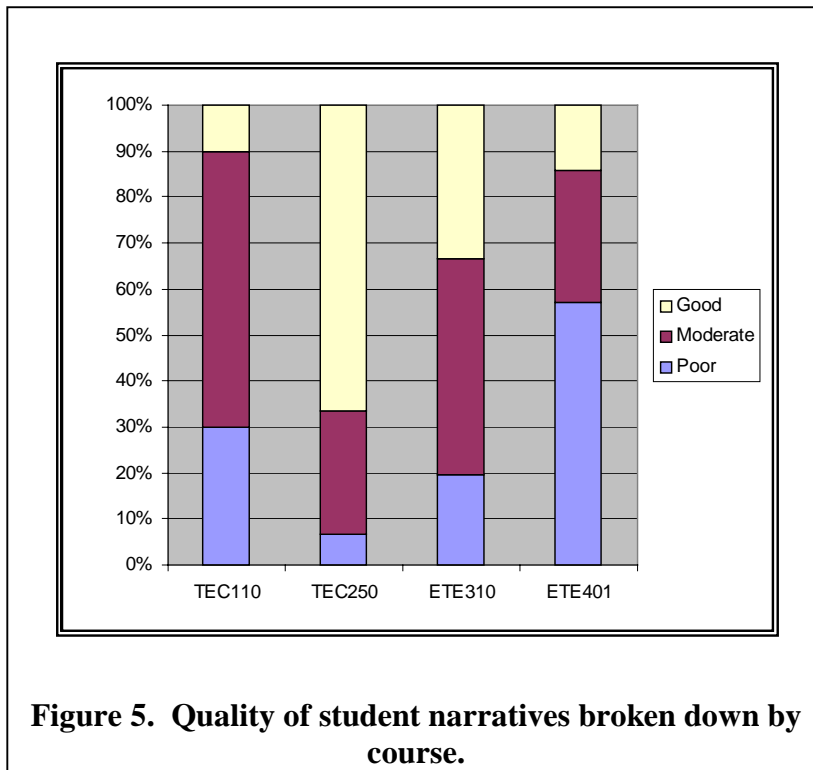
An analysis of the students' narratives revealed 25 good quality narratives, 31 moderate narratives, and 19 poor narratives.

Figure 5 shows the quality analysis of student narratives broken down by course. The percentage of moderate and good quality narratives in TEC 110, TEC 250, ETE 310 and ETE 401 is 70 percent, 93 percent, 81 percent, and 43 percent respectively.

Note that there is a substantial variation in quality between courses. TEC 250 had a large number of good quality narratives, and ETE 401 had a lot of poor quality narratives, about 30 percent and 55 percent respectively.

Figure 5. Quality of student narratives broken down by course.

5.4.3. Student Discernment of Outcomes

Discussion. For every experience a student submitted, he or she was expected to select at least one of the eleven educational outcomes, based upon the written content of their narrative. An analysis of the students' outcome selections shows that a majority of students selected too many outcomes for a given experience. For example, a student may have selected an outcome such as "an ability to function on teams" while their narrative contained no mention of teamwork at all.

Figure 6 shows the analysis of appropriateness of student outcome selections by course. Note that the students selected extraneous outcomes for approximately 70 percent of all narratives. Note also that the students in ETE 401 course were most effective at selecting appropriate outcomes, about 35 percent or so, while only about 15 percent of the students in TEC 250 course were effective in selecting appropriate outcomes.

Figure 6. The appropriateness of students' selection of educational outcomes.
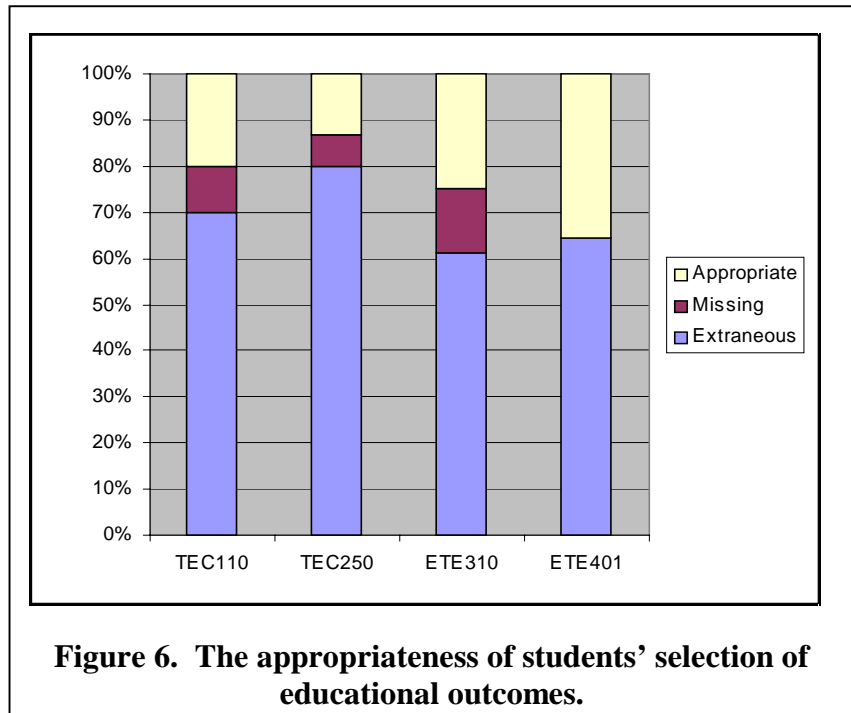
5.4.4. Obtaining Assessment Reports

The EnableOA software can automatically generate assessment plots based on the descriptions of experiences that students and instructors submit with respect to the outcomes previously entered by the course coordinator into the system (the eleven ET2K outcomes here), like that shown in Figure 7. Here, the percentages of students in TEC 250 who submitted experiences for the eleven ET2K outcomes are shown. The different shades of the stacked bars highlights the percentage of students submitting one, two, or three or more experiences, as defined in the legend at the top of the figure. For the TEC 250 course shown, the percentage of students who

Figure 7: Percentage of students in TEC250 who submitted experiences based on ET2K educational outcomes.
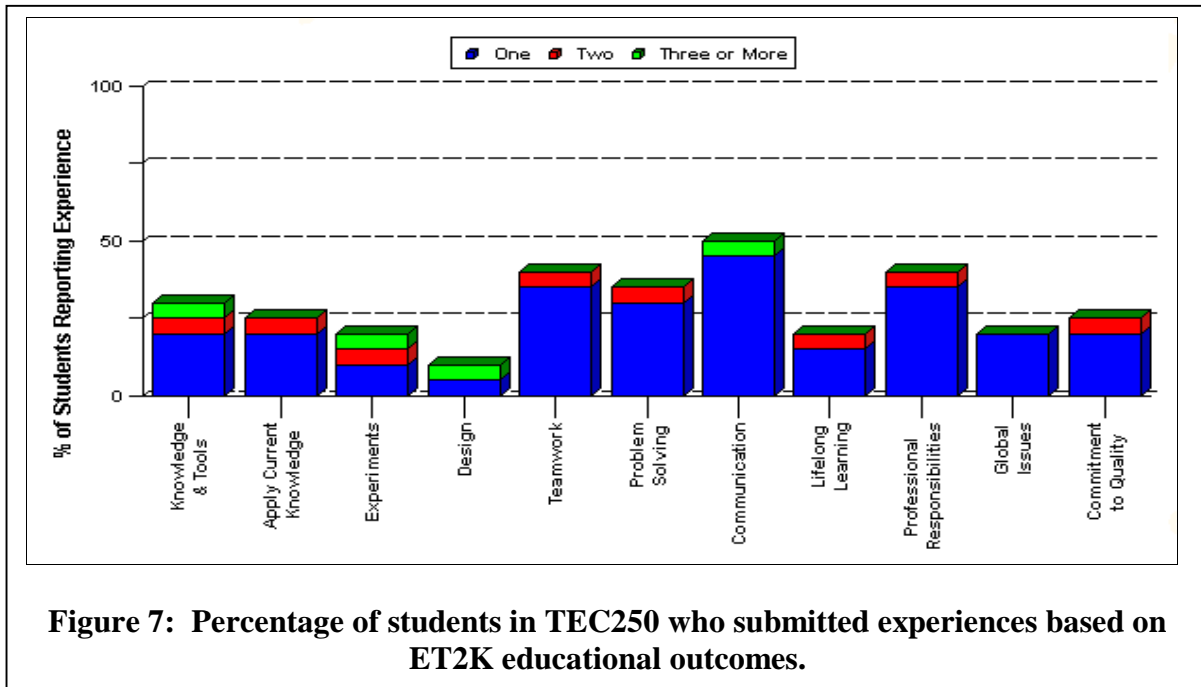
perceived and reported at least one significant educational experience that demonstrated "*an ability to communicate effectively*" was 53 percent, while 42 percent selected "*an ability to function on teams.*" Also 42 percent of the students selected "*an understanding of professional, ethical and social responsibility,*" while 37 percent selected "*an ability to identify, analyze, and solve technical problems.*" If the students who participated in the assessment process only are considered, the percentages are 77 percent, 62 percent 62 percent, and 54 percent respectively.

Note – an instructor can "check the validity" of each bar by "drilling" into any one of the outcome bars. When drilled, the graph changes to a view of student responses that lists each student's narrative, attached documents, and selected outcomes for the given course. For example refer to Figure 1, and Appendix A.

Discussion. If the quality of the student narratives was moderate or good, and the students were able to select appropriate outcomes, then Figure 7 provides clear evidence that TEC 250 is developing those four outcomes to a substantial degree, as well as other outcomes to a lesser degree.

However, for the TEC250 course shown, the quality of narratives was quite good, but the selection of outcomes often included more than the narrative justified. Thus, the graph is not as valid as we would like. Nevertheless, the raw evidence, the student narratives and attached documentation, is available to the instructor for assessment purposes.

5.4.5. Matrix Charts of Course Titles versus Selected Outcomes

Figures 8 and 9 shows the standard matrix of technology courses vs. the outcomes they are designed to develop at SMSU and Cal Poly Pomona. Across the top are the eleven ET2K educational outcomes. Down the first column are all of the technology courses offered at each respective institution. (In this case, only the two courses in this pilot study are listed for SMSU, and three courses for Cal Poly Pomona.)

	Knowledge & Tools	Apply Current Knowledge	Experiments	Design	Teamwork	Problem Solving	Communication	Lifelong Learning	Professional Responsibilities	Global Issues	Commitment to Quality
TEC110	100	--	--	--	100	--	100	--	--	--	100
TEC250	100	--	--	--	100	--	100	100	100	100	--

Figure 8: Matrix of technology courses at SMSU
vs. ET2K educational outcomes.

	Knowledge, skills, and tools	Apply engg	conduct experiments	design	teamwork	problem solving	Communicate	lifelong learning	ethics	Global issues	Quality
ETE310	100	100	100	--	100	100	100	100	--	--	--
ETE401	--	--	--	100	100	--	100	100	--	--	100
ETE450	100	100	100	100	100	100	100	100	--	--	--

Figure 9: Matrix of technology courses at Cal Poly Pomona
vs. ET2K educational outcomes.

The cells of the matrix are either blank, which means that the instructor does not intend to develop the associated outcome in the associate course, or else 100 percent, which means that all of the students in the associated course have an instructor intending to develop the associated outcome.

Discussion. EnableOA uses percentages instead of the more common X's because some courses are not uniform across all sections and instructors. For example, one section may have an instructor who uses project teams, thus developing Teamwork, while another section of the same course may have an instructor who does not. If there are 60 students in the former section and 40

in the latter, EnableOA will report 60 percent in the cell associated with Teamwork and the course.

Notes -- The graphs of the respective data for ETE 401 at Cal Poly Pomona are similar to Figures 7, 8 and 9, hence they have been omitted here for brevity. Note that a third course, ETE 450, is shown in the study at Cal Poly Pomona. This course ended up with low enrollment and was subsequently withdrawn from the study; hence no other data is presented here regarding this course.

6. Overall Assessment of the EnableOA Software and Process

As mentioned in the introduction, the purpose of this study was to learn how to conduct continuous course improvement based upon the newly-mandated TAC/ABET criteria, and to evaluate the effectiveness of a web-based software tool to assist in that process, as compared to what is currently available. Five characteristics were identified as necessary minimums for a suitable computer-assisted assessment process. Each one is highlighted below:

6.1. The Process Should be Easy to Use

Both Dr. McCurdy and Dr. Drake used the EnableOA software for the first time for this project. Both professors found the tool relatively difficult to use the first time, and required assistance from Dr. Walcerz to get started. For example, they both required Dr. Walcerz's assistance in setting up each course, entering the eleven TAC/ABET outcome criteria into the system, entering their instructor intentions, and figuring out what to tell the students. However, after a little use, the system did become easy to use.

6.2. The Process Should Allow Faculty to Easily Write Educational Outcomes

This is a two-pronged issue. First of all, EnableOA is not designed to be a tool for writing instructor intentions. However, by using the tool, a faculty member is encouraged to write effective instructor intentions based upon the given criteria he or she has selected for his/her course(s). Once the instructor has written his or her intentions, they are easy to enter into the software system. Both professors felt that the process of developing those outcomes also provided some new insight in to the accomplishments of the course. "Gee, I am accomplishing more with this course than I thought."

6.3. The Process Should Encourage Students to Write Meaningful Outcomes of Learning

Bringing students into the process was easy and met with no expressed resentment on the part of those who participated in the study. However, a number of problems were noted -- lack of participation, poor quality of written responses, and the selection of too many unsupported educational outcomes. Each of these problems is addressed below:

6.3.1. Lack of participation and quality at SMSU. The number of students who elected to participate in the study at SMSU was disappointing. For example, a difference in student response was noted that is probably indicative of student maturity. Even though the TEC 110

class was introduced to EnableOA in class and given lab time to submit information, the participation and quality was not as good as in TEC 250. This may be because the TEC 250 students tended to be more mature, and self-supporting.

Students in both classes reported that the help sections they were referred to in the EnableOA software were easy to follow. That is somewhat tempered by the fact that their response rates were lower than expected. Dr. Drake speculates that that this may have been caused by the students failing to click on the "**submit**" button at the end of their data entry exercise. Students have been contacted via email to see if this was the case.

The quality of the descriptions that were submitted by students in TEC 250 was quite good, probably due to the same reasons that the level of participation was high, i.e., mature students. The quality in TEC 110 was relatively low, perhaps because the students were freshmen and relatively immature.

In the TEC 110 class it became clear that some specific instruction on working in teams would be helpful. In TEC 250 input was received from an English as a second language student that indicated that more attention was needed in overcoming language difficulties. The initial implementation of the process demonstrated substantial buy-in from students and indicated that they can learn and actively participate in the process after being introduced to it in a single class session or, in one case, from a single Email notice.

6.3.2. Lack of participation and quality at Cal Poly Pomona The number of students who elected to participate in the study at Cal Poly Pomona was equally disappointing. As mentioned earlier, the response rate in ETE 310 was initially very poor at the 8th week; only one student had responded at that time. To increase participation, the students in both courses were told that they would be given additional homework credit if they would respond to the system. This improved the ETE 310 response rate considerably, up to about 40 percent by the end of the 10th week of the quarter. The response rate in the ETE 401 course remained the same.

The quality of student responses in ETE 310 was acceptable and consistent with the expectations for a junior-level course. Conversely, the quality of student responses in ETE 401 was the worst of all four courses, which was a surprise because the students were all seniors, and good technical-writing skills were emphasized.

6.4. The Process Should Provide Meaningful Tabular and Graphical Information

The usefulness of the process and reports must be evaluated from the perspective of accreditation as well as operations. The tables and graphs shown in Figures 4 through 8 clearly highlights the educational outcomes of the assessment process to the instructor, and indirectly, indicates the student involvement in the process. And, for accreditation purposes, the graphs also highlight the educational experiences obtained by students relative to the desired experiences specified by the instructor.

6.5. The Process Should Provide Useful Information in a Timely Manner

The EnableOA process was found to provide ***"real-time" feedback*** to the professors once the processes was initiated in a given course. The tabular, graphical, and student responses allowed the professors to readily comparisons between the outcomes they intended to develop and the ones the students believed they were developing. The evidence of student achievement in the form of narrative descriptions of educational experiences plus copies of actual student work by course, outcome, and a variety of student demographics was especially useful.

Dr. Drake, based upon his first exposure to the EnableOA software process, reported that the thing that intrigued him the most was the feedback that he could obtain from the software at mid-semester, and that this feedback can be applied to current students. "You do not have to save the improvements for the next group that takes the class."

7. Overall Conclusions and Recommendations

7.1. Correlation with mandated TAC/ABET criteria. The EnableOA process is able to provide reports that should substantially satisfy TAC/ABET accreditation requirements for assessment. The process was found to be very useful in helping the researchers develop instructor generated objectives, garnering student feedback in a comprehensive and timely manner, all related to the eleven TAC/ABET outcomes.

7.2. Enhancement of continuous course improvement. Although the researchers have had limited use of the software tool to date, it does appear to have been useful to them for planning enhancements into their courses based upon student feedback, especially with respect to the eleven new TAC/ABET criteria. And, the tool provided greatly-enhanced course-improvement information on a timely basis above what the researchers currently use. This should be of benefit to others as well. And, the software includes the ability to document changes to courses in response to outcomes analysis over time; however, since this was a one-term study, the use of this feature was not practical.

7.3. Friendliness of the software tool. Although the software tool was found to be reasonably hard to use at first, it was found to become much more functional with use, and in some respects, actually became quite "intuitive." The researchers believe that the Enable software process can be utilized effectively for continuous course improvement based upon the mandated TAC/ABET criteria. This software tool should seriously be considered for use by other departments and faculty as they begin the process of meeting the new TAC/ABET mandates.

7.4. Summary comments for student response rates. Overall, student participation in the study was about 65%. This suggests that the "portfolio" process built into the EnableOA system may be insufficient to motivate students to participate in mandated course-improvement processes. If EnableOA is to be used for accreditation purposes, it is apparent that some way must be found to improve the student response rate to a reasonable percentage for data validation purposes. The grade motivator utilized by Dr. McCurdy seemed to work well, and may be one such mechanism.

7.5. Summary comments for student response quality. The quality of student responses overall was marginal. Many responses were brief and poorly written, with numerous English, spelling, and mechanical errors. (For example, refer to the ETE 310 and ETE 401 responses shown in Figure 1 and Appendix A respectively. These have been inserted verbatim.) And, most responses provided little or no detail of what the students actually did to demonstrate that actual learning had occurred.

7.6. Summary comments regarding over-selection of educational Outcomes. Students in all four courses were largely unable to limit the selection of the educational outcomes for a given educational experience. In all four courses, about 70 percent of the submitted narratives had extraneous unsupported outcomes, which resulted in over-reporting of educational outcomes for every course. Also, this meant that the students were over-reporting extraneous outcomes in their own electronic portfolios, which may be misleading to potential employers, etc.

Hopefully, as students gain experience with the software and begin to use their electronic portfolios for their own purposes, they will learn the value of selectivity, and this problem will diminish. As a side note, the Student Instruction document shown in Appendix B has been revised to include a number of examples for students to follow, including the selection of course outcomes. The original instruction sheet that Dr. McCurdy provided to his students did not include these examples.

8. On-Going Activities

Both programs, ECET at Call Poly Pomona, and the IT program at SMSU have contracted with Enable Technologies, Inc., to keep their respective systems on-line for at least three more years. This has been done so that the students who participated in the study would be able to utilize their "on-line portfolios," and so that on-going research can be conducted. A yearly fee of $250 has been agreed upon for this service for each department.

At Cal Poly Pomona, Dr. McCurdy is continuing his pilot study for the Winter and Spring quarters of 2001. He hopes to increase student response quality, and selection of educational outcomes by utilizing the revised student Instruction document shown in Appendix B. Although he believes that lack of student participation may still be an issue, he plans to minimize it by utilizing the grade motivator scheme again. To aid in this process, Dr. Walcerz at Enable Technologies has agreed to display the names of those students who have responded on-screen for instructor use.

As a side note, both McCurdy and Walcerz believe that grade motivation is probably more compelling for freshmen and sophomores than the utility of an on-line resume because these students are too far removed from the reality of job-hunting, although there is no statistical evidence to support this notion. Likewise, they both believe that juniors and seniors will probably find the on-line resume as compelling as grades.

At SMSU, Dr. Drake plans to continue the pilot project in the spring semester to further gauge student motivation, which is crucial to the success of this process.

9. Recommendations for Future Study

9.1 Evaluate the EnableOA process for institutional assessment activities. Conduct a study to assess the usefulness of the process with respect to departmental or institutional educational outcome requirements. It seems likely that the reports shown in Figures 7 and 8, when available for full degree programs or entire institutions, would be of great benefit for accreditation purposes.

9.2 Evaluate the EnableOA process for longitudinal studies. Conduct a longitudinal study over three to four years to see if students improve in their ability to write clear descriptions of what they have learned with supporting evidence, and are able to select appropriate outcomes for those respective learning outcomes.

9.3 Evaluate the EnableOA process for articulation purposes. The impact of the new TAC/ABET outcomes assessment-based criteria with respect to articulation between two and four-year programs in engineering technology is unknown at this time. As such, a study to evaluate the effectiveness of the EnableOA process to articulate the equivalency of course topics should be done.

9.4 Evaluate ways to enhance student motivation. To enhance data validity for class-oriented assessment activities, a high-rate of student participation is essential. It is recommended that a study be conducted to find ways of motivating more students to participation in the EnableOA process.

10. Appendices

===

Appendix A
Instructor-Intentions for ETE 401

===

1. **An ability to apply creativity in the design of systems, components, or processes appropriate to program objectives.** Student teams in ETE 401 will utilize project-manage techniques to write a technical proposal using the four phases of project management: definition, planning, implementation, and completion. The proposal will document the processes involved with setting up a production line for a new electronic device. The proposed solution is expected to consider applied-engineering design processes.

2. **An ability to function effectively on teams.** Students in ETE 401 will work effectively in teams to conduct research, write papers, and present oral reports.

3. **An ability to communicate effectively.** Student teams in ETE 401 will formulate research topics into an appropriate topical outline; followed by a rough draft, culminating in a final formal library research report that meets professional writing standards. Each paper submitted for grade must be word-processed on white bond paper and be complete, on-topic and effective, with appropriate margins, white space, fonts and headers utilized. It must include a cover page; table of contents; list of figures; table of definitions; and introduction.

   The body of the report must include at least three computer-generated-and-inserted graphic elements (line drawing, table of data, and plot of data), each appropriately numbered, titled, and referenced in the text prior to use. It must also use at least levels of headings and sub-headings, with at least two paragraphs per section, and two sentences per paragraph. Following the body, the remainder of the paper must include a summary section, a conclusions section, a recommendations section, a references-cited section with all paper-citations referenced; and an appendix section with at least three appendices -- the title and first-text page of each reference cited within the paper.

   Student teams in ETE 401 will present a brief but complete oral summary of the project that the team proposes to undertake, based upon the work documented in their Written, Team-Oriented Formal Senior Project Proposal. Each of the remaining students in the class will evaluate the team's oral presentation based upon an instructor-provided rating form with the following criteria: 1. Eye contact -- speaker should look and talk to each person in the audience, not at one person only, at the ceiling or floor, or at the board only; 2. Voice -- speaker should talk "out" to everyone, speaking clearly and slowly, emphasizing the strong points; talk should not be dull or boring; 3. Professionalism -- speaker looks and talks like a professional; grooming, dress, and appearance count; 4. Interest and gestures -- audience interest is maintained; use of gestures to emphasize high points; some movement at front of the room; 5. Quality of Overheads -- readable, unreadable; professional looking (computer generated) with large font; information neat, clear, and uncluttered; 6. Number and use of Overheads -- an overhead should be used for each main topic; without "flipping" from one to the other; 7. Organization and completeness -- you were told, told in detail, then told again in summary; report body was organized and complete; 8. Technical content -- the report was technically accurate, to the point, but not overly technical; 9. Non-technical content -- budget info, selection criteria, comparative analysis, etc. was appropriate; 10. Overall quality -- rate the presentation overall, were you "sold" by the presentation?

4. **A recognition of the need for and the ability to pursue lifelong learning.** Students teams in ETE 401 will prepare a formal technical library research paper. With respect to the selected topic, each team will research at least five well-documented, technically-oriented sources, of which at least three must be from the library, the others may be from the internet. These sources are to be technical in nature, with some form of "engineering-oriented" equations, graphs, tables, or other related information in them; general-technology sources like Popular Electronics, etc., will not be acceptable for credit. All five sources must be well documented to serve as references for the team's follow-on formal technical library research paper. Through this experience, students will develop independent learning abilities. Students in ETE 401 will also develop team skills essential to working with others in the pursuit of research, writing papers, and presenting oral reports.

5. **A commitment to quality, timeliness, and continuous improvement.** Students in ETE 401 will use peer grading to evaluate a library research paper, a senior project proposal, and a project management proposal. The students will be informed that the process will utilize two criteria (a) grading mechanics (numerical accuracy, neatness etc.) for up to one grade debit, and (b) the "spread of grades" that they assigned to the other teams; the wider the "better." If they assign grades with a range of four or greater (A to D for example), they will receive their assigned team grade. If they assign grades with a range of three but less than four (A to C for example), their team grade will be de-weighted by one letter grade. If they assign grades with a range of two but less than three (A to B for example), their team grade will be de-weighted by two letter grades. If they assign grades with a range of one but less than two (A to B+ for example), their team grade will be de-weighted by three letter grades.

On peer-grading day, all teams will place their final papers on a common table, typically in a lab room. Then, each individual student, using an instructor-generated grade specification sheet, will go around the table and evaluate and grade the other team's papers, excluding their own. When done, each team will meet as a group, combine their individual grades into a composite grade for each other team, from **A** grades to **F** grades, as appropriate; and then submit this set of composite team grades to the instructor. Through this experience, students will appreciate the need for, the difficulty in, and the ability to, assess the work of others.

===

Appendix B
EnableOA Instruction Sheet for Students
(Revised 1/18/01)

===

1. **Locate the EnableOA Technologies' Operations Site.** Go to website *www.enablecollege.com*

2. **Select an area of choice (school of choice).** Select *Cal Poly Pomona*

3. **Log in as a Cal Poly Pomona Student.** Enter your User ID (Login ID) Your Login ID is created by taking your first initial plus your last name, removing all punctuation and spaces, truncating to eight characters, and switching to lower case. Note -- Leave the **password** blank during your initial login -- when you click the *Submit* button, you will get a screen asking you to establish a password. Select and enter a password then.

4. **Submit your student experiences.** Once you are logged in, select *Describe Experience*, select *Add Experience* next to the class you are "writing" about (ETE 310, etc.), type in your experience, select one or more appropriate criteria for the experience, and then submit the experience by clicking on the *Submit* button -- your submission will be saved to the EnableOA server.

   Notes on entering "experiences" -- typically, a student should plan on entering a number of small single-topic "experiences" rather than one great big one. Each experience should relate to a single outcome that you obtained from the course and/or lab that was significant to you and that required significant effort on your part to learn. For each experience, tell the reader what it was that you learned, and then provide ample back-up comments that will help a reader "see" what you actually did as a result of learning the new material.

   Notes on selecting "Criteria" -- below the "experience" text box, click on one or more *Criteria* that actually pertain to the experience just described. Each criteria selected should be supported by some specific text information in the "experience" to be most effective to a reader.

   Example #1. I learned to work with Laplace transforms. The Laplace transform homework assignments required me to convert time-domain equations into Laplace transforms; and to convert Laplace equations back into their time-domain equivalents using inverse transform techniques. This required the use of real first-order, non-repeating roots, imaginary roots, complex roots, and multiple-order roots.

   Possible Criteria Covered -- as Selected by the Student:
   - an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines.
   - an ability to identify, analyze, and solve technical problems.

   Example #2. A second learning experience could involve the s operator and the s-plane. For example, you could talk about the s-domain, transfer functions, the s-plane, pole and zero placement, and stability as a function of the poles of a given equation. The criteria selected could be the same as the above.

Example #3. A third learning experience could involve your team-oriented lab work and lab reports. You could discuss what you learned from the team activities including how the team functioned, how the work was divided among the team members, who took the leadership role and why, and how the percentage of work was divided and recorded. You could also describe what you learned as a result of writing your formal lab reports to meet professional-writing standards. The criteria selected could include "an ability to function effectively on teams," and "an ability to communicate effectively."

5. **View your student portfolio.** Select *Report Gallery*, *Portfolio of All Experiences*. Your portfolio will appear after 30 - 60 seconds or so. You can look at your responses by "drilling" (clicking) on any bar on the resulting histogram. **Important** -- remember that the EnableOA process allows you to develop a functional on-line portfolio of work that <u>you</u> can "show" to others at any time; for example, your parents. Later, your portfolio may be of great interest to many other people such as company personnel when you are applying for work, etc.

6. **Review, modify, update your submissions.** Since the system is web-based, you can log on at any time and add, review, and/or modify your experiences. You can also upload additional examples of work to your portfolio.

11. List of References

i Allen, M. J, Noel, R. C., and Rienzi, B. M., <u>PACT Outcomes Assessment Handbook</u>, The Program Assessment Consultation Team (PACT), California State University, Bakersfield, Bakersfield, CA 93311-1099. August 2000 Edition.

ii Criteria for Accrediting Engineering Technology Programs, Criterion 1 & 6. Technology Accreditation Commission of The Accreditation Board for Engineering and Technology, Baltimore, MD, September, 2000. Accessed at http://www.abet.org/downloads/2000-01_Engineering_Technology_Criteria.pdf on 12/28/00.

iii Principles of Good Practice for Assessing Student Learning. American Association for Higher Education. Accessed at http://www.aahe.org/assessment/principl.htm on 12/28/00.

iv The Program Evaluation Standards, 2nd Edition. The Joint Committee on Standards for Educational Evaluation. Sage Publications, Thousand Oaks, CA, 1994. Accessed at http://www.wmich.edu/evalctr/jc/PGMSTNDS-SUM.htm on 12/28/00.

v Walcerz, D.B. EnableOA: A Software-Driven Outcomes Assessment Process Consistent with the Principles of Good Practice for Assessing Student Learning. Presented at the ASEE mid-Atlantic Conference, Monmouth University, West Long Branch, NJ, 1999. Accessed at http://enableoa.com/enabletech.html on 12/28/00.

vi Walcerz, D.B. A New, Time-Efficient, High Quality Outcomes Assessment Process. Presented at the ASEE North Central Conference, Penn State Erie, Erie, PA, 1999. Accessed at http://enableoa.com/enabletech.html on 12/28/00.

WILLIAM H. DRAKE
Bill Drake is an associate professor of manufacturing in the Industrial Management program at Southwest Missouri State University. He holds a B.S. in Technology '76 and a M.Ed. '78 from the University of Houston and a Ph.D. in Industrial Education, from Texas A&M University in 1983. He is an MECI certified manufacturing engineer and a distinguished member of the American Welding Society.

LYLE B. MCCURDY
Dr. McCurdy is a Professor and Coordinator of the Electronics and Computer Engineering Technology (ECET) Program in the Department of Engineering Technology at Cal Poly Pomona. He earned his BS and MS degrees in Electronics Engineering Technology at Arizona State University in 1971 and 1973 respectively. He earned his Ph.D. in Technical Education at Texas A&M University in 1986.

DOUGLAS B. WALCERZ
Douglas Walcerz is an Associate Professor of Mech Engg at York College of Pennsylvania and Vice President of Enable Technologies, Inc. Dr. Walcerz received a B.S. in Mech Engg from Purdue in 1983, and an M.S. in Mech Engg and a Ph.D. in Biomedical Engg from the University of Texas at Austin in 1988 and 1990 respectively. He has been active in outcomes assessment research since 1990, and co-founded Enable Technologies in 1998.