Implementing classroom outcomes assessment (TAC) with commercially available software. A Computerized Approach to Outcomes Assessment A Pilot Study

Bill Drake, Ph.D., Southwest Missouri State University
Douglas Walcerz, Ph.D., Enable Technologies, Inc.

Abstract

The Industrial Management program at Southwest Missouri State University (SMSU) has begun the process of designing and implementing an outcomes assessment process for to continuous improvement of the programs and in preparation for accreditation by the National Association of Industrial Technology. The university contracted with Enable Technologies, Inc., to conduct a pilot study using EnableOA, which is a Web-based, software-driven assessment process. The study involved two courses TEC 110 – Fundamentals of Engineering Drafting and TEC 250 – Industrial Safety in the Fall semester 2000. Two additional courses, TEC 237 – Mechanics/Statics and TEC 437 – Materials Testing and Measurement were used in the spring, 2001. Results of the study show that the EnableOA process was relatively easy to learn for instructors and students. The instructor spent approximately four hours incorporating the first course into the assessment system, and less than half that time incorporating additional courses. It is anticipated that in the future only one hour of assessment software preparation per existing course will be adequate. Students were introduced to the process, which involved the creation and maintenance of an electronic portfolio, in a single class period for one course and via Email for the second course. Student participation was entirely voluntary.
Approximately two thirds of 37 eligible students participated in the fall term. The quality of the material that students submitted was, in general, good or moderate quality; however, students had difficulty associating their respective educational experiences to appropriate educational outcomes. The data and reports that were automatically generated by EnableOA were judged to be useful for continuous improvement and accreditation, with the caveat that students must improve their ability to select appropriate outcomes. The university expects to continue developing the assessment program using EnableOA.

Introduction

Outcomes assessment and continuous improvement are essential elements of educational programs. Emphasis on assessment is primarily based upon the requirements of accrediting agencies, but also based on the perceived value of assessment to satisfy demands for accountability and the increased competition in higher education. Educational research shows that measurement of educational outcomes can be used to inform an institution about educational goals that are being satisfied and those which are not. This information can motivate and direct efforts to improve curriculum.

In practice, the measurement of educational outcomes is difficult and can be expensive, the results are often ambiguous or statistically unsound. The positive impact of continuous improvement on the curriculum is difficult to prove[i]. Despite the difficulties and expense, accrediting groups and other agencies have mandated outcomes assessment and continuous improvement. Of special note are new criteria by the Accreditation Board for Engineering and Technology (ABET), which apply to engineering programs in 2000[ii], and are projected to be mandated for engineering technology programs in 2001[iii]. The new criteria rely extensively on outcomes assessment for accreditation, and there is a need for efficient and effective assessment processes to satisfy them. These outcomes are also applicable to many other programs, including those accredited by the National Association for Industrial Technology (NAIT). This paper describes the first-term implementation of a web-based assessment process in the technology program, and examines the effectiveness of the process in terms of student and faculty buy-in, and whether the process produces useful data and reports for accreditation and continuous improvement.

Backgroun

The importance of outcomes assessment in higher education is growing, especially in engineering and technology, due to new or expanded mandates by accrediting agencies and recognition that assessment is an essential element of continuous improvement and programmatic well being. However, outcomes assessment is a difficult process to implement. This study, which is primarily limited to the fall of 2000, was designed to test the implementation of the EnableOA assessment process. Additional comments from the spring 2001 implementation are included. The purpose of the study is to:

- qualitatively measure the difficulty of learning the assessment process for instructors and students,
- quantitatively measure the level of participation of students,
- qualitatively measure the quality of the descriptions of educational experiences that are submitted by students,
- qualitatively measure the ability of students to categorize their experiences according to educational outcomes, and
- qualitatively measure the usefulness and appropriateness of the assessment process and reports.

The technology department at Southwest Missouri State University, participated in the study. The university tested the process in two technology courses in the fall of 2000 and two additional courses in the spring, 2001. The university is subject to both a regional accreditation agency and a specialized accreditation agency for technology programs. The following seven sections provide background information on the EnableOA process, the participating university and the associated accrediting agencies.

EnableOA

EnableOA is a web-based, software-driven outcomes assessment process that was designed to be consistent with the nine Principles of Good Practice for Assessing Student Learning[iv] published by the American Association of Higher Education (AAHE), and the Program Evaluation Standards[v] approved by the American National Standards Institute (ANSI).

The EnableOA process[vi, vii] collects descriptions of educational experiences that instructors intend for their students, and descriptions of educational experiences that students perceive they have received from their instructors. Instructors write the former, students write the latter. Every description is associated with one or more educational outcomes, and students are encouraged to attach electronic copies of their actual work, e.g., reports, PowerPoint presentations, CAD files, spreadsheets, programs, digital pictures of design projects, etc., to their descriptions. The descriptions submitted by instructors are used to generate a matrix of coursework vs. educational outcomes that is used for curriculum planning and evaluation. The descriptions that are submitted by students serve two primary purposes.

First, students develop and maintain a personal, electronic portfolio that serves as an extended resume and can be used for professional advancement. The usefulness of this extended electronic resume is the primary motivation for students to participate in the assessment process.

The second purpose, and for assessment the more important, is to aggregate all of the student descriptions for a specific course or set of courses to see if students perceive and report the instructors intended educational outcomes.

Southwest Missouri State University

Southwest Missouri State University (SMSU) is a multi-campus metropolitan university system. The main campus at Springfield is home to the Department of Technology, which offers a baccalaureate degree in Industrial Management (IM) with concentrations in CADD, Construction, Electronics, and Manufacturing. The IM program enrolls about 300 students. The two courses that participated in the fall pilot study are Fundamentals of Engineering Drafting, TEC 110, and Industrial Safety, TEC 250. In the spring, 2001 courses in Statics and Materials Testing were piloted.

TEC 110 is a typical freshman-level drafting course in which CAD skills, sketching skills and orthographic and isometric drawing techniques are practiced. There are two lecture and two lab hours per week, and it is mainly populated by traditional, full-time students. Industrial Safety, TEC 250, is 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. The course emphasizes management of occupational safety programs. There were 18 students enrolled in TEC 110, and 19 students enrolled in TEC 250 in the fall semester of 2000 when this study was conducted.

National Association of Industrial Technology (NAIT)
NAIT accredits the SMSU Industrial Technology program. NAIT has the following requirements with respect to assessment:
Assessment Plan and Integration: An assessment plan shall be comprised of, but not limited to, the following for each program: (1) program mission statement, (2) the desired program outcomes/student competencies, (3) evidence that the program incorporates these outcomes/student competencies, (4) the assessment measures used to evaluate student mastery of the student competencies stated, (5) compilation of the results of the assessment measures, and (6) evidence that these results are used to improve the program.[viii]

The Accreditation Board for Engineering and Technology (ABET)

ABET has the following requirements with respect to assessment:
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.[ix]

ABET developed and is in the process of introducing the following objectives, as a part of Engineering Technology Criteria 2000 (ET2K). These standards include the following statements about outcomes assessment that we believe are compatible with the NAIT accreditation requirements. Since his group of outcomes was developed they were adopted for this pilot study.

An engineering technology program must prepare graduates who:

1. *demonstrate an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines,*
2. *apply current knowledge and adapt to emerging applications of mathematics, science, engineering, and technology,*
3. *conduct, analyze, and interpret experiments and apply experimental results to improve processes,*
4. *apply creativity in the design of systems, components, or processes appropriate to program objectives,*
5. *function effectively on teams,*
6. *identify, analyze, and solve technical problems,*
7. *communicate effectively,*
8. *recognize the need for and possess the ability to pursue lifelong learning,*
9. *understand professional, ethical, and social responsibilities,*
10. *recognize contemporary professional, societal, and global issues and are aware of and respect diversity, and*
11. *have a commitment to quality, timeliness and continuous improvement.*

North Central Association of Colleges and Schools (NCA)

NCA, which accredits SMSU, defines five Criteria for Accreditation and "Patterns of Evidence" to demonstrate the criteria. Statements relating to assessment are:

In determining appropriate patterns of evidence for (Criterion 3: the accomplishment of educational purposes), the Commission considers evidence such as: . . . assessment of appropriate student academic achievement in all its programs, documenting:
proficiency in skills and competencies essential for all college-educated adults;
completion of an identifiable and coherent undergraduate level general education component;
mastery of the level of knowledge appropriate to the degree granted.
control by the institution's faculty of evaluation of student learning and granting of academic credit.

In determining appropriate patterns of evidence for (Criterion 4: continued accomplishment of educational purposes), the Commission considers evidence such as: . . . structured assessment processes that are continuous, that involve a variety of institutional constituencies, and that provide meaningful and useful information to the planning processes as well as to students, faculty, and administration.[x]

In addition to the NAIT and NCA the state legislature, the State Coordinating Board for Higher Education and the university administration all encourage verifiable assessment tools.

Materials and Methods

Contract between Enable Technologies, Inc., SMSU.
SMSU contracted with Enable Technologies, Inc. to run a pilot assessment program using the EnableOA software. The university paid $250 for a temporary software license. Enable Technologies, acting as an Application Service Provider, established application Web sites for SMSU on the Enable Technologies Web server; thus, the institution did not need to buy hardware or software. The cost to implement EnableOA permanently depends on the size of the institution and the number of services that are desired. Costs for a full implementation would include the up-front cost of the software, consulting and instructor training, infrastructure elements, software maintenance, hardware upgrades as well as the cost of assessment administration.

Data Import
SMSU provided Enable Technologies with a spreadsheet containing the names of the courses and instructors and rosters of students participating in the pilot. Enable imported this information into the software in order to establish accounts for all the involved students and instructors. The eleven educational outcomes defined by ABET ET2K were also entered into the software. SMSU 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.

Instructor Intentions
Dr. William Drake from SMSU composed Instructor Intentions for two courses, TEC 110 and TEC 250 in the fall with the help of Dr. Walcerz. In the spring TEC 267 and TEC 437 Intentions were added independently. He and Dr. Walcerz discussed the objectives that were intended for the students taking the course, and compared them with the TAC-ABET standards shown above. This exercise alone was found to be very useful. This process exposed intended outcomes that had not been well formulated and it also indicated that the course content was much broader scope than was initially perceived.

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 standard *1." 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 is addressed by this same standard. Working in small groups to check each other's drawings before final submission was also encouraged standard *5. Function effectively in teams.*

The TEC 250 – Industrial Safety course addressed some standards that were significantly different from those of the Engineering Graphics course. In one instance we were 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 we learned that there the method for transferring concrete is significantly different than the concrete pumps we find so familiar in the United States. In their construction practice women were engaged to move concrete. They carried the concrete up ladders balanced, in baskets, on their heads. This addressed the ET2K standard; *8. 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 standard *7. communicate effectively* as well as *5*. Communication with Blackboard software and associated e-mail techniques gave another example of *1. . . . mastering modern tools of their disciplines.*

The process of working through course objectives and comparing them to the outcomes standards gave a much better appreciation of how the objective fit into the overall scheme of providing, in our campus vernacular, "an educated person." The process of developing these objectives and associating them with the ET2K standards initially took about one hour for each course. This involved reviewing the course syllabus and text to identify what reasonable outcome objectives might be, composing those instructor intended outcomes (word processing software recommended) and pasting outcomes into the Enable software. The ET2K standards were utilized due to availability and the fact that they addressed the learning outcomes critical to any Technology program.

Collecting Student Data

The assessment software was presented to students in two different ways. The TEC 110 class, was a combination lab/lecture format, this allowed presentation to students 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 making entries. Further efforts are being made at the time of submission of this document to see if we can determine why student input was less than expected. Follow up efforts at the beginning of the spring 2001 semester yielded no new insight.

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 Enable OA "Help" process was easy to follow. However, again, 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 a common last step, the *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. A follow-up survey of those participating students at the beginning of the Spring 2001 yielded no additional insight.

Results

Difficulty of Learning the Assessment Process for Instructors and Students

At SMSU we found the processes of developing instructor intentions to be a relatively easy process working with the EnableOA consultant, 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 outcome 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. The process does provide data which, if acted on, can be used for program improvement.

Student Participation in the Assessment Process
A total of 37 students in two courses were encouraged to participate in the assessment process, and 17 of them did so by submitting from one to three experiences to their electronic portfolios. Fig. 1 shows participation broken down by course and number of experiences submitted. In general, about one third of the students did not participate at all, one half submitted a single experience, and one sixth submitted more than one experience. We suspect the lack of participation may be related to not picking on the "submit button" as entries were made.

Quality Analysis of Student Narratives
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 26 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. For example:

> "On October 26, 2000, the class to a trip to the Paul Mueller plant and I got to observe first hand how companies like, Paul Mueller, follow safety and health procedures on the job. So with this trip it gave me a understanding on what should be done in order to keep the company you work for safe, and this is what this class is all about understanding what it takes to keep the company you work for safe, so you don't have loss of work days,have to pay workerman's comp,hire a replacement for the days you are gone, and pay for overtime to catch up for the absents of a employee. You need to have a understanding of safety and health, on the job, or it could costs the company a lot of money in hidden costs. With the tour of the Paul Mueller, I saw a company with good safety procedures, in the employee's working environments, through out the company."

Moderate narratives were written in first person, didn't have enough detail, and sometimes included a collection or unrelated experiences. For example:

> "Recently we took a tour of a local manufacture. I thought the trip was a good idea and very informative. I It was well worth the time to do so. It would be great if more such trips were possible."

Poor narratives were either too short, e.g., a single 3-word phrase, or talked about what the student learned instead of what he or she did, e.g., "I feel that TEC 250 is a valuable course and all industrial technology majors should take it or something close to it. Safety should be a huge part in the industry, however it is not always a main priority. I think all managers should be trained in the safety arena."

An analysis of the students' narratives revealed 11 good quality narratives, 10 moderate narratives, and 4 poor narratives. Fig. 2 shows the quality analysis of student narratives broken down by course. There is a substantial variation in quality between courses; TEC 250 had a large number of good quality narratives. Note also that TEC 250 had more "non-traditional" students who were more apt to see this as something more than another academic exercise.

Student Discernment of Outcomes
For every experience a student submits, he or she must select the educational outcomes that are evident in the narrative. An analysis of the students' selections shows that a majority of students selected too many outcomes; in other words, students selected outcomes such as "an ability to function on teams" when their narrative contains no mention of teamwork at all. Fig. 3 shows the analysis by course. We believe this is consistent with the customary "mark sense" course evaluations where no active thought processes might be engaged.

Assessment Reports
The EnableOA software automatically generates assessment reports based on the descriptions of experiences that students and instructors submit. Figure 4 shows the percentage of students in TEC250 who submitted experiences for each of the eleven outcomes. According to the figure, the percentage of students who perceived and reported at least one significant educational experience demonstrating "an ability to communicate effectively" and "an ability to function on teams" and "an understanding of professional, ethical and social responsibility" and "an ability to identify, analyze, and solve technical

problems" was 53%, 42%, 42%, and 37% respectively. If we only consider the students who participated in the assessment process, the percentages are 77%, 62%, 62%, and 54%. If the quality of the student narratives was moderate or good, and the students were able to select appropriate outcomes, then this graph provides patently clear evidence that TEC250 is developing those four outcomes to a substantial degree, as well as other outcomes to a lesser degree. The software allows an instructor to "drill into" any of the outcomes to read the student narratives, review the selected outcomes, view attached documents, and thus check the validity of each bar in the graph. As discussed previously, the quality of narratives in TEC250 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.

Figure 5 shows a standard matrix of technology courses vs. the outcomes they are designed to develop. Across the top of the matrix are the eleven educational outcomes. Down the first column are all of the technology courses offered at SMSU. (In this case, only the two courses in the fall study are listed.) The cells of the matrix are either blank, which means that the instructor does not intend to develop the associated outcome in that course, or else a 100%, which means that all of the students in the associated course have an instructor intending to develop the associated outcome. 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% in the cell associated with Teamwork and the course.

Comparing Fig. 4, which shows experiences submitted by students, with Fig. 5, which shows experiences intended by the instructor, it is clear that the instructor's intentions are being fulfilled with respect to the outcomes relating to Teamwork, Communication, and Professional Responsibility. The instructor's intentions are partially fulfilled with respect to outcomes relating to Knowledge and Tools, and Commitment to Quality. The intended outcomes of Global Issues and Lifelong Learning are not being well met. It is interesting to see that a large percentage of students reported developing Problem Solving, when this was not an intended outcome of the course. This initial analysis must be tempered by the knowledge most students selected extraneous outcomes, so "drilling into" the bars in Fig. 4 is necessary to verify the results. Graphs and matrices similar to Figs. 4 & 5 are available for the other course in the pilot, but are omitted because they are similar.

Discussion

This study conducted a pilot implementation of the EanbleOA assessment process in order to:

- qualitatively measure the difficulty of learning the assessment process for instructors and students,
- quantitatively measure the level of participation of students,
- qualitatively measure the quality of the descriptions of educational experiences that are submitted by students,
- qualitatively measure the ability of students to categorize their experiences according to educational outcomes, and
- qualitatively measure the usefulness of the assessment process and reports.

Difficulty of Learning the Assessment Process

The instructor who learned the process for the first time for this study reported that the software was relatively easy to utilize, with the support of Dr. Walcerz, in developing instructor intentions. The process of developing those outcomes also provided some new insight about the intended accomplishments of the courses. The initial reaction was; "I am potentially accomplishing much more with this course than I had previously considered." Bringing the students into the process was relatively easy and met with no expressed resentment or resistance on the part of students. There was some disappointment in the number and quality of responses by students. This indicates that students will need to be prompted more effectively to participate in utilization of the software. A follow up e-mail has been sent to students asking them to check the software portfolio and determine whether they want to make additional entries. Results of this extra effort were disappointing. No additional student input was obtained.

Student Participation
Student participation in the assessment process was about 65% overall. That is disappointing and, as mentioned earlier, requires some further inquiry. Since the classroom indications were that everyone had participated we need to know if the "Submit" button is the cause of the apparent lack of submissions. It is also apparent, from the submissions that were made that better preparation for the students is necessary. Feedback after the initial submissions was given by email but was not individualized. The relative maturity of the TEC 250 students is believed to be a factor in their better quality responses. Instruction by email and out of class participation appears to have been as effective if not more so that having an initial in-class activity.

Quality of Student Narratives
The quality of the descriptions that were submitted by students in TEC250 was quite good, probably due to the same reasons that the level of participation was high, i.e., mature students. The quality in TEC110 was relatively low, perhaps because the students were freshmen and relatively immature in there ability to respond to this "academic exercise."

Selecting Outcomes
The pilot study shows that when students first learn to use the assessment process they are largely unable to limit the selection of outcomes for a given educational experience. In both courses, about 70% of the submitted narratives had extraneous outcomes, which resulted in an over-reporting of educational outcomes for both courses. This also means that in the students' own electronic portfolios, there are reports of educational experiences with extraneous outcomes. 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 be reduced.

Usefulness of the Process and Reports
The usefulness of the process and reports must be evaluated from the perspective of accreditation as well as operations. The process clearly disseminates the desired educational outcomes to both instructors and students and involves both in reflecting on educational experiences and the relationship of the experiences to outcomes. The process clearly collects evidence of student achievement in the form of narrative descriptions of educational experiences plus copies of actual student work, and stores the evidence in a database categorized by course, outcome, and a variety of student demographics to allow practical data analysis. The process also clearly has the potential of engaging students in a cognitive process for course evaluation. This as opposed to the traditional mark sense sheet given near semester end.

The initial implementation of the process demonstrated substantial buy-in from students and that students could learn and actively participate in the process after being introduced to it in a single class session or, in one case, from a single e-mail notice. The reports provide near real-time feedback to instructors and allowed comparisons between the outcomes they intend to develop and the ones the students believe they were developing. (The process and software includes the ability to document changes to courses in response to outcomes analysis; however, since this was a one-term study, the use of this feature was not practical.) A review of accreditation agencies' requirements for assessment, as provided in the Background of this paper, shows that the EnableOA assessment process can substantially satisfy them. This is not to say that the EnableOA process as described in this paper is a complete answer to outcomes assessment; it is widely accepted that multiple tools are necessary for adequate outcomes assessment. However, the EnableOA process can play a major role in an assessment program because of its comprehensiveness. From an operations standpoint, i.e., usefulness to instructors in the planning and improvement of their courses,the results motivated practical changes in the courses. 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 which gave some insight into efforts necessary to insure language does not prove preferential.

The ability to see what was happening at mid term is most intriguing. This "real time" access to student perceptions allows adjustments with current students. This is preferable to having input that can only be

applied to the next group of students. The fact that student have to be cognitively involved with this process also provides much better insight into evaluations.

The usefulness of the assessment process and the reports for curricular planning from a departmental or institutional perspective were not examined in this paper because the pilot study only involved two courses, and that was not sufficient for departmental or institutional analysis. However, it seems likely that the reports that are shown in Figures 4 & 5, when available for full degree programs or entire institutions, would provide important information about the educational effectiveness of a department or institution.

Conclusions

The software and process were straightforward to learn and use for both the instructor and students. Student participation and the quality of student submissions were acceptable but not as good as would be desired. Reports provide meaningful feedback and can be used to document the continuous improvement process for accreditation purposes. The process does not require an excessive time commitment on the part of the instructor. Students can access the software at their convenience.
The effort that is required to set up the EnableOA program provides new insight into the educational process. That insight into the way that activities engage students and address outcomes provides new opportunity by emphasizing areas where improvements can be made. The pilot project is continuing in the spring semester with two additional courses. Greater efforts to encourage student participation will be crucial to the success of this process.

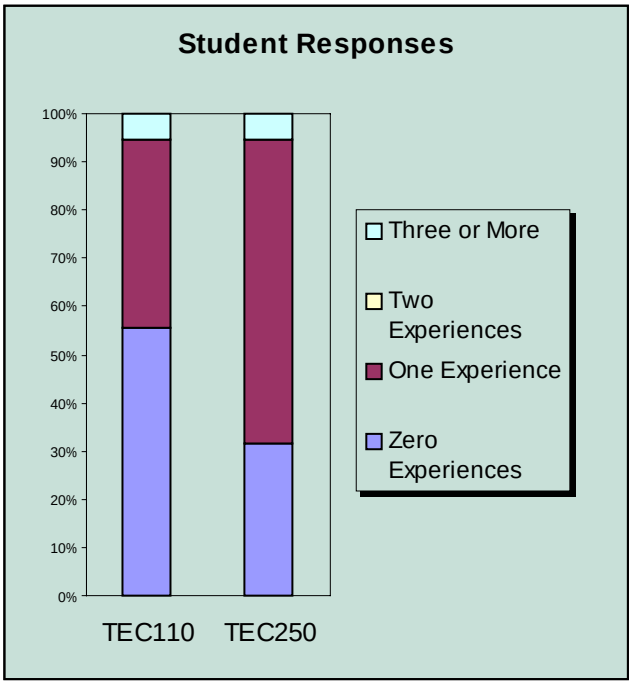

Figure 1: Student participation in the assessment process. The percentage of students who submitted at least one experience in TEC110, TEC250 was 44%, 68% respectively.

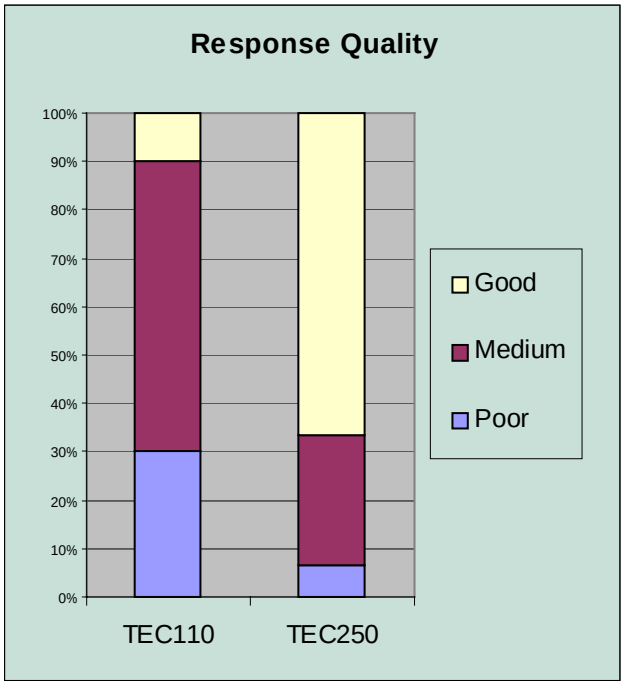

Figure 2: Quality of student narratives broken down by course. The percentage of moderate and good quality narratives in TEC110, TEC250, ETE310 & ETE401 is 70%, 93%, 81% and 43% respectively.

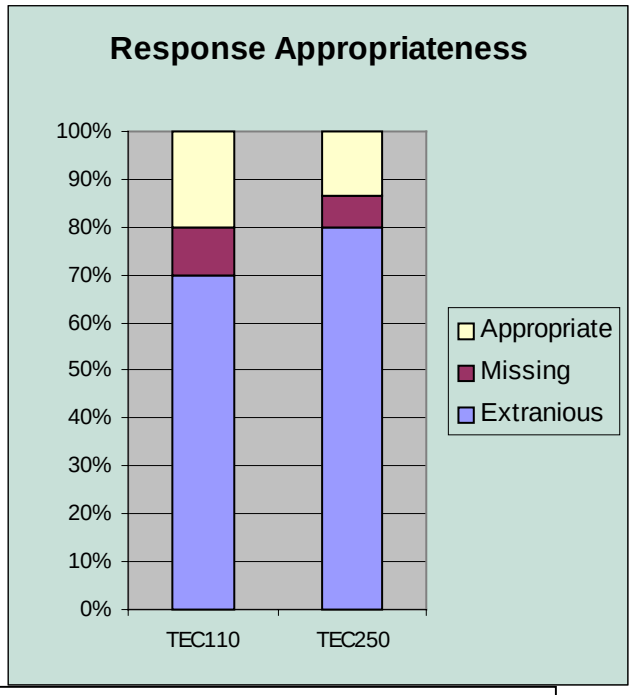

Figure 3: The appropriateness of students' selection of educational outcomes. Students selected extraneous outcomes for approximately 70% of all narratives.

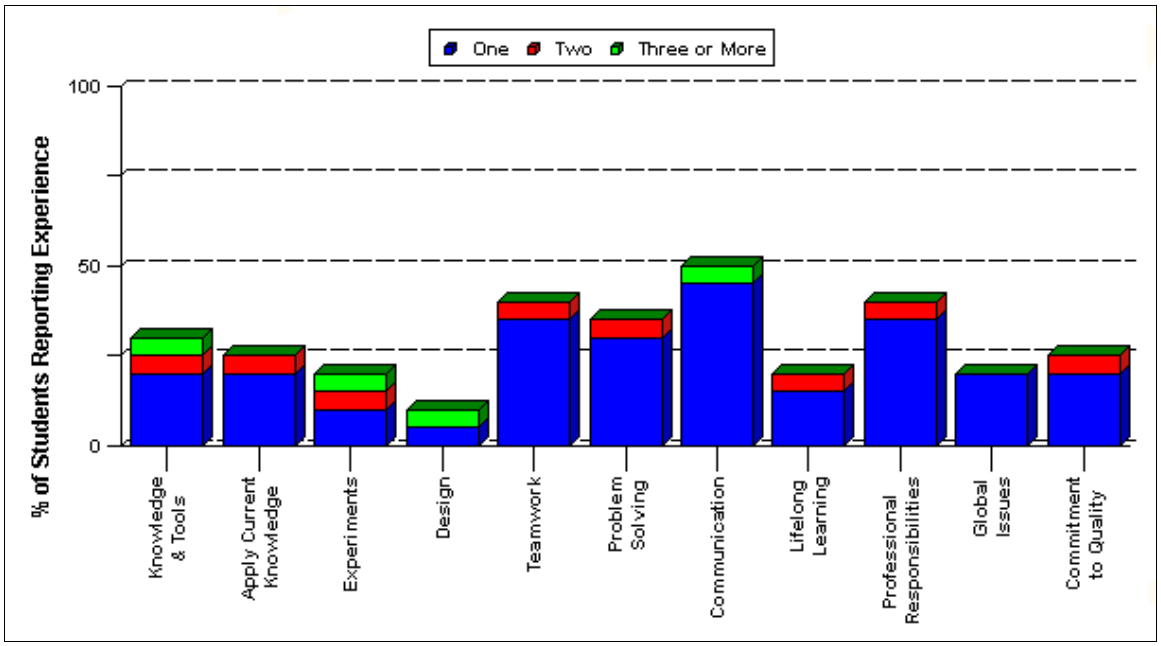

Figure 4: Percentage of students in TEC250 who submitted experiences demonstrating ET2K educational outcomes. The different shades of the stacked bars show the percentage of students submitting one, two, or three or more experiences, as defined in the legend at the top of the figure.

	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 5: Matrix of technology courses vs. ET2K educational outcomes. The Industrial Safety course, TEC250, is intended to develop 6 outcomes, including "an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines" and "an ability to function effectively on teams" and "an ability to communicate effectively" and "a recognition of the need for and the ability to pursue lifelong learning" and "an understanding of professional, ethical, and social responsibilities" and "a recognition of contemporary professional, societal, and global issues and an awareness of and respect for diversity"

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William H. Drake is an Associate Professor of Technology at Southwest Missouri State University. Dr. Drake received a B.S. in Technology and a Master of Education at the University of Houston in 1976 and 1978 respectively and a Ph.D. in Industrial Education from Texas A&M University in 1983. He is a Certified by the Manufacturing Engineering Certification Institute and is a Distinguished Member of the American Welding Society.

Douglas Walcerz is an Associate Professor of Mechanical Engineering at York College of Pennsylvania and Vice President of Enable Technologies, Inc. Dr. Walcerz received a B.S. in Mechanical Engineering from Purdue in 1983, and an M.S. in Mechanical Engineering and a Ph.D. in Biomedical Engineering 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.