Outcomes Assessment: A Pilot Study

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Web-Based Continuous Outcomes Assessment: A Pilot Study

Outcomes assessment and continuous improvement are essential elements of educational programs. Emphasis on assessment is based primarily upon the requirements of accrediting agencies, but also on the perceived value of assessment in satisfying the demands for accountability in an increasingly competitive environment. Educational research has shown that measurement of educational outcomes can be used to inform an institution about educational goals that are being satisfied and those that are not. This information can motivate and direct efforts to improve curricula.

In practice, the measurement of educational outcomes is challenging and can be expensive. Results are often ambiguous or statistically unsound. The positive impact of continuous improvement on the curriculum is difficult to prove (Allen, Noel, & Rienzi, 2000). Despite the difficulties and expense, accrediting groups and other agencies have mandated outcome assessment and continuous improvement. Of special note are new criteria by the Accreditation Board for Engineering and Technology (ABET). The new criteria rely

extensively on outcome assessment for accreditation, and there is a need for efficient and effective assessment processes to satisfy these requirements. These same outcomes are also applicable to many other programs, including those accredited by the National Association for Industrial Technology (NAIT), North Central Association of Colleges and Schools (NCA), and other accrediting groups. This article describes a pilot study of the implementation of a Web-based (TrueOutcomes©) assessment process in a 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.

We qualitatively measured the following:

- Difficulty of learning the assessment process for instructors and students.
- Quality of the descriptions of educational experiences submitted by students.
- Ability of students to categorize their experiences according to educational outcomes.
- Usefulness and appropriateness of the assessment process and reports.

We quantitatively measured the level of participation of those students who participated.

TrueOutcomes (formerly 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*, an online publication by the American Association for Higher Education (AAHE, n.d.), and the *Program Evaluation Standards* developed by The Joint Committee on Standards for Educational Evaluation (1994).

The TrueOutcomes process (Walcerz, 1999a, 1999b) collects both descriptions of educational experiences that instructors intend for their students and descriptions of educational experiences that students perceive they have received from their instructional experiences. Instructors prepare the former and students develop the latter. Every outcome description is associated with one or more of the educational outcomes developed by the instructor. 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 support their descriptions. The outcome descriptions submitted by instructors are used to generate a matrix of coursework vs. educational outcomes that can be used in curriculum planning and evaluation. The descriptions that are submitted by students serve two primary purposes:

1. 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.
2. The descriptions are aggregated for a specific course or set of courses to see if students perceive and report the instructor's intended educational outcomes.

The Department of Industrial Management at Southwest Missouri State University (SMSU) offers a baccalaureate degree in industrial management (IM) with concentrations in construction and manufacturing management. The IM program enrolls about 300 students. The fall 2000 pilot study was conducted in two courses: Fundamentals of Engineering Drafting (TEC 110) and Industrial Safety (TEC 250). In the spring 2001, courses in Statics and Materials Testing were also piloted.

TEC 110 is a typical freshman-level drafting course in which CAD skills, sketching skills, and orthographic and isometric drawing techniques are practiced. TEC 250 is a sophomore-level course that meets one evening each week for three hours and is populated mainly by young adults with full-time jobs. The course emphasizes management of occupational safety programs.

Three accrediting agencies were associated with this study. Two directly impact SMSU and the third was included because of its impact on the development and application of the software.

Those agencies and their impact are briefly described here.

NAIT accredits the SMSU industrial technology program and has the following requirements with respect to assessment that are taken from the industrial technology accreditation handbook:

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. (NAIT, 2000, §§ 5.16 & 6.16)

NCA accredits SMSU as an institution and defines five criteria for accreditation and patterns of evidence to demonstrate the criteria. Statements relating to assessment are:

Criterion 3: The institution is accomplishing its educational and other purposes.

In determining appropriate patterns of evidence for this criterion, 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; 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.

Criterion 4: The institution can continue to accomplish its purposes and strengthen its educational effectiveness. In determining appropriate patterns of evidence for this criterion, 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. (NCA, 2000, p. 9)

ABET has the following requirements with respect to assessment taken from criteria for accrediting engineering technology:

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. (ABET, 2000, Criteria 1 & 6)

ABET developed and has introduced the following objectives as a part of Engineering Technology Criteria 2000 (ET2K). We believe that these objectives are compatible with the NAIT accreditation requirements. Since these outcomes were already developed and ready for use, they were adopted for this pilot study. The ABET objectives for graduates are:

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.

11. Have a commitment to quality, timeliness, and continuous improvement. (ABET, 2002)

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

Implementation

Outcomes Assessment Solutions (formerly Enable Technologies), an application service provider, established an application Web site for SMSU on their Web server. Therefore, the institution did not need to buy hardware or software. Outcomes Assessment Solutions was provided with a spreadsheet containing the names of the courses, the instructor, and rosters of students participating in the pilot study. They then imported this information into the software to establish accounts for all the involved students and the instructor. The 11 pre-existing educational outcomes defined by ABET ET2K were also entered into the software.

Instructor intentions were composed for the fall courses, in consultation with Dr. Walcerz, the service provider representative. In the spring course, intentions were added independently by the instructor. The objectives intended for the students taking the courses were compared with the previously listed ABET-TAC standards. This exercise was found to be helpful in better defining course objectives. This process exposed intended outcomes that had not been well formulated and also revealed that course content was much broader in scope than was initially perceived.

Examples include:

- Intended outcome: Students will learn to utilize computer aided design (CAD) software. This matches Outcome 1: "Demonstrate an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines."
- Intended outcome: Students will develop sketching skills, which addresses this same standard.
- Intended outcome: Students will work in small groups to check each other's drawings before final submission. This matches Outcome 5: "Function effectively in teams."

The lack of submissions for last outcome emphasized that specific instruction in team building is needed for teamwork to be an outcome.

TEC 250, the industrial safety course, addressed different standards. 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 in India. We learned from her that their method for transferring concrete is significantly different than the concrete pumps we now find so familiar in the United States. In India women were engaged to transfer concrete by climbing ladders carrying the concrete, balanced in baskets, on their heads. This unintended consequence addressed the ET2K Outcome 8: "Recognize contemporary professional, societal, and global issues and are aware of and respect diversity."

Working in groups to develop reports and requiring many brief written reaction papers addresses Outcome 7, "Communicate effectively," as well as Outcome 5, "Function effectively on teams." Communication with Blackboard software and associated e-mail techniques is another example accomplishing Outcome 1, "Mastering modern tools of their disciplines."

The process of working through course objectives and comparing them to the outcomes yielded a much better appreciation of how the objectives fit into the overall scheme of developing, to use the campus vernacular, "an edu-

cated person." The process of formulating 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(s) to identify what reasonable outcome objectives might be, creating instructor intended outcomes (word processing software recommended), and copying outcomes into the TrueOutcomes software.

Collecting Student Data

We presented the assessment software to students in two different ways. Because the TEC 110 class is a combination lab/lecture format, we were able to present the software 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 TrueOutcomes software. The students reported that these instructions were easy to follow and, after reading the introductory material, proceeded to make entries. Later analysis revealed that they were not all successful in making entries.

The same instructions used for TEC 110 were distributed to the TEC 250 class via e-mail and the Internet using Blackboard software. Later discussion with an informal sampling of students indicated that the TrueOutcomes "Help" process was easy to follow. However, analysis with the software indicated that only a little over 50% of the students successfully submitted entries. Speculation is that some students had failed to complete the submission process by missing a common last step . . . clicking the Submit Button.

Student Participation in the Assessment Process

A total of 37 students participated in the fall assessment process in two courses. Seventeen students submitted from one to three experiences to their electronic portfolios. In the software a color bar chart, Student Responses, provides data on student participation and indicates the percentage of students submitting experiences as well as the number submitted. In general, about one third of the students did not participate at all; one half submitted a single experience, and one sixth submitted multiple experiences. The apparent lack of participation may have been related to not clicking on the

Submit Button as entries were made. This theory is reinforced by the observation that the TEC 110 students who were observed in a lab exercise had lower overall participation than the TEC 250 class.

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. This cognitive engagement in the evaluation process is one of the most valuable attributes of this assessment system. A total of 26 narratives were submitted in the fall and 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. An example:

> . . . a trip to the . . . plant and I got to observe first hand . . . safety and health procedures on the job. . . . this trip it gave me a[n] 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 lost work days, have to pay workerman's [sic]comp, hire a replacement . . . and pay for overtime to catch up for the absents [sic] of a[n] employee. You need to have an understanding of safety and health, on the job, or it could cost the company a lot of money in hidden costs. With the tour . . . I saw a company with good safety procedures, in the employee's working environments . . .

Moderate narratives were written in first person, did not have enough detail, and sometimes included a collection of unrelated experiences. For example:

> Recently we took a tour of a local manufacture[r]. I thought the trip was a good idea and very informative. I It [sic] 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. Example:

> 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. The quality analysis of student narratives showed a substantial variation in quality between courses: TEC 250 had nearly 70% good quality narratives, while the TEC 110 class had nearly 70% medium to poor narratives. TEC 250 had more nontraditional students; therefore, student maturity would be expected to influence narrative quality. The software also provides a graphical display of the quality analysis.

For every experience students submitted, they selected the educational outcome that reflected their individual narrative. Our analysis showed 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 contained no mention of teamwork at all. A graphic showing Response Appropriateness is also provided. We found nearly 70% selected extraneous outcomes. Clearly more training in the use of the system is indicated. We believe this is consistent with the customary "mark sense" course evaluations where no active thought processes might be engaged. The cognitive engagement potential made available with this system could clearly provide some benefit in assessment.

The TrueOutcomes software automatically generates assessment reports based on the descriptions of experiences that students and instructors submit. A bar-chart presentation is available showing the percentage of students submitting experiences related to each of the 11 outcomes and the number of experiences related to that outcome. According to the data analysis, the percentage of students who perceived and reported at least one significant educational

experience demonstrating "an ability to communicate effectively," "an ability to function on teams," "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%, respectively. If the quality of the student narratives was moderate or good and the students were able to select appropriate outcomes, then it is patently clear evidence that TEC 250 is developing those four outcomes to a substantial degree and other outcomes to a lesser degree.

The software also allows an instructor to "drill into" any of the outcomes to read the student narratives, review the selected outcomes, view attached documents, and thus to check the validity of the data. As discussed previously, the quality of narratives in TEC 250 was quite good, but the selection of outcomes often included more than the narrative justified. However, the raw evidence, the student narratives and attached documentation, is available to the instructor for assessment purposes.

A standard matrix of technology courses vs. the outcomes they are designed to develop is also available. Across the top of the matrix are the 11 educational outcomes. Down the first column are listed all of the technology courses offered. 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. TrueOutcomes uses percentages instead of the more common "Xs" 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, TrueOutcomes will report 60% in the cell associated with teamwork and that course.

When comparing experiences submitted by

students with experiences intended by the instructor, it was clear that the instructor's intentions were fulfilled with respect to the outcomes relating to teamwork, communication, and professional responsibility. The instructor's intentions were partially fulfilled with respect to outcomes relating to knowledge and tools, and commitment to quality. The intended outcomes of global issues and lifelong learning were 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 that most students selected extraneous outcomes, so "drilling into" the reported experiences will be necessary to verify the results until students become more familiar with the process.

The ability to see what was happening as the term progresses is most intriguing. This "real time" access to student perceptions allows adjustments with current students as opposed to the standard end of term evaluation. This is preferable to having input that can only be applied to the next group of students. The fact that students have to be cognitively involved with this process also provides much better insight into evaluations.

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 desired. Analytical 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 in addition to the creation of a portfolio of personal achievements that may be of value in future endeavors.

The effort required to set up the TrueOutcomes program is balanced by the provision of in-depth 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.

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References

Accreditation Board for Engineering and Technology ,Technology Accreditation Commission. (2000). *Criteria for accrediting engineering technology programs.* Retrieved April 2002 from http://www.abet.org/downloads/2000-01_Engineering_Technology_Criteria.pdf (No longer available from this Web Site; http://www.abet.org/criteria.html shows current TAC criteria.)

Allen, M. J., Noel, R. C., & Rienzi, B. M. (Eds.). (2000). *PACT outcomes assessment handbook.* Bakersfield: California State University, Program Assessment Consultation Team.

American Association for Higher Education. (April, 2002). *Principles of good practice for assessing student learning.* Retrieved April 2002 from http://www.aahe.org/assessment/principl.htm

The Joint Committee on Standards for Educational Evaluation. (1994). *The program evaluation standards.* Thousand Oaks, CA: Sage.

National Association of Industrial Technology. (2000). *Industrial technology accreditation handbook.* Retrieved April 2002 from http://www.nait.org/accred/accreditationhandbook.html#1

North Central Association of Colleges and Schools. (2000). *The criteria for accreditation.* Retrieved April 2002 from http://www.ncacihe.org/overview/2001HLCOverview.pdf

Walcerz, D. B. (1999a). *EnableOA: A software-driven outcomes assessment process consistent with the principles of good practice for assessing student learning.* Paper presented at the American Society for Engineering Education Mid-Atlantic Conference. Retrieved April 2002 from http:www.trueoutcomes.com/ASEE%20Monmouth.pdf

Walcerz, D. B. (1999b). *A new, time-efficient, high quality outcomes assessment process.* Paper presented at the American Society for Engineering Education North Central Conference. Retrieved April 2002 from http://www.trueoutcomes.com/ASEE-Erie%204.9.99.pdf