"Getting from Anecdotal to Measured Outcomes Assessment for Out of Class Experiences"

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Abstract

It has been said that internships, co-ops, involvement in student organizations, and international experiences add value to engineering students' education. Industry representatives send a clear message that grade point average is not the only thing considered when making hiring decisions. Can the value of such activities on the educational experience be measured? The Biological Systems Engineering Department and the Student Programs staff in the College of Engineering & Technology at the University of Nebraska-Lincoln are developing methods to get from anecdotal information to tangible, measurable outcomes. The process is being guided by: i) ABET program outcomes (A-K)[1]; ii) the need for "quantitative" information; iii) ease of access to students in time and place; iv) a goal of having an effective and efficient process for obtaining and interpreting results and; v) the desire to measure outcomes longitudinally.

To accomplish this task, several surveys have been developed for completion by students through various stages of their engineering education. The surveys focus: a) "work"-related experiences; b) international experiences; c) academic advising; d) involvement in student organizations; and e) post-graduate placement. The goal is to get the right survey to the right student, at the right time. This paper discusses the process for developing the surveys, the means in which the data is collected, and preliminary results from over 400 students who took the "work"-related and international surveys in the fall of 2003.

Introduction

Faculty generally acknowledge that extra- and co-curricular activities are valuable to the overall learning and education of engineering students. Prior to ABET 2000, the nature and contributions of these activities were rarely, if ever, assessed. At best, anecdotal information was collected and analyzed in an ad hoc manner. Rarely was an effort made to formalize the collection and interpretation of such information. The implementation of ABET 2000 has caused engineering programs to rethink how academic performance is measured [2]. Trends in outcomes assessment point to the day when anecdotal information will no be longer satisfactory.

The strategy for outcomes assessment at the University of Nebraska-Lincoln (UNL) involves collection of a variety of information with which to discern performance of students. It is assumed that any one piece of information is incomplete or inconclusive, and does not reveal the full extent of achievement. Further, it is assumed that combining information collected from

different perspectives will reveal pertinent and accurate information about the achievement of our students.

Assessment instruments can be divided into those which provide direct versus indirect data. Direct data is of the type collected from student portfolios, standardized tests such as the FE exam, grades in specific courses, and so forth. Indirect data is of the type collected from surveys and other instruments. They provide supplemental information for outcomes and objectives assessment which, when combined with direct data, yield useful measures of the degree to which a program's outcomes and objectives are truly being achieved. The concept of combining direct and indirect sources of data to acquire a sense of the extent to which an outcome or objective is truly achieved is illustrated in Figure 1.

The Agricultural Engineering (AGEN) and Biological Systems Engineering (BSEN) Programs of the College of Engineering & Technology (CoET) at UNL have taken the lead in outcomes assessment in the college. They were accredited in 1999 under ABET 2000 criteria. These programs have been engaged in ongoing assessment and improvement of levels of achievement for its program outcomes and objectives. Part of AGEN and BSEN program assessment process has involved development of strategies for quantifying anecdotal data on the learning which may, or may not, have occurred through internships, co-op and part-time work experiences, international involvement, on-campus organizational activities and so forth. The purposes of this paper are to share information about the process of acquiring such data, and to illustrate the kind of data that can be developed for assessment purposes. Also, selected preliminary data is presented and initial interpretation of that data is provided.

Process

Developing the Surveys

In 2002, a plan to move from anecdotal to measured outcomes for out-of-classroom experiences was presented to the Deans of the CoET and the College of Agriculture and Natural Resources (AGEN and BSEN are jointly administered by the two colleges.) The plan called for acquiring indirect but measurable outcomes data through a series of targeted surveys. The surveys, parts of which had been administered in the past as periodic hard copy versions, were to be web-based and given to the "right student at the right time and the right place". The surveys were designed to maximize the efficiency of data management and interpretation.

Six surveys were identified as having value in providing information and feedback of use for measuring the level of achievement of ABET program objectives and outcomes: (1) "work"-related experiences, (2) international experiences, (3) involvement in student organizations, (4) advising, (5) exit interviews and (6) post-graduate experiences. Currently, each survey is in a different stage of implementation, the "work"-related and international surveys being the most advanced. All surveys contain a mixture of questions targeted at gaining insight and measures of student or alumni perceptions on various aspects of their out of class experiences. The unifying theme of the surveys is their connection to program objectives or outcomes. Each of the surveys, except the post-graduate survey is focused on assessing program outcomes. The post-graduate survey is the least developed of the tools and is targeted at program objectives.

The questions in the surveys were developed in such a way that they each relate to one or more of ABET's *A-K* outcomes. No survey produces data limited to a single outcome, instead, a few questions regarding a variety of outcomes are included on each survey. For example, six of the 46 questions asked on the "work"-related survey are targeted at Outcome *K* ("ability to use …. modern engineering tools ….."). Survey questions cover a broad range of topics such as understanding of computer-aided drafting, understanding of finance and economics in the work world, and the ability to manage time (see Appendix for other examples). The results of three questions, two related to outcome *D* (ability to function on teams) and one focused on Outcome *I* (recognition of the need for … life-long learning) are presented later in this paper.

Information for constructing the surveys was first gathered from various hard copy versions that existed in the CoET and a series of outcome-related questions was developed in a manner to be compatible with ABET Outcomes *A-K* and web-based administration. The surveys were then pilot-tested using a hard copy with a focus group of students. Feedback was then integrated into revised surveys and a second (and sometimes a third) focus group was used to further refine the surveys. Finally, the survey was converted to web-format and tested again with another focus group of students. Final revisions of the "work"-related experiences, and the international experience surveys were made in the summer of 2003 and implemented in the fall semester of 2003-04.

The implementation process has benefited greatly from the involvement of the Information Services Division at UNL <http://www.unl.edu/IS/>, which provides software and hardware support for providing a user-friendly, web-based data acquisition system.

Populating the database for each survey with demographic information (name, major, year in school, survey history, etc) is currently done by the students in the first part of each survey. In the future this will be achieved through UNL's Blackboard© (**Blackboard Inc**., all rights reserved). Upon logon to Blackboard, one click will link the "right survey at the right time to the right student." This strategy provides longitudinal assessment capability by storing student response data from previous years during their CoET matriculation. Thus, for example, data can be acquired which track students' changing (hopefully growing) "appreciation of the need for life-long learning" (Outcome *I*) as influenced by "work"-related experience, international experience, and so forth.

The concept of using disparate data, some of which comes from surveys such as these, to gain understanding of the 'truth' about a student's educational experience is depicted by the intersection of a variety of measurement instruments. It is assumed that any one piece of information is incomplete or inconclusive, and does not reveal the full extent of achievement. Further, it is assumed that combining information collected from different perspectives will reveal pertinent and accurate information about the achievement of students (see Figure 1).

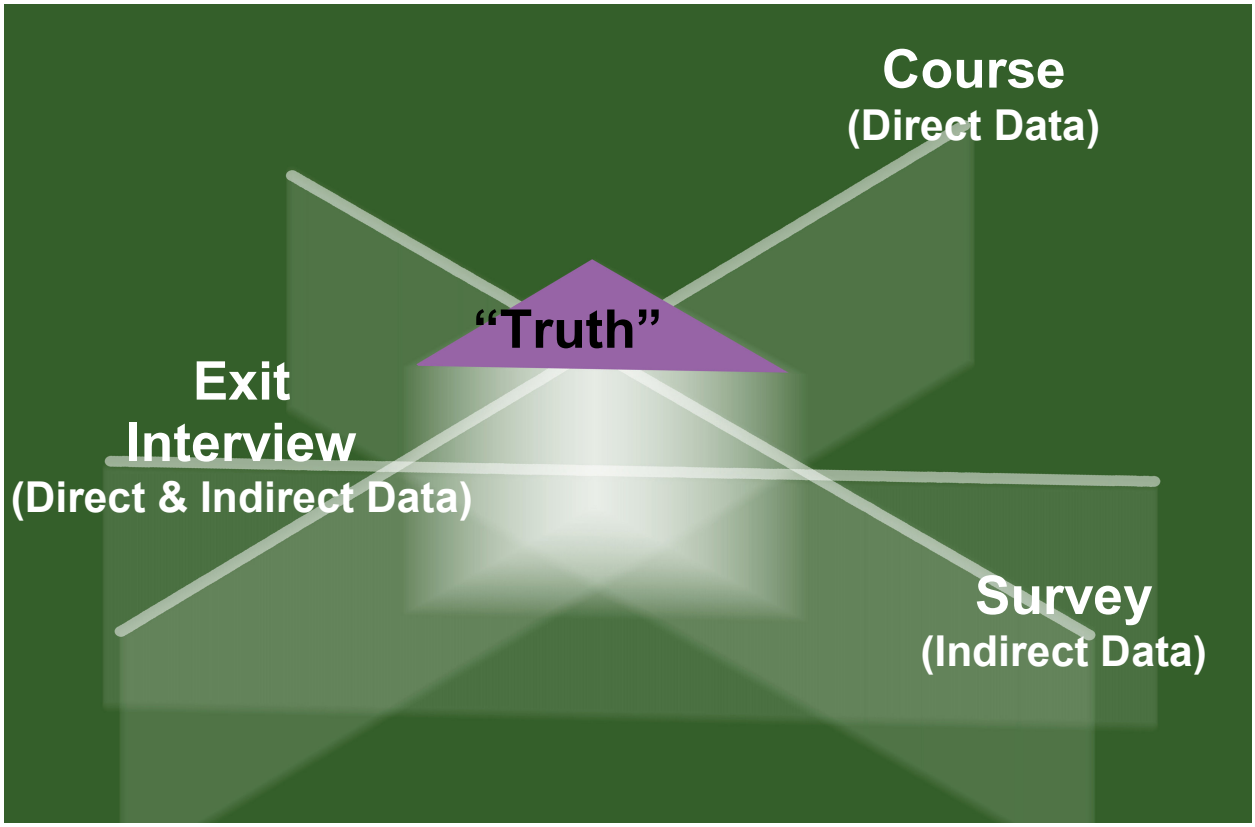

Figure 1. Conceptual representation for the use of several instruments to improve the reliability of outcomes measurements.

Collecting the Data

The surveys, parts of which had been administered in the past as periodic hard copy versions, are to be given to the "right student, at the right time, and at the right place." Three questions guided this process. When should we give these surveys? Where should we give these surveys? How can we assure students will take the surveys?

It was decided that the best time to give the "work"-related experiences survey would be at the beginning and end of each academic year (August and May) to capture the most recent experiences. International experience data would be captured at the beginning of each academic year to assess summer abroad experiences. Academic advising and involvement in student organizations data would be collected at the end of each academic year. Exit interviews would be conducted just prior to graduation.

"Where to give the surveys" was answered based on the assumption that web-based delivery was best so as to reduce in-class time requirements and to provide convenience for the students and faculty. The challenge of how to insure that students actually take the surveys was met by using CoET-required courses such as freshmen, sophomore and senior seminars, and required AGEN and BSEN courses. These seminars and course include the selected survey requirement on the syllabus assuring completion of the surveys at the "right times."

Results

This section provides a snapshot of the kind of data being acquired, but the project is very early in its evolution and conclusions at this time would be premature. The "work"-related and international surveys were conducted in the fall of 2003 on all freshmen and sophomores in the College of Engineering and Technology and on the juniors and seniors from the Agricultural and Biological Systems Engineering majors. Approximately 425 students took the surveys. "Work"-related was defined to include summer internship, part-time academic year or co-op experience, with internships and part-time work further defined as either engineering or non-engineering related, or of a research nature (see Appendix). International experience was defined as having been to a foreign country for either study abroad, employment, or personal travel.

Figure 2 represents the results from three questions on these surveys. Two questions (1 and 2 in Figure 2) were asked on both surveys while Question 3 was only present on the "work"-related survey. Question 1 asked whether "*humanities and social science electives were: 1 - of no importance, 2 - of minimal importance, 3 - important or 4 - of great importance, before and after their experience*". This question was intended to elicit student perception of "work"-related and international experiences supportive of ABET Outcome *H*, (broad education necessary to understand the impact of engineering solutions in a global and societal context). Question 2 asked whether in their opinion "*teamwork on the job" was: 1 - of no importance, 2 - of minimal importance, 3 - important or 4 - of great importance, before and after their experience*". Question 2 was targeted at ABET Outcome *D* (ability to function on teams) and was asked on both surveys.

As shown in Figure 2, the responses to Questions 1 and 2 indicate an increase importance given to the issues at hand from before, to after the "work"-related and international experiences. In the case of the "work"-related survey, where 148 to 161 of the 425 respondents had a "work"-related experience to report (the majority of respondents were 1st and 2nd-year students accounting for the large number of non-respondents). The mean response for all students increased from a 2.5 before to a 2.7 after (Question 1 – Outcome *H*) and from a 3.2 to 3.6 (Question 2 – Outcome D).

However, the increases shown in Figure 2 were not statistically significant at a probability level of 0.20, based on a paired comparison of means using the t-statistic. Few students (n = 14 to 16) had an international experience and this may have contributed a high variance to the responses to survey questions. However, relatively greater participation in internships (n = 142 to 161) failed to reduce variance sufficiently, and the increased importance given to the issues raised in Questions 1, 2 and 3 on the work survey were also not statistically different at the 0.20 probability level.

Question 3 was only asked on the "work"-related survey and was intended to obtain feedback on ABET Outcome *I* (recognition of the need for and an ability to engage in life-long learning). It asked whether, according to their experience, "*an understanding of education as a continuing process for professional growth and productivity was: 1 - of no importance, 2 - of minimal importance, 3 - important or 4 - of great importance, before and after their experience*". The

increase from a response level of 3.2 before to 3.5 after (Figure 2) was again not significantly statistically different.

In spite of the lack of statistical verification, the mean response to every question related to Outcomes D, H and I indicated a positive growth by students having work-related or international experiences. Thus, there appears to be evidence (beyond anecdotal information) that, in the eyes of students, such experiences increase the importance of a obtaining a broad education in understanding the impact of engineering in a global and scientific context (Outcome *H*); improve their ability to function on teams (Outcome *D*) and; enhance their recognition of the need for engagement in life-long learning (Outcome *I*). The data also show that, at UNL, dramatically fewer CoET students have an international experience than an experience which is "work"-related, a fact that is now being addressed with a new study abroad program in the college. Though not statistically proven, students did report that international experiences not only enhanced their attitude toward the importance of teamwork and the broad education needed in a global and societal context, but also may have increased their appreciation of the need for and an ability to engage in life-long learning.

Figure 2. Student perception of the impact of "work"-related and international experiences based on targeted survey questions. Rankings are: 1=No Importance, 2=Minimal Importance, 3=Important, 4=Great Importance. Thin bars represent one standard deviation in the data.

Summary

Faculty, generally understand and accept the notion that extra- and co-curricular activities are valuable to the overall learning and education of engineering students. But how do they really know the effect of these activities on the educational experience? The implementation of ABET 2000 has caused engineering programs to rethink how all aspects of academic performance is measured. The Biological Systems Engineering Department and the Student Programs staff in the College of Engineering & Technology at the University of Nebraska-Lincoln are developing a process with which to measure outcomes for out of class experiences. The process involves acquisition of indirect but measurable outcomes data through a series of targeted surveys. The unifying theme of the surveys is their connection to ABET program outcomes. Although conclusions cannot be drawn at this time, preliminary data analysis indicates that surveys, given to the right students, at the right time and place in their undergraduate experience, can provide useful information for getting from anecdotal to measured outcomes for assessment purposes.

References

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Biographical Information

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Dennis teaches graduate and undergraduate environmental engineering, nonpoint source pollution control, agricultural waste management as well as design in biological systems engineering. He has received several college and national teaching awards and is the Holling Family Distinguished Engineering Educator in the College of Engineering & Technology. He has a BS in Agricultural Engineering from the University of Nebraska and an MS and PhD from Cornell University.

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David teaches graduate and undergraduate courses in engineering design and problem solving, biological transport processes, and mathematical modeling of biological systems. He has received several college and national teaching awards and received the Holling Family Master Teacher Award in the College of Engineering & Technology. He has a BS and MS in Agricultural Engineering from Texas A&M University and PhD from Oklahoma State University.

Ann Koopmann, MA
Ann is Director of College Relations/Student Programs in the College of Engineering & Technology. She teaches the freshmen and sophomore seminar courses, which focus on college acclimation and career planning. She plans major recruitment and outreach events, and oversees the College's Cooperative Education program. She has a BA in Communication and a MA in Educational Psychology from the University of Nebraska.

Beth Tieszen
Beth is a senior Biological Systems Engineering and Biochemistry double major from Canistota, South Dakota. She is involved on campus in the Cornhusker Marching Band, Society of Women Engineers and the Biomedical Engineering Society.

Appendix

Sample of Questions From "Work"-Related Experiences Survey (eleven of 46 questions are shown here). Thirty five questions are used in the International Survey.

Section I: Preliminary Questions:

Name:

Student ID number:

Major:

My current class standing is

Section II: Experience

For clarity the following definitions apply:
Internship: a full-time summer or part-time academic year experience
Co-op: taking off a semester and a summer during the academic year and working full-time in an engineering environment
Research: experience on or off campus in a research role
Non-engineering: experience not related to engineering
No Work Experience: classes, vacation, study abroad, etc.

My experience (other than classes) was/is: (check the one that best applies).

a summer internship

engineering work non-engineering work engineering research non-engineering research

a part-time academic year

engineering work non-engineering work engineering research non-engineering research

a co-op

no work experience

Compensation for the work experience

This was a paid experience.

This was a non-paid experience.

I received academic credit toward my major for this experience.

Section III
Please respond to the following question regarding the impact of your experience by *comparing your knowledge and appreciation of the various topics before and after your experience.*

Understanding and Appreciation of Science, Engineering and Related Issues

Use the following scale: 0=no understanding 1=not enough 2=enough 3=more than enough NA=Not applicable

Understanding of engineering statics

before my experience	0 ☐	1 ☐	2 ☐	3 ☐	NA ☐
after my experience	0 ☐	1 ☐	2 ☐	3 ☐	NA ☐

Understanding of engineering dynamics

before my experience	0 ☐	1 ☐	2 ☐	3 ☐	NA ☐
after my experience	0 ☐	1 ☐	2 ☐	3 ☐	NA ☐

Development of your abilities

Use the following scale: 0=no understanding 1=not enough 3=enough 3=more than enough NA=Not applicable

Ability to use computers for problem solving

before my experience	0 ☐	1 ☐	2 ☐	3 ☐	NA ☐
after my experience	0 ☐	1 ☐	2 ☐	3 ☐	NA ☐

Ability to analyze and interpret data

before my experience	0 ☐	1 ☐	2 ☐	3 ☐	NA ☐
after my experience	0 ☐	1 ☐	2 ☐	3 ☐	NA ☐

Ability to manage a project

before my experience	0 ☐	1 ☐	2 ☐	3 ☐	NA ☐
after my experience	0 ☐	1 ☐	2 ☐	3 ☐	NA ☐

Appreciation and Sensitivity to Other Issues

The following questions deal with aspects of your education not specifically covered in engineering curricula.

Complete each statement below using <u>the following scale and statement: Rate each one before and after your</u> experience: 0=no importance 1=minimal importance 2=important 3=great importance NA=Not applicable

I think...

Multi-disciplinary teams (e.g. between engineering and disciplines like business administration, chemistry, etc.) are (of)

before my experience	0☐	1☐	2☐	3☐	NA☐
after my experience	0☐	1☐	2☐	3☐	NA☐

Teamwork on the job is (of)

before my experience	0☐	1☐	2☐	3☐	NA☐
after my experience	0☐	1☐	2☐	3☐	NA☐

An appreciation of family and/or social commitments is (of)

before my experience	0☐	1☐	2☐	3☐	NA☐
after my experience	0☐	1☐	2☐	3☐	NA☐

An understanding of professionalism is (of)

before my experience	0☐	1☐	2☐	3☐	NA☐
after my experience	0☐	1☐	2☐	3☐	NA☐

An understanding of the importance of business and economics in the work world is (of)

before my experience	0☐	1☐	2☐	3☐	NA☐
after my experience	0☐	1☐	2☐	3☐	NA☐

An understanding of education as a continuing process for professional growth and productivity is (of)

before my experience	0☐	1☐	2☐	3☐	NA☐
after my experience	0☐	1☐	2☐	3☐	NA☐