Assessment of Engineering Educational Outcomes through Student Portfolios

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Introduction

Student portfolios have assumed increasing importance in engineering educational program outcomes assessment. This is especially true since ABET published its Engineering Criteria 2000 (EC 2000). As a response, institutions to be reviewed by ABET with these new criteria have implemented some type of student portfolios. A common approach involves collecting various pieces of evidence such as design projects and national test results to prove that their graduates have met the required outcomes under Criterion 3 of EC 2000. In many cases, however, a lack of the fundamental concept of educational outcomes assessment is clearly visible – the linkage between portfolio content, content assessment, corrective action planning and implementation, and evidence of program improvement.

In this paper, we share our experience in portfolio development and present a tool that assisted us in the assessment of student educational outcomes set forth by ABET. In the following sections we first answer the question *where does the portfolio fit in a typical assessment plan*. Second the goal, content, evaluation, and analysis of the portfolio are addressed. Finally the challenges encountered and conclusions are provided.

Educational Outcomes Assessment Plan

The educational outcomes assessment process can be viewed as a way to reassure stakeholders (students, parents, faculty, administration, governing board, alumni, donors, accrediting bodies, etc.) of the quality of education provided by an institution. Its purpose is for an institution to use the results for self-improvement. Typically, an assessment plan includes the following:

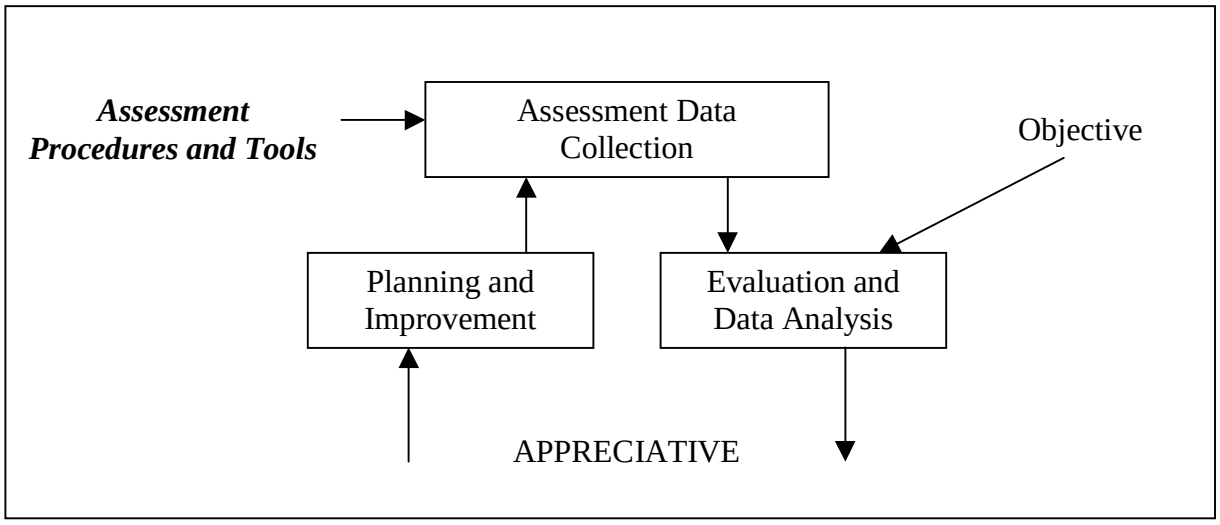
- Objectives based on the programs role in the institution's mission
- Criteria against which to measure objective attainment
- Tools to collect data and procedures indicating how assessment is done

Part of our assessment plans are the student portfolios [1]. For example, Appendix A shows the assessment plan for the Electrical Engineering program. In this plan, the student portfolio is used to address ABET's requirements which in turn address the fourth program objective as follows:

4. Provide an education recognized within the profession.	A. Maintain EAC of ABET accreditation.	a. Conduct periodic reviews of the program (curriculum, faculty, facilities, administration, etc.) to maintain EAC of ABET standards. ***b. Maintain student portfolios and perform periodic analysis*** c. Request EAC of ABET accreditation visits when due.

The following figure answers the questions *where does the portfolios fit in the overall assessment process followed by the Institution*. The assessment process the Institution follows is guided by the philosophy of Appreciative Inquiry [2] which builds on positive attainment. That is, the assessment and evaluation phases start from the identification of strengths and successes and building on them. The portfolios are part of the assessment procedures and tools (highlighted in the figure).

Figure 1: The Assessment Process



Student Portfolio

We choose a selective portfolio [3,4] where a student's representative work is selected by the assessment committee. This is to avoid duplication and to reduce the volume of the contents. The goal, content, and evaluation of the portfolio are as follows:

Goal

A student portfolio is considered a framework for documenting and assessing student outcomes. The individual portfolio is be used as a mechanism to demonstrate a student's proficiency for each outcome.

Content

The portfolios provide information regarding student skill development over time in writing, critical thinking, humanities and social sciences, and engineering. For this purpose, the content of the portfolio has been identified as follows:

(a) Essay on educational objectives at the start of the program
(b) Essay on understanding of contemporary issues at program midpoint
(c) Essay on the importance of life-long learning at the end of the program
(d) ETS Academic Profile Test Scores at start, midpoint, and end of the program
(e) Sample of student project reports at midpoint
(f) Senior design projects
(g) FE examination results of engineering
(h) Other items as deemed relevant

Evaluation and Analysis

Typically, the team of portfolio assessors is composed of faculty and industrial advisory committee members. When analyzing student writing skills, for example, the team considers items (a), (b), (c), and (e); for general studies (humanities, social sciences, communications) item (d); and for math and science items (d), (g), and (h).

An Excel based Competency Matrix (see Appendix B) is developed by the authors to summarize the evaluation results. Such a matrix is completed for each student and included in the portfolio. Ideally, the matrix should be full to guarantee that all the eleven competencies are covered by the degree program content. The entries of this matrix are programmed to yield measures reflecting the student's performance. The following 1 to 5 scale is adopted:

5 Superior Ability
4 Excellent Ability
3 Satisfactory Ability
2 Weak Ability
1 Poor Ability

In this scale, the numeric 3 is assigned for a medium level of academic performance no matter what the competence is. If a student exhibits generalization abilities then a 4 is given. A 5 is warranted if the performance well exceeds expectation. On the other hand, if the student performance is weak a 2 is assigned. A 1 is given when the student performance is very weak.

Challenges and Further Work

At this stage of the Competency Matrix development, the challenges encountered stem from:

- *The ETS test*. In this test, only the overall score of a student is given: student scores in different areas are not accessible.
- *The EIT test*. In this test, students are grouped into clusters and only the scores of the clusters are given: individual student scores are not accessible.

While work is underway to overcome the above mentioned challenges, it is worth mentioning that our ultimate goal is to shift to electronic portfolios such as the one reported in [5].

Conclusions

In this paper the content of a portfolio has been defined. The selection of the appropriate student work was (1) done to yield measurable samples (2) guided by the educational outcomes in the ABET criteria 2000, (3) chosen to yield meaningful assessment results, and (4) such that the process in not intrusive and would not create unnecessary work for the faculty. A competency matrix has been developed to serve as an assessment environment in which indicators are calculated at different stages of the student's learning experience. These indicators should (1) reveal the competencies in which the student is not performing adequately, and (2) point to where the program needs strengthening.

Bibliography

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Appendix A: Electrical Engineering Degree Program

OBJECTIVES	PERFORMANCE STANDARDS	ASSESSMENT PROCEDURES AND TOOLS
1. Provide a broad-based educational experience in order that graduates may have the knowledge, skills, and motivation to succeed professionally.	A. The curriculum meets the requirements of the department, the institution, NASC, and EAC/ABET. B. The curriculum is outcome based.	a. Detailed audit of the curriculum at least every three years. b. Goal-based per course evaluation and expanded course outlines detailing expected learning outcomes. c. Analysis of GE 290 projects. d. Analysis of senior design projects e. EIT exam results.
2. Prepare graduates for employment or graduate study.	A. The program meets the needs of industry. B. Eighty percent of alumni are appropriately employed or admitted to graduate school within one year of graduation. C. Eighty percent of alumni pass the Fundamentals of Engineering examination within one year of graduation.	a. Periodic review of the program by the industry advisory committee. b. Alumni surveyed one year after graduations.
3. Prepare alumni for life-long learning and professional development.	A. Majority of graduates are well prepared for continuing life-long learning and professional development following graduation.	a. Alumni surveyed at one, three, five and ten years following graduation.
4. Provide an education recognized within the profession.	A. Maintain EAC of ABET accreditation.	a. Conduct periodic reviews of the program (curriculum, faculty, facilities, administration, etc.) to maintain EAC of ABET standards. b. Maintain student portfolios and perform periodic analysis c. Request EAC of ABET accreditation visits when due.

Appendix B. Student Competency Matrix

Student Name:	STUDENT COMPETENCY MATRIX										
	START			MID-POINT			END				
COMPETENCIES	Essays	Class Project	ETS	Essays	Class Projects	ETS	Essays	Class Projects	Capstone Projects	ETS	EIT
A Ability to apply knowledge of mathematics, science, and engineering					EE 322				EE 490 EE 491		TEST
B Ability to design and conduct experiments as well as to analyze and interpret data					GE 290 EE 352 GE 305			EE460 EE 420	EE 490 EE 491		
C Ability to design a system, component, or process to meet desired needs								EE 460 EE 420	EE 490 EE 491		
D Ability to function on multi-disciplinary teams					GE 290				EE 490 EE 491		
E Ability to identify, formulate, and solve engineering problems									EE 490 EE 491		
F Understand of professional and ethical responsibility									EE 490 EE 491		
G Ability to communicate effectively					GE 290				EE 490 EE 491		
H Broad education necessary to understand the impact of engineering solutions in a global and societal context			TEST 1			TEST 2			EE 490 EE 491	TEST 3	
I Recognition of the need for, and an ability to engage in life-long learning	ESSAY 1						ESSAY 3				
J Knowledge of contemporary issues				ESSAY 2	GE 290				EE 490 EE 491		
K Ability to use the techniques, skills, and modern engineering tools necessary to engineering practice									EE 490 EE 491		

ESSAY 1: Educational goals ESSAY 2: Understanding contemporary issues ESSAY 3: Engaging in life-long learning	TEST 1: 1st ETS Test TEST 2: 2nd ETS Test TEST 3: 3rd ETS Test	TEST: EIT Test	EExx: Elect. Eng. Courses from which samples are taken GExx: Gen. Eng. Courses from which sample are taken	EE490: First senior design project course EE491: Second senior design project course