Development of Assessment Procedures for Academic Activities Within the Context of a Departmental Continuous Quality Improvement Policy

Albert B. Grubbs Jr.
Michael R. Kozak

University of North Texas

Abstract

The success that companies achieved using Total Quality Management (TQM) or Continuous Quality Improvement (CQI) to improve quality and productivity is well documented. Representatives from industry serving on accreditation boards and commissions suggested that the same practices should be adopted to affect quality improvements in academia. The Accreditation Board for Engineering and Technology (ABET) considered their suggestions with the result that its accreditation criteria requires programs to implement, utilize, and document improvements as a result of a CQI program.

Academic departments are required to produce results in several different but complementary areas. Activities are categorized in three broad areas of teaching, scholarly, and service. ABET criteria is focused on the academic area of the departments in undergraduate programs. However, departments must also engage in other activities that must also be included in a total quality improvement (TQI) system. Those activities include responsibilities such as administrative activities, graduate programs, faculty development and retention, staff development, advising, student recruiting, research administration, and resource development.

The focus of this paper is on that portion of TQI related to the delivery of the academic programs. Course objectives and learning outcomes are indexed to departmental, college, and university college missions to insure homogeneity in activities, i.e. marching to the same drummer. A description of the process used to develop the system, difficulties in achieving the desired time line for completion of the project, level of achievement in the first phase of implementation, and anticipated activities required to achieve a complete TQI process for every facet of the departmental activities is described. A detailed example of one course is presented to provide a detailed illustration of the system.

Introduction

Southern Association accreditation! ABET assessment! Texas Higher Education Coordinating Board program objectives. Mission of the University! Vision of the University! Goals of the College! Department Objectives! Program Objectives! Exemplary Educational Objectives! Course Objectives! Learning Objectives! Performance-based Outcomes! Learning Objectives! Student Learning Outcomes! Measurable, Specific Outcome Competencies! Sound familiar? Where will it end?

Continuous Quality Improvement should be the result of goals/objectives analyses based on change justification utilizing learning outcomes. This is only one, but an important one, of many aspects of total program evaluation. An adequate CGI program can be equally applied to

Southern Association Commission as Well as TAC of ABET self study practices.

ABET Accreditation

ABET accreditation is shifting from auditing to learning outcomes of students.[1] Learning takes place through hands-on activities that represent the application of real life problems. To provide an environment of learning by doing, a series of activities must be carried out that achieves a desired outcome.[2]

Learning strategies establish relevance and applications for all course material, balance concrete information with abstract concepts and use a variety of delivery modes. Learning strategies include lectures, in-class demonstrations, laboratory experiences, consultations, industrial field trips, oral presentations, written reports and working in teams.[2] Criteria 2000 requires each program to have:

- objectives consistent with its unique mission;
- an assessment process that demonstrates that objectives and their associated learning outcomes are being achieved; and
- a system of evaluation that shows a commitment to continuous quality improvement.[3]

Continuous Improvement

Faculty must establish a process for evaluating and continuously improving programs and ensure that the curriculum, as a whole, satisfies the program's overall educational objectives and incorporates an improvement track. Course development includes defining course objectives, student learning outcomes, and criteria and/or tools to assess student outcomes. Engineering/ Engineering Technology programs should be effectively planning their curricula and courses to achieve specific student learning outcomes within a continuous improvement process.[3]

Faculty who incorporate a continuous improvement process, must develop outcomes-based courses and assess these student learning outcomes.[2] Continuous Quality Improvement (CQI) is based on constituents and the services, facilities and policies required to satisfy them. Measurements are used to continuously improve the services provided. Continuous improvement requires the integration of defined objectives and regular assessment. CQI focuses on learning performance. CQI synchronizes course objectives with the mission of the program, department, college and university. Continuous improvement measures the achievement of objectives through the assessment of learning outcomes and uses the results to improve not only the curriculum but the process itself.[1]

Assessment

The design of an assessment program for any degree-granting unit is a critical step in the overall assessment process. The assessment of engineering technology programs is best accomplished in concert with a coordinated institution-wide effort at program improvement.[2] Measuring student learning is an imprecise activity based on self-defined criteria. The outcomes assessment process requires that each program measure what it wants its graduates to know and be able to do.[2]

It is important to remember that only one aspect of a total assessment program is learning

outcomes assessment. Assessment, in addition to learning outcomes assessment, also includes:

- alumni surveys,
- departmental GPA,
- exams,
- homework,
- special problems,
- exit interviews,
- overall GPA,
- post-graduation satisfaction surveys,
- GRE scores,
- Industrial Advisory Board evaluation,
- employer satisfaction survey,
- cooperative education evaluations,
- laboratory reports,
- membership in professional societies,
- oral presentation assessment forms,
- portfolio evaluation,
- professional examinations,
- senior projects,
- simulations,
- standardized examinations,
- student projects,
- teamwork assessment forms,
- research papers and presentations, and
- assessment of written reports.[2]

A passing grade in a course can serve as an additional indicator that a student has achieved the learning outcomes. A failing grade may indicate that the:

- teaching approach is not compatible with the course;
- objectives may not be appropriate for the course;
- prerequisite course may not be preparing students to perform at the level expected for this course.[3]

Objectives.

Objectives are general statements that communicate how an engineering technology program intends to fulfill its educational mission and meet its constituency's needs.[3]
Objectives identify critical course material, facilitate the design of in-class activities and effective student evaluation, and focus students' attention on learning tasks by telling them what they can expect. Objectives are tangible intentions that can be supported through learning outcomes and must be stated at the proper level of generality yet be independent.[4].

More specifically, course objectives must be in harmony with the philosophy of the institution. Course objectives are stated in terms of student, not instructor, performance. Objectives should follow a general statement: "At the end of this course, the student will be able to..." and begin

with a verb.[2]

Instructional objectives are beyond course objectives and learning outcomes. Instructional objectives contain three parts: condition, criteria, and outcome competencies. Condition includes what the student will be allowed to use (text, calculator), will not be allowed to use (notes), and conditions under which the student is expected to perform (classroom). Criteria states the quality and standards of the desired performance. Outcome competencies state how the student will prove that the student can perform the task. (Words like "know" and "understand" are not observable and should not be used.[5]

Learning Outcomes.

Objectives are where we aim; outcomes are where we hit. Review course objectives and identify student learning outcomes.[2] Learning outcomes are narrow, precise, concrete, tangible statements that provide validation feedback and are measurable, meaningful and achievable.[6] Each learning outcome must be relevant to at least one course objective. A sufficient number of learning outcomes are required to adequately describe the performance of students who achieve any given course objective.[4]

All faculty members must agree to develop "learning outcomes based courses" integrated with outcomes assessment.[2] Assessment must recognize the pitfalls of overspecialization of learning outcomes. Learning outcomes must not be so complicated and numerous that assessment becomes too complex to manage.[3]

Learning outcomes should be stated such that a student can demonstrate them. Learning outcomes are activities that permit students to demonstrate the extent to which they have learned specified skills and/or information.[1]

Learning outcomes should be measured with multiple methods. However, measures of performance expectations are the "how" and are not included in the learning outcomes.[1]

Course Syllabus

The course syllabus should contain clearly defined course objectives, educational activities to achieve the objectives, and student learning outcomes assessment. Faculty must switch from lecturer to facilitator prior to the preparation of a course syllabus. The course syllabus is a tool to establish the skills (psychomotor), knowledge/competencies (cognitive) and values (affective) to be developed in the student. Engineering technology is in a unique position because of its emphasis of the psychomotor domain - the "doing" domain. The syllabus is written evidence of changes made to a course's objectives and learning outcomes based on assessment.[2]

University of North Texas

The University of North Texas has stated goals/objectives for the University. The College of Arts and Sciences has stated goals/objectives for the College. The Engineering Technology Department has stated goals/objectives for the Department. Each Program (Electronics, Manufacturing, Mechanical, Nuclear) has stated goals for the program. See Table 1. These

program goals include academic, research and service goals. Each course has objectives for that particular course. See Table 2.

A syllabus template was developed and approved for use for every course in the Engineering Technology Department. The template includes course objectives and learning outcomes. A list of "verbs" was distributed to faculty to assist with objectives and learning outcomes. See Table 3.

Each learning outcome addresses at least one course objective. See Table 2. Each course objective addresses at least one program goal. Each program goal addresses at least one department goal/objective. Each department goal/objective addresses at least one college goal/objective. Each college goal/objective addresses at least one University goal/objective.

In addition to grades, departmental faculty include the assessment of goals/objectives as a criteria in determining program effectiveness. Students in each course, at the end of each term, are asked to evaluate the effectiveness of each learning outcome on a 1 to 5 scale with 5 indicating the most effective. See Table 4. The Engineering Technology staff enters the results of learning outcomes evaluation onto a spreadsheet. Formulation calculates how effective, in the students' opinion, the learning outcomes were in achieving the goals/objectives of the course and program. See Table 5.

Program Coordinators have initiated a continuous quality improvement process that adjusts appropriate learning outcomes and course objectives. For example, the Electronics Engineering Technology Coordinator will review the results of ELET 2720. See Table 5. The lowest averages are for Learning Outcomes i), l), m), and n). Referring to Table 2, these are:

i) Use digital instruments to troubleshoot digital circuits and systems.
l) Describe digital IC terminology as specified in Manufacturers' Data Sheets.
m) Analyze the process by which a computer, in conjunction with an ADC, digitizes an analog signal.
n) Construct an analog signal from digital data.

Discussion is held between the Coordinator and teaching faculty. If a decision is made to change any or all of the learning outcomes, the change is made in all sections of the course. A record is filed of any changes along with justification for the change.

Any new instructor is provided with a copy of the filed syllabus. Changes cannot be made to the learning outcomes or course objectives without prior approval by the Program Coordinator and all involved faculty.

Summary

Prepare department goals, in the areas of teaching, scholarly activities, and service, that can be applied to college goals. Prepare program goals that reinforce the department goals. Write course objectives, in general terms that can be applied to program goals. Write measurable learning outcomes that can be applied to one or more course objectives. Prepare a student questionnaire to determine how well the learning outcomes have been accomplished. Initiate a spreadsheet to obtain mean scores for each learning outcome and how these results apply to the appropriate course objectives and program goals. Utilize the faculty to review and analyze the results and determine the steps necessary to improve instruction.

References

[1]Emshousen, F. (2001, March 2-4). Technological Education Initiative. Houston, TX: ABET TEI Regional Faculty Workshop.

[2]Morell, L., Buyxeda, R., & Velez-Arocho, J. I. (2001, June 24). Developing an Outcomes Based Course: a Hands on Workshop. Albuquerque, NM: ASEE Annual Conference.

[3]American Society for Engineering Education. (1998). How do you Measure Success? Washington, DC: Author.

[4]Gronlund, N. E. (2000). How to Write and Use Instructional Objectives (6th ed). Columbus, OH: Merrill.

[5]Mager, R. F. (1997). Preparing Instructional Objectives. Belmont, CA: Lake Publishers.

[6]Rogers, G. (2001, March 2-4). Introduction to Assessment Methods. Houston, TX: ABET TEI Regional Faculty Workshop.

Table 1: PROGRAM GOALS

ELET Program Goals	NUET Program Goals	MFET Program Goals	MEET Program Goals
Academic	**Academic**	**Academic**	**Academic**
a. Provide meaningful undergraduate educational experiences	a. Provide meaningful undergraduate educational experiences	a. Provide meaningful undergraduate educational experiences	a. Provide meaningful undergraduate educational experiences
b. Enable students with a variety of backgrounds to acquire technical knowledge and skills that will assure their professional success	b. Enable students with a variety of backgrounds to acquire technical knowledge and skills that will assure their professional success	b. Enable students with a variety of backgrounds to acquire technical knowledge and skills that will assure their professional success	b. Enable students with a variety of backgrounds to acquire technical knowledge and skills that will assure their professional success
c. Prepare students for lifelong learning by instilling the desire and skills for learning	c. Prepare students for lifelong learning by instilling the desire and skills for learning d. Prepare the program for assessment by continuing improvement per TAC of ABET criteria	c. Prepare students for lifelong learning	c. Prepare students for lifelong learning
Research	**Research**	**Research**	**Research**
d. Provide industry with expertise that assists in the application of new technology	e. Provide industry with expertise that assists in the application of new technology	d. Provide industry with expertise that assists in the application of new technology	d. Provide industry with expertise that assists in the application of new technology
e. Develop new technologies for use in the field by the application of knowledge acquired through basic research	f. Develop new technologies for use in the field by the application of knowledge acquired through basic research	e. Develop new technologies and new applications of extant technologies for use in the field through the utilization acquired from research	e) Develop new technologies and new applications of extant technologies for use in the field through the utilization of knowledge acquired from research
Service	**Service**	**Service**	**Service**
f. Provide assistance to the department, college, university and community through the use of applied knowledge and skills	g. Provide assistance to the department, college, university and community through the use of applied knowledge and skills	f. Provide assistance to the department, college, university and community through the use of applied knowledge and skills	f. Provide assistance to the department, college, university and community through the use of applied knowledge and skills
g. Further the Development of the profession through participation in local state, national, and international professional organizations	h. Further the Development of the profession through participation in local state, national, and international professional organizations	g. Further the Development of the profession through participation in local, state, national, and international professional organizations h. Further the development of the profession through aggressive support of student professional organizations	g. Further the Development of the profession through participation in local state, national, and international professional organizations h. Further the development of the profession through aggressive support of student professional organizations.

Table 2 EL ET 2720 DIGITAL LOGIC

COURSE LEARNING OUTCOMES			COURSE OBJECTIVES		
Letter	**Statement**	**Course Objectives Addressed**	**Number**	**Statement - At the conclusion of this course, the student will (be able to):**	**Program Objectives Addressed**
a)	Analyze and design basic logic circuits and systems using Altera's Max+ Plus II software	1, 2, 4	1	know Boolean algebra and the Karnaugh map method.	a, b, c
b)	Analyze the behavior of a digital logic circuit.	1, 2, 5	2	understand digital electronic components.	a, b, c, d
c)	Synthesize descriptions of logical problems to efficient digital logic circuits.	1, 2, 5	3	conduct independent study.	a, b, c
d)	Design, analyze and implement combinational digital circuits.	2, 5	4	comprehend how computers are used for the design, evaluation and production of digital electronic circuits.	a, b, c, d
e)	Design analyze and implement sequential digital circuits.	1, 2, 3, 5	5	understand integrated circuits and programmable logic devices.	a, b, c, d
f)	Design, analyze and implement algorithmic state machines.	1, 2, 3, 6	6	work effectively with others.	a, b, d, f
g)	Design digital circuits using PLDs and TTL logic.	1, 2, 3, 5			
h)	Analyze digital circuits using PLDs and TTL logic.	1, 2, 3, 5			
i)	Use digital instruments to troubleshoot digital circuits and systems.	2, 3, 4, 5			
j)	Apply Boolean algebra method to the design and analysis of a digital circuit.	1, 2, 3, 6			
k)	Apply the Karnaugh map technique to the design and analysis of a digital circuit.	1, 2, 4			
l)	Describe digital IC terminology as specified in Manufacturers' Data Sheets.	1, 2, 5			
m)	Analyze the process by which a computer, in conjunction with an ADC, digitizes an analog signal.	1, 2, 5			
n)	Construct an analog signal from digital data.	2, 4, 6			

Table 3 Verbs to be used with Learning Outcomes					
Categorized by Level of Thinking					
Knowledge	**Comprehension**	**Application**	**Analysis**	**Synthesis**	**Evaluation**
Cite	Alter	Act	Analyze	Adapt	Appraise
Define	Convert	Administer	Ascertain	Add to	Assess
Enumerate	Depict	Articulate	Associate	Anticipate	Compare
Identify	Describe	Apply	Break Down	Collaborate	Conclude
Label	Discover	Calculate	Categorize	Combine	Consider
List	Discuss	Change	Classify	Compile	Contrast
Locate	Distinguish	Chart	Correlate	Compose	Criticize
Measure	Estimate	Choose	Determine	Conceive	Critique
Memorize	Explain	Classify	Diagnose	Construct	Debate
Name	Express	Collect	Diagram	Create	Decide
Pronounce	Extend	Compute	Differentiate	Design	Deduce
Quote	Generalize	Contribute	Discrimminate	Develop	Defend
Recall	Give	Control	Disgram	Devise	Evaluate
Recite	Match	Demonstrate	Disignate	Expand	Interpret
Recognize	Paraphrase	Detail	Dissect	Express	Judge
Record	Rephrase	Direct	Distinguish	Extend	Justify
Remember	Represent	Dramitize	Divide	Facilitate	Recommend
Repeat	Restate	Draw	Examine	Formulate	Relate
Reproduce	Review	Employ	Find	Generalize	Select
State	Reword	Illustrate	Focus	Generate	Solve
Tell	Substitute	Implement	Infer	Hypothesize	Summarize
Write	Transform	Inform	Investigate	Imagine	Support
	Translate	Interpret	Limit	Incorporate	Verify
	Vary	Make	Outline	Initiate	Weigh
		Manage	Point-out	Integrate	
		Manifest	Prioritize	Invent	
		Model	Reduce	Modify	
		Paint	Research	Negotiate	
		Practice	Separate	Organize	
		Predict	Sequence	Originate	
		Prepare	Subdivide	Plan	
		Present	Survey	Pose	
		Protect		Produce	
		Relate		Progress	
		Report		Project	
		Show		Propose	
		Sketch		Rearrange	
		Solve		Reinforce	
		Teach		Revise	
		Trace		Rewrite	
		Transfer		Role play	
		Use		Synthesize	
		Utilize		Theorize	

Words That Tend to be Combined		
Compute and Interpret	Explain the need for	Explain why
Draw and interpret	Explain the difference between	Explain how
Distinguish between	Explain what	Draw and estimate
Use formulas to	Compare and contrast	Explain the relationship between
Explain the impact of	Explain when	Construct and interpret
Explain the terms	Distinguish from	Explain the role of
Explain the dangers of		

Words such as "know" and "understand" are not observable and should not be used.

Table 4 Student Rating of Learning Outcomes						
Fall 2002		**ELET 2720 - Digital Logic**				
Learning Outcome		**Not at all helpful-1**	**A little helpful-2**	**Somewhat helpful-3**	**Helpful-4**	**Very Helpful-5**
a)	Analyze and design basic logic circuits and systems using Altera's Max+Plus II software					
b)	Analyze the behavior of a digital logic circuit.					
c)	Synthesize descriptions of logical problems to efficient digital logic circuits.					
d)	Design, analyze and implement combinational digital circuits					
e)	Design, analyze and implement sequential digital circuits					
f)	Design, analyze and implement algorithmic state machines.					
g)	Design digital circuits using PLDs and TTL logic					
h)	Analyze digital circuits using PLDs and TTL logic.					
i)	Use digital instruments to troubleshoot digital circuits and systems					
j)	Apply Boolean algebra method to the design and analysis of a digital circuit					
k)	Apply the Karnaugh map technique to the design and analysis of a digital circuit					
l)	Describe digital IC terminology as specified in Manufacturers' Data Sheets					
m)	Analyze the process by which a computer, in conjunction with an ADC, digitizes an analog signal					
n)	Construct an analog signal from digital data					
o)						
p)						
q)						
r)						
s)						
t)						
u)						
v)						
w						

Table 5 ELET LEARNING OUTCOMES, COURSE GOALS & PROGRAM GOALS

COURSE - 2720						All Sections				Instructor - Baatarjav			
SEMESTER - 2002						YEAR - 2002							
ELET PROGRAM GOALS						COURSE GOALS/OBJECTIVES					LEARNING OUTCOMES		
Program Goal		Applicable Response Totals	Total	AVG	Dept Goals Addressed	Course Goal/ Objective	Applicable Response Totals	Total	AVG	Program Goals Addressed	Learning Outcome	Actual Totals	Total	AVG
Academic	a.	3728	15449	4.1441	1,8	1	876	3703.8	4.2281	a,b,c	a)	80	368.8	4.61
	b	3728	15449	4.1441	2,8	2	1110	4617.3	4.1597	a,b,c,d	b)	80	355.2	4.44
	c	3728	15449	4.1441	1,3,8	3	478	1964.5	4.1099	a,b,c	c)	79	346.02	4.38
Research	d	2141	8855.4	4.1361	4,6	4	314	1287.1	4.0989	a,b,c,d	d)	80	367.2	4.59
	e				4,5,6,8	5	717	2951.1	4.1159	a,b,c,d	e)	80	352.8	4.41
Service	f	233	925.35	3.9715	6,9	6	233	925.35	3.9715	a,b,c,f	f)	79	324.69	4.11
	g				7						g)	79	328.64	4.16
											h)	80	328	4.1
											i)	80	288	3.6
											j)	80	342.4	4.28
											k)	80	372	4.65
											l)	79	281.24	3.56
											m)	80	304	3.8
											n)	74	258.26	3.49