Assessment of Course Objectives in a Mechanics Program

***Don H. Morris*[1]**

Abstract – A uniform procedure for assessing course objectives for continuous improvement, consistent with ABET, has been developed at Virginia Tech in the Department of Engineering Science and Mechanics. This paper will describe the details of this procedure, and how the procedure fits within an overall process for student outcomes assessment, especially Criterion 3 (a – k): Program Outcomes and Assessment of ABET Criteria for Accrediting Engineering Programs. A specific example of the course assessment process, and how the assessment data are used to evaluate achievement as well as form the basis for recommendations for course improvement will be discussed. The process is efficient, a critical aspect for faculty members at a comprehensive land-grant Research I university.

Keywords: course assessment, assessment, ABET.

INTRODUCTION

An objective of ABET EC 2000 [1] is the continuous improvement of student learning and maintaining relevancy of the content of courses required for graduation. Thus, to support such an approach a process for assessing individual courses as well as student outcomes from the overall program is needed. Faculty members at a Research I university (such as Virginia Tech) have responsibilities that include not only teaching, but also research and outreach. As a consequence, the process must be effective and efficient.

The procedure developed and implemented in the Department of Engineering Science and Mechanics at Virginia Tech for assessing individual courses will be described and an example presented. The course assessment process is part of an overall effort to sustain an outstanding undergraduate educational program in engineering science and mechanics at a comprehensive land grand Research I university. The undergraduate program objectives are maintained consistent with needs of its constituents as well as the University and College of Engineering strategic plans through this procedure.

OVERALL COURSE ASSESSMENT PROCESS

The overall process for course assessment is depicted schematically in Fig. 1. The course assessment process is designed to achieve two main objectives, the assessment of the individual course and assurance that the part of the overall program of study supported by learning objectives of that course are also fulfilled. The faculty member of an individual course performs the course assessment and his, or her, evaluation is reported to the Undergraduate Curriculum Committee (UGC). This committee examines the individual course assessments to assure that the desired student outcomes are being achieved. The committee also considers any recommendations for curriculum changes as regards their impact on the overall program of study or for their potential impact on other courses. In that all curriculum changes must be approved by the departmental faculty and in some instances also require extra-departmental approval the UGC coordinates the necessary follow-up actions. Courses that support the

[1] Department of Engineering Science and Mechanics, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, dhmorris@vt.edu

undergraduate program of study as well as courses taught as a service to other departments are assessed using the same procedure.

Course Assessment Process: individual courses

The faculty member of an individual course is recognized as an expert for the course subject matter and is relied on to develop appropriate tools for assessing each of the course learning objectives. Figure 2 is an example of the form used to describe a course and list the means by which the course will be assessed. Any particular assessment tool, homework, group project, laboratory reports, quizzes, testing, or combination deemed necessary by the instructor could be used. The assessment might be used to monitor (M) or summatively assess (S) the student achievement.

The instructor is expected to determine if the students satisfactorily achieve the course learning objectives. Although somewhat arbitrary, it was decided that if less than 75% of sophomore students, 80% of juniors, and 90% of seniors achieve a course objective then it is imperative that improvement be considered to improve student success. Of course, recognizing the inherent variability of assessing human subjects it is considered reasonable to delay any major changes until problem areas are confirmed by assessment from more than one offering of the course. Furthermore, the instructor is only asked to determine how many students satisfactorily achieve each objective. It is assumed that instructors will continually consider proactive course improvements that will more effectively present course materials even if the minimal levels are achieved. However if these levels are repeatedly not achieved it is assumed that either student preparation, or prerequisite course requirements, should be improved, or course coverage is overly ambitious, and the number of course learning objectives should be reduced.

Outcomes Assessment

Assessing how successful the program of study has been in supporting student achievement of the program outcomes requires both a formative component and a summative component. Since various course learning objectives from different courses support the program outcomes finally assessing whether students have achieved the outcomes upon graduation is accomplished by assessment in senior capstone design course and supplemented by performance on the nationally-normed Fundamentals of Engineering examination. This senior course provides a learning experience that is anticipated to allow students to synergistically apply the assorted course learning objectives so as to achieve the program outcomes. However if this summative assessment suggests that an outcome is not being achieved it may not elucidate the root causes. Consequently at various intermediate points in the program a formative assessment can be done that can provide greater insight into impediments to the ultimate achievement of the outcomes. Of course any curriculum changes designed to improve the achievement of program outcomes will require careful consideration of assessment data for several years in order to observe the effects of these changes.

Refining the Process

Increased experience by faculty member instructors with the course assessment process will lead to suggestions for refining the process. For example the arbitrarily set percentages for triggering a recommendation for course improvement are likely to be adjusted to more appropriately accomplish the program objectives.

Example

Figures 3 and 4 show the form used to monitor assessment of individual course learning objectives. For this example the course is ESM 4074, a senior level course in Vibration and Control. Figure 2 shows the standard format used to list course objectives and their relationship to Program Outcomes and a – k of ABET Criterion 3. The tools used to assess this particular course are listed at the bottom of Fig. 2.

As indicated in Fig. 3, the students did not meet learning objective (e). Also listed on this figure is the recommendation for meeting this objective the subsequent semester the course is taught. As shown in Fig. 4, the recommendation to meet learning objective (e) resulted in complete success in meeting all learning objectives.

This process occurs for each required ESM course in the curriculum, each semester the course is taught. Thus, assessment data are used to evaluate achievement as well as form the basis for recommendations for course improvement.

SUMMARY

A process for assessing individual courses has been described. A specific example of the assessment process, and how the assessment data were used to evaluate achievement as well as form the basic for recommendations for individual course improvement were discussed. The process is efficient, an aspect for faculty members at a comprehensive Research I university.

REFERENCES

[1] Engineering Criteria 2000, Program Self-Study Instructions, EC 2000 Visits, Accreditation Board for Engineering and Technology , Baltimore.

Biographical Information

Don H. Morris is a Professor of Engineering Science and Mechanics and is the Assistant Department Head with more than 30 years experience teaching mechanics courses. He has taught at Mississippi State University, Iowa State University, Virginia Tech, and was a Visiting Professor at the United States Military Academy.

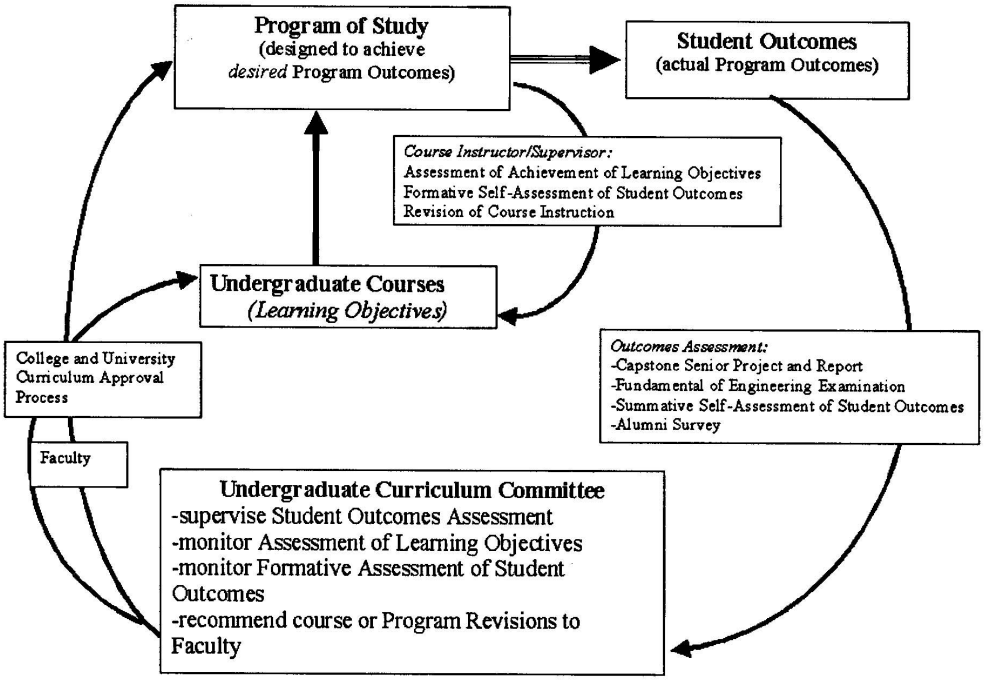

Figure 1 Process Used to Assess the Achievement of Program Outcomes

ESM 4074
Vibration and Control

CATALOG DATA: Single-degree-of-freedom vibration, two- and n-degree-of –freedom systems, continuous systems, introduction to nonlinear systems, system stability, introduction to the control of dynamic systems.

PREREQUISITES AND COREQUISITIES:
Pre: ESM 3124, MATH 4564

TEXTBOOK: Meirovitch, L. *Fundamentals of Vibrations*, McGraw-Hill, 2001.

OBJECTIVES:
[numbers in brackets indicate Program Outcomes supported by this Learning Objective],
(letters in parenthesis indicate a-k of ABET Criterion 3)

1. Derive the equations of motion of, determine the natural frequency and period of, and determine the response of one-degree-of-freedom systems, including the effects of damping and forcing. [2,3,4,6], (a, e)
2. Derive the equations of motion for two-degree-of-freedom systems and determine the natural modes of vibrations. [2,3,4,6], (a, e)
3. Determine the natural modes of vibration for simple continuous systems. [2,3,4,5], (a, e)
4. Perform modal analyses of n-degree-of-freedom discrete systems. [2,3,4], (a, e)
5. Design simple feedback control systems for single and multiple degree-of- freedom systems. [2,3,4,6], (a, c, e)

TOPICS COVERED:
(numbers in parenthesis indicate percentage of time devoted to topics)

1. Introductory concepts (5%)
2. Single-degree-of- freedom systems (12%)
3. Two-degree-of-freedom systems (7%)
4. Continuous systems (15%)
5. Multi-degree-of-freedom systems (15%)
6. Introduction to nonlinear systems (7%)
7. System stability (6%)
8. Introduction to control theory (33%)

COURSE SCHEDULE:
3 hours lecture, 3 credits offered in Fall Semester

PROFESSIONAL COMPONENT:
Engineering topics, engineering science, and introduction to design

ASSESSMENT:

1. Homework
2. Tests
3. Final Exam
4. Survey of students regarding course learning objectives

PREPARED BY:

Figure 2 Course Description and Tools Used to Assess Learning Objectives

ESM 4074: Vibration and Control
ASSESSMENT AND EVALUATION, Fall 2000

Learning Objectives/Elements	Assessment Tools												Overall/Recommendations
	HW 1	HW 2	HW 3	HW 4	HW 5	HW 6	HW 7	HW 8	HW 9	T1	T2	EXAM	Have 90% of the students met this learning objective?
(a) Derive the equations of motion of, determine the natural frequency and period of, and determine the response of one-degree-of-freedom systems, including the effects of damping and forcing	S	S	S	S	S					S		S	Yes
(b) Derive the equations of motion for two-degree-of-freedom systems and determine the natural modes of vibration						S					S	S	Yes
(c) Determine the natural modes of vibration for simple continuous systems							S				S	S	Yes
(d) Perform modal analyses of n-degree-of-freedom discrete systems								S			S	S	Yes
(e) Design simple feedback control systems for single and multiple degree-of-freedom systems												S	No (see next page)

M-denotes tool used for monitoring, S-denotes tool used for summative assessment

Notes: Homework exercises 1-9 varied greatly in length and complexity. Homework 9 did not directly deal with the five stated course objectives, but with a minor element of the course outline. There was an informal (not collected) homework exercise late in the semester on Learning Objective (e).

This semester, the ESM 4074 students on an overall basis, achieved every course learning objective except (e) "Design simple feedback control systems for single and multiple degree-of-freedom systems".

It is recommended that, instead of having only an informal assignment on this topic (which was done in the Fall 2000 semester due to the topic being finished near the end of the semester), a formal assignment (to be turned in) should be given during the Fall 2001 semester.

Instructor's Name:_____
Date Prepared:_____

Figure 3 Method of Assessing Course Learning Objectives

ESM 4074: Vibration and Control
ASSESSMENT AND EVALUATION, Fall 2001

Learning Objectives/Elements	Assessment Tools													Overall/Recommendations
	HW 1	HW 2	HW 3	HW 4	HW 5	HW 6	HW 7	HW 8	HW 9	HW 10	T1	T2	Exam	Have 90% of the students met this learning objective?
(a) Derive the equations of motion of, determine the natural frequency and period of, and determine the response of one-degree-of-freedom systems, including the effects of damping and forcing	S	S	S	S	S						S			Yes
(b) Derive the equations of motion for two-degree-of-freedom systems and determine the natural modes of vibration						S						S	S	Yes
(c) Determine the natural modes of vibration for simple continuous systems								S				S	S	Yes
(d) Perform modal analyses of n-degree-of-freedom discrete systems							S					S	S	Yes
(e) Design simple feedback control systems for single and multiple degree-of-freedom systems										M			S	Yes

M-denotes tool used for monitoring, S-denotes tool used for summative assessment

Notes: Homework exercises 1-10 varied greatly in length and complexity. Homework 9 did not directly deal with the five stated course objectives, but with a minor element of the course outline.

This semester, the ESM 4074 students on an overall basis, achieved all course learning objectives.

Instructor's Name:_____
Date Prepared:_____

Figure 4 Method of Assessing Course Learning Objectives