Using Learning Objective Assessment Tools to Enhance Undergraduate Engineering Education

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Abstract

The Mechanical Engineering Department at The University of Texas at San Antonio (UTSA) provides an undergraduate program that gives students an opportunity to prepare for professional engineering practice or for entry into a graduate program of study. The undergraduate program is based on a foundation of mathematics, basic and applied science, engineering science, and mechanical engineering fundamentals. It offers design and hands-on laboratory courses. Design is integrated through the curriculum that includes a senior level capstone design sequence. The department has established a set of specific learning objectives to support the mission and the goals of the department and meet the requirements of ABET accreditation under the Engineering Criteria 2000 (EC-2000). The objectives have been reviewed and approved by the major constituencies of the department. A process for systematic evaluation and updating of the department's undergraduate educational objectives and outcome is in place. The faculty of the Mechanical Engineering Department and the College Accreditation Committee conduct these evaluations. The Accreditation Committee has developed procedures for each department to obtain feedback from all major constituencies, evaluate the inputs, and process the collected data for assessment. The committee has identified assessment tools and developed survey instruments to evaluate educational objectives and outcomes. The results are being used to identify the shortfalls of our curriculum in meeting the educational objectives of our undergraduate program. This paper will discuss the educational objects and outcome for our department. It will describe the assessment tools being used for collecting and analyzing data and using the results to enhance our undergraduate curriculum.

Introduction

The Division of Engineering at UTSA was established in 1982 and housed within the College of Sciences and Mathematics and began offering undergraduate degrees in Civil, Electrical, and Mechanical Engineering. In 1983 the college name was changed to Sciences and Engineering. In preparation for the ABET accreditation under the Engineering Criteria 2000 (EC-2000)[1], a set of educational objectives and statements of output assessments[2] were developed for the mechanical engineering undergraduate program in Spring 1999.

An academic restructuring in Spring 2000 resulted in the partition of the College of Sciences and Engineering into two separate colleges: College of Engineering and the College of Sciences. This restructuring became effective in Fall 2000. In Fall 2000, a committee was formed to establish bylaws, mission, and goals for the newly formed College of Engineering and coordinate similar efforts by each program within the college. At the same time the mechanical engineering faculty began developing bylaws, a mission statement, and goals and proposed the establishment of the Mechanical Engineering Department. The Department of Mechanical Engineering was formally established in Fall 2001.

Undergraduate Educational Objectives

With the establishment of the College of Engineering and transformation of mechanical engineering program into a department, the educational objectives and outcomes were revised in Spring 2002 to support the mission and the goals of the newly established department and meet the requirements of ABET accreditation under EC-2000[1]. The major constituencies have reviewed the program educational objectives and their input has been considered in the final revision.

The educational objectives of the Bachelor of Science degree in mechanical engineering program are to provide students with opportunities to:

A. acquire the ability to apply the fundamentals of mathematics, sciences and engineering to quantitatively analyze problems
B. develop innovative design skills, including the students' ability to formulate problems, to think creatively, to synthesize information, and to communicate effectively
C. develop the ability to use modern experimental techniques, collect, analyze, and interpret experimental data; and effectively communicate the results
D. prepare students with the diverse skills needed to be successful engineers

Evaluation of Educational Objectives

A process for systematic evaluation and updating of the department's program objectives is in place. Mechanical Engineering Department faculty and the College Accreditation Committee conduct the evaluation. The Accreditation Committee consists of the Associate Dean for Academic Affairs, all department chairs, a faculty representative from each department, and a representative from the College of Engineering Undergraduate Advising office. The Accreditation Committee has developed procedures for each department to obtain feedback from all major constituencies, evaluate the input, and process the collected data for assessment. Input from industry, employers, and alumni are obtained through surveys, phone conversations, personal contacts, and industrial board meetings. Each department reviews the collected information, evaluates the input and works with the constituencies to revise and propose changes to the program objectives. The Accreditation Committee assures that the changes to program objectives are compatible with the College and University mission and at the same time it clearly reflects the unique features of the department.

Outcomes Required to Achieve Objectives

The faculty members in each department have developed a set of outcome statements for achieving program objectives. The mechanical engineering department has identified a total of thirteen (13) outcomes. The relationships between student outcome statements and the objectives A, B, C, and D are shown below.

Student Outcomes for Objective A: Students in this program will develop the following abilities through their undergraduate education in this department:

A-1 to use the principles from chemistry, physics, statistics, and mathematics in engineering applications

A-2 to use computer-based tools for engineering applications

A-3 to identify, formulate, and solve engineering problems

Student Outcomes for Objective B: Students will develop the following abilities through their undergraduate education in this department:

B-1 to formulate design problem objectives, constraints, and synthesize problem information

B-2 to develop creative and innovative designs that achieve desired performance criteria within specified objectives and constraints

B-3 to communicate effectively through written, oral, and graphical presentations

Student Outcomes for Objective C: Students will develop the following abilities through their undergraduate education in this department:

C-1 to design and conduct experiments to analyze and interpret experimental data

C-2 to use modern engineering tools, software, and laboratory instrumentation

C-3 to communicate effectively through written, oral, and graphical presentations

Student Outcomes for Objective D: Students will be introduced to the following issues through their undergraduate education in this department and will gain:

D-1 an ability to work in teams to solve multi-faceted problems

D-2 an ability to understand and contribute to the challenges of a rapidly changing society

D-3 an understanding of ethical and societal responsibilities of professional engineers

D-4 an understanding of the need for lifelong learning and continuing professional education

The department educational objectives also relates to ABET's Criterion 3 a-k "Program Outcome and Assessment"[1]. The relationships are summarized in Table 1.

Outcomes Assessment Process

The learning objective outcomes are achieved, mainly, through the curriculum. Student activities in student professional organizations will augment the curriculum in achieving the stated outcome. The Accreditation Committee has identified a set of tools to monitor student progress in achieving the outcomes. The assessment instruments fall into three general categories: audits, surveys, and student performance results.

Table 1. Correlation of Program Objectives with ABET Criterion 3 a-k "Program Outcome and Assessment"[1]

Program Educational Objective	**ABET Criterion**
A "fundamental analysis skills" acquire the ability to apply the fundamentals of mathematics, sciences and engineering to quantitatively analyze problems	(a) an ability to apply knowledge of mathematics, science, and engineering (e) ability to identify, formulate and solve engineering problems
B "creative thinking and design skills" develop innovative design skills, including the students' ability to formulate problems, to think creatively, to synthesize information, and to communicate effectively	(k) ability to use techniques, skills, and modern engineering tools necessary for engineering practice (c) ability to design a system, component, or process to meet desired needs (g) an ability to communicate effectively
C "experimental and data analysis skills" develop the ability to use modern experimental techniques; collect, analyze, and interpret experimental data; and effectively communicate the results	(b) ability to design and conduct experiments, as well as to analyze and interpret data (k) ability to use techniques, skills, and modern engineering tools necessary for engineering practice (g) an ability to communicate effectively
D "diverse career skills" prepare students with the diverse skills needed to be successful engineers	(d) an ability to function on multi-disciplinary teams (h) broad education necessary to understand the impact of engineering solutions in a global and societal context (i) a recognition of the need for, and an ability to engage in life-long learning (j) a knowledge of contemporary issues (f) an understanding of professional and ethical responsibility

The feedback cycle varies for each of the instruments. Some provide immediate feedback on student progress in achieving the outcomes and corrective actions can be made at the beginning of each semester. Others require long term analysis over several years.

Audits

Several types of audits are identified as described below for assessing program outcomes:

Curriculum Audit: Shows how the curriculum relates to the student outcome objectives. The ME undergraduate program is designed to meet the student outcomes for objectives A through D. Table 2 summarizes the correlation between each engineering course in the mechanical engineering program and the student outcomes. It is clear that all educational objectives are well addressed throughout the curriculum. Other instruments, such are surveys and test results, are used to determine whether the student outcome are being achieved. The analysis is an on going process and the curriculum will be adjusted when necessary.

Table 2. Relationship between undergraduate engineering courses and student outcomes

Course		Student Outcomes												
No	**Title**	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3	D4
Required Courses														
EGR 1303	Exploring Engr. Profession	√	√	√			√				√	√	√	√
EGR 2213	Statics and Dynamics	√		√										
EGR 2323	Engineering Analysis I	√	√	√										
EGR 3323	Engineering Analysis II	√		√										
EE 2213	Electronic and Circuit	√		√										
ME 1403	Engineering Graphics &Design	√	√	√	√	√	√							
ME 3103	Kinematics and Dynamics	√		√										
ME 3173	Numerical Methods in ME	√	√	√										
ME 3241	Materials Engineering Lab	√	√					√	√	√	√			
ME 3243	Materials Engineering	√		√										
ME 3263	Materials Processing	√		√										
ME 3293	Thermodynamics I	√	√	√								√		
ME 3312	Electronics & Data Acq. Lab	√	√					√	√	√	√			
ME 3513	Mechanism Design	√	√	√	√	√	√							
ME 3663	Fluid Mechanics	√		√										
ME 3813	Solid Mechanics	√		√										
ME 4293	Thermodynamics II	√	√	√	√	√	√				√	√		√
ME 4313	Heat Transfer & Rate Processes	√	√	√	√	√					√	√		√
ME 4523	Dynamic Systems and Control	√	√	√	√	√					√	√		√
ME 4603	FEA in Mechanical Design	√	√	√	√	√	√							
ME 4702	Mech. Systems/Controls Lab	√	√	√	√	√	√	√	√	√	√			
ME 4802	Thermal/Fluid Lab	√	√	√	√	√	√	√	√	√	√			
ME 4811	ME Project Planning Lab	√	√	√	√	√	√				√	√	√	√
ME 4813	ME Design Project	√	√	√	√	√	√				√	√	√	√
Technical Elective Courses														
ME 3323	Dynamics of Mech. Systems	√		√	√	√	√				√			√
ME 3823	Machine Element Design	√	√	√	√	√	√				√			√
ME 4113	Engineering Fracture Mechanics	√		√	√	√	√				√			√
ME 4183	Propulsion	√	√	√	√	√	√				√			√
ME 4243	Intermediate Materials Engr.	√		√	√	√	√				√			√
ME 4323	Thermal Systems Design	√	√	√	√	√	√				√			√
ME 4343	Heating, A/C, and Refrig. Des.	√	√	√	√	√	√				√			√
ME 4613	Power Systems Design	√	√	√	√	√	√	√	√	√	√			√
ME 4623	Internal Combustion Engines	√	√	√	√	√	√	√	√	√	√			√
ME 4663	Fluid System Design	√	√	√	√	√	√				√			√
ME 4723	Reliability and Quality Control	√	√	√	√	√	√				√			√
ME 4963	Topics in Bioengineering	√	√	√	√	√	√				√			√

Advising Process and Enforcement of Prerequisites: Advising and the enforcement of course prerequisites ensures that the students are taking required courses in the proper sequence. The

College of Engineering has established a policy requiring all students to see a faculty advisor before registering for courses each semester.[3,4] An administrative "hold" is placed on engineering students' records to prevent registration. The electronic hold is removed only after a student has met with a faculty advisor. Each faculty receives a degree audit plan for the students assigned to him/her. The degree audit plan shows the completed courses with grades and the list of remaining courses required for the degree. A system to check prerequisites has been implemented. At the beginning of each semester, the academic advisors check each student record for the required course prerequisites and those lacking the required prerequisites are dropped administratively from the course.

<u>Course Transfer Audit:</u> Transfer credits from community colleges and other universities are reviewed and approved by the engineering advisors and department chair for quality and topic coverage. When students want to apply course work completed at other institutions for transfer to UTSA, the student files are initially processed through the Transfer Evaluation Unit in the Office of Admissions and Registrar. Typically, courses designated by Texas Common Course Numbers (TCCN) are automatically accepted. These include the 42 SCH of Core Curriculum requirements and lower division courses such as calculus, physics, and introductory engineering courses. For upper division courses, students requesting transfer credit must provide sufficient documentation that the transfer course is equivalent to a course offered at UTSA. Based on the submitted documents, the department chair (sometimes in consultation with faculty members teaching the course being requested for transfer approval) will approve or deny the transfer request.

<u>Course Portfolio Audit:</u> A course portfolio contains the syllabus and samples of student work. Each ME course syllabus, as a minimum include the following information:

- Instructor information (name, office, office hours, etc.)
- Course coordinator
- Catalog course description
- Textbook information
- List of course prerequisites
- List of prerequisites by topic
- Course learning objectives
- Relationship between individual course learning objectives and ME department objectives and outcomes, as summarized in Table 2
- Topics covered in the course
- Evaluation methods (homework assignments, quizzes, exams, projects, reports, etc.)
- Performance criteria (evaluation methods used to assess student performance for each of the course learning objectives)
- Course content (Engineering Science, design, etc.)

Each course portfolio is peer reviewed by a set of faculty in the area related to the course to ensure adequate coverage of topics. The reviewing faculty group will provide feedback on topic coverage and on whether the course objectives are being met. The course portfolio audit is a short-cycle assessment tool that provides diagnostic feedback each semester.

Surveys

Survey instruments for assessing the objective outcomes are as follows:

Student Course Survey: This survey assesses student opinions on their success in reaching course objectives. In Spring semester 2002 each department began to develop survey instruments to obtain feedback from students regarding educational objectives and outcomes. In that semester we selected and conducted survey in seven (7) undergraduate courses. The courses surveyed in that semester included engineering foundation courses, an engineering science course, two laboratory courses, and a technical elective. The student course survey process was expanded to include all courses offered in the Fall 2002. Course surveys are typically conducted close to the end of the semester (12-14 week). The student course survey coincides with the student rating of instruction. Since Fall 2001, UTSA has used the instrument developed by the Individual Development and Educational Assessment (IDEA) Center[5] to evaluate the quality of instruction. Questions 1-47 of the instrument are used exclusively for the evaluation of the instruction. This instrument also allows an option of using question 48-66 for 19 additional questions. Starting in Fall 2002, we began using items 48-66 to assess the learning objectives for each course. A set of additional questions was developed for each course and was given to students during the course instructor survey.

The questionnaires included information on prerequisites and a list of course objectives. These were followed with a set of questions seeking student opinions on their knowledge of prerequisite topics and their success in meeting the learning objectives of the course. Table 3-a shows the information provided to students and Table 3-b shows the results of the course survey for ME 3293-Thermodynamics I. Students had the following choices to respond to questions on the survey: 1= definitely false, 2= more false than true, 3= in between, 4= more true than false, and 5= definitely true. Table 3-b gives the number of responses in each category, the average score, and standard deviation for each question. Occasionally, participants omitted responses to some of the questions as shown in Table 3-b. We also suspect that almost one third of participant did not realize that there were additional items on the backside of the questionnaire. Item 13-19 were printed on the backside of the questionnaire and the results shows that almost 30% of participants omitted these items.

An average score above 3 represents a collective positive attitude of respondents towards a particular question. The average scores for all items in Table 3 are above 3.0. Items 1-5 are related to prerequisite topics. Most respondents indicated that the basic calculus courses have prepared them for ME 3293. The responses related to courses in technical physics and statics were not as strong. The average score for the statement "Statics and Dynamics has prepared me for this class (e.g. I have no difficulty applying free body diagrams in solving problems) was 3.4. Items 6-19 in Table 3 relate to the course learning objectives. With the exception of items 11-13 and 17, the average scores for items related to the course learning objectives were greater or equal to 4.0. Items 11-13 are associated with the second law of thermodynamics and the application of thermodynamics cycles. These topics are covered near the end of the semester.

Since the survey was conducted two weeks before the end of semester students did not have adequate experience with these topics.

Student course surveys provide instructors immediate feedback on learning objectives at the end of each semester. For example Table 3-b gives an average score of 3.5 for the statement "I have utilized computers in solving engineering problems for this course." The average score for the same item was 2.5 in Spring 2002 indicating that a number of students in ME 3293 did not fully learn how to use the interactive computer software[6] or did not take advantage of utilizing the software in solving thermodynamic problems. Therefore, better instructions for using the software were provided in Fall 2002 and the average score for this item was increased by one point.

Table 3-a. ME 3293 survey: course prerequisite, topic prerequisite, and course objectives

Course Prerequisites: EGR 2213- Statics and Dynamics

Major Prerequisites by Topic:
1. Differentiation
2. Integration
3. Static equilibrium
4. Force free-body diagram
5. Fundamental units and dimensions

Course Objectives:
To provide an opportunity for students to
1. learn about thermodynamic systems and boundaries
2. study the basic laws of thermodynamics including
   - conservation of mass
   - conservation of energy or first law
   - second law
3. understand various forms of energy including heat transfer and work
4. identify various type of properties (e.g., extensive and intensive properties)
5. use tables, equations, and charts, in evaluation of thermodynamic properties
6. apply conservation of mass, first law, and second law in thermodynamic analysis of systems (e.g., turbines, pumps, compressors, heat exchangers, etc.)
7. use computer software in evaluation of thermodynamic properties and graphical presentation of problem solutions
8. enhance student problem solving skills

Relationship to ME Department Objectives and Outcomes:
The course objectives primarily address the ME department educational objectives and outcome [A.1, A.2, A.3, B3]. Lectures make references to outcomes [D2, D3, and D4]

Table 3-b ME 3293 course survey – responses to specific questions. 1= definitely false, 2= more false than true, 3= in between, 4= more true than false, 5= definitely true, O = omit

No.	Question	1	2	3	4	5	O	Avg	s.d.
1	Calculus I (differential calculus) has prepared me for this class	0	2	5	4	7	1	**3.9**	**1.1**
2	Calculus II (integral calculus) has prepared me for this class	0	1	5	5	7	1	**4.0**	**1.0**
3	Technical Physics I (Mechanics and Heat) has prepared me for this class	1	4	1	6	6	1	**3.7**	**1.3**
4	Statics and Dynamics has prepared me for this class (e.g. I have no difficulty applying free body diagrams in solving problems)	1	4	4	5	4	1	**3.4**	**1.2**
5	I have no difficulty applying differentiation and integration	0	0	5	7	6	1	**4.1**	**0.8**
6	I can define a thermodynamic system	0	0	1	7	10	1	**4.5**	**0.6**
7	I can evaluate properties, using thermodynamic tables and charts (general compressibility, etc.)	1	0	2	5	10	1	**4.3**	**1.1**
8	I can evaluate properties, using appropriate equations for ideal gases	0	0	5	7	6	1	**4.1**	**0.8**
9	I can write down the mass rate balance equation and simplify it for a closed system, an open system, a steady state process, or a transient process (uniform state, uniform flow)	0	0	2	8	8	1	**4.3**	**0.7**
10	I can apply the first law of thermodynamics to a closed system, an open system, a steady-state process, a transient process (uniform state, uniform flow)	0	0	3	6	9	1	**4.3**	**0.8**
11	I can apply the second law of thermodynamics to the following systems and processes to a closed system, an open system, a steady state process, a transient process (uniform state, uniform flow)	1	0	4	5	8	1	**3.8**	**1.1**
12	I can apply the first law for thermodynamic cycles	1	0	6	6	5	1	**3.8**	**1.1**
13	I can apply the second law for thermodynamic cycles	1	0	7	6	4	1	**3.7**	**1.0**
14	I can define the thermal efficiency of a power cycle, the coefficient of performance for a cooling cycle, or coefficient of performance for a heating cycle (heat pump)	1	0	2	5	5	6	**4.0**	**1.2**
15	I can convert units, check dimensions, and solve problems using both US customary units (ft, lb_f, lb, Btu, hp) and SI (m, N, kg, J, W)	1	0	0	4	8	6	**4.4**	**1.1**
16	I have a firm understanding of the many applications of thermodynamics encountered by engineers	0	1	2	5	5	6	**4.1**	**1.0**
17	I have utilized computers in solving engineering problems for this course	1	3	2	3	4	6	**3.5**	**1.4**
18	This course has helped develop/enhance my problem solving skills	0	0	3	4	6	6	**4.2**	**0.8**
19	The recitation hour in this course has helped me in learning the course materials and enhancing problem solving skills	0	1	3	4	5	6	**4.0**	**1.0**

Instructor Course Assessment: This survey assesses the instructor's opinion on the student success in reaching course objectives. The course survey is almost identical to the student course survey, except the instructors are asked to evaluate how well those students who have successfully completed the course (with grade of C or better) meet the course objective. For example, the instructor course survey for ME 3293 replaces the statement "I can apply the first law of thermodynamics to a closed system, an open system, a steady-state process, a transient process (uniform state, uniform flow)" for item 10 in able 3-b with "Students who have successfully completed this course can apply the first law of thermodynamics to a closed system, an open system, a steady-state process, a transient process (uniform state, uniform flow)."

Student Exit Survey: A surveys was conducted at the end of Spring semester 2002 to assess the opinions of graduating seniors in the ME programs on their success in achieving program outcomes and on their attitudes toward the department. Students had a choice of ranking each item in the questionnaire as: exemplary = 5, positive = 4, neutral = 3, negative = 2 , extremely negative =1. The results of this survey are summarized in Table 4. The average scores for all questions are above 3.0, except question 6 (computer hardware and facilities) with an average score of 2.9. It appears that the students were not completely satisfied with the access to the computer lab/lecture, since this space is heavily used for instruction. Additional lab space is necessary to improve the situation. This survey provides important information for the assessments of educational objectives and outcomes: A-1 through A-4, B-1 through B-3, C-1 through C-3, D-1 through D-4.

The IDEA Student Rating of Instruction Group Summary Report: This report summarizes the quality of instruction in the department, shows how the course objectives identified by instructors as essential or important relate to the student outcome for the program objectives.

The learning objectives identified by faculty as "Essential" and "Important" are summarized below. The relationships between the selected course objectives and the specific student outcomes are also identified. The percentage column indicates how often the ME faculty members have identified a course learning objective as important or essential. Not all items given in the IDEA report are included here. Only those items related to our program objectives are included.

Course Learning Objective	% of ME Course	ME-Outcome #
1. Gaining factual knowledge	68	A-1, A-3
2. Gaining the fundamental principles	90	A-1, A-
3. Learning to apply course material	94	A-1-A-4
4. Developing specific skills	74	A-2, C-
5. Acquiring skills working in a team	26	D-1
6. Developing creative capacities	26	B-2
7. Developing skills in oral and written communications	26	B-3
8. Learning how to use resources to find a solution	29	D-4

The results in the IDEA report indicate that with the exception of course objective 5, the student rating of the UTSA's ME courses in meeting the course objective always exceeds those for the IDEA system.

Alumni and Employers Survey: Survey instruments have been developed to obtain input from such major constituencies as alumni and employers. We are in the process of seeking alumni and employers opinions on the outcomes of the program objectives. The results of these surveys will influence the long term planning for the department.

Table 4. Graduating seniors exit survey results. Student choices for rating each items were: 5 = exemplary, 4 = positive, 3 = neutral, 2 = negative, 1= extremely negative. Specific outcome measures are shown in parenthesis.

No.	Question	5	4	3	2	1	T	Ave
		No. of Respondents						
1	Overall education at UTSA	0	9	0	2	0	11	**3.6**
2	Overall education in the COE	0	9	1	0	1	11	**3.6**
3	Engineering Faculty	4	6	0	0	1	11	**4.1**
4	Engineering Staff	2	6	2	0	1	11	**3.7**
5	Advising:							
a	COE Advising Center	2	6	2	1	0	11	**3.8**
b	Faculty Advising	3	3	5	0	0	11	**3.8**
6	Computer hardware and facilities	0	2	6	3	0	11	**2.9**
7	Computer software tools	2	4	4	1	0	11	**3.6**
8	Laboratory							
a	Facility	1	4	2	4	0	11	**3.2**
b	Equipment	1	4	3	2	1	11	**3.2**
9	Quality of mathematics courses							
a	Fundamental (Calculus) (A-1)	3	6	2	0	0	11	**4.1**
b	Engineering Analysis (A-1)	4	4	2	1	0	11	**4.0**
c	Probability and Statistics (A-1)	3	2	4	2	0	11	**3.5**
10	Quality of engineering courses							
a	Fundamental (A-1)	2	7	1	1	0	11	**3.9**
b	Laboratory-oriented (C-2)	3	5	2	1	0	11	**3.9**
c	Design-oriented (B-2)	4	4	2	0	1	11	**3.9**
d	Technical electives (A-1, A-2, B-1, B-2)	4	5	1	0	0	10	**4.3**
e	Senior capstone (b-1, B-2, B-3, D-1, D-3)	4	5	1	0	1	11	**4.0**
11	Your ability to apply							
a	Basic knowledge of mathematics, science, and engineering (A-1, A-2, A-3))	3	6	2	0	0	11	**4.1**
b	Probability and statistics in engineering applications engineering (A-1)	2	4	3	2	0	11	**3.5**
c	Economics in engineering applications (B-2)	2	4	5	0	0	11	**3.7**
d	Computer-based tools for engineering applications (A-2)	4	5	2	0	0	11	**4.2**
12	Your ability to							
a	Identify, formulate, and solve engineering problems (A-3)	2	7	0	2	0	11	**3.8**
b	Design laboratory experiments (C-1)	3	6	0	2	0	11	**3.9**
c	Design a system, component, or process (B-1, B-2)	2	5	2	1	1	11	**3.5**
13	Your ability to communicate technical information							
a	Written (B-3)	5	3	2	1	0	11	**4.1**
b	Orally (B-3)	6	2	2	1	0	11	**4.2**
14	Your ability to function in teams (D-1)	4	5	1	1	0	11	**4.1**
15	Your capacity for lifelong learning (D-4)	6	3	0	2	0	11	**4.2**
16	Your understanding of professional and ethical responsibilities (D-3)	6	3	1	0	1	11	**4.2**

Student performance measures

The student performance measures used in the assessment include the Fundamental Engineering Exam and student retention.

Results of Fundamentals of Engineering (FE) Exam: This national exam is used as a first step in the professional licensing of engineers and was developed to measure minimum technical competence. It is a pass/fail exam that is taken by approximately 50,000 people who are either a senior within one year of graduation or recent college graduates. The exam provides data on performance in specific topic areas within the engineering curriculum.

In the last few years engineering students have been given the choice of taking either a general FE exam or a discipline-specific exam. The 8-hour exam includes a morning and an afternoon period. The morning session includes questions in math, science, and basic engineering topics. The afternoon session questions cover specific engineering topics.

The FE exam results also provide data on student performance in specific topic areas within the engineering curriculum. The results show that our student performances in many of the topic areas are the same as those from other state and national institutions. However, our students have not performed as well in a few of the topics in the FE exam (Statics, Mechanical Design). We are making adjustments in our curriculum to improve instruction in the weak performance areas.

The results of the FE exam passing rates reported by the National Council of Examiners for Engineering and Surveying (NCEES) are summarized in Fig. 1 for the ME program. Since the number of students taking the exam might be very low in a given semester, we are showing the running average of the passing rate for the period between 1990 and 2002. The passing rates for the ME department have been in the range of 0% (when only one student took the exam) to 100%. Figure 1 shows that the current cumulative passing rate for ME students is 83.4% that is above the college rate and is comparable to the state and national rates.

At UTSA we encourage all engineering students to take the FE exam. Before the offering of the discipline-specific exams by NCEES, the engineering faculty at UTSA provided review sessions for the FE exams outside the regular class periods. However, it became more difficult and impractical to offer three different discipline-specific review sessions. As a result, the passing rate has dropped slightly since Fall semester, 1997. We are again exploring ideas to find an efficient way to start offering FE exam review sessions for our students.

Student Retention: The 1999-2000 student retention data shows that engineering student retention rates are similar to those for the entire university and the rates at other similar institutions. For example, the retention rate of entering ME full-time freshmen at UTSA was 63.6 % as compared to 58.6% for the entire university, 64.4 % at The University of Texas at El Paso, and 65.5% at The University of Texas at Arlington. Data tracking first-time freshmen admitted to the University in Fall 1993-1996 exhibits higher retention rates for engineering students as compared to those for the entire University student population.

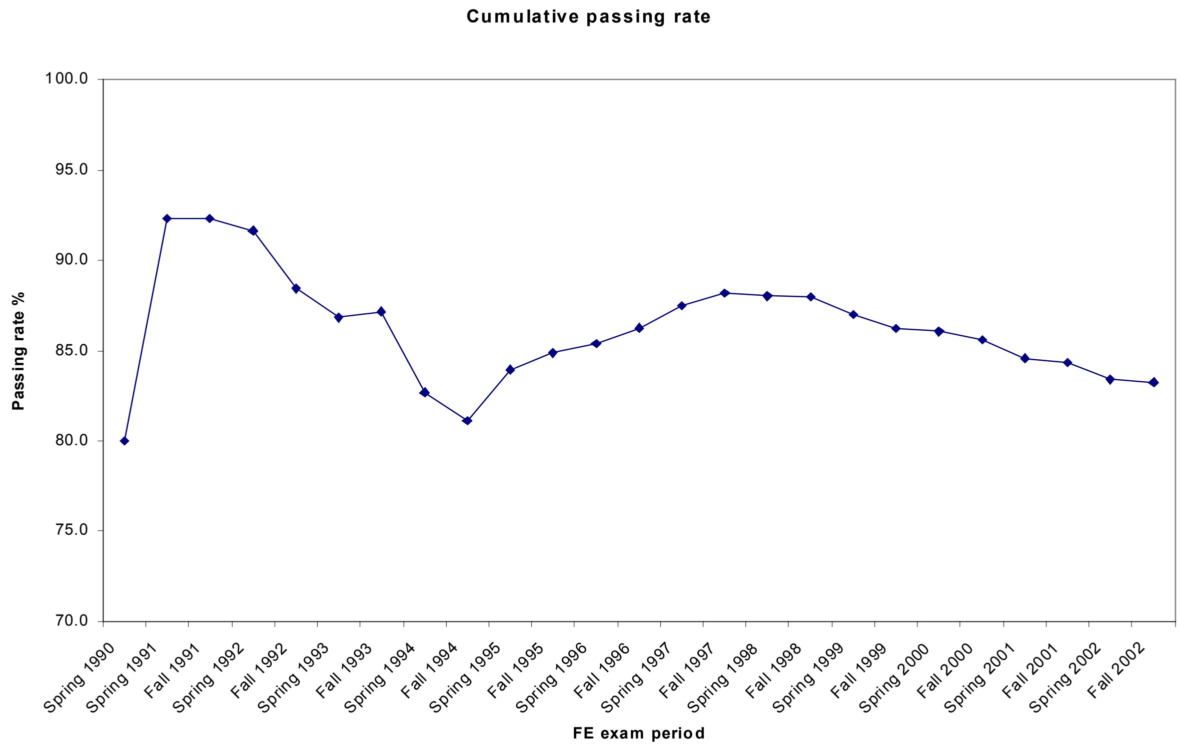

Fig. 1. FE exam running average passing rate for the ME students.

Summary of Outcome Assessment Results and Overall Action Items

The overall assessment results are positive. Several types of student surveys were used to measure the outcomes of the program learning objectives. Respondents were asked to rate their satisfaction with various aspects of their educational experience at UTSA. They have indicated high levels of satisfaction with faculty in several areas: access, enthusiasm for teaching, and quality of instruction. The majority of the ME students surveyed were satisfied with the quality of skills, knowledge, and understanding they had acquired in the Department of Mechanical Engineering and the College of Engineering. The IDEA report on student rating of the faculty showed superior performance by the ME faculty over the IDEA system for meeting those course objectives identified either as Essential or Important. The undergraduate course surveys provided useful information for individual courses and a correlation between the topic coverage in these courses and the program learning objectives.

The faculty assessments of course prerequisites have indicated student deficiencies in knowledge of topics in Statics. In Fall 2000, the ME and CE programs decided to combine Statics and Dynamics in a single course in order to reduce the required semester credit hours for a B.S. degree. To correct the deficiency faculty members in both departments have decided to revise the curriculum for the 2004-06 catalog by requiring two separate courses in Statics and Dynamics.

Other assessment instruments, such as the passing rate for the FE exam showed positive results for the ME program. However these results also indicated that our students have not been performing well in the area of mechanical design in the last few years. In fall 2000 Machine Element Design was changed from a required course to a technical elective in the curriculum. During the revision of 2004-06 catalog, the ME faculty decided to make Machine Element Design a required course again.

Student surveys also identified other problems. For example scheduling courses is a difficulty for those students who work off campus, even though we are currently offer all required courses during the Fall and Spring semesters. The dilemma is that these students want the courses to be available at a time that does not conflict with their work schedule. One remedy is to offer multiple section courses. However, this requires additional resources. To improve the situation, a two-year course rotation schedule has been developed and made available to students showing the days and times of the course offerings. This will allow students to plan ahead for work and class schedules. The exit survey has also indicated that students have had difficulty in getting access to the Engineering computer facilities. Currently, the computer facilities have dual usage. Two out of the three computer facilities are being used for instruction and students have access to these facilities only when they are not used for instruction. This problem of space should be resolved when the new Biosciences and Bioengineering building is complete.

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