AC 2007-371: WEB-BASED COURSE OUTCOME ASSESSMENT EXPERIENCE IN COMPUTER ENGINEERING TECHNOLOGY

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Web-Based Course Outcome Assessment Experience in Computer Engineering Technology

Abstract

In November 2004 an innovative undergraduate Computer Engineering Technology program based on TAC of ABET program assessment criteria was granted licensure by the State Department of Higher Education. The University has considerable experience with accreditation and associated assessment activities, most recently reporting on an "In-common Methodology for Objective- and Outcome-based Programs Assessment" (Lema, L.F., Baumann, P.F., and Prusak, Z., ASEE 2005 Annual Conference) across three engineering technology programs. This study reports an assessment component within the Computer Engineering Technology program in accordance with ABET accreditation criteria. The implementation process was conducted in an undergraduate course in the program. The initial phase involves identification of course goals, and based on these goals, the measurable learning outcomes are formulated. Using web-based methodology and course management tools such as WebCT or Vista, the learning outcomes are measured in the form of pre- and post-course survey data from students. Data can be imported to data management tools such as Excel for analysis and evaluation. This study uses computer programs as tools to facilitate data collection and data analysis, making the data intensive portion of the assessment and evaluation process an easier endeavor. Applicability towards the assessment efforts of other engineering technology programs is also addressed.

Bachelor of Science in Computer Engineering Technology

The mission of the computer engineering technology program is to provide graduates with the academic and practical knowledge that is widely accepted in the field of computer engineering technology. This is done by encouraging students to incorporate hardware and software computer systems in solving science, engineering, technology, and manufacturing problems.

The computer engineering technology degree program offers students a balanced foundation and a wide choice of career paths. This program will also be a solid and a very marketable program of professional training to fit in many of the high paid, high demand positions such as system administrators, network administrators, system designers, quality control engineers, and software developers. Graduates can also find positions as information technologists, lab technicians, system maintenance personnel, system testers, and help desk attendants. Numerous choices are available to focus endeavors if they plan to continue their graduate studies.

The Bachelor of Science in Computer Engineering Technology is a planned program of study requiring a minimum of 124 semester hours of credit. Out of this, a minimum of 43 credits is required from the university General Education studies. In addition to that, all Computer Engineering Technology majors are required to complete 27 credits of core requirements (Table 1) in the area of Computer Science, General Engineering Technology, and Math/Technical Writing skills, and 36 credits of Computer Engineering Technology Specialization courses (Table 2), 15 credits of directed electives, and 3 hours of free electives.

Table 1: Core Courses

Course number	**BS Computer Engineering Technology Core Requirements**	**Credits**
ET 150	Intro to Engineering Technology	3
ET 251	Applied Engineering Mechanics I	3
ET 260	CAD & Int. Mfg. OR MFG 121	3
ETM 356	Materials Analysis	3
ET 357	Strength of Materials	3
STAT 104	Elementary Statistics	3
ENG 403	Technical Writing	3
CS 151	Computer Science I	3
CS 152	Computer Science II	3

Table 2: Specialization Courses

Course number	**BS Computer Engineering Technology Specialization Requirements**	**Credits**
CET 113	Intro to Information Processing	3
CET 229	Computer Hardware Architecture	3
CET 236	Circuit Analysis	3
CET 249	Introduction to Networking	3
CET 323	Analog Circuits	3
CET 339	Computer System Administration	3
CET 346	Signals and Systems	3
CET 349	Networking Devices	3
CET 366	Fundamentals of Logic Design	3
CET 449	Advanced Networking	3
CET 453	Microcomputers	3
CET 498	Senior Project	3

Computer Engineering Technology Program Objectives and Outcomes

As indicated later for the new Computer Engineering Technology Program, the continuous improvement plans for the CCSU Engineering Technology Programs prescribe four objectives and ten outcomes in accordance with ABET TC2K Criterion I a-k requirements.[1] Due to the commonalities between ET programs at CCSU, program objectives 3 and 4 and learning outcomes 1 through 10 could be identical for all ET programs. Objectives 1 and 2 are discipline specific and geared toward ultimate career goals.

Program Objectives

(Letters indicate the TAC of ABET TC2K a-k requirements addressed*)*

1. Graduates are prepared with an understanding of fundamental technical sciences that are integrated with the applied technical specialty, such as engineering materials, electrical circuits, and computer-aided engineering graphics, developing analytical techniques and problem solving skills necessary to adapt to technological changes, and for a career in computer engineering technology.(a,b,f)
2. Graduates acquire industry relevant experience within the academic environment through laboratory projects, experimentation, classroom lecture and demonstrations, and acquire in-depth technical knowledge in areas such as hardware and software, wired and wireless network communication, engineering design, advanced PC operating systems, internet technologies and computer programming. (a,c,d)
3. Graduates possess effective communication skills in oral, written, visual and graphic modes for interpersonal, team, and group environments. (e,g)
4. Graduates have appreciation for the responsibility of the contemporary engineering technologist by demonstrating professionalism and ethics including a commitment to utmost performance quality and timeliness, respect for diversity, awareness of international issues, and commitment to continuing professional development throughout their careers. (h,j,k)

Program Outcomes

(Numbers indicate the related objectives and letters indicate the TAC of ABET TC2K a-k requirements addressed*)*

The computer engineering technology program demonstrates that graduates have:

- Ability to apply basics knowledge of mathematics, science and engineering principles to solve technical problems. (1) (a,b,f)
- Ability to identify, formulate and solve technical problems. (1,2)(a,c,d,f)
- Ability to use computational methods, skills, computers and modern technical tools in engineering practice. (1,2,3)(a,b,c,f,g)
- Ability to design and conduct experiments, and to analyze and interpret data. (2)(c)
- Ability to design a system, component or process to meet desired needs.(2)(a,d)
- Ability to function effectively on teams and within a diverse environment.(3,4)(e,j)

- Ability to communicate effectively in oral, written, visual and graphic modes.(3),(g)
- Recognition of the need for self-improvement through continuing education and the ability to engage in lifelong learning. (4)(h,k)
- Understanding of professionalism and ethics and associated responsibilities. (4)(i,k)
- Knowledge of contemporary issues and understanding of the impact of engineering/technical solutions within a global perspective.(1,2,4)(i,j)

Assessment for the B.S. in Computer Engineering Technology

The BS in Computer Engineering Technology is based[2] on the new TAC of ABET dynamic accreditation philosophy on a formalized assessment plan for measurable outcomes. According to Kremens, this is a "two-fold approach comprising minimum accreditation standards and continuous improvement process through self-evaluation and quality improvement". He continues that "the outcomes must be continuously measured, analyzed and corrective actions implemented. The approach is evidently "dynamic" and results in ongoing evaluations and corrections as a response to changes in industry, technology trends etc." This approach as outlined in Figure1. fits with the University requirement that departments submit assessments of their programs at the start of each academic year.

ENGINEERING TECHNOLOGY ACCREDITATION MODEL

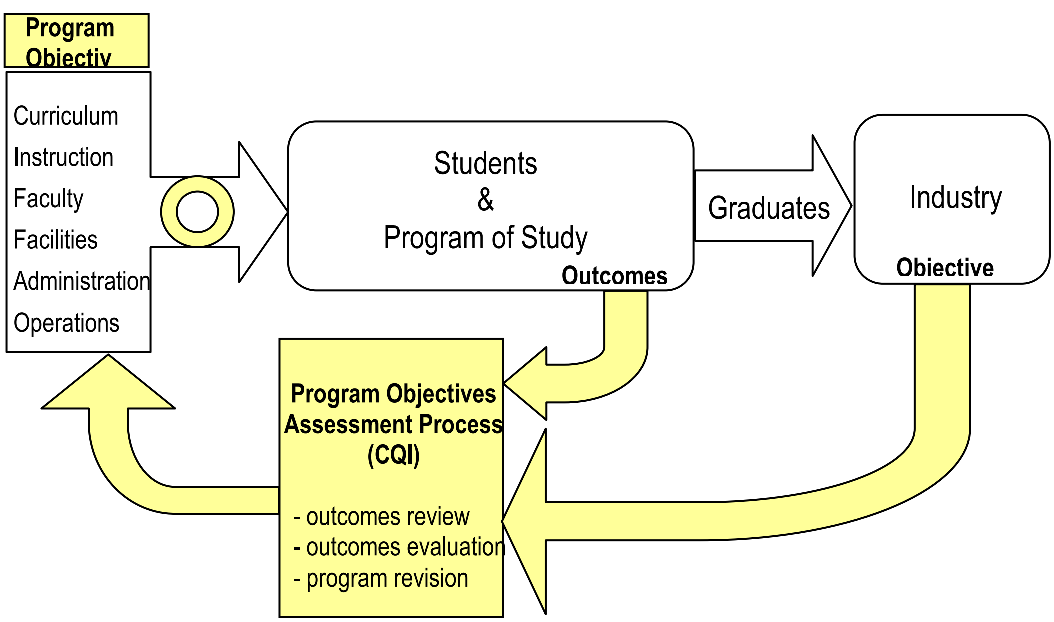

Figure 1. "Dynamic" accreditation model (input monitoring and continous assessment process) Based on Kremens[2]

Assessment Methods and Tools

As mentioned earlier, our University has considerable experience with accreditation and associated assessment activities in civil, mechanical, and manufacturing engineering technology programs. The Engineering Technology Department has presented an "In-common Methodology for Objective- and Outcome-based Programs Assessment".[3] Through it Central has streamlined its process by assessing common learning objectives and outcomes across three TAC of ABET TC2K accredited programs simultaneously leaving only a limited number of additional discipline specific program assessments. The methodology detailed and formalized is built upon the foundations established by predecessors.

Palomba and Banta, in providing generic assessment process organization, indicate that procedures should be efficient and describe effective assessment program aspects.[4] Efficiency with regard to the time involvement of faculty in the data gathering and evaluation process was one of the principle motivations for the initial planning based upon commonalities between programs and subjects taught. Generally, the programs as described by Palomba and Banta encourage top-down sharing of tasks instead of bottom-up development data gathering and evaluation procedures for a more productive use of faculty time.

Angelo and Cross describe the Teaching Goals Inventory (TGI) used to map direction towards goal achievement.[5] Prior to the establishment of the ABET TC2K requirements, detailed TGI was developed for the Manufacturing ET program at CCSU and subsequently adapted for the Civil and Mechanical ET programs. Large matrices documented or mapped learning objectives with the applicable program courses with the degree of fulfillment obtained indicated by color code. Use of these matrices for TC2K program assessment was judged too cumbersome for thorough execution at CCSU when considering the very short time frame before ABET accreditation visitation and the significant allocation of faculty time and financial resources required for completion. Thus an alternative methodology was needed and developed using an approach resembling Group Technology (GT), which is common in design and manufacturing, whereby commonalities are focused upon and only required differences are independently assessed.

Table 3 reveals the various assessment methods used to evaluate the four objectives and ten outcomes. For much of the internal outcomes assessment, specific courses provided the needed data as outlined in Tables 4 and 5. The Computer Engineering Technology Program internal data are collected yearly, while data from external sources are collected less frequently so as not to overburden graduates, employers, and Industrial Advisory Board (IAB) members with assessment. Although significantly reduced by assessment plan design based on program commonalities, the data gathering and evaluation process still require significant faculty efforts and commitment for yearly cycle completion of the continuous improvement plans.

Table 3. Assessment Method Used to Evaluate Program Objectives and Outcomes Based on Lema, Baumann, and Prusak [3]

Assessment Method	Objective				Outcome									
	1	2	3	4	1	2	3	4	5	6	7	8	9	10
Written Surveys	●	●	●	●										●
Focus Group	●	●	●	●										
Locally Developed Exams					●	●							●	
Portfolio							●	●	●		●			
Exit Interview									●			●		
Performance Appraisal										●				
Behavioral Observation								●			●			
Standardized Exam					●									
External Examiner														●
Rubric						●		●		●	●			

Table 4. Specific Courses Used in Assessment Process Modified from Lema, Baumann, and Prusak [3]

Course Number	Course Title
ET 150	Introduction to Engineering Technology
ET 357	Strength of Materials
CET 498	Computer Engineering Technology Senior Project
CET 346	Signals and Systems
CET 349	Networking Devices
CET 453	Microcomputers

Table 5. Specific Courses Used to Substantiate Learning Outcomes Modified from Lema, Baumann, and Prusak [3]

Course Number	Program Plan Supported	Learning Outcome	Substantiation Method
ET 150	CET/Civil/Mfg/Mech	9	Locally developed exam
ET 357	CET/Civil/Mfg/Mech	1, 2	Locally developed exam
CET 498	CET	2, 4, 5, 7, 8, 9	Rubric (2), Student work portfolio (4,5,7), Exit interview (5,8), Behavioral observation rubric (7), Locally developed exam (9)
CET 346	CET	3	Electronic student work
CET 453	CET	4	Student work portfolio / Behavioral observation rubric
CET 349	CET	6	Performance appraisal rubric

Proposed Review, Evaluation, and Program Revision

The assessment data are collected by the computer engineering technology faculty. The program coordinator and program faculty compile, review, and analyze the data and report their findings to the department chairperson. At a department meeting scheduled for a full review and analysis of the program assessment data, faculty propose recommendations.

The Program Coordinator, department faculty and Industrial Advisory board members meet to formalize recommendations regarding curriculum revisions, course topics and subject content, laboratory exercises, and other concerns as determined from the assessment data.

Program revision, curriculum and course revisions are to be approved by the Computer Electronics and Graphics Technology Department faculty before being submitted according to School of Technology and University procedures to the University Curriculum Committee, Faculty Senate and appropriate administrators for approval.

Student's Evaluation of Learning Outcomes

Course evaluation is a continuous process and should include a feedback from students about their learning experience. Traditionally, student evaluations focus on the learning outcome measured by the instructor through quizzes or other tools, as summarized above. However, these measures do not reflect the individual learning experience of the students. Assessment of the students' perception of a course provides insight into the effectiveness of the learning process as well as to the teaching thereof. Therefore, course evaluations performed by students are also included in our learning outcome assessment procedures. The approach provides departments and programs with bottom up evaluations to motivate faculty to make appropriate and effective improvements in teaching and learning practices.

This study reports as an example on the implementation of an assessment component within the Computer Engineering Technology program based on the model "Bottom Up Program Assessment using Learning Outcome Measurements".[6] The process was implemented in an undergraduate course (CET 349 Networking Devices) within the Computer Engineering Technology program. The initial phase involves identification of course goals. Then, based on these goals, measurable learning outcomes are formulated (Table 6). CET 349 Networking Devices is credit hours. In this class 11 chapter topics were covered combining the theory with laboratory exercises. Students are required the take tests for each of the 11 chapters in addition to a comprehensive final exam. They also performed 10 lab assignments based on the course content. At the end of the semester an external examiner from industry and the class instructor assessed their lab skills on an individual basis. In addition, to engage and motivate the students, periodic open quizzes in the form of the Jeopardy game were conducted.

Table 6. Pre- and Post-Assessment for CET 349-Networking Devices

Number	Syllabus: Learning Outcomes	Assessment Survey: Question
0.	Students expectations from this course	What are your expectation for this course?
1.	Understand routers and their roles in WANs	Do you know routers and their roles in WANs?
3.	Identify the major internal and external components of routers , and describe the associated functionality	Are you ready to identify the major internal and external components of routers, and describe the associated functionality?
4.	Connect router Fast Ethernet, serial WAN, and console ports	Can you connect router Fast Ethernet, serial WAN, and console ports?
5.	Explain router configuration and router file management	Can you explain router configuration and router file management?
6.	Understand and configure RIP and IGRP routing protocols	Do you know how to configure RIP and IGRP routing protocols?
7.	Describe the operation of the ICMP and identify the reasons, types, and format associated with distant vector routing protocols	Can you describe the operation of the ICMP and identify the reasons, types, and format associated with distant vector routing protocols?
8.	Perform router troubleshooting	Are you ready to perform router troubleshooting?
9.	Describe the operation of major transport layer protocols and the interaction and carriage of application layer data	Can you describe the operation of major transport layer protocols and the interaction and carriage of application layer data?
10	Analyze, configure, implement, and rectify access control lists within a router configuration	Can you analyze, configure, implement, and rectify access control lists within a router configuration?

Using web-based methodology and course management tools such as WebCT or Vista, the learning outcomes are assessed at the student level in the form of pre- and post-survey data. Results are included as Figure 2 and Figure 3 indicating overall achievement of outcomes. This efficient data gathering and evaluation bottom-up approach, as described in this paper, focuses on the learners and assesses the learning outcomes by comparison to the course objectives as set forth by the instructors.

Student Feedback using WebCT

In addition to these course outcomes survey, students were requested to submit their course feedback via WebCT or Vista by the end of the semester. Results of students' feedbacks for 10 questions are shown below:

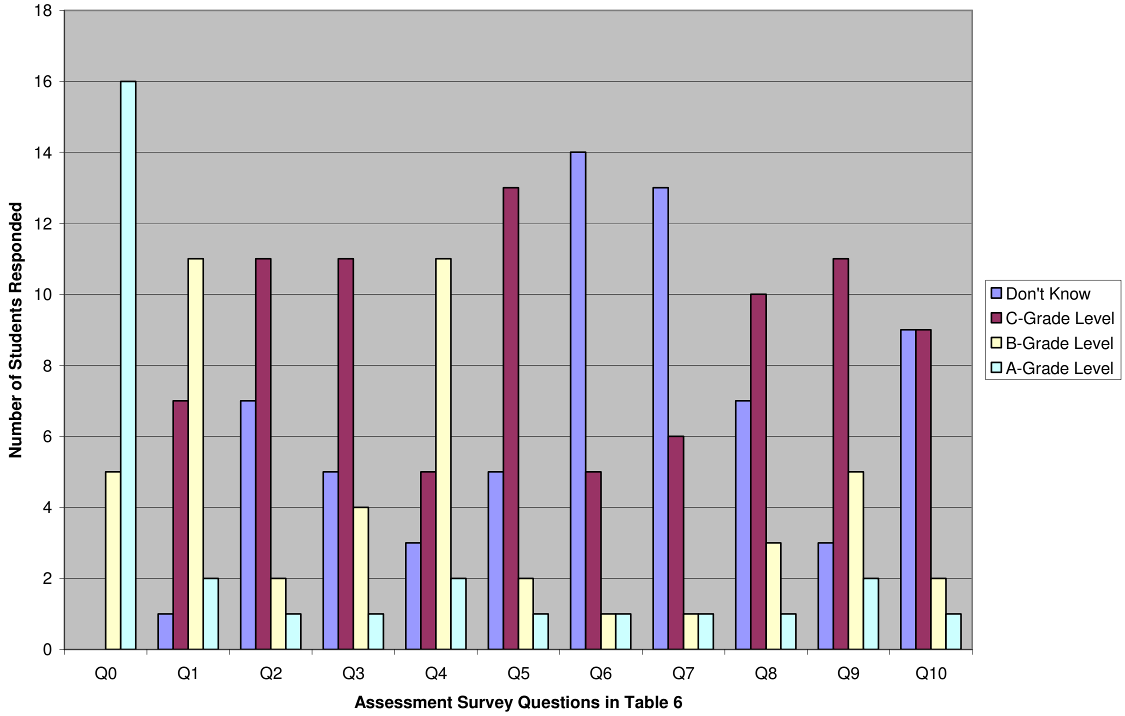

Figure 2. Pre-assessment learning outcomes for CET 349 class

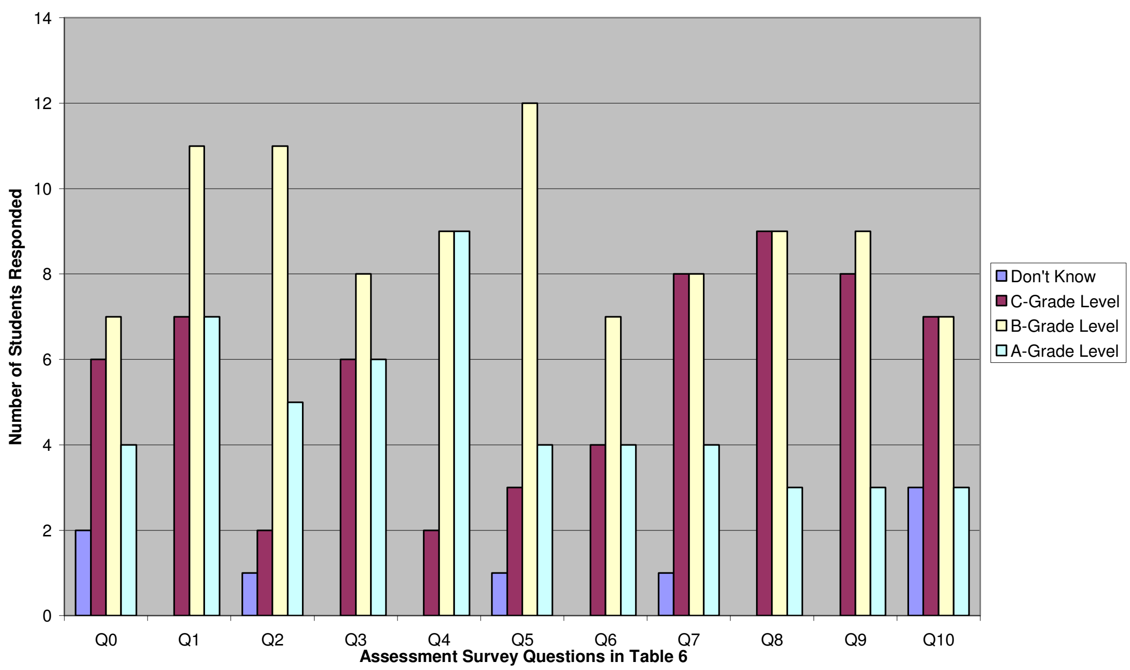

Figure 3. Post-assessment learning outcomes for CET 349 class

Question #1: Why did you sign up for this course?
Responses varied from a required course in curricula to students who wished to learn and get hands-on experience with network tools.

Question #2: What are the reasons for your attendance or the lack of your attendance?
Students responded that class was interesting and weekly exams provided motivation. Sickness, conflicts and attitude were blamed for lack of attendance.

Question #3: How did you cope with the course assignments?
Some students noted that with study and balancing other requirements that they could cope, but a few commented on difficulties.

Question #4: How hard or easy were the quizzes?
Students' response depended entirely on the individual chapters. Some chapters were simpler than others; some were long and complex. In general the quizzes seemed fair for most of the students.

Question #5: Were the sessions sufficiently prepared by the lecturers?
Everyone in the class felt that the lecturer prepared the students to the best of his ability.

Question #6: Were the topics presented in a confusing way? Why or why not?
In general, students felt certain topics were confusing, but they were often presented in a way that made them seem simpler by comparing them to real life situations. However, some concepts, such as Access Controls Lists, are confusing few students.

Question #7: Did you read the assignments? Why or why not?
Most students read their assignments

Question #8: What do you think about the course content?
Students felt the course material was interesting

Question #9: What topics are missing?
Most students felt that the coverage was complete. Subnetting and more ACL details were recommended.

Question #10: What would you like to know more in addition or instead of which course topic?
Students would like to learn more about real life networking applications such as security, physical networks, router programming, and router operation which is covered in the third semester of networking course.

Conclusion

ABET requirements can be met with simple assessment tools which complement the traditional learning outcome measurements performed by the instructor through final quizzes and other means. The student's perspective of the learning outcome adds a valuable tool to be considered. Clearly defining goals and objectives in a program and at the course level help greatly in understanding the role of each course in the program. Using web based course management tools, together with learning outcomes linked student assessment feedback from students, is beneficial without over burdening faculty in the data collection stage.

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