Electronic Engineering Technology Program Exit Examination as an ABET and Self-Assessment Tool

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Abstract

Each engineering, computing and engineering technology program accredited by the Accreditation Board for Engineering and Technology (ABET) has formulated many and varied self-assessment methods. Methods used to assess a program for ABET accreditation and continuous improvement are for keeping programs current with academic and non-academic trends and standards.

The methods used to assess a program range from course assessment report (CAR) done solely by faculty for every course that the faculty member teaches, student and faculty survey instruments, industrial advisory board input on curriculum, and the fundamentals of engineering exam (F.E.). These methods provide a continuous self-evaluation of instruction related activities which are critical to maintaining a quality undergraduate program and critical to maintaining ABET accreditation of engineering, computing and Technology programs.

This paper examines the usefulness of the exit examination given to senior students in their final year or final semester of the Electronics Engineering Technology program. This examination is comprehensive and covers every course taught in the program. It consist of problems on the analog and digital electronics segments of the program. It also covers ABET's objectives which assess lifelong learning, diversity, ethical and professional behavior and responsibilities of engineers, and global issues. The examination is given to students to complete graduation requirements but the data gain from such examination is also used for self-assessment of the program as a tool for continuous improvement of the program and ABET assessment criteria. The format of the exit examination, how it conforms to ABET assessment and program objectives is discussed. Further, we provide data and analysis of students' results over a five year period and show how feedback from the results is used to make improvement to the program.

Introduction

National and international programs that offer baccalaureate degrees in engineering, computing and engineering technology programs aspire to reach the highest standards possible. To that effect programs have formulated many and varied self and external assessment methods. Some of these methods are used as assessment tools for the mentioned programs to obtain or become accredited by the premier accreditation board, ABET (Accreditation Board for Engineering and Technology). Assessment methods also help programs to maintain a continuous improvement plan, keep current with academic and industrial trends and standards.

Some methods used to assess a program range from course assessment report (CAR); solely by faculty members for every course he/she teaches, student and faculty survey instruments, industrial advisory board inputs into curriculum, and the fundamentals of engineering exams (F.E), students' capstone design experience; commonly called senior design project. These methods provide a continuous self-evaluation of instruction related activities which are critical to maintaining a quality undergraduate program and critical to maintaining and obtaining ABET accreditation.

ABET provides leadership in assuring quality of programs and stimulating innovation in programs. Quality assurance of a program resides within the program itself [1, 8]. Programs should be certain of the best methods or tools to evaluate level of achievement of expected outcomes for the programs graduates. Successful programs will select assessment methods which strengthen the quality and standards of the program and prepare its graduates for a life of learning and development.

Too often the most common assessment tool used by department to gather data is the survey method[1, 2, 3]. This method is quick and easy to disseminate, while useful in measuring certain objectives it can be limited in measuring others. The survey instrument may provide data on laboratory equipment, instruction (which maybe subjective), course scheduling and so on but lack the appropriate data to provide insight into student learning, levels of quality in graduates, ability of students to assess their learning. Ultimately, a professional should have the ability to assess their own leaning and knowledge and fill in areas where there are gaps in knowledge and skills[2].

Other methods that are used include examination, quizzes, homework, and research papers. The most popular method is the formal and traditional examination given to assess students' learning of course content. Whereas most exams are used for internal assessment purposes some may be used for program evaluation (such as evaluations of students to see if some of the program's objectives are being met), they can be a useful tool in assessment for the ABET educational objectives.

Any method of assessment must incorporate the different levels of Bloom's taxonomy of knowledge, comprehensive, application, analysis, synthesis and evaluation. The very nature of exams lend itself to incorporate knowledge and comprehensive but the remaining levels are more difficult to incorporate into this type of assessment [6, 9].

Bloom's taxonomy provides an important structure to focus on higher order thinking. The taxonomy provides a hierarchy of levels which can assist educators in designing performance tasks, crafting questions and providing feedback to students on their work. Division of questions into different levels exemplifies the focus needed for critical thinking ability. The use of critical thinking in the classroom can be instrumental in developing all levels of thinking within the cognitive domain. The results is improved attention to detail, increased comprehension and expand problem solving skills[9].

We discussed the usefulness of using examinations specifically what we refer to as the exit examination given to seniors or graduating students in their final semester of our Electronics Engineering Technology program. We examined the usefulness of the exit examination given to senior students in the last year or semester of the Electronics Engineering Technology program. This examination is comprehensive and covers every course taught in the program. It consist of problems on the analog and digital electronics segments of the program. It also covers ABET's objectives which has to do with lifelong learning, diversity, ethical and professional behavior responsibilities of engineers and technologists, and global issues. The examination is given to students to complete graduation requirements but the data gain from such examination is also used for self-assessment of the program as a tool for continuous improvement of the program and ABET assessment criteria. We will show the format of the exit examination, how it conforms to ABET assessment and program objectives. Further, we will provide analysis of the results from the examination and how feedback from the results is used to make improvement to the program.

Method

The exit exam is a three part comprehensive exam. Students taking the exam spends five hours in a room answering ten objective test questions from each course in the program's curriculum. The exam is separated into three parts; analog and digital courses, and lifelong learning, ethical and global issues. The analog and digital parts of the exam is done in a room with an invigilator for five hours; the third part is a take home portion where the students are provided with current topics in engineering related problems, case studies and other relevant societal and global issues. The students use these topics and cases to write lengthy discussions and provided appropriate solutions or application of engineering, math and science concepts to solve these issues.

The analog section of the exam covers the following subject in the curriculum; direct current (DC) circuit analysis, alternating current (AC) circuit analysis, electronic devices, operational amplifier (OPAMP) analysis and applications, communications system analysis and control system analysis.

The digital section covers the following subjects: structural programming with C++, digital logic circuits, digital hardware design, microprocessor architecture, microprocessor software application, computer control systems, microprocessor interfacing, and advance structured programming with C++ and microcomputer network.

The third section of the exit exam covers the following subjects: lifelong learning, ethics and professionalism in Engineering Technology and diversity and global issues.

Throughout the academic year (September 1st to May 31st), the exam is given once per regular semester; summer sessions not included. It is expected that a total of twelve or more students will take the exam for the academic year. To pass the exam students must score an overall score of 70% but they must also demonstrate proficiency in each subject by scoring seven out of ten on the subject matter of the courses. Students obtaining a 70% (7 out of 10) is said to have reached the minimum acceptable level of proficiency in that course. Any score less than 70% is below the proficiency level.

Each course in the program's curriculum has a list of ABET student outcome, the outcomes are named after the letters of the alphabet. These outcomes are a-k. The students' outcomes a-k are used to determine if the educational objectives are being met. The students' outcomes are as follows[10]:

a. an ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities;
b. an ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies;
c. an ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes;
d. an ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives;
e. an ability to function effectively as a member or leader on a technical team;

f. an ability to identify, analyze, and solve broadly-defined engineering technology problems;
g. an ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature;
h. an understanding of the need for and an ability to engage in self-directed continuing professional development;
i. an understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity;
j. a knowledge of the impact of engineering technology solutions in a societal and global context; and
k. a commitment to quality, timeliness, and continuous improvement.

Whereas the student outcomes mentioned are used primarily for ABET assessment, they are also used internally for program assessment and evaluation. If students fail to meet the minimum proficiency level of 70% in anyone of the outcomes, the instructor of that course has to devise an improvement plan of action which will enable the students to attain the required level of skills to meet or surpass the minimum proficiency level. Below are samples of improvement plans instructors have prepared to deal with deficiencies in some of the courses they have taught. Also given are the guidelines on the preparation of the improvement plans (data was taken from "Comprehensive Exam (Exit Exam) Result and Improvement plan from ELET 441 Comprehensive Exam (spring 2007 – fall 2013 data analysis))".

Continuous Improvement Plan Guidelines:

Faculty members are required to utilize the analyzed result and implement a different approach to help student to understand the subject matter better. This is not only limited to the following actions:

- Usage of simulation software to help students to understand the subject matter
- Usage of tutor within the department of Engineering Technology
- Assign more homework assignments and return the graded paper back at reasonable time
- More emphasis of the topics which students demonstrated some difficulties.

Throughout is discussing outcome 'a' will be used as the example to strengthen the discussing of using the exit examination as an assessment tool. **Outcome A:** This outcome is being evaluated in the courses shown below. The proficiency level reached is shown along with the improvement plan. The average for all outcomes of entire ELET curriculum is 76.5%. Any subject with outcome less than 70% is considered as a weakness and improvement plan is required. The proficiency level reached by students on 5 selected courses for outcome 'a' is shown for the spring 2007 semester.

- ELET 130 – Introduction to computer programming with C++: Average outcome is 67%
- ELET 133-AC Circuits: Average outcome is 60%
- ELET 232- Electronics II: Average outcome is 52%

- ELET 331-Communication Systems: Average outcome is 67%
- ELET 332-Control Systems: Average outcome is 63%

The various improvement plans from the instructors who taught the courses are given below for each course.

<u>ELET130:</u>

I will emphasize more on the problem solving aspect of the programming which utilizes the application of the math. I will also introduce more examples to ensure students gain the better understanding of the topics.

<u>ELET 133:</u>

Students who took the exam and scored below average expressed their concerns verbally, and indicated in writing on the exam paper, that there was no review session for this course prior to the exam. However, students who had taken ELET 133 had performed above average during the semester they had taken the class. Therefore, the results would have been satisfactory if a review session had taken place and students had been given ample time to study the material.

<u>ELET232:</u>

My plan for improvement to achieve the 70% proficiency standard set by the department in outcome A is as follows: encourage the students to read more on the material being covered in the course. It is my belief that students do not read or prepare for class sufficiently. Therefore, I am going to assign reading assignment on topics to be cover in class. Each student will be responsible for a topic and at the start of class I will spend 5-10 minutes discussing a topic each class period. To ensure that reading is done student will be given the equivalent of the score he/she would receive on a homework assignment; on exercises such as computer simulation of circuits. This I believe will help them visualize the operation of circuit components. These measures if executed successfully will help improve students' knowledge in the course.

<u>ELET331:</u>

I will solve more problems during the lecture session and I will assign more homework problems to address this concern.

<u>ELET332:</u>

My plan for improvement to achieve the 70% proficiency standard set by the department in outcome B is as follows: encourage the students to read more on the material being covered in the course. It is my belief that students do not read or prepare for class sufficiently. Therefore, I am going to assign reading assignment on topics to be cover in class. Each student will be responsible for a topic and at the start of class I will spend 5-10 minutes discussing a topic each class period.

The samples given above for the assessment data for the continuous improvement plan were for the spring 2007 semester. Instructors were given two semesters (fall 2007 to spring 2008) to implement these plans and then evaluate to determine if the plans were successful. If the action plans were successful meaning no deficiency found after the two semesters then no further action was needed but continuation of the previous plan. The data obtained for the semesters (fall 2007 to spring 2008) shows that significant improvement were made and students achieved the required proficiency level.

Implementation of continuous Improvement Plan:

According to the analyzed data from Spring 2007, Fall 2007 and Spring 2008, it was noted that the average of both analog and digital sections of the exam showed notable improvement. The average of the analog section improved by 8.3% while the Average for Digital section showed improvement of 8.8%. It appears that the improvement plan worked. Therefore, the recommendation, it is suggested that the continuous improvement plan be continued.

Table 1. This table shows the action plan applied to the courses with deficiency in Fall 2007. The comparison between the result of exam in Fall 2007 to Spring 2008 and the result of the exam from Spring 2007 illustrates a reasonable improvement.

Table 1. Deficiency and improvement in outcome ‘a’ over 3 semesters

Outcomes	**Courses**	**Spring 2007**	**Fall 2007**	**Spring 2008**	**Is Any Action Plan Required**
Outcome A	ELET 130	67%	75%	81%	None
	ELET 133	60%	78%	88%	None
	ELET 232	52%	87%	80%	None
	ELET 331	67%	79%	75%	None
	ELET 332	63%	83%	78%	None

Analysis

As mentioned above the samples shown were taken from the exit exam data collected over a six year period. The data was used to accomplish two purposes; one for ABET accreditation assessment and internal program assessment and evaluation as part of the electronic engineering technology (ELET) program's continuous improvement. This program is ABET accredited and recently received reaccreditation for six more years in August 2014.

The various improvement plan put forth by the respective faculty members indicated a positive correlation between the implementation of plans and improvement in performance on the various outcomes (a-k) assessed over that six years of data collection of the exit exam. Because the data obtained from the exam has a zero probability of being skewed by the instructors it is considered reliable and accurate. The data is trustworthy because it is the chair of the department who invigilates the exams and grades all parts of the exam (the chair is not an instructor in the program; instructors provides the chair with the key to the exam).

Over the course of six years the trend has been mainly positive in improvements of the outcomes a-k. This trend has remained steady throughout that time period. Increases of 2% to 8% on average have been recorded for all outcomes especially for the example outcome 'a' used earlier. Figure 1 shows a bar graph for outcome 'a' of spring 2013 for several of the courses in the ELET program. Only two courses did not meet the required level of proficiency but it should be noted that the courses considered earlier have all met the proficiency level. So even after six years of data the students are still meeting the mark set for them. This is attributed to implementation of those improvement plans and continuous feedback received form the results of the exit exams.

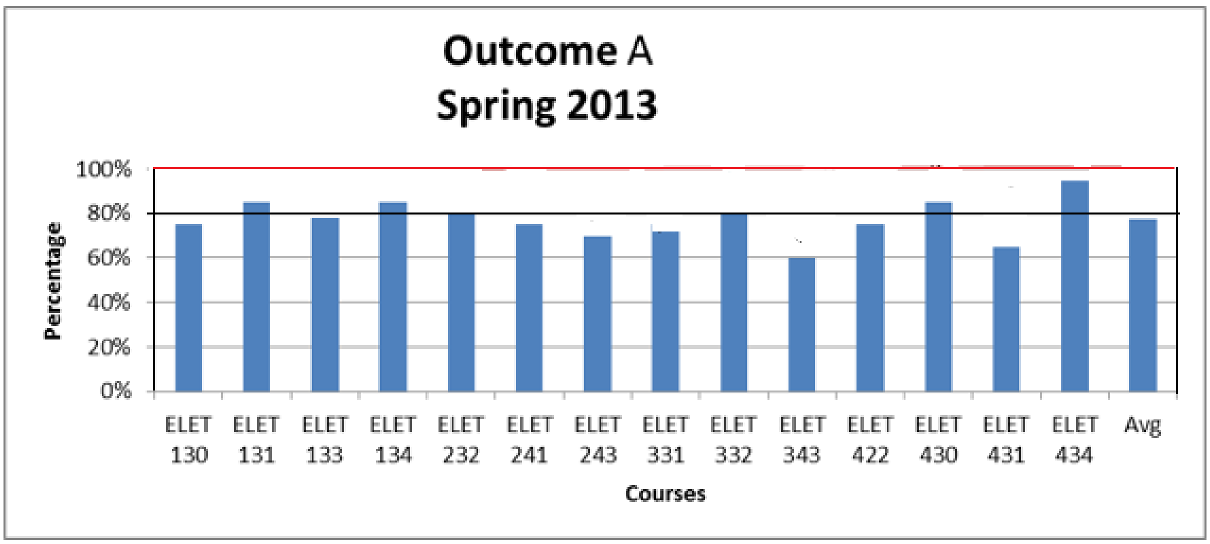

Figure 1. Results for outcome — spring 2013.

Conclusion

The exit exam document prepared for ABET accreditation visit was 76 pages long. The document covered six years of assessment, evaluation and improvement plans. When the document is examined as a whole it shows significant improvements in students' performance, and program strength and quality. Because of continuous improvement in the ELET program we have been enjoying record enrollment in the program over the past few years. There is no doubt that using the exit examination as an assessment tool has contributed to the success of the ELET program.

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Biographical Data

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Dr. Thomas is an Associate Professor of electronics engineering technology in the Department of engineering Technology at the College of Science and Technology at Texas Southern University. He received his Ph.D. in Electrical Engineering from New Mexico State University, New Mexico. Dr. Thomas' research interests include, but are not limited to, System on Chip (SoC) testing, alternative sources of energy, bio-magnetism, and engineering education and development (curriculum and pedagogical change and integration across disciplines). Dr. Thomas' experience includes traditional and non-traditional classroom teaching styles as well as online classroom teaching. He also has experience working in industrial setting where he was a digital and analog design engineer.

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