Assessment of Student Professional Outcomes for Continuous Improvement

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Abstract

This article describes a method for the assessment of professional student outcomes (performance-type outcomes or soft skills). The method is based upon group activities, research on modern electrical engineering topics by individual students, classroom presentations on chosen research topics, final presentations, and technical report writing. Assessment activities include application of a checklist that measures professional student outcomes of teamwork, life-long learning, and communication skills including oral and written communication and presentation skills. The results are discussed with the students and faculty for feedback purposes to establish a stronger relationship between quality assurance and continuous improvement of professional student outcomes crucial for engineers to be successful in their profession.

Keywords

Assessment, evaluation, team work, life-long learning, communication

Introduction

The University of Tehran was established in Teheran in 1934 (Bazargan, 2000). Its top priorities are quality assurance and higher academic standards**.** The University strives to develop strategies that achieve these goals and meet international academic accreditation standards.

Education quality at all levels is a key to poverty reduction and economic growth. However, both industry and the educational community stress the need to teach performance-type (soft) skills so that students attain the following outcomes by the time they graduate. These are: (a) an ability to function on multi-disciplinary teams, (b) an understanding of professional and ethical responsibility, (c) an ability to communicate effectively, (d) a recognition of the need for, and an ability to engage in, life-long learning, (e) a knowledge of contemporary issues, (f) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

During its meeting in Fall 2010, the External Advisory Board (EAB) of the Electrical Engineering Program at the University of Tehran stressed the importance of social or "soft" skills for electrical engineering graduates. The EAB, constituted of local industry and academic community, were of the opinion that the electrical engineering graduates from local universities were quite competent in their engineering knowledge but lacked skills related to communication (which is very important for customer services), team skills (essential for working in diverse environments and motivation), critical thinking skills (imperative for assessing and analysing ideas more effectively), and management skills (crucial for bringing in the project on budget and on schedule).

These skills are very important for engineering professionals to think independently and propose new ideas and implement them. A new MIT *Engineering Leadership Program* promoted by Bernard M. Gordon, an entrepreneurial alumnus of MIT, grafts social skills onto problem-solvers. This program supersedes the stereotype of the antisocial engineer and gives budding engineers skills that go beyond technical risk assessment, decision making, interpersonal relations, resourcefulness and flexibility (Karlin, 2010).

The Electrical Engineering (EE) Program Curriculum Committee (comprised of the Chair of the EE program, the program coordinator, and a key faculty member) at the University of Tehran decided to teach, assess, evaluate, and improve the following performance-type student outcomes in a one-credit hour *Seminar in Electrical Engineering* course. This paper considers how these skills were incorporated and assessed in the teaching of this subject at the University of Teheran.

Assessment Process

The assessment process for the *Seminar in Electrical Engineering* course focuses mainly on the aforementioned student outcomes and the results specifically related to these outcomes. At the beginning, experienced faculty members were encouraged to work on this assessment process in order to achieve the goal of maintaining the process for the long-term. The Department Curriculum Committee and a faculty member with considerable administrative experience were the major contributors in the process. The results of evaluation and analysis were shared with the entire faculty during the Departmental council meetings to gather additional input and suggestions. Younger faculty members were encouraged to observe the instructional activities of the *Seminar in Electrical Engineering* course to become familiar with the outcomes assessment process and its implementation. The students were made aware of these outcomes at the beginning of the semester through the Specific Outcomes of Instructions stated in the syllabus of the course as follows:

- Students will be able to collect and understand the relevant technical information regarding a research topic.
- Students will demonstrate how to perform library research (achieving information literacy skills) and understand the importance of life-long self-learning.
- The students will be able to think open-mindedly within alternative systems of thought.
- Students will be able to communicate effectively with others in figuring out solutions to complex problems
- Students will learn how to come to well-reasoned conclusions and solutions (critical thinking).
- Students will be able to raise critical questions and problems (formulating them clearly and precisely).

- Students will be able to use technology for presentation and enhance their presentation skills.
- Students will learn the art of addressing an audience and public speaking.

Assessment Tools and Methods

The assessment tools, with each evaluated by through a customised checklist, used in the assessment process are as follows:

Classroom Activities: Involves working in teams; writing minutes of the meeting, writing introductions, identifying problems, thinking critically to solve a technical problem related to electrical engineering, and writing conclusions.

Research Activities: Involves choosing an issue in modern electrical engineering; performing research using variety of sources including library, internet, and textbooks, engaging in independent learning about the research topic, understanding the importance of life-long learning, writing rough drafts of a technical report related to research topic, making a final PowerPoint presentation regarding the research topic in front of the class, and writing a technical report about the research topic.

Classroom Presentation Activities: Involves preparing small presentations; learning the art of public speaking, making small presentations in front of the class, and using computer applications such as Microsoft PowerPoint® for creating presentations.

Instructional Strategies Lectures

A series of interactive classroom lectures were conducted during the class time. These covered the following topics.

Choosing a Research Topic: Students are guided via a PowerPoint presentation about choosing a research topic on *modern* electrical engineering. During *the first semester* of the assessment process, the students are generally reluctant to perform research on modern issues. Instead, they tend to choose very *basic* electrical engineering topics, for example diodes, junction transistors. As a result, the students were asked during *the second semester* onward to choose the topic of their interest from a set list of modern electrical engineering topics provided by the faculty. The topics were:

- Smart Grid
- Optical Network
- FPGAs Used in Telecommunications
- LCD Displays
- Power Line Communication
- Analysis of operation and design criteria of single-phase synchronous motors
- Digital energy counters
- Intelligent systems for electric lines protection

- Piezoelectric transformers
- Radio Frequency Identification (RFID)
- Microcontrollers and the Robots
- iPhones

Critical Thinking: Foundational concepts of critical thinking are presented in the class, for example, elements, intellectual standards*,* intellectual traits, and powerful barriers to the development of critical thinking (Paul & Elder, 2005).

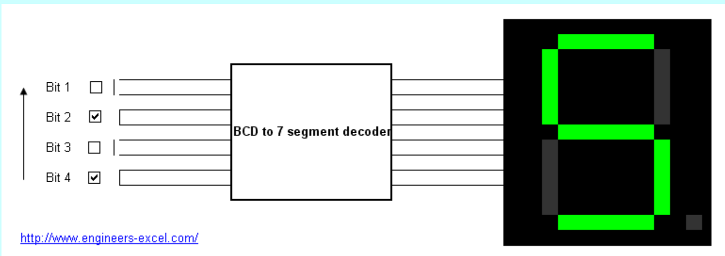
Presentation Skills and Public Speaking: The art of public speaking is demonstrated in the classroom. The students are encouraged to be clear and distinct in their oral expressions. The students are also guided on how to prepare better slideshows by organising their slides in a logical order.

Guide to Technical Report Writing: The elements of technical report writing are outlined to guide students to prepare and arrange their technical reports in a professional format. These include: (i) introduction; (ii) background and context; (iii) technical detail; (iv) results; (v) discussion; (vi) conclusion; (vii) citation/references; and (viii) results.

Classroom Activities

Teams of four students are formed randomly from a class of 16-20 students. A basic electrical engineering problem is presented with an introduction, block diagram, circuit diagram and tables. Each team works on the same problem for 20-25 minutes. Each is required to choose a leader and perform the activities as described by the example in Figure 1 and Figure 2.

Today's Classroom Activity: Problem Definition
Digital voltmeters, frequency counters etc. use seven-segment displays to show the result of measurements. However, all the internal electronics use binary for manipulation of the data. To convert this binary to a form that can be used by the display requires the use of a DECODER, in this case a "binary to seven-segment display decoder". This has four inputs for the binary and seven outputs for the display.



The 4511 is designed to drive a common cathode display and won't work with a common anode display. You need to check that you are using the right kind of display before you start building. You and your team have been given the Common Anode Seven-Segment Display and Seven-Segment Decoder Driver 4511 chip. Your team is required to make a truth table for a Common Anode Seven-Segment Display

Figure 1. Example of a classroom activity: problem definition (Briedes, 2002)

<table>
<tr><td>1</td><td>Minutes

Choose a leader of your team and assign tasks as follows:

- Minutes by: ______________________________
- Problem Identification by : ______________________________
- Problem Solving by: ______________________________
- Introduction by: ______________________________
- Conclusion by: ______________________________

Write a sentence or two about the minutes of the meeting:
____
____
____</td></tr>
<tr><td>2</td><td>Write a paragraph of Introduction

• It must be in proper English with proper grammar and spelling.
• Proof read it before submitting to the instructor for evaluation.
• It must be very clear and concise.</td></tr>
<tr><td>3</td><td>Problem Identification
Given: ___________________________________
Goal: ___________________________________
Signature: ___________________________________

You and your team have been given the Common Anode Seven-Segment Display and Seven-Segment Decoder Driver 4511 chip. Your team is required to make a truth table for the Common Anode Seven-Segment Display and come with a working solution of the problem</td></tr>
<tr><td>4</td><td>Solve the problem and perform data analysis
1. Draw the block Diagram of the Seven-Segment Decoder Driver and the Seven-Segment Display.
2. What will be the data if the seven-segment display has to display a ‘5’?

3. D C B A =: _________________________
4. a b c d e f g =: _________________________</td></tr>
<tr><td>5</td><td>Write a conclusion paragraph
- It must be in proper English with accurate grammar and spelling.
- Proof-read it before submitting to other team for evaluation.
- It must be very clear and concise.</td></tr>
</table>

Figure 2. Example of a classroom activity: activities performed by students in teams (Briedes, 2002)

Classroom Presentations

Students were required to start preparing their PowerPoint slides from the start of the semester. The directions for these preparations were:

1. Start preparing your presentation.

2. Prepare first slide for *Title* and *Your Name*.

3. Prepare slide for the *Agenda* or *Outline* of your presentation.

4. Prepare slide for *Introduction* or *Objective* or *Purpose.*

5. Prepare 10 to 15 slides for the body of your topic.

6. Prepare a *Conclusion* slide.

7. Prepare the last slide for *thank you!* And *any questions!*

Individual students presented their research topic's introduction and a little technical description in two classroom presentations, each for 3-5 minutes. They were assessed on oral communication skills, electronic and graphical presentation skills by faculty and peers.

Final Presentation

The students were required to make a final presentation at the end of the semester. Each student presented their research topic via a slideshow of 19-24 slides in 12-15 minutes in front of classmates and faculty. Only faculty evaluated the students for oral communication, electronic and graphical presentation skills. The students were also asked questions to assess their understanding of the research topic and their skills to handle the audience's questions.

Final Technical Report

The students were guided on how to write, plan, and finalise a technical report by elaborating on the aspects of a clearly organised and attractive technical report. The criteria include:

1. Correct structure: including Title page, Summary, Table of Contents, Introduction, Body, Conclusion, References, Acknowledgement and Appendices.
2. The Report Layout: Take note of appearance, format, headings, diagrams and tables, mathematics.
3. Presentation: including script, page numbers, binding
4. Originality and plagiarism:
    a. Indicate references for other people's work
    b. Put in quotations for copied work
    c. Copying others' work without acknowledging them is plagiarism.

5. Finalising the Report: With an introduction, main text in sections, conclusions, properly formatted references and any appendices, your report is nearly complete. Now you can add the page numbers, contents and title pages and write the summary.

6. The Summary

Results

The expert faculty members assessed student work through customised checklists. (See Tables 1, 2 and 3). The results have provided useful information to improve the program in future years.

Table 1. *Criteria for* oral and presentation skills

Organisation	The speakers organised their material to make it persuasive and interesting
Impact	The speakers were comfortable. Their posture, gesture, or attitude added to the overall presentation
Expression	The speaker's expression was not exact and concise with proper choice of words.
Elocution	The speaker spoke clearly with correct pronunciation.
Delivery	The speaker's spoke fluently with proper weight and emphasis and without hesitation (appropriate voice, tone and pitch).
Illustration	The speaker's used graphic or other illustrative materials effectively.
Time	The speaker's presented balanced material within the prescribed time.
Question/Answers	The speaker's handled questions appropriately, with confidence and with patience.

The results of oral and presentation skills showed differing performance levels. The criteria requiring further attention is "Expression" with students not being sufficiently exact or concise or not choosing their words properly or appropriately. Therefore, students should be strengthened in this area.

Table 2. *Criteria for written communication, problem solving and team skills (classroom activities)*

#	Description of criterion
1	The objective (Introduction or Purpose) of the report was written with correct grammar and spelling. It was clear and brief.
2	Knowledge of mathematics, science and engineering was applied.
3	The data was analysed and interpreted appropriately.
4	The engineering problem was identified, formulated and solved properly.
5	The report was organised and proof-read for high impact.
6	The leader was able to facilitate the team and was written the minutes of the meeting properly.
7	The tasks were accomplished in the prescribed time.
8	The tasks were performed with the team discussion.
9	The conclusion was written with proper grammar and spelling. It was clear and concise.

Students performed well in these aspects of their work. This provided reassurance that the design of activities supporting written communication, problem solving and team skills had been effective.

Table 3. *Criteria for the final technical report (written communication skills)*

#	Description of criterion
1	The objective (Introduction or Purpose) of the report was written with correct grammar and spelling. It was clear and brief.
2	Knowledge of mathematics, science and engineering was demonstrated in the entire report.
3	The engineering problem was identified, formulated and solved properly.
4	The report was organised and proof-read for high impact.
5	The conclusion was not written with correct grammar and spelling. It was not clear and concise.

Students generally performed well in developing their final technical reports. An area in written communication, however, which requires strengthening is the writing of clear and concise conclusions.

Conclusion

This article presented a proactive approach to enhance students' professional (performance-type of or soft- skills) outcomes of effective communication, ability to work effectively in teams, presentation, problem solving and critical thinking, and life-long learning skills. Various activities were implemented to provide opportunities to students in order to enhance the crucial professional skills required to be successful in engineering profession. Student performance of these outcomes was assessed through criteria and checklists.

The activities and assessment methods described in this paper have helped students understand the importance of these professional skills and have given the majority of them the means to enhance their skills. The assessment required considerable effort from the faculty and also required increased student effort for what was only a one credit hour course. The analysis of evaluation discussed with faculty generated the idea of transforming this course into a 2 credit hour course, "Engineering Design." The new "Engineering Design" course syllabus has been developed from the experience of the course described in this paper and is proposed in the EE curriculum renewal proposal.

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