Assessment Results in Teaching for Control System Course (ELEC 431) in the Perspective of Gender

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Abstract
This paper discusses the assessment in teaching for course of Control Systems (ELEC 431) in Department of Electrical Engineering, United Arab Emirates University (UAE-U) in the perspective of gender. In UAE-U, there is segregation for teaching the male and female students. This means that the instructor needs to open two sections for one course. Even though doubling the resources and effort for one course, this brings unique experience to analyze the course based gender perspective. In this study, we analyze the assessment for the course of Control Systems (ELEC 431) for the duration of two years or two offerings. The attainment of the course is analyze using ABET system. The results showed that the attainments for the CLOs for the male students are slightly better than the female students. The questioner response about the course and instructor comparatives course from the students showed male students feels better with the course delivery and its instructor compare to the female students.

Keywords: Assessment of the course, gender perspective, control systems course.

Introduction

The comparative studies discussing the results between the male and female students for a course were discussed in several papers. Cen et all stated those male and female students were performed better if they were allowed to work in the same group. The female students outperformed the male student in both mixed and uniform groups. Kumar found that there is no different in the performance for the male and female students for a software course. However, the male has fewer patient compared to the female students. A study for aerospace engineering in Moll et al concluded the same result as in Kumar, with the female students has a slightly better performance. A robotic curriculum on high school students' engineering was assessed in Terry at el, with the female students has a more motivation compared to the male students. Another robotic curriculum was assessed in Milto et al. The study reports that the female students had a lower level of confidence for the course compared to the male students. However, this level of confidence had come closer throughout the duration of the program

In this study, the students' attainment for the course learning objectives (CLOs) are studied and analyzed via assessment tools. We also studied the questioner from students regarding the course and its instructor in the end of the semesters.

The paper is organized as follows. In the section of **Method**, we describe the detail of the course. We present and discuss the results in the section of **Result and Discussion**. Finally, we give the conclusion in the section of **Conclusion.**

Method

This study was conducted to find outcome the assessment results for two different classes (sections) for the same courses at the same offering. Here, we assessed the course for two offerings. The course is only offered once a year, which is fall semester. Two different instructors taught the course. However, we assured that the teaching quality of the course quite similar as we shared the same course contents, slides, and assessment tools. The following is the detail of the course:

a) Participant.

We analyze the course in the last two offering. Table 1 presents the number of the students for the offerings.

Table 1: Number of male and female students for the last two offerings

Academic Year	Number of male students	Number of female students
2015-2016	25	32
2016-2017	12	38

b) Course description.

The course catalogue for ELEC 431 can be found in UAE-U website, as the following: Control systems in the real world, feedback concept, modeling of electromechanical systems, block diagrams, steady-state error analysis, stability

analysis, time-domain analysis of control systems, root-locus, frequency domain analysis of control systems, control systems design in the frequency domain (phase lead and phase lag compensation, Nyquist and Nichols charts), and proportional-integral-derivative (PID) control.

c) Course learning outcome (CLO).

The CLOs are composed based on the course catalogue. The CLO have designed appropriately and gone through many necessary revisions to meet the ABET program-learning outcome (PLO) as follows:

1. Derive mathematical model of systems [a,e].
2. Analyze time response of the first order systems, second order systems, and higher order systems [c, e].
3. Simplify multiple subsystems [e].
4. Evaluate the stability of the closed-loop systems [c,e].
5. Evaluate steady-state error of systems [c,e].
6. Analyze systems using frequency techniques [a,c].
7. Design controller for systems [c,d,g].

The program-learning outcomes (PLOs) for the department of Electrical Engineering are stated as the following:

(a) Ability to apply knowledge of mathematics, statistics, science and engineering principles. The mathematics knowledge includes linear algebra, vector algebra, partial differential equations, complex analysis, and probability.
(b) Ability to design and conduct experiments safety, as well as to analyze and interpret data.
(c) Ability to design electrical components, systems or process to meet desired specifications and imposed constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
(d) Ability to work in teams including multidisciplinary teams.
(e) Ability to identify, formulate and solve problems encountered in the practice of electrical engineering.
(f) Understanding of professional and ethical responsibility.
(g) Ability to communicate effectively orally and in writing.
(h) Ability to understand the impact of engineering solutions in a global and societal context.
(i) Recognition of the need for, and ability to engage in life-long learning.
(j) Knowledge of contemporary issues.
(k) Ability to use the techniques, skills, and modern engineering tools necessary for electrical engineering practice.

d) Tentative weekly schedule of course topics and contents.

The tentative weekly schedule to accomplish the course content is depicted in Table 2.

Table 2. Tentative Weekly Schedule

Week	Session content	Assignments
Week 1	**Topic: Introduction to control systems** **Content:** History of control systems; systems configuration; Analysis & design objectives.	**-**
Week 2	**Topic: Modeling in frequency domain** **Content:** Laplace transform; Transfer function; Transfer function for electrical & mechanical systems.	**HW 1**
Week 3	**Topic: Modeling in time-domain** **Content:** State-space representation; Converting state-space to transfer function and vice-versa.	**HW 2 & Quiz 1**
Week 4	**Topic: Time response** **Content**: Poles, zeros, and system response of first order system.	**Quiz 2**
Week 5	**Topic: Time response** **Content:** System response of second order systems; Higher order systems; System response with zeros.	**HW 3**
Week 6	**Topic: Stability** **Content:** Routh-Hurwitz criterion; Routh-Hurwitz criterion for special cases.	**Quiz 3 and HW 4**
Week 7	**Topic: Reduction of multiple subsystems** **Content:** Block diagram reduction.	**Quiz 4**
Week 8	**Topic:** - **Content:** -	**Test 1 & Midterm**
Week 9	**Topic: Reduction of multiple subsystems** **Content:** Block diagram reduction (Cont.).	**HW 5**
Week 10	**Topic: Steady-state error** **Content:** Steady-state error for unity/non-unity feedback systems; Static error constant and system's type.	**HW 6 & Quiz 5**
Week 11	**Topic: Frequency response techniques** **Content:** Bode plot and Nyquist diagram.	**HW 7 & Quiz 6**
Week 12	**Topic: PID and design via root locus** **Content:** The concept of PID; Ideal PI design.	**HW 8 & Quiz 7**
Week 13	**Topic: PID and design via root locus** **Content:** Ideal PD design.	**HW 9 & Quiz 8**
Week 14	**Topic: PID and design via root locus** **Content:** Lead and Lag compensators.	**Quiz 9**
Week 15	**Topic: Project** **Content:** -	**Test 2 & Presentation**
Week 16	**Topic: Review** **Content:** -	

e) Assessment tools

The CLOs were measured quantitatively based on students' performances in the course through the designed assessment tools. These assessment tools are shown in Table 3.

Table 3: Assessment tools and its percentage contribution

Activities contribution to grades	**% Contribution**
Weekly Homework	5%
Quizzes	5%
Project	10%
Test 1 (before midterm)	10%
Test 2 (after midterm)	10%
Midterm exam	25%
Final exam	35%

The weights in the Table 2 are appropriate and proportional to the time student get for the preparation and the level of difficulty. The final exam and midterm exam have the highest weights of 35% and 25%, respectively. They are comprehensive exams and cover complete course material through during semester. In this course, we divide the covering material for the midterm (and its Test 1) and final exams (and its Test 2) for reducing the load for the students. The material for the midterm is covering the CLO #1 to CLO #3. These CLOs will not be assessed again the final exam.

f) Appropriateness of textbooks and other learning resources.

The textbook of the course is Control Systems Engineering (6^{th} edition) by Norman Nise (Wiley & Sons). The textbook is one of the best textbooks to teach the basic of control system engineering.

g) Appropriateness of prerequisites.

The prerequisite of the course is ELEC 305 (Signal and Systems) and MATH 2220 (Linear Algebra and Engineering applications). ELEC 305 provides fundamental for the discussion in frequency domain, while ELEC 2220 gives fundamental for discussion in time domain.

Result and Discussion

The CLOs are assessed using the assessment tools for two offerings in the fall semester 2015 and 2016. The attainments are showed in Fig. 1. Although the attainment for both gender students meets the targeted value (75%) in majority of the CLOs, we can show male student has a slightly better performance compare to the female students. Therefore, the obtained grade for the male students is better compared to the female students, as depicted in Fig. 2.

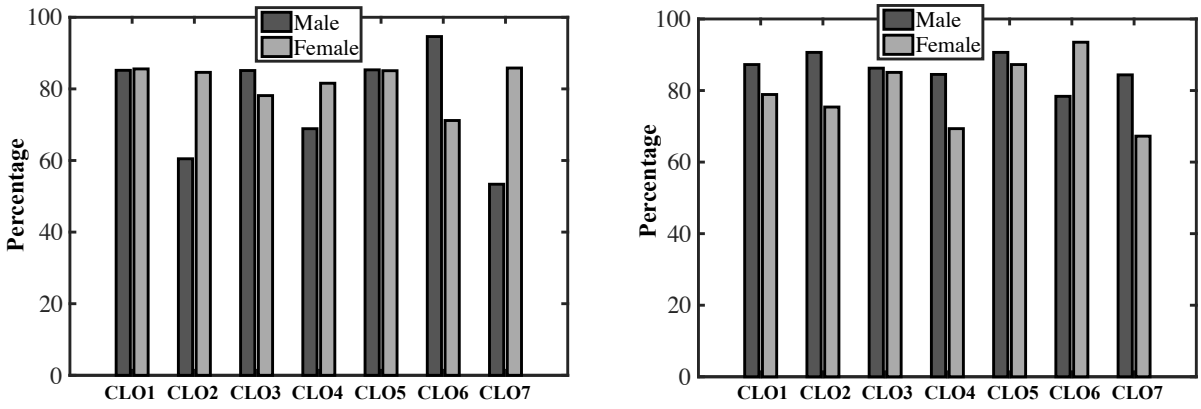

Figure 1: Attainment of CLOs for the class in 2015 (left) and in 2016 (right)

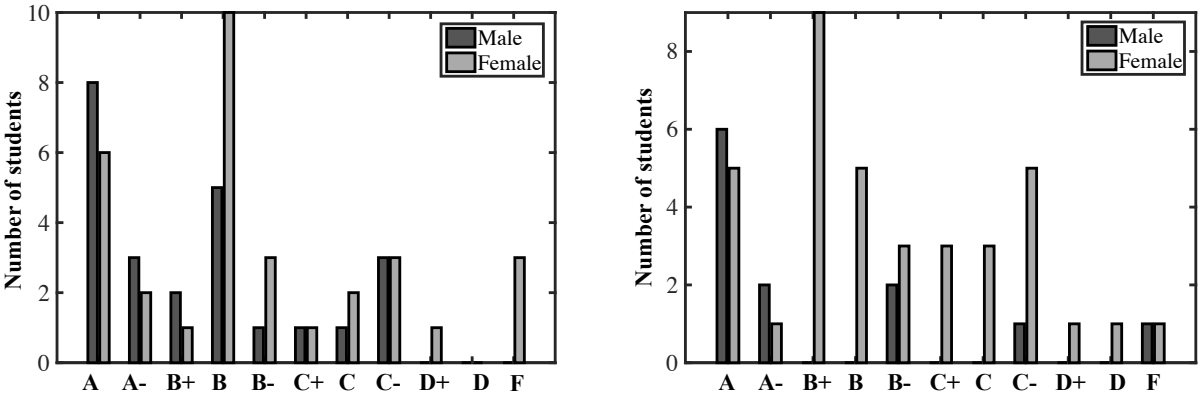

Figure 2: Grade distribution for the class in in 2015 (left) and in 2016 (right)

We also conducted the questioner to study the student opinions regarding the course and its instructor. Table 4 and 5 depicted the results. We can see the male students feel better with the course and its instructor.

Table 4: Course comparative analysis

Question	Course		Department (Mean)	College (Mean)
	Male (Mean)	Female (Mean)		
The course objectives were clearly explained	4.83	4.47	4.27	4.20
The course outline was consistently followed	4.67	4.67	4.26	4.21
Expectations for learning in this course were clearly communicated	4.67	4.40	4.20	4.10
There was close agreement between the stated course objectives and what was actually covered	4.83	4.53	4.30	4.21
Evaluation methods were clearly explained (rubrics/marking schemes given in advance of assignment and explained to the students)	4.83	4.47	4.29	4.16
The evaluation methods used in this course were fair and appropriate	4.67	4.47	4.15	4.07
The assignment in the course were clearly related to the course objectives	4.83	4.60	4.19	4.14
The requirements of the course (projects, papers, exams) were adequately explained	4.83	4.53	4.19	4.12
Course materials were presented in an organized manner	4.83	4.67	4.29	4.20
Students were invited to share their ideas and knowledge	4.83	4.67	4.18	4.09
The general climate in this course was good for learning	4.67	4.53	4.16	4.14
In general, the level of difficulty in this course was appropriate	4.83	4.40	3.99	3.95

Table 5: Instructor comparative analysis

Question	Course		Department (Mean)	College (Mean)
	Male	Female		
Treated students with respect	5.00	4.87	4.50	4.38
Was helpful to students seeking advice	4.83	4.47	4.35	4.25
Was available to students outside of class	4.83	4.67	4.26	4.15
Provided useful feedback on my progress in the course	4.83	4.53	4.12	4.05
Stimulated my interest in the course	4.83	4.33	4.07	3.99
Conducted class sessions in an organized manner	4.83	4.60	4.35	4.18
Used teaching technology (e.g., Blackboard, audio-visual presentations, PowerPoint presentation, email) in an effective and appropriate way	4.83	4.87	4.41	4.27
Overall, the instructor's explanations were and understandable	4.83	4.47	4.24	4.13

Conclusion

We have conducted the comparative studies for delivery of Control Systems (ELEC 431) based on gender perspective. We analyze the course learning outcomes via the assessment tools and questioner regarding the course and its instructor. We conducted the study based on two years/offering results. The results showed the performances of the male students are slightly better compared to the female section. In order to have a more valid finding, a study for a longer period need to be done.

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