Using Instant Feedback System And Micro Exams To Enhance Active Learning

N. Sabag, ORT Braude Academic College for Engineering, Israel
S. Kosolapov, ORT Braude Academic College for Engineering, Israel

ABSTRACT

This paper presents the outcomes of the preliminary survey in which the method of IFS was used to integrate motivating questions into the lecture presentations in order to increase the students' involvement. Instant Feedback System (IFS) enables the educators to improve their own teaching by getting instant and real-time feedback about how clear the lesson for the students is; it also advances the students' participation and active involvement that improves the understanding of the learned materials.

Our long term objectives are to conduct a series of studies to explore both technological and didactic aspects of integrating the IFS system into engineering education.

As a first step in our long journey, we designed a new academic course of analog electronics with motivating questions embedded. A ten minute micro exam was conducted every three weeks, during the lesson. The students expressed opinions like:" my recommendation is to keep teaching this way. I believe in active learning during the lectures, it motivates me to come and participate in the lectures." And: "It drives the students to participate in all the lectures of the course. The motivating questions and the micro exams are an efficient tool to bring the students into the lectures." Half of the students chose to participate in one micro exam at least while the other half did not; the academic achievements of the motivated group showed a 26 points advantage in comparison to the other group.

The lecturer's conclusions and his perceptions are described in this paper as well.

Keywords: Active Learning; Instant Feedback Systems; Technology to Improve Teaching and Learning; Innovative Teaching and Learning

1. INTRODUCTION

*I*nstant Feedback System (IFS) enables educators to improve their own teaching by getting instant and real-time feedback about how clear the lesson for the students is; it also advances the students' participation and active involvement that improves understanding of the learned materials.

Many educators present their lectures using a computer and a video projector. Some of the existing presentations enable students' active involvement during the lesson. In the most common use of such audience response systems, presentation slides built with the audience response software display questions with several possible answers, more commonly referred to as multiple choice questions.

The audience participates by selecting the answer they believe to be the correct one and pushing the corresponding key on their individual wired keypad (clicker). Their answer is then sent to a base station that is also attached to the presenter's computer.

The audience response software collects the results, and the aggregate data are graphically displayed within the presentation for all to see or for the instructor only.

Depending on the presenter's requirements, the data can either be collected anonymously or it can be traced to individual participants in circumstances where tracking is required (e.g., micro exams, classroom quizzes, homework, or questions that ultimately count towards a student's course grade). Incoming data may also be stored in a database that resides on the host computer, and data reports can be created after the presentation for further analysis.

The objective of this study is to explore both technological and didactic aspects of integrating IFS system into engineering education. From a technological point of view, we intend to investigate the pros and cons of the existing IFSs with the aim of developing a new system that possesses the advantages of the existing IFSs and overcomes their weaknesses. From the pedagogical point of view, we intend to develop complete academic courses in the field of electronics engineering consisting of motivating questions to be projected every thirty minutes within the lecture to promote the students' involvement during the lessons. The students' responses will be collected and analyzed using IFS.

2.   THIS PAPER'S GOAL

The objective of the study is to examine the benefits of using IFS in large scale class lectures from both the lecturer's and students' points of view.

3.   THEORETICAL BACKGROUND

Two issues are of main concern in this paper: Active learning and improving teaching. The coming literature review relates to these subjects. Since we used qualitative research methods, we included a short background on this issue as well.

Active Learning

The roots of the active learning methodology reach back to Confucius (450 B.C.) who coined the phrase: "Tell me, and I will forget, Show me, and I may remember, Involve me, and I will understand". Pestalozzi in 1801 envisioned schools that were homelike institutions where teachers actively engaged students in learning by sensory experiences through engagement in activities. Students were to learn useful vocations that complemented their other studies (Education Encyclopedia, 2011). Dewey (p. 7, 1938) argued that "there is an intimate and necessary relation between the processes of actual experience and education". Effort has been made to engage students in active learning such as the Learning Physical Science (LEPS) that is inquiry-based, and is suitable for a large lecture hall environment (Goldberg, et al., 2010). In his article, Ford (p. 265, 2010) argues for "increased theoretical specificity in the active learning process. Whereas constructivist learning emphasizes construction of meaning, the process articulated here complements meaning construction with disciplinary critique". The analysis highlights disciplinary critique as a complementary and supporting feature of the learning process. The China's National Undergraduate Electronic Design Contest (NUEDC) (Yuqing, Xiaoshan and Jian, 2010) is a competition where teams of students are required to complete an electronic design process, and demonstrate their product in a test venue.

Felder (p. 1, 2009) states: "if you think of anything a teacher might ask students to do—answer questions in class, complete assignments and projects outside class, carry out lab experiments, or anything else other than sitting passively in a classroom—you will find people who would classify it as active learning".

We find that a more restricted definition limited to in-class activities is more useful: Active learning is anything course-related that all students in a class session are called upon to do other than simply watch, listen and take notes.

Improving Teaching

Much has been written on promoting learning. Nevertheless, improving teaching has received much less attention, even though improving the teaching methods of one teacher can affect tens or hundreds or even thousands of students' studies.

Bhattacharya (2004), claims that excellence in teaching in engineering higher education seems to transcend the boundaries of expounding subject matter, invoking interest, promoting analytical thinking, and motivating and inspiring students. However, when it comes to teaching quality evaluation, we ask for the students' opinion. Our study suggests using the students' perceptions during a real time lecture to improve teaching.

Some of the efforts made across countries to improve teaching and learning in higher education yielded the organizational centers for promoting learning and teaching (Lewis, 2010), known as "Faculty Development," "Teaching and Learning Center," "Center for Teaching Excellence," etc. According to Lewis (2010), improving teaching and learning in higher education became an important international endeavor in the 1960s and 1970s, corresponding to an influx of students coming in greater numbers than ever seen before, from a broader range of backgrounds, and with diverse expectations for attending colleges and universities. The same situation exists nowadays in Israel's higher education institutions. More and more "Teaching and Learning" centers have been established in academia during the last decade. However, most of the activities of these centers are aimed at advancing students learning rather than promoting teaching.

Most of the programs to improve teaching such as teacher training (Sabag and Doppelt, 2011) or using continuous assessment to improve teaching and learning in engineering education (Christoforou and Yigit, 2007) operate without the students' presence, i.e. teachers and students are not sitting together in the same environment and acting on improving teaching. These two important activities: enhancing learning and promoting teaching are carried out separately.

The current paper describes a case study in which the teacher uses the Instant Feedback System (ISF) ideas and approaches to perform the "On the Lecture Improvement" (OLI) method.

Qualitative Research

The current study used a qualitative approach, developed in the second half of the 20th century in social sciences, such as sociology and anthropology (Denzin & Lincoln, 2005). In this approach, the emphasis is on the study of human behavior, and on the aspects that seem significant to the interrogator, in particular. Sabar Ben-Yehoshua (1999) mentions five characteristics of qualitative research: 1. Data is drawn out of the natural system and the investigator is the central research instrument, so he or she must be as skilled and objective as possible. It requires vigilance against possible biases and errors in interpreting the reality under investigation. 2. It is descriptive; consequently, presentation of results includes quotes from interviews and observations, photos, certificates and documents. 3. The researchers are interested in processes rather than outcomes. 4. Researchers tend to analyze the data inductively; therefore, the research has a circular nature in which the researcher might rephrase the research questions while the research is in progress. 5. The participants' point of view is important; therefore, the researcher should use various research tools to confirm that the phenomenon under investigation was understood correctly. Qualitative research methods are particularly necessary in educational studies in order to understand students' behaviors, thinking processes, teacher-student interactions, etc.

Among all the methods described by Denzin and Lincoln (2005), we used the interpretive research. The research tools in use were interviews with students and their lecturer, and written notes from the researchers' file.

4.   METHODOLOGY

To meet the research goals a qualitative[1] methodology was used. The main tools were interviews with the lecturer and five students of the new organized course. The interviews were recorded and the main findings are reported here. Thirty four students studied the course of analog electronics during a fourteen week-semester. Five micro exams and a final exam were given to the students throughout the semester. The grades of these micro exams did not count toward the final grade, so the students were not obligated to take them. Seventeen students performed

---

[1] Note: even though we use some statistics to demonstrate differences between two groups of students, we refer to the study as a qualitative research since the students assigning into the groups was not random. We cannot conclude from these outcomes. They can only serve as a motivating trigger for continuing research.

at least one micro exam; therefore we will call them the motivated group and the other seventeen students will be called the other group. The interviewer was the first author and the teacher was the second author of the presented paper. A detailed description of the course is in next paragraph.

Procedures

As a first step in our long journey, we designed a new academic course of analog electronics with motivating questions embedded. A ten minute micro exam was conducted every three weeks, during the lesson. In depth interviews were conducted with five students, and with the lecturer of the course. This paper presents the outcomes of the preliminary survey in which the method of IFS was used to integrate motivating questions into the lecture presentations in order to increase the students' involvement. The students' academic achievements and their opinions were tested and reported in the current paper.

The Learning Course

As argued before, we started our long journey with integrating motivating questions into an academic course of analog electronics, whose scope is fourteen three-hour lectures. The lectures were delivered to the students using Microsoft Power Point. Each one of the fourteen lectures was started with the question: "Is this lecture needed?" immediately after presenting the lecture's title. Then the students were asked to answer four-five diagnostic multiple choice questions for the teacher to determine the starting level of the lecture in accordance with the students' background. For example: Questions relating to the characteristics of an ideal amplifier in comparison to a realistic amplifier. The students were given about a minute to respond. Throughout the lecture, there were additional four to five yes/no questions embedded after a group of slides relating to a certain principle. At this preliminary stage of the research, we had no budget to purchase the IFS, therefore the students were asked to answer by raising hands and the lecturer counted them and wrote down the answers of each category.

A step forward to increase the students' participation in the lectures was done by conducting ten minute micro exams every three weeks, during the lesson. The micro exams were not an obligatory requirement and the students' grades did not count to the final course grade so the students' drive to participate in the exams was the desire to succeed. Additionally, the micro exam outcomes helped the teacher to focus on the students' misunderstanding and to provide additional explanation when needed.

The final test at the end of the semester was the same for all students; its grades constitute the final grade of the course.

Participants

Thirty four students studying, in their third year, towards the B.Sc. in electrical and electronics engineering studied the course of analog electronics with motivating questions and micro exams embedded. Seventeen of them chose to perform at least part of the exams; the other seventeen did not attend any of the micro exams. Interviews with the lecturer and five students were conducted in order to study the students and the lecturer opinions on the new way of learning and teaching. All the students are 21 – 28 years old.

5.   FINDINGS

Learning Perspective

As mentioned above, the grades of the micro exams did not count to the final grade, only the final exam constituted it. The final exam included five questions different than the questions in the micro exam.

The table below shows a comparison (out of 100 points) between the groups' achievements and standard deviation (S. Dev.) obtained in the final grade in each group. The number of failed students of each group is presented in the failed column as well; it means scoring less than 55 on the final exam.

Table 1: A comparison between the total group grades and failures

Group	N	Mean	S. Dev.	Failed
Motivated group	17	79.1	20.1	2
Other group	17	53.3	20.5	10
Difference		25.8		8

The motivated group gained the mean grade of 79.1 that is almost 26 points better than the other group's mean grade. Additionally, only two students failed the course from the motivated group, while ten students failed from the other group.

The gap between the groups' achievements can be attributed to the findings obtained from the interviews, and indicating that integrating questions and micro exams into the lectures indeed motivated the students.

Students' interview

The following responses of the participants indicate that the motivated question and the micro exams motivated the students to participate in the lectures and to invest time in reviewing their lecture notes.

Student A: *motivating questions were incorporated at the beginning of each lecture to stimulate thinking, that's great. The answers to these questions were given at the end of the lesson, it made me curious, I wanted to understand; I waited with great interest to the end of the lesson to hear the answers.*

Student B: *the micro exams were very good, they caused the students to review their lecture notes and do the home work. By doing this we polish our knowledge and sharpen our understanding.*

Student C: *the micro exams contributed to keeping me on track with the studied material during the semester. I am not meeting the studied material at the end of the semester or at the final exam for the first time.*

Student D: *my recommendation is to keep teaching this way. I believe in active learning during the lectures, it motivates me to come and participate in the lectures.*

Student E: *It drives the students to participate in all the lectures of the course. The motivating questions and the micro exams are an efficient tool to bring the students into the lectures.*

These findings are compatible with the theoretical background of active learning. The students in class were actively solving problems; some of them spent extra time at home, to review their lecture notes. So, according to Felder (p.1, 2010), the students were actively involved. Moreover, Confucius (450 B.C.) claims that involving the students facilitates understanding, which may explain the gap of 26 points in favor of the motivated group.

Teaching Perspective

The lecturer of the course of analog electronics is a Ph.D. holder, with more than thirty years of experience in scientific research and electrical and electronics engineering teaching. He describes the improvement of his own teaching in his words below:

Lecturer: *I started all my lectures with describing the subject of the lecture then immediately after that I asked my students: Do you think that this lecture is needed? After this I asked a few diagnostic questions to find out the students knowledge concerning the issues I am going to teach. Based on their answers, I decided whether or not to start teaching the issues from the beginning. In most cases, it was necessary to begin from the beginning. During my explanations, I used to ask about four to five yes or no questions, leaving the students one minute to answer. Following the students' answer I modified my explanations; in case where most of the students chose the wrong answer, I extended my explanations.*

Interviewer: *Tell me about the students' participation in the lecture.*

Lecturer: *Very few students participate at the beginning, but as the semester advances more and more students become involved in the lesson.*

Interviewer: *Can you tell me about a change in your teaching?*

Lecturer: *My experience allowed me to make a priory guess about the students' difficulties in understanding the lesson. However, the feedback from the students' answers helped me a lot with adjusting my explanations to my students.*

Interviewer: *Can you give an example?*

Lecturer: *The first step in analyzing the multistage-amplifier response to small signal is drawing its equivalent model. Till the last semester, I thought it's a trivial procedure and need not be dwelled upon. The students' responses helped to concentrate their difficulties. Today I am very pedantic in replacing one component at a time with its model; I am doing this till I replace all the circuit's components.*

The findings above meet the need to improve teaching, as mentioned in the theoretical background, using the students' feedback in real time.

6.   DISCUSSION AND RECOMMENDATIONS

It is evident from the results of this study that following the integration of motivating questions into the lectures presentations and embedding micro exams in the course of analog electronics, the students' interest in participating in the lectures increased, as argued by student E: "*It drives the students to participate in all the lectures of the course. The motivating questions and the micro exams are an efficient tool to bring the students into the lectures".* The quantitative results show an advantage of 26 points in the course's average final grade for the motivated group in comparison with the other group. This might encourage future students to attend the lectures more frequently. To emphasize this idea, we cite student D who said: *my recommendation is to keep teaching this way. I believe in active learning during the lectures, it motivates me to come and participate in the lectures.*

The lecturer testimony in his interview was witness that the teaching habits of the lecturer were improved as well.

In our future research, we intend to develop the technological system that will help us to govern all the necessary logistics to make the students' responses instantaneous.

AUTHOR INFORMATION

N. Sabag, Department of Electronic and Electrical Engineering, ORT Braude Academic College for Engineering, Karmiel, Israel. E-mail: nsabag@braude.ac.il (Corresponding author)

S. Kosolapov, Department of Electronic and Electrical Engineering, ORT Braude Academic College for Engineering, Karmiel, Israel. E-mail: ksamuel@braude.ac.il

REFERENCES

1.   Bhattacharya, B. (2004). What is good teaching in engineering education in India? A case study. *Innovations in Education and Teaching International*, 41(3), 329-341.
2.   Christoforou, A.P., & Yigit, A.S. (2008). Improving teaching and learning in engineering education through a continuous assessment process. *European Journal of Engineering Education*, 33(1), 105–116.
3.   Denzin, N. K., & Lincoln, Y. S. (Eds.). (2005). *The sage handbook of qualitative research (3rd ed.).* Thousand Oaks, CA: Sage Publications.
4.   Dewey, J. (1938). *Experience and Education*. New York: Simon and Schuster.

5.   Education Encyclopedia, (2011, December 25). Retrieved from:
      http://education.stateuniversity.com/pages/2319/Pestalozzi-Johann-1746-1827.html
6.   Felder, R.M., & Brent, R. (2009). Active Learning: an Introduction. *ASQ Higher Education Brief*, 2(4),
      August 2009.
7.   Ford, M. J. (2010). Critique in academic disciplines and active learning of academic content. *Cambridge
      Journal of Education,* 40(3), 265–280.
8.   Goldberg, F., Price, E., Harlow, D., Robinson, S., Kruse, R., & McKean, M. (2010). Development and
      evaluation of large-enrollment, active learning physical science curriculum. Physics Education Research
      Conference, 153-156, American Institute of Physics.
9.   Lewis K.G. (2010). Pathways toward improving teaching and learning in higher education: International
      context and background. *New Directions for Teaching and Learning*, No. 122, Wiley Periodicals, Inc.
10.   Sabag, N., & Doppelt, Y. (2011). Methodology of change assimilation in technology education - Case
      study. *IEEE Transactions on Education*, 55(2), 190-195.
11.   Sabar Ben-Yehoshua, N. (1999). *Qualitative research in teaching and learning. (5th ed.)*. Tel Aviv: Modan
      publishers. (in Hebrew).
12.   Yuqing, C., Xiaoshan, P., & Jian, S. (2010). National undergraduate electronic design contest: A vehicle for
      enhancing active learning. *British Journal of Educational Technology*, 41(4), 660–664.

NOTES