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COOPERATIVE LEARNING APPLICATIONS IN AUTOMATIC CONTROL COURSE

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Abstract: *This study includes the cooperative learning practices in Automatic Control Course which is a core course in the curriculum of Electronics Engineering Department of Turkish Air Force Academy (TurAFA). These practices with the results obtained and the students' opinions collected are examples of active learning techniques in an engineering course. TurAFA cadets are unique engineering students in that they will be future officers with an engineering degree and be assuming operational responsibilities under severe conditions. So, the contributions of active learning techniques to the TurAFA cadets who need to develop problem-solving skills for tough conditions are also depicted in this study. This study shows that through case-based scenarios it is possible to enable cadets to write poems summarizing the content studied in an engineering course. The feedback received from participants of the study proved the active learning practices enhance the quality of learning.*

Keywords: *cooperative learning practices, active learning techniques*

1. INTRODUCTION

Cognitive psychology has emerged as a reaction to behaviorism since the early 1970s. Unlike behaviorists, constructivists think that learners construct their own knowledge. Constructivism is proposed by cognitive psychologists who claimed knowledge is not independent of people and constructing knowledge means that students are active participants in a learning process by seeking to find meaning in their experiences. In a literal sense, learners construct their subjective experiences, and this result becomes knowledge (Sener, 1997). In addition, according to the constructivists knowledge is constructed in the socio-cultural context within the framework of the learners' experiences and their present knowledge. Constructivism regards the individual learner as the core element of learning process and learners build the knowledge by forming links to the ground to which former knowledge structures are attached. In other words, learners transfer new knowledge structures to their own mental schema by taking advantage of their prior knowledge and experiences and ability to create meaningful structures by synthesizing old and new.

According to constructivists, learner has an active role in teaching-learning process. Constructivist classroom environment, therefore, is not a place to transfer the information, is a place where students' active participation is provided, inquiry and research are conducted and problems have been solved.

So, classroom environment should be arranged to allow students to live rich learning experiences (Demirel, 2002).

Constructivist approach is based on Piaget's theory of cognitive development. According to Piaget, cognitive development is the result of activities rather than the words. According to him, activities with real experiences should be given in the lessons rather than verbal symbols of expression.

The conception of learning as an inherent process mediated by cognitive processes rather than environmental factors led to changes in the perception of learning which in return changed the perception of teaching. As a result, studies in the field of education have focused on cognitive processes and their roles on learners (Açıkgöz, 1996).

Constructivists concerned with the issue of teaching and learning and interested in the nature of knowledge, how information is configured and factors influencing cognition process. Constructivist theory explains how students learn but does not state the procedures to be applied in constructivist classrooms. Active learning model developed on the principles constructivist theory sets techniques and procedures to apply constructivist theory in the classroom. Active learning is an approach to learning and it claims the existence of an important relationship between knowledge and social interaction (Elby, 2000).

Evaluation of Group Process: It should be decided which member acts of the group contribute to reach the group goals and which of them should be changed or eliminated.

Equal Opportunity for Success: Contribution of students by developing their own performances. Scoring individual efforts can be used to ensure this goal (Açıkgöz, 1992).

At first glance, cooperative learning can be thought as a single method such as lecture and discussion. However, cooperative learning has various techniques such as student teams, ask together-learn together and writing poems (Açıkgöz, 2007).

1.1. Effectiveness of Cooperative Learning

Within the past 90 years more than 875 researches examining the effects of cooperative learning on students have been carried out. Participants of those studies were of various economic class, age, gender, and cultural background.

Richard M. Felder-North Carolina State University Department of Chemical Engineering Faculty Instructor, Gary N. Felder-Stanford University Department of Physics Instructor and E. Jacquelin Dietz-North Carolina State University Department of Statistics Instructor carried out a research exploring the use of active learning practices in higher education in 1990. This study carried out in North Caroline State University, USA and lasted for five consecutive semesters in five field courses given by the same instructor. Participants of the study were 123 chemical engineering students. The aim of the research was to determine the degree of effectiveness of active learning practices on chemical engineering students' academic performance and their attendance to the program. In the study participants are assigned to control and experimental groups. Experimental group students received intensive active learning practices whereas the control group students are taught via traditional teaching methods. The researchers concluded that active learning practices of which effectiveness are proven by numerous researches led to positive learning and teaching experiences for the participants (Felder, Felder, Dietz, 1998). The results of the survey are summarized below:

- Attendance and graduation rates of the experimental group students attending chemical engineering program are quite high compared to control group students.
- Students in the experimental group have developed critical skills. Some of these skills are open-ended inter-disciplinary problem solving skills, to predict differences between the actual situation and estimated designs, leadership, communication, conflict resolution and team-work skills.

- With the help of teaching method applied to the experimental group peer-learning is ensured. It is indicated that peer-learning is very important factor affecting the academic development in undergraduate education. It has also shown that peer-learning not only increases the participants GPAs, but also it improves leadership ability, developing analytical problem – solving and communication skills.

In this article, cooperative learning practices applied in Automatic Control Course which is part of Air Force Academy-Department of Electronics engineering junior class curriculum are described. The transition process from traditional to active learning method in the Air Force Academy will be presented in part two. Participants of the study, and cooperative learning techniques used are described part three. Findings of the study and interpretations of the findings are described in part four and the results are given in part five.

2. ACTIVE LEARNING IN AUTOMATIC CONTROL COURSE

After the completion of the staff's in-service training program, active learning practices in automatic control course are carried out within the framework of the preset design.

2.1. Participants

In this study, all participants are junior class students of Automatic Control Course that is a core part of Air Force Academy's Electronic Engineering Department curriculum. Cooperative learning techniques started to be applied in the Automatic Control Course with 70 students in the 2008-2009 academic years. The study continued in the following academic years 2009-2010 with those 70 students and 2010-2011 academic years with 60 students. The total number participants during these three years are 200 and they are all male students.

2.2. Method

Faculty members play a vital role in successfully sustaining a new teaching method. For an instructor who has taught a course via traditional lecture method for years to shit to a new method is quite demanding. For the instructors the hardest part is to adapt the new techniques to their subject matters and classroom activities.

Active and cooperative learning practices explained below helped the learners to comprehend the content of the Automatic Control Course which is a notorious course with a heavy theory requiring mathematics proficiency.

2.3. Cooperative Learning Applications

Automatic Control Course is a four hour 3.5-credit course with three hours of theory and a practice hour. It is a sixteen-week semester course with a two additional exam weeks. Course topics covered are as follows; introduction (definition and the history of automatic control, open loop and closed loop concepts and the effects of feedback), the mathematical bases of automatic control, transfer functions, block diagrams and signal flow diagrams, mathematical modeling of physical systems, stability of control systems, control systems' time domain analysis and root-locus technique.

Cooperative Learning Classroom:

Cooperative learning techniques comprising real life activities are reflections of the constructivist approach. So, Automatic Control Course is given in Electronic Engineering Department's Control Laboratory to provide cadets with a classroom environment offering real life experiences. Control Laboratory is a place where the graduate and undergraduate control laboratory projects are implemented. This laboratory is

also equipped with chairs convenient for group formation, a traditional blackboard and a smart board ready to use in Control Courses. It was understood from the student feedback (student opinions obtained at the end of the semester by the written student course evaluations) that courses given in the laboratory motivate the students to participate the classroom activities. In the control laboratory which is used as cooperative learning environment there are also electronic materials i.e. classroom realia related to course topics in addition to classical teaching materials. The most important control system element of the automatic control course applications is feedback components such as different types of sensors (operative sensors or damaged sensors, Li-Po batteries, motors in different sizes etc.) which are used as course materials during the presentation of the new subject matters. During the time domain analysis a modular servo control experiment set contributes to comprehension of the subject. Most important of all, the presence of an ongoing project in the lab to which the students are expected to contribute by giving ideas make students highly motivated to the lesson.

Case-Based Scenarios:

Automatic control course sessions start with the presentation of the unit by the instructor and goes on with the appropriate form of cooperative learning techniques embedded in case-based scenarios.

The first two weeks of the semester, students are informed about the course content and they are motivated to course. The history of automatic control is given by slide presentations in the introduction part of the course. After discussing application areas of automatic control in detail, it is emphasized with examples that the course is not only related to the fields of electrical, electronic, or mechanical engineering but also it is used in economics and even in social sciences. Together with the concept of feedback open loop and closed loop control system are also defined. Afterwards students get in groups. Students in groups are expected to produce ideas about automatic control projects and to prepare a project including the control system elements. After the completion of the group projects, the group spokesman describes the project. Thus, a fruitful discussion ground is provided for other students to criticize the presented project by demonstrating the weaknesses of the project. In return the presenter team is given chance to defend their projects.

During the following weeks students are engaged in cases given by the instructor and they are expected to handle with the given cases using the techniques such as problem-solving and classroom discussion. The sample cases and the tasks given are as follows;

- To create a block diagram in order to control pitching movement of a space shuttle,
- Time domain analysis for passenger aircraft and fighter aircraft and the performance expectations,
- Control system elements of air platforms that are capable of vertical landing.

As it can be seen from the above cases, the groups are given tasks directly related to the Air Force and cadets' prospective careers. This aspect of the cases is an additional motivating factor for the cadets taking the course.

Other Active Learning Techniques:

In automatic control course sessions, all of the following activities are carried out in the laboratory which is used as a classroom for student centered activities.

- Preparing multiple choice and open ended questions with short answers,
- Designing projects and realizing those projects,
- Producing different solutions to the problems given on Control Projects carried out in the laboratory,
- Making a demonstration using a modular experiment system as a group work,
- Writing a poem related to the subject matter studied in class.

Writing Poems:

A cooperative learning technique which may be interesting and even difficult to implement in an engineering course is writing poems. Actually it was successfully applied as a group work in Automatic Control Course for the topic called Stability Analysis. Upon the

presentation of the topic by the instructor, this technique entails students in groups to write a line related to the topic by taking turns. The rule is all lines added to the poem should contain some piece of new information about the topic. By the contribution of each single team member the poems are completed by each group. Some groups wanted to write their poems as a whole group work. This was allowed because that also required close cooperation which is the essence of a group work.

When the instructor told the students that they are going to write a poem for the topic studied, almost all of the students found the idea of writing poems in an engineering course strange. Some of them said that they thought that they cannot do this. But after the application they said that they really got surprised. Some of the groups wrote stability analysis poems composed of seven stanzas. This might be a reflection of cognitive and affective integrity achieved by a cooperative learning technique. One of the poems entitled "Towards Stability", written by a group of four students is given below as a sample poem:

Towards Stability

A stable system is like sunrise
The characteristic equation giving us all the information
We write all the parameters on table
In the way of uncle Routh's, *s* cube, *s* square

Instability is a case to tender minds
To solve this case it is necessary to find stability
Changing one sign infects the entire compliance
All must be the same, this gives meaning to compliance

Systems are temporary, but it must be stable
Unknown parameters must be enlightened
How big you are Routh that you show us the way
You portrayed unknown numbers easily

Exceptions do not break the rule
We apply this rule in the zero-line
Oh zero! You cause trouble for us
We just go to the next line
We continue our way with the helping equations

We look at the first column from top to bottom
If there is a change on the basis of sign
Then roots are on the right-half plane
Leads system to instability

Passes through zero both the virtual and the real axis
Confused heads work for you
Conjugate roots in virtual axis always swing
The only way to stop it lets close the system

O the left half-plane how vast you are
You perish the system with all your roots
That is the time we say we have become an engineer
We rise to the skies with new inventions

3. RESULTS AND COMMENTS

At the end of the Automatic Control Course practices, students' views on these practices are collected using a questionnaire including five open-ended questions developed by the researcher. Participants were not given any clue in open-ended questions in order to get deep and original responses (Best, Kahn, 1989). Students' opinions on the

implementation of cooperative learning techniques are presented below.

- The way course is given and classroom environment are very beautiful and motivating. My interest in this course increased even more when I figured out the possible uses of Control Systems in the field of aerospace and aviation.

-Active-learning techniques applied to the course were really useful and I believe they will help us not to forget the things we learned. Especially poems we wrote on the issue of stability are very effective in better understanding of the subject and in permanency of what we learned. Supporting the course with the multimedia (video, photos, slides, etc.) makes the lessons more interesting. Learning the course in the laboratory and seeing the usage of what we learn on the projects expands our perspective.

- Automatic Control Course that I took this semester has attracted my attention due to the different techniques implemented. Writing poems, preparing questions or using of multimedia elements in presentations lead better understanding of the course content. We think that lessons are more meaningful when they involve real-life examples embedded in the units.

- In my opinion, using these techniques should continue while teaching the lesson. Also, active learning techniques create very different atmosphere in class. These techniques are useful for the development of the students.

- I think the most beneficial applications were active learning practices. Through those practices lessons became interactive as we engaged in group works. One day, we wrote poems on the subject and it was so funny. It was not only funny but also an educational activity. For example, I wrote a poem line about stability and I think with the help of it I won't forget the subject. At the same time we got mentally relaxed.

Even those sample students' comments given above show that when active learning techniques are used appropriately in the course, we get positive student responses. Active learning approach with cooperative learning techniques applied to 200 students in the Automatic Control Course in three years and they increased students' interest in the course. Almost all of the students took part in this study responded active learning techniques positively. They also think that active learning techniques applied in the course increased the course attendance rates.

4. CONCLUSION

In order to fulfill their missions assigned to them, educational institutions should spend time not only on what issues should be taught but also how this content should be taught. It is also essential for those institutions to have instructors compatible with 21st century needs and requirements. The findings of this study showed that through active learning techniques even in engineering courses, which are usually perceived as difficult and mechanic, students can be motivated to participate actively in classroom activities and develop positive attitudes towards the course. Within the framework of the Automatic Control Course practices in engineering curriculum, it can be concluded that those practices should also be applied in the rest of the engineering courses to increase student participation in classroom activities and help the students achieve deep learning.

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