ANALYZING AGENT FUNCTION DESIGN TEACHING IN ELECTRICAL ENGINEERING EDUCATION

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ABSTRACT: In this study, the effect of chosen examples in agent function design teaching is aimed to be analyzed. Traditional problem solving method is used at the beginning of agent function design teaching. Then, a workshop has been organized before a quiz. Totally 22 number of students have been divided into two groups. Each group members are randomly chosen. Each group needs to develop an agent function in a specific time. All the participants of the first group, those are expected to find a new example; choose the solved examples in lectures. Some of the students in the other group perfectly develop an agent function for a given new example. Results of the study revealed that students who asked to develop a new example require additional thinking than the ones that have an example. Both groups have been asked the same questions in midterm and final examinations. Student's success on agent function design is also analyzed.

Key words: teaching methods, agent function, robot design, robot control

INTRODUCTION

In higher education, especially in engineering faculties, students are aimed to be reached to the critical thinking level for several courses in their education. Engineering education mainly involves critical thinking and problem solving activities. In all engineering programs, courses in last semesters, students are generally fulfilled to perform a project which requires creativity. Therefore, in the education of engineering faculties, students' learning abilities should be aimed to reach higher thinking levels.

Teaching methods are generally divided into two categories; Teacher Centered Approaches and Student Centered Approaches. Teacher Centered Approaches are widely used teaching methods. The well-known and mostly used teaching strategies can be classified into three. These are namely; expository teaching, discovery teaching and inquiry teaching strategies (Demirel, 2009). Especially, education in engineering faculties' given by an expert teacher is an example of expository teaching method. Expository teaching method can be more effective with discussion and problem solving techniques (Sönmez, 2011).

Robotics is one of the multidisciplinary course in Electrical and Electronic Engineering program in Cyprus International University. This course involves robot design for a specific task and real time robot control. This study is motivated from the students' learning difficulty about agent function design learning which is the first step in robot design topic. This topic requires higher problem analyzing ability and additionally students should have good computer programming skills. Traditional problem solving methods are used at the beginning of the agent function design teaching. After giving the definition of an agent function, a simple vacuum cleaner world problem is introduced to the class. This problem was firstly solved in the class with discussions. After that, the same problem is modified twice with small changes having an increasing complexity. Because of the students' difficulties to find an acceptable solution, a new teaching method for agent function design is applied.

Totally 32 number of students were registered to the Robotics course at the beginning of the 2015-2016 fall semester. After finishing the explanation and problem solving parts about agent functions, one workshop has been organized before a quiz. Only 22 students have attended the workshop and these students were divided into two groups. Each group members are randomly chosen. Like in workshop, in the quiz, one group has been asked to develop an agent function for a given example, whereas the other group asked to create their own example. Each group needs to develop an agent function in a specific time. All the participants of the first group, those are expected to find a new example; all they choose the solved examples in lectures. Some of the students in the other group perfectly develop an agent function for a given new example.

Benefits of problem based learning are studied by Yenal, (2003). That research reports that in adult education the problem based learning method might increase students' cognitive competence and higher thinking ability. Another study about student centered learning method is done by Başbay, (2005). The effect of project based on

learning approach which is supported by layered curriculum is studied and results of that study shows that students' learning levels are increased. Especially, students having higher level learning abilities are positively affected.

In this paper, two well-known cognitive level teaching model and approach; namely Bloom's Revised Taxonomy and Layered Curriculum by Kathie Nunley, are summarized in the Teaching Methods section. The effect of chosen examples in agent function design teaching is aimed to be analyzed with this study. The analysis of students' performance about agent function solutions and the observations based on new teaching method is given in Results and Findings section. Observations about example choice are discussed in Conclusion section.

TEACHING METHODS

Effective teaching methods should be used to teach today's new technology to the next generations. Psychologists and educationists are working on learning taxonomies and effective teaching methodologies. Widely accepted learning taxonomy is introduced by Benjamin Bloom in 1956 and it is revised by Anderson and Krathwohl in 2001 (Krathwohl, 2002). In the last decade, a Student-Centered teaching approach namely Layered Curriculum is introduced by Kathie Nunley (2005). The reason of all these studies is to have improvement in the students' learning levels to desired learning outcomes.

If a teacher uses traditional methods in higher education, the teacher determines course objectives and tasks by her/himself. On the other hand, if the teacher prefers to use interactive teaching method such as problem based learning and cooperative learning students' interest increases. Armstrong observed that the example choice increases the students' interest about what they are taught (Armstrong, 2012).

In this study, discovery teaching strategy is applied for agent function design teaching which is one of the Teacher-Centered Approach. In order to increase student interest in agent function design learning, some of the students are asked to find their examples related with agent function design activities as a workshop and a quiz. The implementation details of this strategy are explained in Agent Function Teaching section.

Bloom's Taxonomy

Benjamin Bloom and his friends aim to create a basis to evaluate a course or curriculum in a broad educational goal in cognitive level. Additionally, this taxonomy can be used to determine the consistency of a course objective. The original taxonomy consists of six layers starting from simple to complex categories. When it became a popular within the researchers, some discussions have been started about the lack of the original taxonomy. Especially, analysis done by many researchers put emphasis on the objectives at knowledge category requiring only recognition or recall of information. Therefore, the original teaching-learning taxonomy is revised by Anderson and Krathwohl et al (Krathwohl, 2002). The category names for both taxonomies are summarized in Table 1.

Table 1. Bloom's Taxonomy versus Revised Taxonomy

Original Taxonomy (1956)	**Revised Taxonomy (2001)**	**Level of Thinking**
Evaluation	Create	Higher order thinking
Synthesis	Evaluate	↑
Analysis	Analyze	↑
Application	Apply	↑
Comprehension	Understand	↑
Knowledge	Remember	Lower order thinking

The brief definitions of revised taxonomy is listed below (Krathwohl, 2002).

1. Remember: Retrieving relevant knowledge from long-term memory.
2. Understand: Determining the meaning of instructional messages.
3. Apply: Implementing a procedure in a given situation.
4. Analyze: Detecting how the parts relate each another and to an overall structure or purpose.
5. Evaluate: Making critiquing based on subject.
6. Create: Combining elements together to form a novel or an original product.

The above listed categories are aimed to assist teachers to plan their course objectives. It would be useful to prepare questions having increasing difficulties and related points.

Layered Curriculum

To teach a class of students having mixed-ability levels, a simple teaching approach is developed by Kathie Nunley. This method consists of three layers. Layer C is the bottom level which includes several assignment choices with basic information. The Layer B consisting of problem solving activities where students are able to show applications of the knowledge gained from Layer C. The top and the last layer is Layer A requires critical thinking and analysis about the real-world issues (Nunley, 2005).

Students decide their work layers and points are assigned with oral presentations and discussions. Depending on the worked layer, each student earns a grade of C, B or A. The Layered Curriculum design is illustrated in Figure 1.

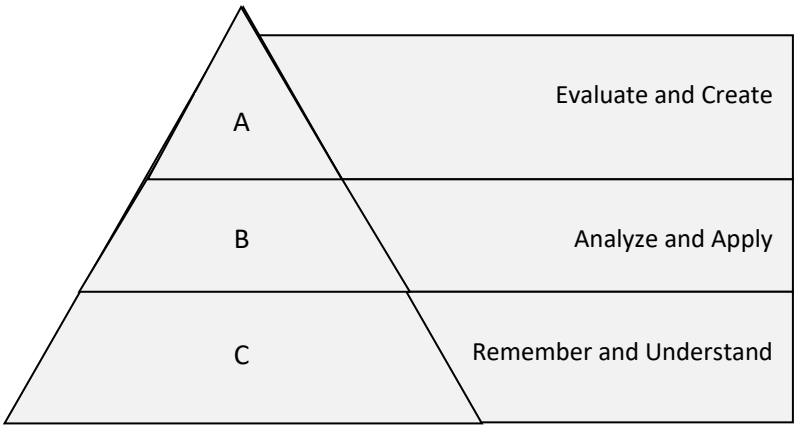


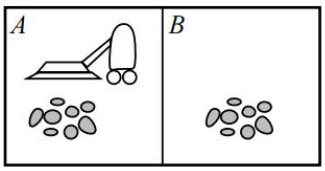
Figure 1. Layered curriculum

Like Bloom's taxonomy, the Layered Curriculum teaching approach also categorizes the learning levels. The difference is that students have chance to reach upper layers with their choices. However, with the Bloom's taxonomy all students should do all activities that are defined in a course.

Agent Function Teaching

Agent function is a well-known problem in artificial intelligence. A simple robot design and control code can be demonstrated with agent function. In an agent function, a robotic system's perceptions and actions are decided and processed. A classical agent function definition and an example are given from Russell (2005).

An agent function concept is explained to the class of students with lecturing method. After the definition of the agent function, a simple example as Vacuum-Cleaner world problem is introduced by demonstrating technique together with lecturing as shown in Figure 2.



Percepts: location and contents, e.g., $[A, Dirty]$

Actions: $Left, Right, Suck, NoOp$

Figure 2. Vacuum-Cleaner world problem (Russell, 2005)

The example is analyzed together with the class about the required percepts and actions. In order to develop a control algorithm for this example an agent function concept is introduced.

```
function REFLEX-VACUUM-AGENT( [location,status]) returns an action

  if status = Dirty then return Suck
  else if location = A then return Right
  else if location = B then return Left
```

Figure 3. Vacuum-Cleaner agent function (Russell, 2005).

The syntax of agent function is explained and the control algorithm is traced in the class. An optimal agent function solution is shown in Figure 3. After some discussions related with student questions, the vacuum-cleaner world problem is modified with the following questions:

i. Modify your agent function for a problem of: "having four numbers of locations in the environment."
ii. Modify your agent function for a problem of: "the algorithm must stop when all environments are clean."

The modifications are asked in the given order and they solved one after the other. Firstly, after each question, sometime duration is allowed to students to think about the problem. After that, potential solutions are discussed in the class. The second question is asked after the solution of first question. Again, sometime is given to students to think about it.

The Robotics course and the agent function design topic is taught by using traditional deduction teaching method and it is combined with problem solving and discussion teaching strategies. Additionally, in order to increase students' interests in learning process a workshop is organized and some of the students let free to choose their example about agent function.

The class is randomly grouped into three. One group includes students that not attended the workshop, second group includes students that attended the workshop and they get a question with a given agent function problem. Lastly, the third group of students that attended the workshop and they ask to give an agent function problem. It is expected to have new agent function problems described by the student. One of the aims for this activity is to increase the students' interest about agent function design and to let the students to find their own example.

There was one ungraded workshop, one quiz, one midterm, one group project and a final examination that are planned as course activities. Each activity is graded by the course instructor. Like in workshop, the same group of students are asked to give an agent function example in the quiz where the others are asked solve a new example. Same questions are asked to the class both in midterm and final examinations by using the Bloom's teaching taxonomy of questions from simple to complex ones. Several project groups are assigned with the approval of all members.

RESULTS AND FINDINGS

Students' course performances are analyzed in this section. First of all, the distribution of three groups in the class is illustrated in Figure 4. These three groups are randomly formed within the first-class activity of workshop. Whole class randomly and almost equally divided into three groups and they named as Not Attended, Given Example and Give an Example.

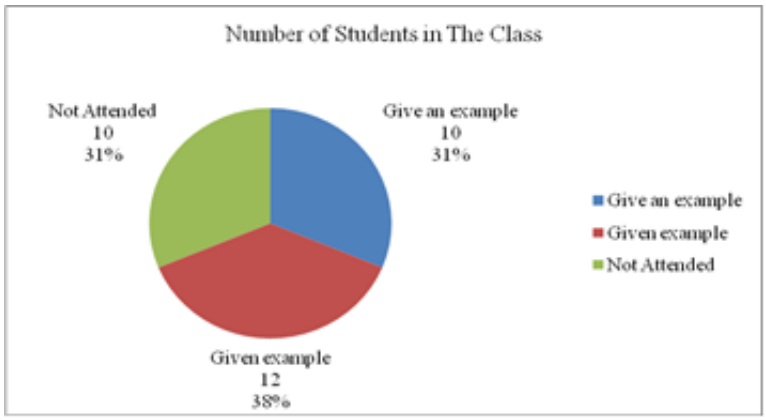


Figure 4. Workshop attendance distribution

After the workshop activity, a graded quiz is done in the class with a predefined date and content. Like in workshop no new example is given in the quiz by the first group but structure of agent function is correctly used. The quiz examination evaluation was out of 5 and the class averages is given in Figure 5. Significant success is seen with the students that attended the workshop.

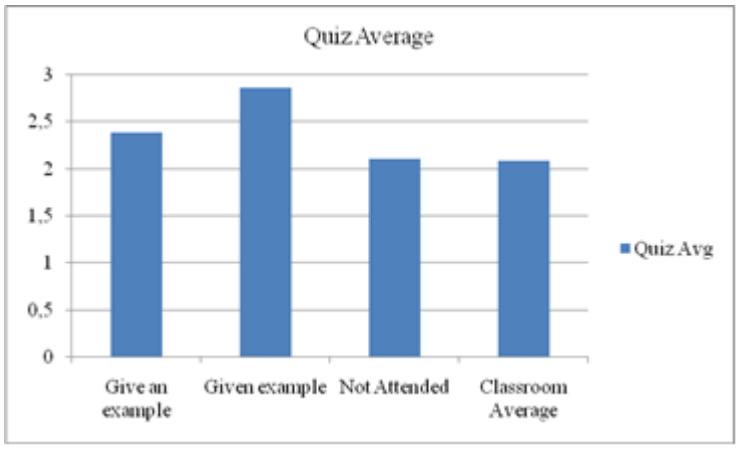


Figure 5. Quiz average for agent function design question

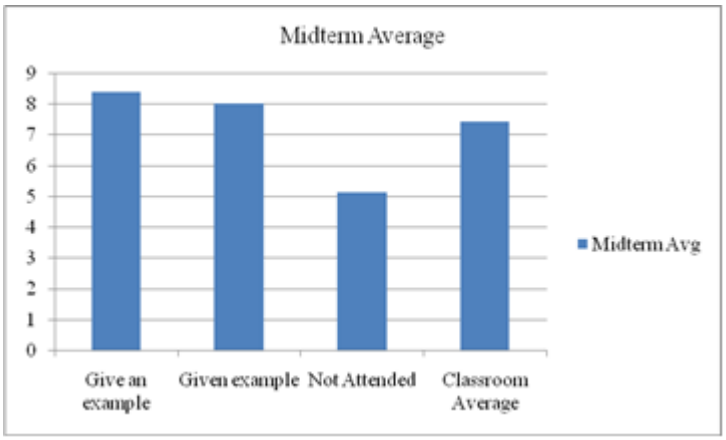


Figure 6. Midterm average for agent function design question

An agent function question is asked in the midterm examination. Its evaluation was out of 25 and the class averages is given in Figure 6. Significant success is also seen with the students that attended the workshop.

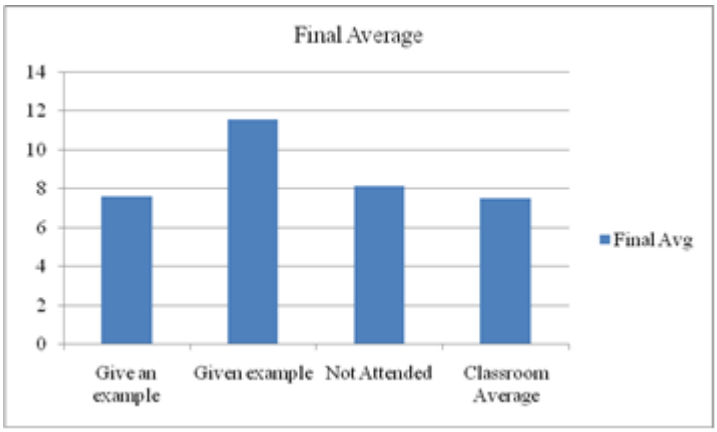


Figure 7. Final average for agent function design question

An agent function question is again asked in the final examination. Its evaluation was out of 20 and the class averages is given in Figure 7. The success average of Given Example group is found as the greatest one. This might be because of the students' personal learning abilities. The personal learning ability plays a big role in teaching-learning methods. It is obvious that asking to find new example has no effect on students' learning interest.

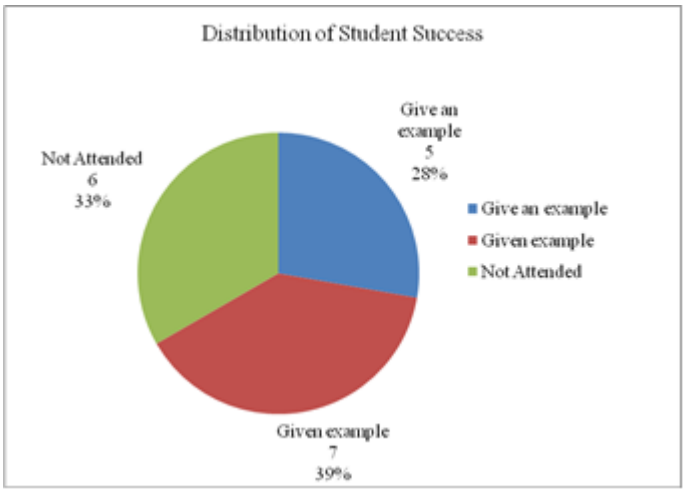


Figure 8. Distribution of passed students in the class

The success rates between these three groups are analyzed in Figure 8. Students that are asked to find an agent function example have the lowest passed ratio regarding the others.

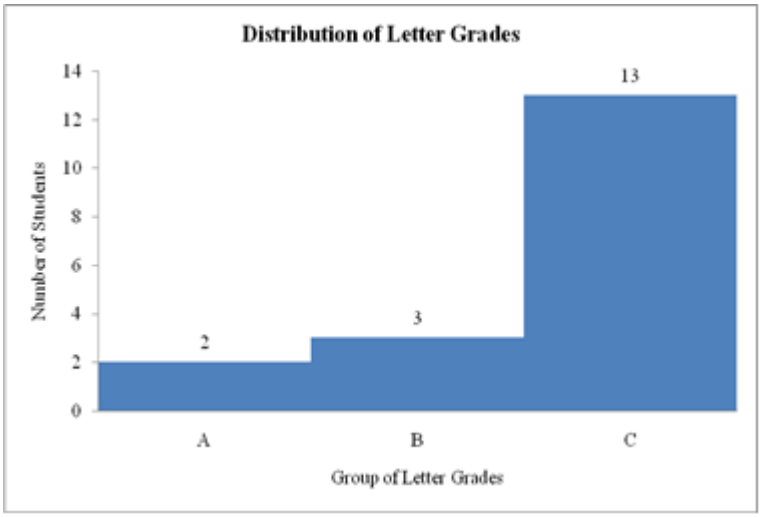


Figure 9. Later grade distribution of the class

The successful students' grades distribution is given in Figure 9. Only few numbers of students have higher thinking levels. It is clearly seen that the distribution of grades perfectly matches with the Layered Curriculum architecture.

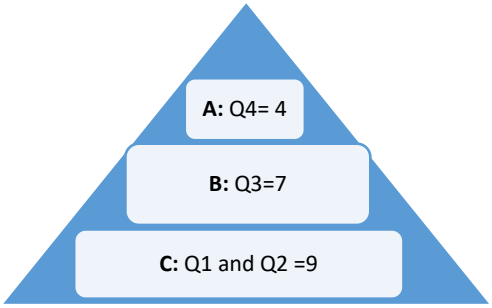


Figure 10. Layered distribution of agent function answers in midterm examination

In the midterm examination four questions are asked to the students. When the questions are categorized depending on the difficulty levels, they match with the three layers of the Layered Curriculum. First two questions were about basic level and 9 numbers of students can be considered as fully understand and answer these questions. Third question was about analysis level and 7 numbers of students can be considered as fully understand and answer this question. Last question was about evaluate level and only 4 numbers of students can be considered as fully understand and answer it.

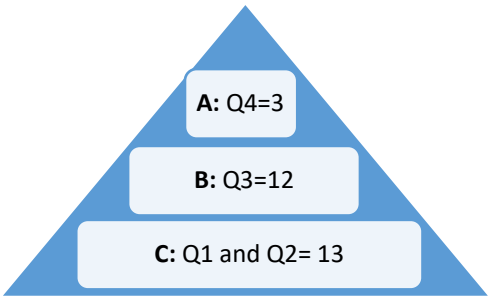


Figure 11. Layered distribution of student success in final examination

In the final examination four questions are asked to the students. When the questions are categorized depending on the difficulty levels, they match with the three layers of the Layered Curriculum. First two questions were about basic level and 13 numbers of students can be considered as fully understand and answer these questions. Third question was about analysis level and 12 numbers of students can be considered as fully understand and answer this question. Last question was about evaluate level and only 3 numbers of students can be considered as fully understand and answer it.

CONCLUSION

This study analyzes the effect of chosen example for agent function design teaching in Electrical and Electronics Engineering students at Cyprus International University in 2015-2016 Fall Semester. Totally 32 students' examination scores are analyzed which are registered at the beginning of the semester.

The agent function design is one of the important topics in Robotics course in Electrical and Electronics Engineering Department. Traditional deduction teaching method was used in the class. Course content is explained and discussed via presentation. After giving the basic information about robotics, the agent function design is subject is introduced. This subject requires problem solving teaching method to improve students' understanding. From the previous semesters' experience, it is observed that students have difficulty to develop an agent function. Therefore, a workshop is organized before the quiz examination.

The students' performances show that a given example by the instructor has significant effect on students' learning levels. This might be because of an experience requirement to find a new example for agent function design problems. It is also observed that with project implementation students' performances from midterm to final examinations are also improved.

It can also be observed that the Layered Curriculum with project based learning might be the most suitable teaching approach for the Robotics course. Furthermore, to see the effect of this approach in the education of engineering faculties further research is required. There are some courses in all engineering faculties where the proposed approach can be easily implemented. Introduction to computer programming, advanced computer programming, logic design and robotics are some examples of those courses.

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