

Using Computer Simulations and Games in Engineering Education: Views from the Field

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Abstract. The purpose of this research is to determine the views of the faculty of engineering and architecture academic staff on the use of educational computer simulations and games in engineering education. The research data were collected using semi-structured interview technique in qualitative data collection method and analyzed conducting the context analysis method. The analysis of the data revealed that academic staffs of engineering and architecture faculties have positive approach to the use educational computer simulations and games in their courses; however they could not be able to employ the games in their class due to deficiencies of the games and simulations appropriate for the curriculum and lack of games in Turkish. Furthermore, using educational computer games and simulations in the engineering courses may improve the quality of instruction, motivate students and make courses more enjoyable according to academic staff views.

Keywords: Engineering education, Simulations, Game based learning, Computer games and simulations

1 Introduction

In recent decades, there have been major developments using technology in engineering education. However, engineering education in Turkey is not keeping pace with the complex and highly dynamic of technological advances in its curriculum and instructional methodologies. Therefore, there is a need to reconsider investing more time and effort in developing new methodologies that takes into account academic staffs' opinions about what should be included in engineering curricula. Computer-assisted learning is an approach to teaching and learning in which computer technology is used as an aid to the presentation, reinforcement and assessment of material to be learned, usually including a substantial interactive element [19]. The traditional teaching environment is a classroom: a single teacher giving lectures to a group of students who are expected to use their notes and textbook to prepare for periodic examinations and demonstrate their mastery of the subject. Furthermore, individuals of in engineering courses in higher education often experience a lack of motivation, partly caused by traditional teaching methods. The use of computers in education shifts the focus away from the teacher to the students themselves who learn through

experimentation on the computer with the teacher acting only as a guide.

1.1 Educational Games and Simulations

When the learning is active, situated, experiential, problem-based, and provide immediate feedback, it is known to be most effective [5]. Most of the engineering courses in higher education do not meet with these features. A typical engineering course consists of a traditional lecture where concepts and theories are taught as a part of passive learning. Most of the assigned projects are very structured and constrained which does not prepare students adequately for the future jobs [20]. One promising approach to increase students' motivation is the introduction of educational digital games and simulations into engineering courses. Educational digital games play a role in future education because students are already integrating technology into their free time at a speed which is not grasped by schools [16]. Administrators who seek to encourage faculty to integrate digital games into their everyday science courses can refer to the study as a reference demonstrating the current adoption of digital games and simulations in teaching. The digital games provides the field of education with innovative opportunities that instruct the learner through engagement by providing an ideal multimedia tool that present concepts in a manner that is engaging, fun, and motivating [18], [21]. Furthermore, digital games promote constructivist principles by allowing the learner to engage in immersive worlds and take ownership of knowledge [3]. Problem-solving experiences embedded within computer games provide the learner with a safe place to fail and experiment with the material as learners encounter new knowledge [9]. In addition, digital games for learners provide with an interactive student-centered environment in order to create a personalized learning experience, progressively incorporating new knowledge and scaffolding it into what students already know.

Simulation can be defined as the use of a computer-generated system to represent the dynamic responses and behavior of a real or proposed system. Computer simulations are used to study the behavior of objects or systems that cannot be easily or safely tested in real life, such as weather patterns or a nuclear blast. The playing of games simulates actual conditions (as of business or war) especially for training or testing purposes. Games can be defined as simulations for entertainment. Simulations are the teaching and learning tools because they are cost effective, repeatable and easy to modify. Simulation is the simplification of the operation of a real world process or system over time [2]. It is a model of systems or processes that include defined relationships between system objects. The aim of an educational simulation is to motivate students, to engage problem solving, experiential learning, and development of mental models [22], [8]. In order to utilize learning, educational simulations rely on scaffolding [8], coaching, and feedback [10]. Simulation provides objective information about the processes that are available today and more importantly tomorrow. Simulation is an imitation of a real thing. Simulation is a computer-assisted modeling of a real event. For example, a flight simulator on a computer is a simulation model used to teach some rules of flight on a computer. It is a simulation event that the pilot will see the screen in the cockpit as he / she sees a similar on the computer screen

and acts as if he is really on board. Flying by simulating the simulator is safer and cheaper than flying with a real plane. The reasons for using models in industry and industry, the low cost, the non-dangerousness and the experimentation on real systems are sometimes impossible. Experimenting on models similar to real systems means saving money and time.

1.2 Using Educational Computer Games in Engineering Education

Radical changes in the world in engineering education in the use of technology experienced engineering education in Turkey is difficult to say how you feel sufficiently the impact of these developments. In this context, to raise awareness of faculty members on the use of current teaching technologies in higher education, especially in engineering education will be an important source for the decision makers in this field. In our country, engineering education cannot meet the expectations due to the economic problems, the attitudes of the instructors and the lack of basic knowledge of the students [1]. This situation shows that alternative education methods are needed in engineering education [13].

1.3 Using Educational Computer simulations in Engineering Education

Simulations are instructional scenarios where the student is placed in a simulated condition representing a reality within which students interact. The instructor controls the parameters of this “world” and uses it to achieve the desired instructional results. Students experience the reality of the scenario and gather meaning from it. Simulation is a form of experiential learning. Therefore, it is a strategy that fits well with the principles of constructivist learning and teaching. Simulations may contain elements of a game, a role-play, or an activity that acts as a metaphor. They are characterized by their non-linear nature and by then controlled ambiguity within which students must make decisions. The inventiveness and commitment of the participants usually determines the success of a simulation. They promote the use of critical and evaluative thinking of engineering students. They promote concept attainment through experiential practice in engineering education setting. Simulations may help students understand the differences of a concept. Engineering students often find them more deeply engaging than other activities, as they experience the activity first-hand, rather than hearing about it or seeing it. Research on the impact of computer games on learning has generally focused on academic achievement and motivation in primary and secondary education [17], [11], [7], [12]. For instance, Kula and Erdem [12] investigated the effects of educational computer games on the development of basic arithmetic processing skills of elementary school students. It was found that the effect of the educational game used in the study on the development of the basic arithmetic processing skills of 4th and 5th grade students was not statistically significant. However, it is among the findings of the study that the students have increased their tendency to perform complex collection procedures after the application. In addition, students have shown positive opinions about the motivation and teaching of computer games. On the other hand, Bayırtepe and Tüzün [4] examined the effects of educational

computer games on primary school students' achievement in computer courses and self-efficacy perceptions. There was a statistically significant increase in the students using the game-based learning environment according to the results of the achievement test before and after the practice. However, there was no significant difference between the students' learning environment and the success in the learning-based learning environment and the computer self-efficacy perceptions. In this environment where computer hardware is learned, it is seen that students have a positive approach to the use of game-based environments. Although studies on game and simulation use in engineering education in the world have increased recently, there is a limited number of studies. Turkey also noteworthy in engineering education is the scarcity of studies on the use of games. The purpose of this research; to expose the views of faculty members in engineering and engineering faculties on the use of educational computer games in engineering education. The research question of the study; What are the opinions of the academic staff working in engineering faculties about the usage of computer games, usage places, usage purposes, features of the games used and usage advantages in course activities? This study will seek answers of these questions.

2 Method

The purpose of this research is to determine the views of the faculty of engineering and architecture academic staff on the use of educational computer games in engineering education. The research data were collected using semi-structured interview technique in qualitative data collection method. Interviews were conducted to eleven faculty members of engineering and architecture faculty at Suleyman Demirel University (SDU). Data patterns of the interviews were analyzed employing content analysis method of the qualitative research. Before the interview questions were prepared, national and international studies related to the research subject were screened and the items that were intended to be included in the interview form were determined. The questions included in the interview form. The three faculty members who have knowledge and experience were asked to be evaluated in order to evaluate whether they are suitable for the purpose, meaning and scope of the study and to give feedback on scope and surface validity [15]. Interview questions were arranged by considering the feedback. In addition, it was seen that the interview form was completed and the interview form was finalized as a result of the pre-application with two other faculty members of the faculty of engineering. The interviews were conducted with 11 faculty members working in Faculty of Engineering and Faculty of Architecture at SDU. In the selection of the faculty members, easily accessible situation sampling method was used. Easy-to-reach status sampling provides the researcher with speed and convenience [14]. In interviews, volunteering and availability are taken as basis. The professional experience of the participants who accept the interview varies between 4-15 years. Interviews with the participating faculty members were recorded on a voice recorder with the permission of the participants. Interviews were held in the offices of the engineering and architecture faculties of the participants and the duration of the interview was limited to 15-30 minutes.

2.1 Data Analysis

Data analysis includes the editing, structuring and interpretation of aggregated data [23]. In the analysis of semi-structured interview data, content analysis (thematic analysis) method was used. Content analysis is used to reveal the underlying concepts of data and the relationship between these concepts [14], [6]. The interviews recorded in the voice recorder were written text by the researcher. The texts written in the manuscripts were checked by two academicians from the related field and the reliability of the texts written in this article was ensured. Transcripts are coded by decoding the word sentence. The answers to each of the open three questions were derived from those related to the research questions [6]. Codes are also gathered under certain themes. Themes were formed by considering the purpose of the study and the problem question. The themes were controlled by three field experts and a consensus was reached and finalized. In order to calculate the reliability of the study, the reliability method proposed by Miles and Huberman [15] was used. The subjects which have consensus and disagreement” for the codes and themes were determined by both the researcher and the experts were discussed and necessary arrangements were made.

3 Findings

In this section, the findings from the analysis of the data obtained from the interviews carried out in order to reveal the opinions of the faculty members of the engineering and architecture faculties on the use of educational computer games and simulations are presented. Content analysis results about the opinions and perceptions of the instructors of engineering and architecture faculties using digital games and simulations in their teaching process were gathered under the themes and presented with direct quotations. The lecturers who are interviewed were the academic staff such as assistant professor, associate professor and professor. Gender distributions of the interviewees were two women and nine men. The age range of the sample group ranged from 32 to 50 years and the professional experience varied between 2 and 15 years. The names of the faculty members were kept confidential and K-1, K-2, ... K-11 were coded.

Table 1. Themes

Themes
The reasons of not using the instructional computer games/simulation
The role of computer games/simulations in engineering education
Attitudes of faculty members towards computer games/simulations
Strengths of computer games/simulations
Limitations of computer games/simulations

As a result of the data analysis; six themes were created. These themes are the reasons engineering academic staff utilize educational computer games and simulations the role of educational computer games and simulations in engineering education, the attitudes towards educational computer games and simulations, the strengths of

educational computer games and simulations, the weaknesses of educational computer games and simulations and necessary conditions to educational computer games and simulations in engineering courses. Table 1 lists the themes that were created based on the content analysis.

The reasons of not using the instructional computer games/simulations. Engineering faculty members reported several reasons why they are not facilitating educational computer games and simulations in their instruction: One of the most reported reason was there are a few game and simulations available in Turkish language. The other reason was they are not aware of current available simulations and games that can be utilize in engineering education. Furthermore, there are limited number of available software developers to develop educational game and simulation. There is a lack of educational games and simulations that can be fit to the engineering curriculum. The main reasons reported are: shortage of game programmers, and educational game that fits to the curriculum, heavy work load of academic personnel, inadequate infrastructure, and shortage of exemplary lecture that games utilized in engineering education. Lecturers in engineering education have little knowledge about the methods that game and simulation can be facilitated. Furthermore, there is also lack of gaming culture among the faculty members.

The Role of Computer Games/Simulations in Engineering Education. Lecturers reported that educational simulations and games can be utilized for the following conditions: teaching abstract and complex concepts, to increase students' motivation and as an alternative teaching method. Participant K-5 reported that *"I believe that simulations and games are useful tools for students. They may help students to demonstrate their skills in the classroom and help them to come up with some new ideas"*.

Attitudes of Faculty Members towards Computer Games/Simulations. All of the faculty members interviewed indicated that educational computer games were seen as a useful teaching and learning tool in engineering education. However, they emphasized that educational computer games can be a useful teaching tool after their contents are prepared appropriately. In this regard, participant K-10 stated that *"I think that simulations will be more useful in practice rather than in theory"*.

Strengths of Computer Games/Simulations. In the analysis of the data, the strengths of educational games and simulations are: Having visual elements, the potential of motivating students, having an attention drawing feature, repeated use of simulations and games. Simulations and games can be used as a personalized learning tool. They can be adopted student's age and learning pace. For example, participant K-3 reported that *"the strongest part of simulations and games is that students are learning while having fun"*.

Limitations of Computer Games/Simulations. In the analysis of the data obtained from the study, faculty of engineering faculty expressed their opinions about the disadvantages of using computer games in education as well as their advantages. Reported disadvantages are: lack of seriousness, experiencing classroom management problems, insufficient connection between game and theory, abuse of students, insufficient curriculum, poor quality, misinterpretation by students, and addiction. For instance, participant K-2 reported that *"students learn by seeing. At this point, games*

and computers can create a good learning environment. But the quality of the games is very important. The curriculum should be inclusive. Otherwise, it may be very time-consuming for its benefit”.

4 Discussions & Conclusions

The purpose of this research was to investigate engineering faculty members' views on the use of educational computer games and simulations in engineering education. The analysis of the data revealed that academic staffs of engineering and architecture faculties have positive approach to the use educational computer games and simulations in their courses; however they could not be able to employ the games in their class due to deficiencies of the games appropriate for the curriculum and lack of games in Turkish. Furthermore, using educational computer games and simulations in the engineering courses may improve the quality of instruction, motivate students and make courses more enjoyable according to academic staff views Furthermore, faculty members raise their concerns about classroom management and the possibility of being addicted to games when employing games and simulations in their lectures. According to the analyzed data about the use of computer based educational games in engineering education, facilitating games in engineering instruction could improve the quality of engineering education, motivate students, and allow to raise well-educated engineering students to the industry based on the views of the engineering and architecture faculty staffs. The engineering and architecture faculty academic staff generally are positive to use educational computer games in their courses. However there is a need for the games appropriate for the engineering curriculum. Furthermore, lack of Turkish games in in the market, it is almost impossible to find and integrate educational computer games in engineering instruction in Turkey. Therefore policy makers and decision takers should support initiatives to develop Turkish language learning games. Most of the faculty members are agree that educational game and simulations have the potential to motivate students. Therefore, in order to encourage faculty members to use educational games and educational computer games and simulations in engineering education, initiatives to develop educational games and simulation should be supported by policy makers.

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