Teaching students programming with the help of educational games in the conditions of additional education in computer science

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Abstract

The purpose of this research is to get students' opinions on teaching programming to students with the help of educational games in the conditions of additional education in computer science. In order to carry out the study in accordance with the main purpose, the phenomenological approach, one of the qualitative research methods, was used. The participant group of the research consists of 40 students studying in computer science departments at various universities in Kazakhstan. Research data were collected with a semi-structured interview form developed by the researchers. As a result of the research, it has been determined that university students have half the experience of learning programming with the help of educational games. University students benefit from learning programming with the help of educational games. They categorised it as ease of learning, fun learning environment, permanence of learning, increasing motivation and developing problem-solving ability. Students categorised the disadvantages of learning to programme with the help of educational

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games as inadequacy in educational games, deficiencies in technical infrastructure and deficiencies in information infrastructure. Some of the students stated that learning programming with the help of educational games is not a disadvantage. Finally, the majority of university students participating in the research stated that they wanted to learn programming with the help of educational games. The results have led to the necessity of giving more space to programming courses with the help of educational games in the curriculum of the departments that provide programming-based education in universities.

Keywords: Computer science, educational games, programming, student opinions;

1. Introduction

Since its existence, human beings have conducted various researches and developed new technological products in order to find easier and faster ways to learn information continuously or to transfer the learned information to the next generations. As a result of these researches, technology, which is developing at a dizzying speed, allows the use of different media tools in education and training processes and the development of new tools. Because, with the development of technology, the fact is that today's generations, which we define as digital natives who grow by using technology and are in constant interaction with technology, differ in terms of learning compared to previous generations, revealing the necessity of reorganising learning–teaching environments (Prensky, 2001).

1.1. Theoretical and conceptual framework

In the classical programming teaching method in computer departments, the students are introduced to programming concepts, syntax and certain structures are explained, and they are asked to know these subjects (Beaubouef & Mason, 2005). However, the classical teaching method is insufficient to encourage the necessary cognitive skills (De Aguilera & Mendiz, 2003). Often, teachers do not spare enough time for problem-solving in explaining the subjects quickly in order to train the curriculum (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005). The use of the classical teaching method in programming courses causes insufficient learning of the programming language and underdevelopment of problem-solving skills and analysis and design skills that will be used in the future (Black, 2006; Jenkins, 2001).

Studies on learning computer programming with the classical method have shown that students have difficulty in understanding how programmes and structures work. Due to these difficulties in the classical method, new approaches are needed in teaching computer programming (Azriel, Erthal, & Starr, 2005; Ma, Ferguson, Roper, & Wood, 2007). Educational computer games are not just an attractive genre of games. At the same time, it has a structure that helps students develop their skills and carries knowledge patterns specific to the subject area they are prepared for. In other words, educational computer games have a feature that allows students to have a good time, but also teaches information in the activity or reinforces previous knowledge. Educational computer games can be used to achieve the goals in the curriculum (Bottino, Ferlino, Ott, & Tavella, 2007).

The use of game elements in education ensures that the process is passed actively (Simpson, 2005). Gamification uses the motivation of games as a driving force in solving real-life problems. In other words, the use of gamification in areas with learning/teaching difficulties in education can enable the use of emotions, especially motivation, as a driving force in increasing success, motivation

and participation in the learning/teaching process (Lee & Hammer, 2011). Educational computer games are an important type of material in terms of increasing motivation, willingness and interest, and it is seen in the literature that educational computer games are frequently used in areas such as science, mathematics, medicine, engineering, language learning, problem-solving and developing strategic thinking skills (Denner, Werner, & Ortiz, 2012).

1.2. Related research

When the literature is reviewed, it is seen that some studies in the field draw attention to the importance and advantages of learning with the help of educational games (Dickey, 2003; Ebner & Holzinger, 2007; Mann et al., 2002; Yip & Kwan, 2006). In the study carried out by Reinders and Wattana (2014), the experiences of five university students who participated in a 15-week game-based learning programme were investigated. It has been seen that the game has many benefits on the participants in the research, especially in terms of reducing their affective barriers to learning and increasing their desire to communicate.

Ulker, Acar, and Bulbul (2017) carried out a study to reveal the point of view of doctoral students on the use of educational digital games in the education process. As a result of the interviews with the graduate students, it was concluded that the use of educational digital games in educational activities would be positive. In the study conducted by Johnson and Schleyer (2003) to develop high-quality educational software, it was stated that developing good educational software consists of analysis, design, development, application and evaluation stages, and these stages can be continued more successfully with teamwork. In addition, it has been revealed that a carefully planned educational software application development process is likely to result in a successful outcome.

Woo (2014) evaluated students' motivation, cognitive load and performance on digital game-based learning studies. The results of the study showed that these parameters exhibited a significant relationship. It was stated that when designing digital game-based learning, designers should increase motivation and take the cognitive load to increase learning effectiveness. In his study, Westcott (2008) investigated the efficiency of playing computer games in the teaching of introductory computer programming. The games are created using the basic programming constructs (sequential, selection and repetition) that should be learned in the introductory programming course. Without clearly explaining the structures to the students, they learned these structures by playing these games for hours.

Mason (2009) investigated the relationship between game programming assignments and student learning. In this study, questions and interviews were applied. As a result of the study, it was seen that there was a significant increase in the students' interest, motivation and self-confidence after the game assignments. It was concluded that teachers can give more application and game programming assignments in teaching.

1.3. Purpose of the research

The purpose of this research is to get students' opinions on teaching programming to students with the help of educational games in the conditions of additional education in computer science. In this direction, the following sub-objectives have been determined:

1. What are the opinions of university students about learning programming with the help of educational games?

2. What are the opinions of university students about the advantages of learning programming with the help of educational games?

3. What are the opinions of university students about the disadvantages of learning programming with the help of educational games?

4. What are the views of university students on their motivation to learn programming with the help of educational games?

2. Method and materials

2.1. Research method

In order to carry out the study in accordance with the main purpose, the phenomenological approach, one of the qualitative research methods, was used. Qualitative research is the expression of a reductionist, explanatory and interpretive process that the researcher conducts to observe people in their natural environments and to examine the formation processes of events and phenomena in order to explain the basic characteristics of individual and social events and phenomena that people experience (Mertens, 2019). Phenomena appear in different forms such as events, experiences, perceptions, orientations, concepts and situations in the world we live in. The phenomenological method focuses on how people perceive a phenomenon, how they describe it, how they judge, how they remember, how they make sense of it, how they feel about the phenomenon and what is spoken. Phenomenology, which is one of the qualitative methodologies, was used in this study because it aims to investigate phenomena that are not completely foreign to us, but that we do not fully understand at the same time, by focusing on the facts that we are aware of in daily life but do not have a deep and detailed understanding of, and because it focuses on the experiences of individuals about the phenomena and is suitable for the purpose (Merriam & Tisdell, 2016).

2.2. Participants

The participant group of the research consisted of 40 students studying in computer science departments at various universities in Kazakhstan. The participant group of the study was selected by simple random sampling method. In random sampling, also called simple random sampling, every possible combination of elements in the universe has an equal probability of being included in the sample (Mertens, 2019). The demographic characteristics of the study group formed in this direction are shown in Table 1.

Table 1

Demographic Characteristics of the Students

Class	Gender		Sum
	Female	**Male**	
First year	5	2	7
Second year	2	9	11

Third year	7	2	9
Fourth year	3	10	13
Sum	17	23	40

In Table 1, the gender and class distribution of the students participating in the research are given. Seven students are in first year, 11 of them are in second year, 9 of them are in third year and 13 of them are in fourth year. 17 students are female and 23 are male. A total of 40 students participated in the research.

2.3. Data collection tools

Research data were collected with a semi-structured interview form developed by the researchers. A semi-structured interview form was used as a data collection tool in the study. In the semi-structured interview form, the aim is to ask questions about the researched subject, and if the question is not clearly expressed, it is more advantageous in terms of making it clearer. In the formation of the questions in the interview forms prepared by the researcher, care was taken to ensure that the questions were clear, understandable and simple. Two expert opinions were sought in order to determine how well the prepared interview forms serve the purpose, their clarity and applicability. The semi-structured interview form, which was prepared in line with the opinions of the experts, is shown in Table 2.

Table 2

Semi-Structured Interview Form

Personal Information
Your gender
Class you are studying
Questions
1. What are your views on your experience of learning programming with the help of educational games?   I have experience (   )   I have no experience (   )
2. What are your views on the advantages of learning to programme with the help of educational games?   3. What are your views on the disadvantages of learning to programme with the help of educational games?   4. What are your views on your motivation to learn programming with the help of educational games?   I would love to (   ) I would like (   ) I'm undecided (   ) I do not want (   ) I never want (   )

The semi-structured interview form used in the research is shown in Table 2. In the form, there are two demographic questions asked to categorise the personal information of the students. In the conditions of additional education in computer sciences, four questions were formed about teaching

programming to students with the help of educational games. Two of the questions are closed-ended and two of them are open-ended.

2.4. Data collection process

The research was conducted face-to-face with university students who voluntarily participated in the study. During the interviews, permission was obtained from the students for audio recording during the interview. The questions in the semi-structured interview form were asked to the students in the same order and without any direction. The interview with each student lasted approximately 30–35 minutes. It took about 5 weeks to complete the interviews with 40 students participating in the research.

2.5. Data collection analysis

The descriptive analysis technique was used to analyse the data. The goal of descriptive analysis was to put raw data into a form that the reader can understand and use if they want to. The data obtained in the descriptive analysis are summarised and interpreted according to the predetermined themes. In this analysis, direct quotations are frequently used in order to reflect the views of the individuals interviewed or observed in a striking way (Topkaya, 2006). The following steps were followed in the analysis of the data in the study:

2.5.1. The transcript of the interviews: After determining the validity of the question items, 40 university students were interviewed. The voices recorded during the interviews were analysed by the researchers and an interview transcript form was created by giving numbers to each line.

2.5.2. Preparation of interview coding keys: After the transcripts of the interviews were made, the interview questions were handled one by one and the options were listed in line with all the answers given for each question. As a result of these evaluations, an 'interview coding key' was prepared, in which the answer options for each question item were written.

2.5.3. Reliability of the research: After the application, the interview coding keys and interview transcripts were read separately by the researchers, and the necessary arrangements were made by discussing the 'consensus' and 'disagreement' issues. For the reliability of the research, the reliability formula suggested by Miles and Huberman (1994) was used (Reliability = Consensus/[Consensus + disagreement]). As a result of the calculation, the reliability was found to be 89%. The result obtained here is considered reliable for research.

3. Results

In Table 3, the opinions of the university students participating in the research on their experience of learning programming with the help of educational games are evaluated.

Table 3

Students' Views on Their Experience of Learning Programming with the Help of Educational Games

Student opinions	F	%
I have experience	19	47.5
I have no experience	21	52.5
Sum	40	100

In Table 3, the opinions of the university students participating in the research about their experience of learning programming with the help of educational games are categorised. While 47.5% of the students stated that they had experience in learning programming with the help of educational games, 52.5% stated that they had no experience.

In Table 4, the views of university students on the advantages of learning to programme with the help of educational games are evaluated.

Table 4

Views of University Students on the Advantages of Learning Programming with the Help of Educational Games

Themes	Codes	F	%
Ease of learning	Makes learning easier	32	80
	Provides easy reinforcement of information		
Fun learning environment	Provides fun learning	23	57.5
	Allows you to have a pleasant time while learning		
Persistence of learning	Provides an effective learning environment	17	42.5
	Makes learning permanent		
Increasing motivation	Stimulates the desire to learn	11	27.5
	Arouses the desire to reinforce learning		
Developing problem-solving ability	Provides the ability to produce rational solutions	5	12.5
	Provides fast problem-solving skills		

In Table 4, the views of university students participating in the research on the advantages of learning programming with the help of educational games are categorised. 80% of the students stated that learning to programme with the help of educational games facilitates learning and 57.5% of them stated that it creates a fun learning environment. 42.5% of the students stated the permanence of learning, 27.5% stated that it increases motivation and 12.5% stated that it allows developing problem-solving skills as the advantages of learning programming with the help of educational games.

The opinions of some students who participated in the research on the advantages of learning programming with the help of educational games are given below.

'I find it advantageous in terms of creating a fun learning environment. So I think it makes learning easier'.

'We usually have a good time playing games, because playing games is fun. This ensures easy reinforcement of information and creates an effective learning environment'.

'I am more willing to learn programming with the help of educational games. It makes me want to learn'.

'I find it advantageous in terms of gaining problem-solving skills as well as easily consolidating information. I see it as an effective method for us to produce rational solutions'.

'I think there will be an environment where I can have a pleasant time while learning. This way, the information will be easier to remember. I think educational games provide a permanent learning about programming'.

'It is very important not only to learn the knowledge, but also to have fun while learning. I believe that knowledge learned with pleasure will be more permanent. It is also directly related to programming problem-solving skills. While learning programming with the help of educational games, fast problem solving skills can be gained'.

In Table 5, the opinions of the university students participating in the research on the disadvantages of learning programming with the help of educational games are evaluated.

Table 5

Opinions of University Students on the Disadvantages of Learning to Programme with the Help of Educational Games

Themes	Codes	F	%
Inadequacy in educational games	Lack of suitable educational games Lack of engaging educational games	21	52.5
Technical infrastructure deficiencies	Technical problems experienced Online access issues	15	37.5
No downside	No downside No disadvantage	14	35
Deficiencies in information infrastructure	Lack of knowledge for students new to programming Insufficient information infrastructure	7	17.5

In Table 5, the views of university students on the disadvantages of learning to programme with the help of educational games are categorised. 52.5% of the students stated the inadequacy of educational games and 37.5% of them stated the lack of technical infrastructure as the disadvantages of learning to programme with the help of educational games. 35% of the students participating in the research stated that there is no disadvantage in learning programming with the help of educational games. On the other hand, 17.5% of the students stated the deficiencies in the knowledge infrastructure as the disadvantage of learning programming with the help of educational games.

The opinions of some students who participated in the research about the disadvantages of learning programming with the help of educational games are given below.

'I think that the lack of educational games suitable for every programme is a big deficiency. I think this is a major disadvantage. In addition, whether the games are played online or not and problems with the internet can be considered as a disadvantage'.

'I don't think it has a negative side. How can there be any downside to learning a piece of information in a fun environment? I don't think there is any downside'.

'Actually, learning to programme with the help of educational games can be fun, but I don't think every game is interesting. I see this as a disadvantage. Games should be interesting'.

'Especially for students who are new to programming, inexperience and lack of knowledge can be seen as an advantage'.

'If you do not have enough knowledge about educational games and programming, the expected efficiency may not be achieved'.

In Table 6, the views of university students participating in the research on their motivation to learn programming with the help of educational games are evaluated.

Table 6

Opinions of University Students on Their Motivation to Learn Programming with the Help of Educational Games

Student opinions	F	%
I would love to	7	17.5
I would like	23	57.5
I'm undecided	5	12.5
I do not want	4	10
I never want	1	2.5
Sum	40	100

In Table 6, the views of university students participating in the research on their motivation to learn programming with the help of educational games are categorised. 17.5% of the students answered that they would very much like to learn programming with the help of educational games, 57.5% would like to learn, 12.5% were undecided, 10% would not want to learn and 2.5% would not want to learn at all.

4. Discussion

It has been determined that the university students participating in the research have half the experience of learning programming with the help of educational games. Wigfield, Tonks, and Klauda (2009) stated in their study that the knowledge and experience that students gain from educational games will help them solve the problems they will encounter in their future lives and professions. In the study, it was determined that students with previous knowledge and experience had higher knowledge, interest and motivation to learn. House (2004) also reached a similar conclusion in his study and revealed that students with increased interest and motivation learned the subjects better and their success increased.

University students categorised the advantages of learning programming with the help of educational games as ease of learning, fun learning environment, permanence of learning, increasing motivation and developing problem-solving ability. Prince (2004) stated that students who play games containing educational information actively learn the knowledge and skills embedded in the game without being aware of it. In the research, it was stated that students learn knowledge and skills dynamically and energetically because they experience emotions such as desire, curiosity and achievement while playing games.

Students categorised the disadvantages of learning to programme with the help of educational games as inadequacy in educational games, deficiencies in technical infrastructure and deficiencies in

information infrastructure. Some of the students stated that learning programming with the help of educational games is not a disadvantage. When some researches in the field are examined, they emphasised that the knowledge infrastructure of the students in the computer department should also be paid attention to. In these studies, it is stated that the syntax of the programming language is generally taught in the introductory programming courses taken by the students who are new to programming and it is accepted that the students have sufficient knowledge on creative thinking, problem-solving and logic. This situation is expressed as a disadvantage (Al-Imamy, Alizadeh, & Nour, 2006; Deek & Espinosa, 2005; Schulte & Bennedsen, 2006).

The majority of university students participating in the research stated that they wanted to learn programming with the help of educational games. In some studies conducted in the field, their attitudes towards learning programming were evaluated with the help of educational games. In these studies, it has been revealed that students have a positive attitude towards learning programming with the help of educational games (Mladenović, Krpan, & Mladenović, 2016). In his study, Vatansever (2018) examined the relationship between programming and problem-solving skills with the help of educational games. As a result of the research, it was revealed that educational games have a positive effect on learning to programme. In the study conducted by Baz (2018), it is stated that as a result of the developments in the field of programming, it also causes diversity in user profiles, and it is stated that platforms are created for students in the field of coding, and fun and educational software should be designed in accordance with the levels of the students.

5. Conclusion

Today, in order to act in line with the needs of the age in the upcoming period, it is seen that programming education has become a necessity rather than a choice. Educational software is used to perform computer-assisted instruction and to use information technologies effectively in education–teaching processes, and is also known as instructional software. Educational software is known as software that is used to enrich the content to be taught visually and audibly in line with student interests and needs, and to present it to students with the help of computer, in order to ensure fast and effective learning in teaching any content or problem situation. For this reason, teaching programming to students with the help of educational games is seen among the new trends of today's education understanding. Starting from here, this research aimed to get students' opinions on teaching programming to students with the help of educational games in the conditions of additional education in computer sciences. As a result of the research, it has been determined that university students have half the experience of learning programming with the help of educational games. University students benefit from learning programming with the help of educational games. They categorised it as ease of learning, fun learning environment, permanence of learning, increasing motivation and developing problem-solving ability. Students categorised the disadvantages of learning to programme with the help of educational games as inadequacy in educational games, deficiencies in technical infrastructure and deficiencies in information infrastructure. Some of the students stated that learning programming with the help of educational games is not a disadvantage. Finally, the majority of university students participating in the research stated that they wanted to learn programming with the help of educational games.

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6. Recommendations

In line with the results obtained from the research, the following suggestions for teaching programming to students with the help of educational games in the conditions of additional education in computer science are presented:

1. In universities, programming courses should be given attention with the help of educational games in the curricula of programming-oriented departments.

2. Programming courses should be included at all grade levels with the help of educational games in the curricula of departments that provide programming-based education in universities.

3. In universities, in departments that provide programming-based education, students should be actively involved in the programme development processes.

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