



An investigation of classroom teachers' educational digital game Designs for mathematics teaching and their opinions on the design process

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Abstract

The aim of this study is to determine the level of compliance of the educational digital game designs developed by the form teachers for teaching mathematics with the determined criteria and to analyze the opinions of the classroom teachers on the educational digital game design process. Case study, one of the qualitative research designs, was used in the research. The study group of the research consists of 19 classroom teachers who work in public schools and are selected by the easily accessible sampling method. During the research, in the first stage, form teachers were trained for 3 weeks through remote education on the development of educational digital games using the Scratch program, and in the second stage, the teachers were given 3 weeks to develop the games. In this second stage, online meetings were held with the working group every week, information was obtained about the development stages of their games and guidance was provided. In the study, the "Educational Digital Game Evaluation Rubric" was used to evaluate the educational digital games developed by the form teachers, and the "Semi-Structured Interview Form" was used to determine the teachers' views on the process. As a result of the research, it was concluded that the level of compliance of the educational digital game designs of the form teachers with all the determined criteria was slightly above the medium level in general, and that they got the highest score from coding/software in terms of compliance with the criteria, and the lowest score from the audio design criteria. In addition, form teachers stated that the educational digital game design process is beneficial for teachers, students and mathematics teaching in general; develop skills such as creativity, problem solving, critical thinking and information and familiarity with communication technologies; they expressed that mathematics teaching contributed positively to their professional competence.

Keywords: Educational digital game, math, classroom teacher

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1. Introduction

While there are developments and changes in information and communication technologies at a dizzying speed, the use of these technologies is rapidly spreading. With the development of the internet and communication infrastructure in the world, software-based services and products are also becoming more effective. In this process, while the countries that adapt to transformation are getting stronger economically, the countries that cannot adapt are in a tough situation economically (Ministry of Development, T.R., 2018).

Information and communication technologies are becoming an indispensable element while making life easier for human beings in every area and every moment of their lives. One of the areas where the use of these technologies has become obligatory is educational environments (Tutgun & Özdenir, 2011). With this obligation, each country carries out different projects to integrate information and communication technologies into their education systems and allocates significant economic resources to this field. For this purpose, the Fatih Project in Education was initiated in Turkey. This project aims to (Ministry of Education, d.n.):

- Ensuring equal opportunity in education
- Improving technology in schools
- To ensure the effective use of information technology tools in classrooms in a way that appeals to more sense organs in the learning-teaching process.

Educational digital games are one of the most significant digital teaching materials that will enable the effective use of information technology tools in learning-teaching processes. Frasca (2001) defines the digital game as “computer-based entertainment and leisure activity software, built on text or visuals, that one or more people can use together over a physical or online network on electronic platforms such as computers or game consoles”. People (5-6 years old) are introduced to digital games at a very young age and today billions of people play digital games (Dinç, 2012). In line with the developments mentioned above, the use of digital games in education is rapidly becoming widespread (Sardone & Devlin-Scherer, 2010). Students' interest in digital games facilitates the use of such digital learning materials in learning environments. Today, the effect of digital games on students' learning and development takes the attention of researchers (Aksoy & Küçük-Demir, 2019). The positive effects of these games on learning and development are listed by some researchers as follows (Rosas et al., 2003; Berns, Gonzalez-Pardo & Camacho, 2013; Dede, Ketelhut & Nelson, 2004; Gros, 2007; González-González & Blanco-Izquierdo, 2012; Karadağ, 2015; Lin & Hou 2015):

- Increases students' interest and participation in the class
- Makes the class fun

- Boosts students' academic achievement
- Helps to motivate students
- Contributes to the development of students' skills such as critical thinking, creative thinking, decision making and evaluation
- Broaden students' curiosity
- Develops students' hand-eye coordination and motor skills.

In addition to the positive effects of digital games mentioned above, there are also negative effects. Provenzo (1991) states that educators have concerns that digital games can limit students' imaginations and distract them from social life. Furthermore, in the "Digital Game Addiction Workshop" report held by Turkey's Ministry of Health in 2018, there are statements that these games increase students' tendency to violence and aggression and negatively affect their brain development.

Considering the interest and attitude of today's primary school students to the digital world, the use of digital games in education also provides benefits in many ways. The use of such applications minimizes negative situations, especially in mathematics, which is the course that students are most worried about and have negative attitudes. The use of digital games in mathematics teaching provides a more effective teaching (Yıldız Durak & Karaođlan Yılmaz, 2019). The use of educational digital games in mathematics teaching enables students to participate more actively in the class, making the teaching process more effective (Foster, Katz-Buonincontro & Shah, 2011), while providing students with the opportunity to have concrete experiences about abstract mathematics subjects (Stupiansky, Stupiansky & Nicholas, 1999). It is an undeniable fact that technology is a teaching tool today. Especially in the last two years, the Covid-19 pandemic has made this situation even more valid. With the pandemic, face-to-face education has been suspended for a long time in the world, and the remote education model has begun to be implemented. In this period, digital teaching materials have become even more valuable. For this reason, it is extremely important for teachers to develop their own digital materials. It is necessary to increase the awareness of teachers about educational digital games and their technical knowledge and skills. As a result, some studies are carried out by Turkey's Ministry of National Education. For instance, "Digital Content and Game Software Course" was prepared by the Ministry of National Education (2021), and it was opened for teachers' applications through Mebbis. In addition, the Ministry of National Education (2021) started to establish digital game, design and animation workshops in Science and Art Centers.

When the relevant literature is examined, it is seen that there are many studies on the use of educational digital games in education. Some of these studies examine the effect of the use of educational digital games in learning processes on academic success in lessons. For example, Kaynar (2020) studied the effect of educational digital games on the

academic success of students in the Life Studies course; Agirgol (2020) examined its effect on academic achievement in Science course; Aşçı (2019) researched its effect on their academic success in Turkish course; Swearingen (2011) explored the effect on their academic achievement in Mathematics course. Some studies have studied teachers' views on the use of educational digital games in learning processes (Önder, 2020; Topçu, Küçük, & Göktaş, 2014; Ertem, 2016; Razak, Connolly, & Hailey, 2012). On the other hand, when the literature is reviewed, it is observed that some of the studies were carried out on the process of designing their own educational digital games by teachers or teacher candidates. Aksoy and Küçük Demir (2019), Üstün (2020) with form teacher candidates; Dönel Akgül and Kılıç (2020) with prospective science teachers; Yıldız Durak and Karaoğlan Yılmaz (2019) with primary school mathematics teacher candidates; Li, Lemiux, Vandermedien, and Nathoo (2013) with 21 teacher candidates; An and Cao (2017) with 50 teachers, conducted studies on the educational digital game design process. When these studies are pondered, it is monitored that the researches related to the educational digital game design process are mostly carried out with teacher candidates. This research, which was carried out for the design of educational digital games related to mathematics with form teachers, will contribute to the field. In this direction, the aim of the study is to examine the educational digital games developed by form teachers for teaching mathematics and their views on this process. For this purpose, the problem sentences of the study were determined as follows:

1. What is the level of consistency of educational digital games developed, by form teachers for teaching mathematics, to the determined criteria?
2. What are the opinions of form teachers on the digital educational game development process for teaching mathematics?

2. Method

2.1 The design of research

In case studies, it is aimed to reveal results related to a specific situation. In qualitative case studies, in-depth investigation of a situation is the most basic feature. In this type of research, the factors belonging to a situation are examined holistically and it is tried to reveal how they affect the related situation and how they are affected by this situation (Yıldırım & Şimşek, 2013). This study was conducted with a case study (Gall, Borg, & Gall, 1996), which is used to identify and see the details that make up an event, to develop and evaluate possible explanations, in order to determine the views of teacher candidates on the educational digital game design processes for teaching mathematics.

2.2 Study group

The study group of the research consists of 19 classroom teachers working in public schools, who were included in the study with the easily accessible sampling method. Personal information of the study group is presented in Table 1.

Table 1. Personal information of the study group

Teacher	Gender	Professional Seniority
T1	M	0-10 years
T2	M	10-15 years
T3	M	0-10 years
T4	M	0-10 years
T5	M	0-10 years
T6	M	0-10 years
T7	M	0-10 years
T8	F	0-5 years
T9	F	0-5 years
T10	F	0-10 years
T11	F	10-15 years
T12	M	10-15 years
T13	M	10-15 years
T14	M	15-20 years
T15	F	10-15 years
T16	F	10-15 years
T17	F	10-15 years
T18	F	10-15 years
T19	M	10-15 years

2.3 Data collection tools

Research data were collected with "Educational Digital Game Evaluation Rubric" and "Semi-structured Interview Form".

2.4 Educational digital game evaluation rubric:

The development process of the "Educational Digital Game Evaluation Rubric" for the evaluation of the educational digital games designed by the researchers by the classroom teachers is as follows: 1) The criteria that an educational digital game should have were determined by scanning the literature. 2) A draft form was created within the framework of these criteria. 3) The draft form was presented to the opinion of two people, an information technology teacher and an academician, who are experts in the field of educational digital games. 4) The form was finalized in line with the feedback from the experts.

2.5 Semi-structured interview form:

A form including draft questions was prepared by the researchers in order to determine the opinions of form teachers about the educational digital game design process. Then, the relevant form was presented to the opinion of two experts. In line with the feedback of the experts, necessary corrections were made on the form and the form was given its final shape. Examples of questions in the semi-structured interview form can be given as follows:

a) What do you think in general about the process of preparing educational digital games related to mathematics?

b) Did the process of preparing an educational digital game related to mathematics have an impact on your professional competence in mathematics teaching? Evaluate in terms of positive and negative aspects.

2.6 Implementation and data collection process

The process of designing an educational digital game related to mathematics took a total of six weeks. This process is planned in three stages. In the first stage, remote education was given to form teachers about the concept of algorithm and creating algorithms, the use of the Scratch program, and the design of educational digital games with the Scratch program. In the second stage of the process, through weekly online meetings, teachers' game design processes were guided. In the third stage, the games were collected and evaluated and interviews were held with 6 teachers about the process.

The work flow chart of the implementation process is presented in Figure 1 below.

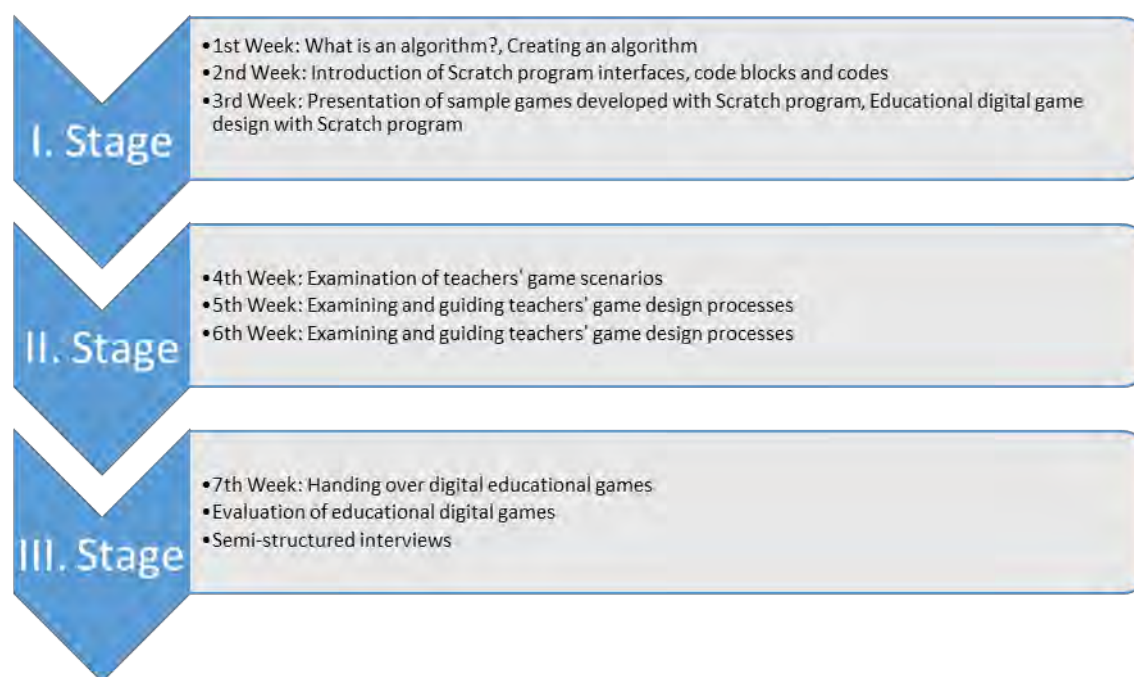


Figure 1. The work flow chart of the implementation process

2.7 Analysis of data

Evaluation of games: In the study, educational digital games related to mathematics prepared by teachers were evaluated by two independent experts other than the researcher, in accordance with the criteria included in the "Educational Digital Game Evaluation Rubric". Evaluation scores from two experts were averaged for each criterion and the overall total score. The average scores that had been obtained were evaluated in line with the score ranges included in the "Educational Digital Game Evaluation Rubric".

Analysis of qualitative data: The audio recordings obtained in the first stage of the qualitative data analysis process were written down. Then, these data were analyzed using content analysis and descriptive analysis techniques. It is aimed to reach concepts and relationships that can clarify the data obtained in content analysis. In descriptive analysis, direct quotations are included in order to effectively reflect the views of the interviewees (Yıldırım & Şimşek, 2013). For this reason, similar data were brought together within the framework of certain concepts and themes and interpreted under themes and sub-themes. In addition, the statements of the participants from the interviews were given with the exact expressions. In order to ensure reliability in the research, the data were coded separately by two researchers who are experts in the field. Later, it was calculated to be 92% with the formula of $\text{Consensus} / (\text{Disagreement} + \text{Consensus}) * 100$ put forward by Miles and Huberman (1994).

3. Results

In Table 2 below, the data obtained as a result of the evaluation of the games developed by the classroom teachers for teaching mathematics on the "Educational Digital Game Evaluation Rubric" are given.

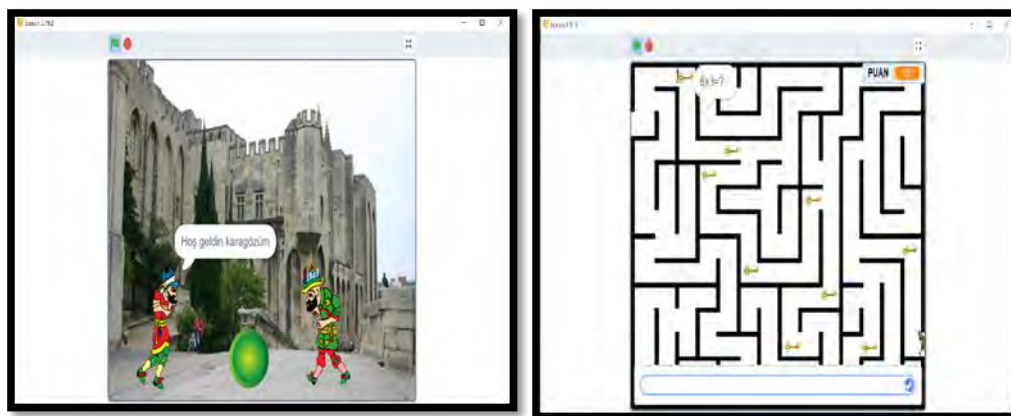
Table 2. Compliance level of digital educational games developed by form teachers for teaching mathematics to the determined criteria

	Script / Story	Software/Coding	Visual design	Aural design	Mathematical content	Eligibility for student's level (in terms of game difficulty)	Eligibility for student's level (In terms of educational content)	General average
1st Game	2	2,5	4	1	2,5	4	3	2,71
2nd Game	4	4	5	3,5	4,5	4,5	4,5	4,28
3rd Game	4	2,5	3	3	3	4	4	3,35
4th Game	3,5	3,5	3,5	3,5	3	4	2,5	3,35
5th Oyun	4	3,5	4	3,5	4	4	4	3,85
6th Game	4	4	4	3	3	3,5	3	3,5
7th Game	3	4,5	3,5	2	2,5	3,5	3,5	3,21
8th Game	4	4	3,5	4	4	4	4	3,92
9th Game	3,5	3	3	3	3,5	3	3,5	3,21
10th Game	3,5	4	4	2,5	3	3,5	4	3,5
11th Game	2,5	3,5	2,5	2,5	3	3	3	2,85
12th Game	2,5	3	3	2	2	3,5	2	2,57

13th Game	3,5	3	3	2	4	2,5	3	3
14th Game	2,5	3	3	3	2,5	3	3,5	2,92
15th Game	3,5	4	2,5	1,5	3,5	3	3	3
16th Game	4,5	4,5	4	3,5	4,5	4	4	4,14
17th Game	2	3	3	2,5	3	2	2,5	2,57
18th Game	2,5	4	3,5	3,5	3,5	4	4,5	3,64
19th Game	2	3,5	3,5	1,5	3	3,5	4	3
Average	3,21	3,52	3,44	2,68	3,26	3,5	3,44	3,29

When Table 2 is analyzed, it is seen that the mathematics-related educational digital game designs of the classroom teachers got the highest score in terms of software and coding ($X= 3.53$) criteria and the lowest score in terms of auditory design ($X= 2.68$) criteria. Furthermore, when the scores of educational digital game designs related to mathematics are studied in terms of other criteria, it is observed that they score between moderate and good. The overall average score of all games ($X= 3.29$) is slightly above the medium level.





Picture 1. Examples of teachers' game design

The views of form teachers about the educational digital game design process related to mathematics are shown in Table 3.

Table 3. Teachers' views on the effects of the educational digital game preparation process on teachers

Theme	Sub Theme	Codes	f	Participants
The effects of the educational game preparation process on the teacher	Benefits related to professional competence	<ul style="list-style-type: none"> • Allowing to explain mathematics with games 	1	1
		<ul style="list-style-type: none"> • Raising awareness about educational digital game 	2	1, 5
		<ul style="list-style-type: none"> • Revealing interest in digital game design 	1	1
		<ul style="list-style-type: none"> • Increasing the knowledge and skills of educational digital game preparation 	1	1
		<ul style="list-style-type: none"> • Increasing professional competence 	3	1, 3, 5, 6
		<ul style="list-style-type: none"> • Increasing crisis solving skills 	1	1
		<ul style="list-style-type: none"> • Facilitating the teacher's skills in teaching mathematics 	1	2
		<ul style="list-style-type: none"> • Contributing to the teacher's self-renewal 	3	3, 4, 6

When Table 1 is analyzed, it is observed that the teachers stated that the process of preparing educational digital games has a positive effect on their professional competence. When the teachers' views on the process of preparing educational digital games are evaluated; the educational digital game preparation training and process for mathematics, which was carried out, increased the interest and awareness of teachers towards digital games, improved their educational digital game preparation knowledge and skills, and allowed them to explain mathematics with games. In this case, it has raised the professional competence of teachers by contributing to their self-renewal. In addition, the process increased teachers' crisis-solving skills. The opinions of teachers supporting these statements are as follows:

T1: Most of our teachers had no interest in digital game design. It was a nice work under the name of revealing these interests. I also think that game design increases the general professional competence of teachers.

T2: In the name of professional competence, I can say that we have witnessed once again that we need to include such activities in order to make the lessons more enjoyable, and we have seen that we can do it ourselves instead of using only the existing ones in such activities. In other words, I think it helps us to teach the lesson effectively.

Table 4. Teachers' opinions on the effects of educational digital game preparation process on teachers' 21st century skills

Theme	Sub Theme	Code	f	Participants	
The effects of educational game preparation process on teachers' 21st century skills	Problem Solving Skills	• Thinking about how to do it differently while writing the codes	1	1	
		• Positive contribution to problem solving skills	6	1,2,3,4,5,6	
		• When creating a scenario, thinking about how to do it	1	6	
		• Finding a way to solve the problems that are encountered while developing games	1	2	
		• Changing our perspective			
		• Problem solving by coding			
				1	3
				1	5
	Creativity Skills		• Giving an effort to produce a game that can make the student interested	2	1, 3
			• Contributing to our creativity	6	1, 2,3,4,5,6
• Contributing to design					

	skills		
	<ul style="list-style-type: none"> • Preventing us from teaching dependent only on books 	2	1,4
		1	3
Critical Thinking Skills	<ul style="list-style-type: none"> • Self-criticism • Thinking about various solutions and their consequences • Criticizing constantly 	3	1,3,4
		3	2,5,6
		1	2
Information and Communication Technologies Literacy Skills	<ul style="list-style-type: none"> • Positive impact on technology literacy • Catching up with the technology • Watching videos to learn • Getting to know programs in the digital world • Learning new apps 	4	1,4,5,6
		2	1,3
		1	2
		2	2,3
		2	4,5

When Table 2 is analyzed, it is revealed that the teachers stated that the process of preparing educational digital games improves 21st century skills. When the views of the teachers about the educational digital game preparation process are analyzed; the process of preparing educational digital games for mathematics developed teachers' skills such as problem solving, creativity, critical thinking and information communication technologies literacy. The opinions of teachers supporting these statements are as follows;

T5: Of course, in problem solving, we encountered the following; We are faced with coding issues in a game all the time. If we use this code, what will happen in the end? All of these are actually a problem, so I have actually improved my problem solving with coding. In digital games, we do the coding in a certain order, as well as the stages of the problem, I think it contributes positively to problem solving in this process. While coding...

T2: Yes, of course, it has an effect on creativity. Because we are going to design a game first and there is only one subject we have to deal with. There is an achievement, and you have to design something to get this achievement. It is not possible for us to achieve this harmony without creativity.

Table 5. Teachers' opinions on the effects of educational digital game preparation process on students

Theme	Sub Theme	Code	f	Participants
Effects of educational game preparation process on students	Benefits for students	• Supporting students in dealing with math fear	1	1
		• Increasing students' interest in mathematics	1	1
		• Useful for students	1	2

When Table 3 is analyzed, it is detected that the teachers expressed their opinions that the process of preparing educational digital games will have positive effects on students. When the opinions of the teachers about the educational digital game preparation process are examined; preparing an educational digital game for mathematics will have a positive impact on preventing students' fear of mathematics and making them love mathematics. The views of teachers supporting these statements are as follows;

T1: Students have some fears about mathematics, one of the best ways to overcome these fears is to think of it as a method of explaining mathematics to students through games. With the effective use of technology, I am sure that mathematics will become a subject that students love more. They will see mathematics as a fun lesson rather than a lesson they fear.

T2: It will also be useful for children. It will of course make our job easier. We won't just stick to the book or stick to the notebook. In a field where children are very eager, we will also offer them an opportunity in the digital virtual space.

Table 6. Teachers' views on the effects of educational digital game preparation process on teaching mathematics

Theme	Sub Theme	Code	f	Participants
Effects of educational game preparation process on teaching mathematics	Benefits for Course	• Making the lesson fun	6	1, 3, 2, 4, 5,6
		• Increasing the quality of the lesson	1	1
		• Preventing learning difficulties related to mathematics.	1	3
		• Being effective in breaking prejudices about mathematics	1	3
	Benefits for the Teaching Process	• Providing diversity in learning	3	2, 5, 6
		• Making the teaching process more effective	2	4, 5

- Making the teaching process more easier 1 5

When Table 3 is studied, it is posed that the teachers underlined that the process of preparing educational digital games will have positive effects on the mathematics lesson and the mathematics teaching process. Preparing an educational digital game about mathematics will have positive effects on making the mathematics lesson more enjoyable, preventing learning difficulties in mathematics, breaking prejudices about mathematics and increasing the quality of the mathematics lesson. In addition, preparing an educational digital game about mathematics will have positive contributions to the teaching process such as providing diversity in learning, making the learning process effective and facilitating the learning process.

T2: Sir, first of all, I think it's fun. In mathematics, students generally have difficulties in learning and such a prejudice. I think positive about it as it gives the opportunity to learn while having fun. I think it is beneficial.

T5: Since it is one of the most beautiful materials we can provide to children, I think it will make the teaching simple and permanent.

Table 7. Teachers' views on the easy and difficult aspects of the educational digital game preparation process

Theme	Code	f	Participants
Easy aspects of making educational digital games	• Easy if it proceeds with a plan	1	1
	• Coding	2	1, 4
	• Easy if it is learnt	3	2, 5, 6
	• Each learning process supports the next one	3	2, 3, 5
	• Using computers	2	1
		1	4
	• It is fun	2	5, 6
Difficult aspects of making educational digital games	• Editing	1	1
	• Not knowing what to do	3	2, 5, 6
	• It takes time to merge the codes	1	3
	• Stage of game	1	4
	• Mounting music	2	3, 4
	• Making the puppets move	1	4
	• Design	1	6

When Table 5 is analyzed, the easy aspects of preparing an educational digital game according to the teachers are coding and computer use; the difficult aspects are designing, editing, mounting music and making the puppets move. The opinions of

teachers supporting these statements are as follows:

T4: It was easy for me on using the computer. It was easy to do the basic things, to mounting the puppets, to code; but when the work progressed and reached the game stage, there were things that I had a lot of difficulty with. Hence, when I ordered the tasks and wrote the codes to the puppets, I realized that sometimes it didn't go where I wanted. Sometimes, I saw that the puppets came to the place I wanted in the first stage, but did not come in the next stage.

T1: If we focus on the game in general, it is really difficult to create fiction, but it is indispensable.

T6: To be honest, we had difficulties in designing in general.

4. Discussion

In this study, the level of compliance of the educational digital games developed by form teachers with the criteria included in the educational digital game preparation rubric and the views of form teachers on the process of preparing educational digital games were analyzed.

As a result of the research, it was concluded that the level of compliance with the generally determined criteria of the educational digital games developed by the form teachers about mathematics is slightly above the medium level. However, it was expected that the educational digital games prepared would be at a good or very good level. In line with this finding, it can be stated that form teachers do not have sufficient knowledge and skills to prepare educational digital games about mathematics. Yıldız Durak and Karaođlan Yılmaz (2019) determined that there are some deficiencies in the designed games in the research they conducted with primary school mathematics teacher candidates. They cited the technical inadequacies and time constraints of the pre-service teachers as the reason for this situation. In the research conducted, form teachers stated that they encountered coding and game development for the first time and that the time given for game development was limited, and expressed their technical inadequacies in this regard. Uluay and Dođan (2016) conducted research to develop educational digital games with teachers in a six-week period in their research. The teachers participating in this study also stated that the time given to the course was insufficient because they had never used an application related to game design before. These statements also support the above-mentioned findings. Dolunay and Karamustafaođlu (2021) also found in their research that teachers are inadequate in designing educational games. Moreover, Fokides (2018) conducted a study on developing educational digital games for teaching mathematics with teachers and finally inclined that there were some technical deficiencies in the games developed by the teachers. When curriculums of undergraduate

programs Elementary Education departments under the Higher Education Institution (YÖK) are analyzed, it is revealed that there is no course related to the preparation of educational games. In this case, it can be argued that the knowledge and skills of teachers about preparing educational digital games cannot reach the desired level. In order to increase the competence of teachers in preparing educational games, they should receive training on educational game preparation both in undergraduate education and in-service training (Akcanca & Sömen, 2018). In addition to educational digital game preparation trainings for teachers, more guidance should be provided (Becker, 2007).

Another finding of this research indicates that form teachers stated that designing educational digital games improved their professional competence in teaching mathematics. Yıldız Durak and Karaoğlan Yılmaz (2019) found in their research that the process of preparing educational digital games has a positive effect on the professional competencies of teacher candidates. Fokides (2018) carried out a study with teachers to develop digital games for teaching mathematics using the Code Game Lab application and expressed that this process had positive results for teachers' professional competencies. As a result of the research, form teachers mostly underlined that preparing educational digital games has a positive effect on the development of problem solving, critical thinking, creativity and information and communication technologies literacy skills. The skills listed here are called 21st century skills. In line with this information, it can be stated that preparing educational digital games has a positive effect on the development of classroom teachers' 21st century skills. In the application phase of the research, the form teachers designed their own unique games about mathematics. In this process, they created their own story/scenario and determined the characters, stage plans, sound elements and other elements to be used in this framework. In this sense, it is an expected result that the process will contribute to the development of teachers' creativity skills. Furthermore, the participants creating their own algorithms during the coding of the games and changing their algorithms when the program did not work as desired had a positive effect on the development of problem-solving skills and critical thinking skills. The teachers who participated in the semi-structured interviews articulated that they faced with a new program and learned to use it in the process of preparing an educational digital game, and stated that their competence in using information and communication technologies increased. In this context, the findings are similar to other studies. For instance, Yıldız Durak and Karaoğlan Yılmaz (2019) revealed in their research that teachers argued that the process of designing digital games improves their problem-solving, creativity, and ability to use technology. Teachers who participated in the research conducted by Li, Lemieux, Vandermeiden, and Nathoo (2013) stated that the game development process contributed to the development of 21st century skills. Aksoy and Küçük Demir (2019) found that preparing educational digital games has a positive effect on the development of teachers' creativity skills.

As a result of the research, it was concluded that using educational digital games in mathematics teaching would have effects such as reducing students' fear of mathematics and making them interested mathematics. In line with this finding, it can be argued that using educational digital games in mathematics teaching will have positive effects on both the student and the mathematics teaching process. In the literature, there are research outcomes indicating that the use of educational digital games in mathematics teaching will have positive effects on both students and mathematics teaching. For example, in the research conducted by Yıldız Durak (2019), mathematics teacher candidates expressed that integrating digital games into mathematics teaching can be effective in breaking prejudices toward mathematics. Byun and Joung (2018) also reported that using digital games in mathematics education will increase students' motivation and performance. Ke (2008) found in his research that a game-based summer course had a positive impact on students' attitudes towards mathematics. On the other hand, in the study carried out by Topçu, Küçük, and Göktaş (2014), form teachers argued that educational digital games will provide students with benefits such as learning by having fun, making them interested in mathematics, making students' learning process more permanent, reinforcing what has been learned, and improving their thinking skills. Yavuzkan (2019) retained that the use of educational digital games in mathematics teaching is influential in increasing mathematics achievement level. Kolovou, Van den Heuvel-Panhuizen, and Köller (2013) researched whether an online game called Hit the Target contributed to greater success in solving variable quantities in early algebra subject areas among 236 sixth graders. As a result, they found out that computer games would be an effective tool in improving students' early algebra performance.

Form teachers participating in the research stated that they had difficulties in preparing an educational digital game about mathematics. The fact that teachers are not familiar with and using a program for digital educational game preparation for the first time can be considered as one of the reasons for this. There are similar results in other studies in this direction. Li, Lemieux, Vandermeiden, and Nathoo (2013) argued that teachers had difficulties in preparing educational digital games using the Scratch program. Uluay and Doğan (2016) stated that teachers emphasized that it is difficult and laborious to prepare digital games. Üstün (2020) underlined the difficulty of teachers in preparing an educational digital game about mathematics. Form teachers participating in the research said that they had difficulty in finding a new idea about preparing games and gamifying it with Scratch. Li, Lemieux, Vandermeiden, and Nathoo (2013) stated that teachers who participated in their research had difficulties in gamifying their ideas with Scratch.

To sum up, the process of designing educational digital games for teaching mathematics has increased the professional competence of form teachers in teaching mathematics and has a positive effect on the development of 21st century skills. Form teachers argued that they had difficulties in game design because they used the Scratch program for the first time in the process of preparing an educational digital game about mathematics. In

addition, the teachers participating in the research stated that using educational digital games in the mathematics teaching process would be beneficial for both the mathematics teaching process and the student, by enabling students to overcome their fear of mathematics and making them interested in mathematics. In the light of these findings, the following suggestions can be made;

-This research on educational digital game preparation is limited to six weeks. This training can be made more comprehensive, implemented in a longer time and the results can be reported.

-In this research on educational digital game preparation, 19 teachers participated in the trainings. Educational digital game preparation training can be designed and researches can be conducted with a wider audience.

-Educational digital games prepared in this study were assessed with an evaluation rubric. Studies examining the effects of these games on students can be conducted.

-This study was conducted with form teachers. Research can be conducted on teachers from various subjects.

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