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Determining Teachers' Views intended the Use of Digital Games in Science Education

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Abstract

The main purpose of the research is to determine teachers' views on the use of digital games in science education. In accordance with this purpose, the research was carried out with the phenomenology method which one of the qualitative research methods, was conducted with eight volunteer science teachers working in different public schools within the 2022-2023 academic year. The participants of the study were selected via the criterion sampling method, which is one of the purposeful sampling methods. A semi-structured interview form was used as a data collection tool in the research. The data collected taking this interview form into consideration was analyzed using the content analysis method. Through the interviews was concluded that digital games are a tool that helps students focus on their attention and learn permanently. Besides, teachers stated that digital games measure science achievements at the sub-cognitive level (knowledge and comprehension) of Bloom's taxonomy. Based on this, digital games ought to be designed to measure the meta-cognitive level of Bloom's taxonomy.

Introduction

Today thanks to the development of technology, Generation Z individuals who are familiar with the internet have emerged (Erten, 2019). After 2000; technology or rather the internet is at the center of the lives of Generation Z individuals, who were born in a period when technological devices such as television, internet and computers were widespread (Altun and Karataş, 2021). Thus, the members of this generation are called "Internet Generation", "Next Generation", "Crystal Children", "Me Generation", "iGen" and "Instant Online" (Çetin Aydın and Başol, 2014; Ericsson, 2012). Once we examine the most distinctive features of Generation Z; we encounter profiles of people who grew up in the age of high technology whose lifestyles are based on technology and who have the ability to use technology even to solve their problems (Kapil and Roy, 2014). Nevertheless, the most distinctive feature of Generation Z is improvement of technology very rapidly and being highly integrated into their lives (Levickaite, 2010). Therefore, this generation is a generation that learns technology quickly, likes to complete its tasks as soon as possible and can overcome these tasks promptly (Ayhün, 2013). Moreover, individuals of Generation Z can supply the majority of their daily needs over the internet, and they also want to supply their educational needs by digital environments. This generation, who doesn't like to memorize, request to learn through fun methods or by playing games (Altuntuğ, 2012; Büyüksulu, 2017). Instead of learning a concept or subject they want to learn with traditional expression, they prefer to learn it in a way that helps them remember it via

gamification, storytelling and dreams. That's why it is very important to enhance various educational software in digital environments for Generation Z individuals (Dönel Akgül and Kılıç, 2020).

Software whose primary goal is to provide suitable lesson environments by acting as a mutual bridge between the student and the computer is called "educational software" (Uşun, 2004). Thanks to these educational softwares prepared in the computer environment, learning environments could be created where individual differences can be highlighted and abstract subjects can be concretized (Karal et al., 2010). It is seen that different educational software such as simulation, animation, digital story, augmented and virtual reality are used in order to execute education more effective in the 21st century (Aktamış and Arıcı, 2013; Altın, 2001; Daşdemir and Doymuş, 2012; Kırıkkaya and Şentürk, 2018). Apart from these, one of the educational software that has become widespread in education recently is digital games.

Digital Game

"Digital game is an individual communication environment that includes digitality, interactivity, virtuality, variability, modularity of the communication atmosphere these features into the act of playing games" (Yengin, 2010). Digital games are defined as software that allows individuals to compete with others while performing various predetermined tasks using technological tools and equipment in digital environments (Deterding et al., 2011). According to Jull (2011), games that do not have any limitations and are used to spend free time are called digital games. Mieczkowski et al. (2011) had pointed out the concept of digital games as "electronic games played online or offline with computers, video game, consoles or mobile devices". The phenomenon of digital games refers to a system that is systematic in itself however generally has a very dynamic structure and develops outside certain standards when compared to traditional games. The most distinctive feature of the phenomenon in terms of form and content is that it allows player-oriented communication. In digital games, the outcome is determined by the actions of the player rather than the game producer (Mul, 2008).

Digital games offer technological elements and services that are products of the technology they use. In this context, digital games have three main features. These; It is interactive, uses visuals generated by computer, and relies on narratives (İlgaz and Abay Cansabuncu, 2020). The interactivity of the digital game enables people playing the game to choose among the options available in the game structure. These options allow the player to progress in the game and take on new responsibilities. With these choices, the player controls the game and places items in the positions in the game (Nitsche, 2008). Computer-generated visuals in digital games are images prepared independently of analog/mechanical restrictions and representations of real-life objects. These objects are not bound by mechanical limitations. Thus it doesn't work with the physics known in the universe. For instance, any simulated ball does not have to obey the laws of gravity like a real ball unless its designer wants it to (İlgaz and Abay Cansabuncu, 2020). The fact that digital games are based on narratives means that the games act as a tutorial and contain usage instructions (McMahan, 2013).

Prensky (2001) explained the elements that should be in digital games as follows. Story, rule, goal, conflict/competition/challenge/opposition, interaction and outcome/feedback. Digital games have a story. There

is a main story in the digital game and this story is fed by sub-stories (Binark and Bayraktutan Sütücü, 2008). Digital games have various rules and purposes surround by the framework of this main story. It requires interacting with features such as competition/struggle/resistance/opposition in the process (Bozkurt, 2013). Digital games, which are teach their own rules and purposes, enable the player to be successful and productive within their own universe inasmuch as the rules are followed (Bogost, 2010).

Individuals can show free behavior in digital game environments. Individuals who enjoy being in these environments can have fun through digital games. Thanks to these games played in digital environments, individuals can switch from static to kinetic (Kurt, 2016). Digital games differ depending on the way the game is played, the number of people playing, its purpose and the environment where it is played (Kukul, 2013). Whereat there are many types of digital games on account of content. The most prominent of these types can be listed as follows; action games, adventure games, simulation games, role-playing games, board and card games, strategy games and intelligence games (Binark, 2007). Action games are games which the player is in a constant struggle by overcoming the obstacles in the game (Akbay, 2015). Call of duty can be given as an example of action games. Adventure games are games which visual and sound effects are used extensively and also time is integrated with real events (Ayanoğlu, 2006). Uncharted 3: Drake's Deception is an example game of the adventure genre. Simulation games are games which players experience things by doing them during the game (Gündoğdu, 2021). Cooking Simulator is an example of simulation games. Role-playing games are games which players start the game after choosing a character. In these games, the selected character is provided with tools and experience by performing various tasks (Gelibolu, 2013). For instance, Stardew Valley is a game developed in role-playing style. Games designed on the basis of carefully and skillfully thought out and planned acting to be successful are called strategy games (McCall, 2022). Endless Legend can be given as an example of strategy games. While games such as backgammon, checkers and chess are referred to table and card games, games that logical puzzles are solved are called as intelligence games (Schaeffer, 2001). Sudoku, table and card games; detective games can be given as an example of intelligence games.

It is stated that digital games, which including many game types, have many positive effects on individuals. Digital games improve individuals' 21st century skills such as reasoning, strategic thinking, communication and decision-making (Kirriemuir and McFarlane, 2004) and psycho-motor skills such as hand-eye coordination (Lin and Hou, 2015). It increases the ability to perceive objects in three dimensions. Moreover, it augments the ability to explore with the help of observation, trial and error and hypothesis tests (Aktemur, 2020). It also boosts direction finding skills by reading maps. It is pointed out that it enables individuals to use their imagination and encourages them (Dinç, 2012).

Even though it is stated that digital games have many positive effects on individuals, digital games also have negative effects. Decreasing age of the players (3-5 years) constantly, not knowing the age and profile of the players, increasing addiction to games, and the popularity of age-inappropriate games (excessive violence, etc.) are shown as negative features of digital games. In addition, it is stated that online and in-game shopping has limitations such as uncontrolled and unregistered transactions, loss of income and tax losses, and difficulty in monitoring and controlling in-game chats (Dinç, 2012).

Digital Game in Science Education

In 1864, Herbert Spencer's *"Why is knowledge valuable?"* His answer to the question *"What is the importance of science in life?"* and *"Why should science be taught?"*, it answers the questions. Generation Z children develop various ideas regarding science subjects both in their school lives and in their daily lives where they are intertwined with the technological world and environment. These ideas they developed are often outside the knowledge we accept as scientifically valid. Owing to this situation, while teachers teach science; they ought to help students in subjects such as asking useful and creative questions, researching events and examining the ideas put forward on that subject, improving reasonable and useful explanations regarding the technological world and the environment, expanding their experiences regarding the technological world and the environment, and finally explaining how scientific knowledge is taken place. It is extremely important to use instructional technologies rely upon correct learning theories by teachers in the education process, in order for science teaching to achieve these goals (Köseoğlu and Kavak, 2001). In this context, digital games are one of the teaching technologies to be used in science lectures.

It is seen that digital games have many positive effects on students when used in science education (Arslan and Çoştu, 2022). Therefore, in the researches carried out on this subject, digital games increase students' attitude and motivation towards lessons because they enable them to learn by having fun (Sabırlı, 2018), It can compensate problem solving skills by making learning continuous, by having fun and learning (Gee, 2009). In addition to providing students with the opportunity to learn by doing and experiencing, it helps them learn by discovering information (Baek, 2010). Due to it provides more concrete learning, it increases academic success and permanence (Şahin, 2015). Nonetheless the border between the pros and cons of digital games; it depends on several variables such as the type of game chosen, design style, and playing time (Özer, 2020). One the other hand, it is a fact that well-planned digital games will supply fun, rich and interactive experiences that can be set on children's learning of the subjects, their mental development, physical activities, social interactions and attitudes towards the lesson (Lieberman et al. 2009).

Justification and Importance of the Research

In the literature, had been observed that there are various researches in accordance with the use of digital games in science education. These are; digital game design (Çatak, 2011; Eroğlu, 2019; Savaş et al., 2021; Usta and Güntepe, 2019), scale development for digital games (Cheng et al., 2014), meta-synthesis studies (Cheng et al., 2015; Li and Tsai, 2013; Wounters et al., 2013) application of digital games in various ways (Adams, 2012; Ağırgöl et al., 2022; Annetta et al., 2009; Cheng and Anetta, 2012; Echeverria et al., 2011; Herodotu, 2018; Liu and Chen, 2013; Miller et al., 2011; Pala and Erdem, 2011; Pusey and Pusey, 2015; Sariçam, 2019; West and Bleiberg, 2013; Yıldız and Zengin, 2021) to determine the perspectives of doctoral students (Koparan, 2021) and teacher candidates regarding the use of digital games in science education (Dönel Akgül and Kılıç., 2022). In these researches, quantitative research approach was mostly used. In addition, within the scope of these researches investigated variables that effects on such as student success, motivation, attitude, etc. However, no research has been found to determine the views of science teachers as regard teaching science with digital games. The current

research is significant for these reasons.

The research had been conducted to determine teachers' views on the use of digital games in science education. In the research science teachers' views were taken to determine in accordance with instructional of digital games and their effects on students, whether there is a difference between science teaching with and without digital games, if so, what kind of difference there is, and whether the digital games used in science lectures supply the relevant learning outcomes and, if so, what kind of extent. In this context, it is thought that the research will contribute to the literature in terms of findings obtained from teachers' views and interview questions. In line with these purposes, the problem of the research was determined as "How are the teachers' views on the use of digital games in science education?" The sub-problems of the research are as follows;

1. How are the teachers' views intended the effects digital games on students?
2. How are teachers' views intended the difference between science teaching with digital games and science teaching without digital games?
3. How are the teachers' views on the relevance of digital games with learning outcomes?
4. How are teachers' views intended for designing digital games for science lectures?

Method

Research Study

The research was conducted by using the qualitative research approach. Yıldırım and Şimşek (2021) defined qualitative research as research that qualitative data collection tools such as interviews, observations and document analysis are used, and a qualitative process is followed to create events and perceptions in their natural environments in a holistic and realistic way. Qualitative research is based on a different philosophical approach that sees the individual and his or her world as interconnected and views social reality as unique (Ary et al., 2010). A phenomenology study, which is one of the qualitative research methods and is carried out to obtain views, is the discovery of the meaning of a group's shared experiences regarding a phenomenon (Cresswell, 2009). The purpose of phenomenological studies is to lay on a basis for researching phenomena that are not completely foreign to people and cannot be entirely understood (Yıldırım and Şimşek, 2021). By virtue of provides a suitable basis for the research, the phenomenology method was preferred in the research, which intend for determining the views of science teachers regarding science teaching with digital games.

Participants

Qualitative research relies on people's perspectives and thoughts. In this context, purposeful sampling methods are used instead of probability-based sampling methods (Yıldırım and Şimşek, 2021). The participants of this study were determined by using the criterion sampling method, which is one of the purposeful sampling methods. Criterion sampling is a sampling method which the sample is created by taking into account individuals, objects, situations or events with specified qualifications (Büyüköztürk et al., 2020). In the research, criteria determined in accordance with the research question and the purpose of the research are, science teachers' use of digital games in their lectures and their use of these digital games at the end of subjects or units. In this regard, the study was

carried out with eight science teachers, four women and four men, working in different public schools, who were volunteers and met the determined criteria. In order to avoid confusion and facilitate understanding, the teachers who consisted of the participants of the research were coded with sequential numbers from T1 to T8, respectively. Demographic characteristics of the study participants; teachers were classified as their place of duty, teaching experience, the university they graduated from, year of graduation, the digital games which they use in their lectures and the frequency of using these games and a table appropriate to this classification was created (see Table 1).

Table 1. Demographic Characteristics of Participants

Participant	Place of Duty	Teaching experience	University graduated from	Year of graduation	Using of Digital Game	Frequency of using digital games
T1	Yozgat/Boğazlıyan	6 years	Erciyes University	2017	Wordwall , Fenus science	Subject breaks
T2	Kayseri/Hacılar	8 years	Erciyes University	2013	Who wants to 500 points, Wordwall Fenus	Unit breaks
T3	Kayseri/Melikgazi	10 years	Erciyes University	2013	science, Scholastic Wordwall, EBA games, Kahoot, Jigsawplan et, Who wants to 500 points	Unit and lecture breaks
T4	Kayseri/Incesu	15 years	Karadeniz Technical University	2007	Morpha Campus games, EBA games	Unit breaks
T5	Mersin/Toroslar	15 years	Karadeniz Technical University	2007	Science activity, Ultra science academy	Unit breaks
T6	Kayseri/Erkilet	9 years	Erciyes University	2012	Science activity, Morpha Campus games	Unit breaks

Participant	Place of Duty	Teaching experience	University graduated from	Year of graduation	Using of Digital Game	Frequency of using digital games
T7	Kayseri/Develi	9 years	Aydın Adnan Menderes University	2012	Morpha Campus games, Kahoot,	Unit breaks
T8	Kayseri/Incesu	12 years	Erciyes University	2011	Morpha Campus games, Wordwall, Who wants to 500 points	Unit breaks

Once Table 1 is examined, it is seen that 6 teachers work in Kayseri, 1 teacher works in Yozgat and 1 teacher works in Mersin. It can also be said that teachers have a minimum of 5 years and a maximum of 14 years of experience. Besides, it was determined that teachers played various digital games such as wordwall, fenus science, morpha campus games, who wants to 500 points and science activities in science lectures. Finally, it was stated that teachers use these digital games at the end of units, at the end of topics or at the end of lectures.

Data Collection Tool

Phenomenology studies, which aim to determine individuals' perceptions and views regarding a phenomenon, data are mostly collected through interviews (Fraenkel et al., 2012). Hence, in the research a semi-structured interview form was used as a data collection tool to obtain teachers' views intended for science teaching with digital games. The reason for using an interview form in the research, this form has a certain level of standardization and provides flexibility (Türnüklü, 2000). The semi-structured interview form is a data collection tool that details can be entered at some points during the interview, the place of the questions and sentence structures can be changed, and the interview is conducted in a chatty mood (Yıldırım and Şimşek, 2021).

While preparing the interview questions of the research, the interview questions which prepared by Dolunay and Karamustafaoğlu (2021) and Sarıçam (2019) were utilized. As a result, a semi-structured interview form was created. The opinions of two academicians who are experts in their professions were taken regarding the interview form. Then, a Turkish teacher had read the forms and evaluated the questions in terms of legibility and intelligibility. Corrections were made to the questions by the researchers in line with the data obtained from expert opinions. To give illustrate, the fifth question was "Do you think there are differences between science teaching with digital games and science teaching with normal activities?" before being presented to expert opinion. After expert opinions, it was amended "Is there any difference between science teaching with digital games and science teaching without digital games?". Additionally, before the expert opinions, two separate questions "What are the positive effects of digital games on students?" and "What are the negative effects of digital games on students?" had been reorganized as "What are the effects of digital games on students?" and it reduced to one question. In

this context, the final version of the interview form consists of 6 questions (Annex 1).

Data Collection Process

Within the scope of the research, eight science teachers who working in different public schools and using digital games in their lessons were reached. Since the teachers worked in different provinces or distant districts of the same province, the interviews were carried out online whereby the Zoom platform. Data were collected over three days. The interviews were lasted between 18.00 and 22.00, for a minimum of 18 and a maximum of 25 minutes and in a chatty mood. Additionally, a voice recorder was made use of during the interviews. Before starting the interview, to teachers participating in the research was mentioned that the interviews would be recorded, was said that no one other than the researchers could access the recordings, and to participants were asked whether they approved the voice recording. All teachers approved the voice recording and the interviews were recorded by a voice recorder. After the interviews were completed, the voice recordings were listened to one by one and the data obtained from the interviews were transcribed. Then, transcripts were sent to the participants and were asked to check their answers to the questions. Participants checked out the answers written in the transcripts sent to them and declared that they were correct.

Analysis of Data

The data obtained as a result of the interviews with science teachers were analyzed by using the content analysis method. Content analysis is a method that implicitly examines human behavior (Fraenkel et al., 2012). The main purpose of content analysis is to reach concepts that will be able to explain the collected data and to establish a relationship among these concepts. Together with content analysis, the data obtained from the participants' views are tried to be defined and the concepts that may be hidden in the data are revealed (Yıldırım and Şimşek, 2021).

While conducting content analysis in the research, researchers examined the data as a whole and superficially coded the data at first reading. Codes that are likely to occur identified in the second reading. In the third reading, codes with similar characteristics were combined and collected under a single code. In the fourth reading, the categories and themes which the codes would be included were determined. In the final reading, harmonies of code, category and theme were reviewed and their final versions were given. Then, tables were created for codes, categories and themes. The table containing all codes, categories and themes is given in Table 2.

Table 2. Table including all Themes, Categories and Codes

Themes	Use of digital games in science education	Effects of digital games on students	Science teaching with and without digital games	The relevance between digital games and learning outcomes	Designing a digital game for science lecture			
Categories	Educational nature of games	Positive effects	Negative effects	There is a difference	There is a relevance	There is no a relevance	5th or 6th grade	8th grade
Codes	Helps gather attention	Attracts students'	Leads to addiction	Involves all students in the	Prepared according	Contains non-	Subjects that can be	Heredity Physics

Enables permanent learning	attention Ensures learning with fun.	Can cause boredom and reluctance	lectures Creates an environment for group work	to science learning outcomes	obtainable questions Does not measure	matched Abstract subjects Systems in our body	subjects such as pressure and simple machines
Detects deficiencies	Provides active participation in the lectures	Creates an environment of competition and chaos	Provides figures out the subject	Aimed at the knowledge and comprehension level	metacognitive level	Subjects that can be used for experiments	
Ensures that questions are solved carefully	Makes students love school, lectures and teachers.	Can give rise to lack of control	Draws attention Helps studying	Associated with technology gains		such as heat, temperature and force	
Appeals to different types of intelligence	Increases willingness and curiosity Takes the lectures out of monotony	inability to focus Increases perception difficulties	Takes away from memorization Arises the effectiveness of lectures			Chart reading subjects such as speed	
Turns the abstract into concrete	Supplies different viewpoints	Can negatively affect sociability	Allows to be carried out experiments				
Allows repetition of concepts	Improves coping with distractors	Could make classroom management difficult					
Provides better learning	Gains productivity	May trigger defeat of the purpose					
Increases academic success	Accelerates the learning process	Can reduce self-confidence					
Intensifies learning	Appeals to more than one sense	May not appeal to all students					

Validity and Reliability

Credibility (internal validity) is the consistency of the researcher both in the data collection process and in the data analysis process, and it is an explanation of how this consistency is achieved (Yıldırım and Şimşek, 2021). So as to ensure the credibility of the study; the semi-structured interview form prepared by researchers to be used in the research was presented to expert views before the application. Changes were made to the questions in line with expert views. In addition, before the interviews, was made a statement to participants regarding the interview. On the side an attempt was tried to create a safe and natural conversation environment between the participants and the researcher. After the participants answered the questions, the researcher presented the answers received from the questions as feedback and tried to increase credibility by confirming whether the participants gave that answer or not. Besides, the answers given by the participants to the questions was presented with direct quotations

in the findings section, and the data obtained was supported by means of evidence.

Transferability (external validity) refers to the generalizability of the results obtained from the research in similar environments (Yıldırım and Şimşek, 2021). In order to ensure the transferability of the research; the reason for choosing the method utilized in the research was explained, why the purposeful sampling method was used, information was given regarding data collection tool and data collection process, the analysis of data was described, how the study group was selected and its demographic characteristics were explained in detail.

Reliability (internal reliability) is whether the results obtained from the research can be obtained within same way in similar environments or circumstances (Karataş, 2015). The consistency of the research was ensured by presenting all findings obtained through the interviews to the reader with direct quotes within quotation marks without comment, and data losses were tried to be prevented by recording the interviews with a voice recorder.

Confirmability (external reliability) is increasing objectivity by reducing prejudices (Başle, 2016). In an effort to increase objectivity, the data are discussed appropriately in the conclusion. Additionally, data codes, categories and themes were created by the researchers. Then, the interview transcripts, data categories, and themes were presented to a different evaluator. This evaluator also examined the transcripts from beginning to end and created codes independently according to the determined categories and themes. As a result of the review, provided that the evaluator and researchers agreed on the codification, it was accepted as "consensus" did not agreed on, it was accepted as "dissidence". Enhanced by Miles and Huberman (1994) to calculate the reliability of codification; the formula $\text{Reliability} = \text{Consensus} \div (\text{Consensus} + \text{Dissidence}) \times 100$ was used. As a consequence of the calculations, it was seen that the reliability coefficient of the codification was 91%. In that this value is greater than 70%, the codification is accepted reliable (Miles and Huberman, 1994).

Findings

Themes, categories and codes were created in line with the answers given by science teachers to the questions in the interview form. It is then presented in the tables given below. In addition, teachers gave the same answers to these questions "*What do you think about digital games?*" and "*What do you think about the use of digital games in science education?*" Therefore, codes of these two questions were combined and expressed in a single table.

Within the scope of the research codes, categories and themes obtained from teachers' views regarding the question "*What do you think about the use of digital games in science education?*" was presented in Table 3. When Table 3 is examined, it is seen that teachers expressed their views regarding the educational nature of digital games, saying that they help gather attention, provide permanent learning and detect deficiencies of their students. From the teachers, T1 said regarding gathering attention: "*The educational side of digital games improves the child's attention concentration. So, for example, he pays attention while playing games. For example, while reading a book, the child may become distracted after a while. You know, when someone from outside says something, he may turn and look at him, but for example, while playing a digital game, the child focuses on the game so much that he does not do much when his friend next to him tells him to do this or that, so it increases the*

focus." Similarly, T4 mentioned "I can say that digital games increase attention. For example, it increases focus, that is, focusing on that event or that question at that moment. It can be seen that he or she is focusing on." In this regard, T8 remarked, "As I just said, I am making these digital games in the form of a competition, which I usually use at the end of the unit or at the end of the topic. Since there is a competition among the students, they inevitably pay attention to a lesson." T7 stated, "Digital games help students learn how to educate students, especially in this environment of the internet age in the 21st century, where students are constantly in touch with computers and the internet. How can I attract them to lessons, how can I include them in this environment, how can I help them attract their attention? It can give great clues to your questions."

Table 3. Teacher Views intended for using Digital Games in Science Education

Theme	Category	Codes	Teachers	f
Use of digital games in science education	Educational nature of games	Helps gather attention.	T1, T3, T4, T5, T6, T7	6
		Enables permanent learning.	T1, T4, T6, T7	4
		Detects deficiencies.	T5, T8	2
		Ensures that questions are solved carefully.	T3	1
		Effective in motivation.	T3	1
		Makes the lecture effective.	T3	1
		Appeals to different types of intelligence.	T5	1
		Turns the abstract into the concrete.	T7	1
		Allows concepts repetition of concepts.	T2	1
		Provides better learning.	T3	1
Increases academic success.	T4	1		
Intensifies learning.	T4	1		

T6 expressed his/her view on the subject of digital games providing permanent learning as follows: "Although I explained the same subject with a few techniques during the lesson, I saw that the student did not remember it, but when you showed this in the game, the student drew his/her attention by saying, 'You mentioned this in the last game, teacher.' It also makes it memorable, I see that it stays in mind because the student is having fun and is involved in the game and answers his own work while playing the game." T7 said, "The creation of a sweet competitive environment among the students during the game. Also digital game helps students both learn by having fun and have a permanent learning. It contributes greatly to learning. That's why using digital games in most units in science education would be beneficial and positive."

At the point of identifying students' deficiencies, while T5 said "As I said, my students evaluate themselves, I evaluate them. In this way, I reveal their shortcomings.", T8 gave him/her view "Since there is already competition for students. Inevitably, they pay attention to a lesson, and in this way, the student who does not actually know or does not listen somehow learns his/her shortcomings."

Within the scope of the research, codes, categories and themes obtained from teachers' views regarding the question "Are there any effects the digital games which you use in your lectures have any effect on students?"

was presented in Table 4.

Table 4. Teacher Views intended the Effects of Digital Games on Students

Theme	Category	Codes	Teachers	f
Effects of digital games on students	Positive effects	Attracts students' attraction.	T1, T2, T3, T5, T6, T7	6
		Ensures learning with fun.	T2, T3, T4, T6	4
		Provides active participation in the lectures.	T1, T3, T4, T6	4
		Makes students love school, lectures and teachers.	T1, T2, T3	3
		Increases willingness and curiosity.	T1, T3, T6	3
		Takes the lectures out of monotony.	T1	1
		Supplies different viewpoints	T6	1
		Improves coping with distractors.	T4	1
	Negative effects	Gains productivity.	T6	1
		Accelerates the learning process.	T8	1
		Leads to addiction.	T1, T3, T4, T6, T7, T8	6
		Can cause boredom and reluctance.	T1, T4, T7, T8	4
		Creates an environment of competition and chaos.	T4, T7, T8	3
		Can give rise to lack of control.	T1, T2, T6	3
		May bring about inability to focus.	T4, T7	2
Increases perception difficulties.	T4, T6	2		
Can negatively affect sociability	T3, T8	2		
Could make classroom management difficult.	T4, T5	2		
May trigger defeat of the purpose.	T2, T7	2		
May not appeal to all students.	T6	1		

When Table 4 is examined, it is seen that teachers expressed both positive and negative views regarding the effects of digital games on students. While teachers stated that digital games attract students' attention, enable learning with fun, ensure active participation in the lesson, make them love the school, the lecture and the teacher, and increase willingness and curiosity as a positive effect; as a negative effect, they stated that digital games lead to game addiction in students, can cause boredom and reluctance, create a competitive environment and chaos, give rise to lack of control. Teacher T5 said regarding digital games attracting students' attention: *"Frankly, I think my students are more interested when I use digital games in my lessons. I think their interest and attention in the lesson has increased even more."* While T1 mentioned, *"When we turn the lesson into a game, the child becomes more interested in the lesson because they are already involved with the computer."* similarly T2 said, *"Because they have fun thanks to the games, they like school and the lesson a little more, they embrace it a little more, and they show a little more interest in the science lesson."*

Regarding the fact that digital games enable learning while having fun, T3 said, *"Plus, I saw that such requests were increasing, I saw that the enthusiasm was increasing. They have fun because I realized that they learn by having fun."* Similarly, T6 pointed out *"I saw that their desires and enthusiasm increased thanks to digital games."*

T2 used the expression *"When this is the case, it actually has a positive impact on many children who are addicted to technology. Children have fun and learn while having fun. I see that learning has become easier."*

T3 said regarding digital games enabling students to be active: *"So, when I play such games in the lessons and myself, I see that even my students, who are very quiet, participate in the lesson very, very actively. I'm even surprised. While I can say that it provides active participation positively."* T4 emphasized that *"It ensures the participation of all students in the lesson, including the students whose participation in the lesson is low."* T6 also expressed this as follows: *"I think it is a playground that attracts the attention of students, allowing them to participate in the lesson more actively and productively."*

In terms of making him or her love the school, the teacher and the lecture, T1 said the following sentence: *"Because student does different activities in science class or against the teacher here, students starts to love the lesson and starts to love the teacher because student does loves the things."* In addition, T2 said, *"Thanks to digital games, students now have a lot of fun in schools. Because they have fun thanks to the games, they love school and the lesson a little more, they embrace it a little more, and they show a little more interest in that lesson."*

Regarding increasing interest and curiosity, T1 gave him/her view *"When the child enters the lesson, the first thing he or she gives is that child becomes more curious about the lessons by saying things like, 'When will we play, when will we do, let's do this, too.'"* T3 said, *"Students' interest and curiosity is always about digital games. In this way, their interest in the lesson increases. I mean, I think from the perspective of our own students."*

Teacher T7 said regarding game addiction: *"Since digital games are played on the internet, students may become more addicted to internet addiction in this period when internet addiction is at the peak. It's like plucking out your eyes when you want to do eyebrows. In other words, there is an educational game aspect, but if you make it permanent, as they say, too much of anything is bad. Here too, internet addiction causes us huge problems."* In parallel with this, T1 mentioned *"Plus, there may be a situation of doing too much. In other words, it can be addictive for students who especially love computers. "For example, if it is an hour or 15 minutes game, I throw it in. For example, 'I may not get up because I am studying in front of the computer for 3-4 hours'."*

Regarding the fact that students may get bored with the subjects or become uninterested in the lessons, T7 used the expression *"If we make the student play the digital game constantly, situations such as boredom and reluctance may arise in the student."* Similarly, T8 said *"They cannot play digital games for a long time. Student made the sentence. They get bored after a certain thing."* T1 said *"There are 7 units and I definitely do not skip the game at the end of each unit. For example, these games are repeated at least 7 times, but children get bored towards the last units."*

Intended for creating a competitive environment and chaos T7 said *"Due to the competitive environment, sometimes students cannot behave maturely, and because they do not behave maturely, misunderstandings can cause an argument among students. This competition can turn into a chaos and a fight between students. When the student loses the game, they cannot digest it. They say 'I don't want to play it again' or 'it is wrong'. Anything*

can be a problem. I don't know, how can I say it? Child looked from someone else, etc., there are such different conversations." With a similar expression, T4 said, "For very ambitious students, shouting, talking loudly, if it is a competitive digital game, it can be a competition, and if it is a competitive game, it can be a problem for the student who cannot handle it." As a matter of fact, T8 formed the sentence. "I usually make these digital games that I use in the form of competitions. Since students are competing in competitions, negativities inevitably occur."

Regarding causing lack of control, T1 used the expression "Then this time student uses it as an excuse to his family to study and plays other games. For example, you know, he or she can use it on worthless things. In that sense, there may be lack of control because the family does not have knowledge." While T2 said "I think there should be a balance. Because if used excessively in lessons, it can cause lack of control." T6 also pointed out "Other than that, sometimes they may choose games that are not appropriate for their age. I can control it when they are on their own, but only when they are with me. I mean, since I allocate a certain amount of time for the lesson, not the whole lesson, but a certain part of it, there is no problem during the lesson, but when they play these by themselves at home, they cannot control the time and they waste a lot of time."

Within the scope of the research, codes, categories and themes obtained from teachers' views regarding the question "Is there any difference between science teaching with digital games and science teaching without digital games?" was presented in Table 5.

Table 5. Teacher Views intended the Difference between Science Teaching with Digital Games and Science Teaching without Digital Games

Theme	Category	Codes	Teachers	f
Science teaching with and without digital games	There is a difference	Involves all students actively in the lectures.	T1, T2, T4	3
		Creates an environment for group work.	T1, T8	2
		Provides figures out the subject	T4, T7	2
		Draws attention.	T5, T7	2
		Helps with studying.	T2	1
		Increases motivation.	T7	1
		Takes away from memorization.	T7	1
		Arises the effectiveness of lectures.	T1	1
		Allows to be carried out experiments	T3	1

In Table 5, teachers said that there was a difference between science teaching with digital games and science teaching without digital games. All teachers stated that this difference was in favor of digital games. Teachers emphasized that thanks to science teaching with digital games, all students actively participated in the lectures, understood the topics, and created an environment for group work. Regarding the active participation of all students in the lectures, T1 made a sentence as follows: "You know, you can involve all the students, thanks to the digital game." Likewise, T2 said "It attracts more attention, especially from students with lower academic levels. Since our aim is to involve every student in the lesson and we want every student to participate, we use these games for this purpose." T4 gave the view "Child, for example, when I explain the subject, there is something

missing. "They can complete it with games, or I think digital games are very effective for all students, including students who do not attend the class."

Regarding the comprehension of the subjects, T4 said "I just mentioned, the simplest thing is that it is better to understand the subject. So, for example, when I explain the subject to a child, there is something missing. " While T7 expressed a view as follows: "Without digital games, various situations may occur such as the student getting bored in the normally taught lesson, the student not being able to achieve a small goal in the lesson, or not being able to understand what the teacher is teaching, or the student not being able to fully understand what the teacher is giving."

T1 as regard preparing the environment for group work: "Due to the crowdedness of normal classes, it is generally through presentation, that is, the progress of the subjects is a little more teacher-centered, but in the digital game, for example, the children are in the form of groups rather than individuals, competitions are generally effective in crowded classes. He made the sentence. " In this context, T8 said "Digital games attract the attention of today's children more, since they are in a game style, they can participate in more activities and group participation is easier with these digital games."

Within the scope of the research, codes, categories and themes obtained from teachers' views regarding the question "Is there any relevance between digital games which you use in your lectures and science learning outcomes?" was presented in Table 6.

Table 6. Teacher Views intended the Relevance between Digital Games and Science Learning Outcomes

Theme	Category	Codes	Teachers	f
The relevance between digital games and learning outcomes	There is a relevance	Prepared according to science learning outcomes	T1, T2, T3, T4, T5, T6, T7, T8	8
		Aimed at the knowledge and comprehension level.	T1, T2, T4, T5, T8	5
		Associated with technological gains.	T5	1
	There is no a relevance	Contains non-obtainable questions.	T1, T3	2
Does not measure metacognitive level.		T8	1	

When Table 6 is examined, it is seen that teacher mentioned that there is a general relevance between digital games and science learning outcomes. For instance, all teachers emphasized that digital games were prepared taking science learning outcomes into consideration. In this regard, T6 said "Some game styles have been adapted as end-of-unit, unit- by-unit, and I see that many of them are made by students in other schools. In other words, games are made that are exactly compatible with the achievements. That's why they have a harmonious relevance." Similarly, the majority of teachers stated that digital games measure sub-cognitive skills such as knowledge and comprehension. T4 who one of the teachers, explained this relevance as follows: "So, in the learning outcomes, things like 'knows', 'this is what student does', 'this is what he designs' are usually mentioned,

and here are the learning outcome sentences. Generally, games are played at the knowledge and comprehension level for gain. So the games I play are at this level. Let me put it that way." he explained. Besides, T2 said, "The games we play are all about gains. It consists of questions about the knowledge level and concept level in the learning outcomes related to our units. Therefore, we can say that it is directly in line with our annual plan. We can say that it is compatible with the curriculum."

Although teachers pointed out that digital games and science learning outcomes were related, they also mentioned cases from which there was no relevance. In this context, T8 said "To be honest, digital games can achieve cognitive gains at the level of meaningful knowing and understanding, but other than that, it is a little more difficult to reach the practical stages. That is to say, digital games aim mostly to repeat theoretical information. In other words, there are mostly no questions that will affect higher-level cognitive thinking." On the other hand, T1 emphasized that there can be questions and activities other learning outcomes in digital games and expressed his/her view as follows: "Digital games are mostly related to science learning outcomes, but we also encounter questions or activities other than learning outcomes."

Within the scope of the research, codes, categories and themes obtained from teachers' views regarding the question "If you had to design a digital game for a science lecture, what kind of game would you design for which subject?" was presented in Table 7.

Table 7. Teacher Views intended for Designing a Digital Game for Science Lecture

Theme	Category	Codes	Teachers	f
Designing a digital game for science class	5th or 6th grade	Systems in our body	T6, T7, T8	3
		Abstract subjects	T1, T3	2
		Subjects such as heat, temperature and force	T2	1
		Subjects that can be matched	T5	1
	8th grade	Chart reading subjects like speed	T6	1
		Heredity	T4	1
		Physics subjects such as pressure and simple machines	T2	1

When Table 7 is examined, it is seen that if teachers designed a digital game, they would design it to be suitable for the 5th or 6th grade level or the 8th grade level. As a matter of fact, T6 stated that he/she would design a game for the 6th grade about the systems in our body and said "At the sixth grade level, about the systems in our body. Because when I was explaining this to my students, I was thinking of designing matching games that could teach and explain these concepts, both because of the limited time and because they were encountering foreign concepts again. To make it more memorable. Because they are really struggling. The subject of the systems in our body is very intense." T1 also said that he/she would design a game at the 5th grade level and for abstract subjects. He/she expressed his/her view as follows: "I would consider designing on incomprehensible subjects, and I think it would be much more useful on verbal subjects, that is, on subjects that remain verbal and abstract. Because the majority of students have difficulties, especially with abstract subjects, but I think it is much easier to understand when we concretize it and turn it into a game. Especially to the fifth grade level."

T2, stated that he/she would design a game 8th grader, on the subject of heredity and said *"I would probably design experimenting games involving physics subjects, such as the subject of pressure or the subject of simple machines. Especially in subjects where dependent and independent variables are frequently asked during the experiment phase, such subjects can be set up. So, if I were to design it myself, the first thing I would design would be on physics subjects, and the first thing I would design would be, does a student know the dependent variable and the independent variable while doing an experiment? Will he or she be able to achieve a result by changing the dependent independent variables on the game or not? I'd like to check this out."*

Discussion and Conclusion

Results obtained in the research, which was conducted to determine the views of science teachers regarding the use of digital games in science education were explained in five themes. These themes are respectively, the use of digital games in science education, the effects of digital games on students, science teaching with and without digital games, the relevance between digital games and science learning outcomes, and designing digital games for the science lecture.

Use of Digital Games in Science Education

Within the scope of this theme, science teachers expressed the view that digital games used in science education are a tool to help students gather their attention. The result reached by Demirel (2002) supports the finding of this research. As a matter of fact, Demirel (2002) had emphasized that even students who cannot pay attention to lectures can achieve successful learning by ensuring active participation through digital games. Thus, it can be said that digital games are a teaching technology that can be chosen to provide that students can participate in lectures by focusing their attention.

Another result reached within the framework of this theme is that digital games enable permanent learning. In this context, it is obvious that the benefits of digital games in the learning and teaching process intersect with both the research results and results in the literature at many points. Frankly, Usta and Güntepe (2019) revealed that designing digital games is a method that supplies the permanence of knowledge and positively affects the learning process, which can form the basis of this research findings. In a similarly conducted meta-analysis research, it is also seen that the use of digital games in science learning supports the permanence of information significantly (Riopel et al., 2020). Based on this, it can be stated that digital games contribute to students' permanent learning of information.

Effects of Digital Games on Students

Within the scope of this theme, teachers stated that the positive effect of digital games on students was to they help gather attention in the lecture. There are similar results in the literature. For instance, in a research conducted by Razak et al. (2012), teachers found the use of digital games in education exciting, enjoyable and interesting. Moreover, Toran et al. (2016) stated in their research that the reason why digital games are preferred by children

is that they are interesting and fun, and they also emphasized that this is the most important reason for them to prefer digital games. These findings support the research result. Based on the research results and studies in the literature, it can be said that digital games are an effective teaching technology to be used to attract students' interest in the lectures.

Within the scope of this theme, teachers pointed out that another positive effect of digital games on students is that they enable learning while having fun. Similarly, in a research conducted by Papadakis (2018), it was underlined that digital games are a useful way for students to learn effectively, thanks to their intriguing and motivating applications. When we start from here, it can be expressed that students not only learn science subjects but also have fun thanks to digital games, within the framework of the research and found researches in the literature.

Within the scope of this theme, teachers emphasized that the negative effects of digital games on students lead to game addiction. As a matter of fact, the result obtained by Güler et al. (2017) supports the finding of the research. Güler et al. (2017) determined that teacher candidates' negative views on using games in lectures stemmed from addiction and loss of connection with the real world. With a similar statement, Horzum (2011) concluded that game addiction is in primary school students, especially 4th grade students. In addition to these results, Haris (2001), in his meta-synthesis research, deduced that one of the prominent negative effects of digital games on students is game addiction. Therefore, it can be said that although digital games have many positive effects, they also have negative effects, and digital game addiction is at the top of these negative effects.

Science Teaching with and without Digital Games

Teachers specify that students participate in lectures actively thanks to science teaching with digital games. Similarly, Sarı and Altun (2016) stated that by means of digital games, students' interest and motivation in the lecture increased and their participation in the lecture became more active. Besides, Hamari et al. (2016) signified that digital games increase students' active participation in lectures (concentration, interest, etc.), in this way, they concluded that they participated in the learning process more effectively. Based on these results, it can be emphasized that thanks to science teaching with digital games, students like digital games more and participate more willingly and actively in lectures with such applications.

Another finding obtained within the scope of this theme is that digital games allow students to work in groups, that is, to cooperate. In the research conducted by Sanchez and Olivares (2011), the effect of digital games on problem solving and collaboration skills was examined. The results of the research indicated that similar results to the present research and it was revealed that the problem solving and cooperation skills of the experimental group improved more. Similarly, Sariçam (2019) stated in his research that 6th grade secondary school students worked in teams while using the Minecraft game, and this enabled them to communicate. It can be interpreted that students playing these games in groups and the high level of cooperation within the group have evolved the students' cooperation skills.

The Relevance between Digital Games and Science Learning Outcomes

All teachers whose views were taken within the scope of the research pointed out that digital games were prepared in accordance with science learning outcomes and that the designed digital games satisfied the knowledge and comprehension level of Bloom's taxonomy in the cognitive field. As a matter of fact, in the research of Arslan and Coştu (2022) emphasized that digital games improved learning outcomes in cognitive, affective and psycho-motor fields, enabled a repetitive learning experience and is a feasible and effective teaching technology for students. On the one hand, Bozkurt (2014) stated that digital games make a positive contribution to cognitive learning.

Based on these results, it was concluded that digital games measure the gains in the sub-cognitive level of the Bloom taxonomy. Unlike the results of this research; Tüzün and Bayırtepe (2007) made inferences that digital games increased academic success by supporting individuals affectively. On the other hand, Tüzün (2006) determined that they strengthened hand-eye coordination in psycho-motor terms. The reason for this may be that digital games are designed to measure affective and psycho-motor fields rather than just measuring the cognitive fields.

Designing a Digital Game for the Science Lecture

The majority of the teachers who participated in the interview said that if they had designed a digital game, it would be for the fifth or sixth grade level of secondary school. Similarly, Karamustafaoğlu and Kılıç (2020) state that digital games can be preferred by students in this period, on the grounds that the secondary school period is considered as the transition to the abstract period. However, it was determined that them researches were conducted for pre-school students. In researches executed on digital games, the selection of primary school students as samples brings to mind the possibility that it might be appropriate to start from smaller groups in order to ensure the effectiveness of digital games in primary education. Supporting the idea put forward, in a research emphasized that digital games in education and training are suitable for all levels, yet are more suitable for younger ages such as preschool (Ülker and Bülbül, 2018). From this perspective, while primary school students are in the process of making sense of scientific concepts in their minds thanks to digital games, they can also reach results through trial and error. That's why it needs to be used more effectively at the primary education level.

Furthermore, the majority of teachers stated that the digital games they would design would be aimed at systems unit in our body. They emphasized that the reason why they chose this unit was that systems in our body unit contains completely abstract subjects and students have difficulty comprehending them. As a matter of fact, Clark et al. (2014) concluded that digital games are a teaching technology that helps students learn and supports their understanding of abstract subjects and concepts. In another research, it was induced that when digital games were used in lectures, students concretized abstract concepts and eliminated misconceptions (Çakiroğlu et al., 2009). Based on these results, it can be deduced that digital games are an effective technology, especially in science teaching subjects included abstract content.

Recommendations

Recommendations that can be made in accordance with results obtained from the research as follows:

- Based on the views of science teachers, it has been concluded that science lectures in which digital games are used attract the attention of students and they learn knowledge permanently. For this reason, it is recommended that teachers include digital games while teaching science subjects.
- It has been determined that digital games are aimed at measuring the sub-cognitive domain in Bloom's taxonomy. Digital games can be designed to measure the metacognitive domain in Bloom's taxonomy.
- More digital games can be produce specifically for abstract science subjects, especially systems in our body.

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References

- Adams, J. (2012). Inquiry learning? Try a game. Teaching boys at the coal face: Mining key pedagogical approaches. *The International Boys' Schools Coalition*, 5-24.
- Ağıröğül, M., Kara, E., & Dönel Akgül, G. (2022). Eğitsel dijital oyunlarla işlenen fen bilgisi dersinin öğrencinin bilgilerinin kalıcılığına, akademik başarısına ve tutumuna etkisi. *Uluslararası Bilim ve Eğitim Dergisi*, 5(3), 157-176. <https://doi.org/10.47477/ubed.1063920>
- Akbay, M. (2015). *Kurmacılık yaklaşımı ile dijital oyun ortamında tasarım yapmanın, lise öğrencilerinin geometri başarı, öz yeterlilik ve uzamsal becerilerine etkisi*. [Unpublished master's thesis] Atatürk University.
- Aktamış, H., & Arıcı, V. (2013). Sanal gerçeklik programlarının astronomi konularının öğretiminde kullanılmasının akademik başarı ve kalıcılığa etkisi. *Mersin Üniversitesi Eğitim Fakültesi Dergisi*, 9(2), 58-70.
- Aktemur, A. (2022). *Bağlam temelli öğrenme stratejisi çerçevesinde dijital oyunların öğrenmeye etkisi*. [Unpublished master's thesis] Binali Yıldırım University.
- Altın, K. (2001). Fizik dersinde bilgisayar kullanımı: Bir simülasyon yazılımıyla ders geliştirilmesi Proceedings book of the Symposium on Science Education in Turkey at the Beginning of the New Millennium, pp.242- 247, Istanbul.
- Altun, Ö., & Karataş, İ. (2021). Z kuşağı ve internetten alışveriş ilgilenimleri. *İnsan ve Toplum Bilimleri Araştırmaları Dergisi*, 10(1), 289-311. <https://doi.org/10.15869/itobiad.795621>
- Altuntuğ, N. (2012). Kuşaktan kuşağa tüketim olgusu ve geleceğin tüketici profili. *Organizasyon ve Yönetim Bilimleri Dergisi*, 4(1), p. 203-211.
- Annetta, L., Mangrum, j., Holmes, S., Collazo, K., & Cheng, M. (2009). Bridging reality to virtual reality:

- investigating gender effect and student engagement on learning through video game play in an elementary school classroom. *International Journal of Science Education*, 31(8), 1091-1113. <https://doi.org/10.1080/09500690801968656>
- Arslan, K., & Coştu, F. (2022). Eğitimin vazgeçilmez parçası dijital oyunlar: Lisansüstü tezlere ait bir sentez çalışması. *Dokuz Eylül Üniversitesi Buca Eğitim Fakültesi Dergisi*, (54), 1329-1359. <https://doi.org/10.53444/deubefd.1169883>
- Ary, D., Jacobs, L. C., Irvine, C. K. S., & Walker, D. (2010). *Introduction to research in education* (2th edition). Cengage Learning.
- Ayanoğlu, M. M. (2006). *Mimarlık eğitiminde üç boyutlu bilgisayar oyun motorlarının kullanımı*. [Unpublished master's thesis]. İstanbul Technical University.
- Ayhün, S. E. (2013). Kuşaklar arası farklılıklar ve örgütsel yansımaları. *Ekonomi ve Yönetim Araştırmaları Dergisi*, 2(1), 102-103.
- Baek, Y. K. (2010). *Gaming for classroom-based learning: Digital role playing as a motivator of study*. IGI Global. <https://doi.org/10.4018/978-1-61520-713-8>
- Başkale, H. (2016). Nitel araştırmalarda geçerlik, güvenilirlik ve örneklem büyüklüğünün belirlenmesi. *Dokuz Eylül Üniversitesi Hemşirelik Fakültesi Elektronik Dergisi*, 9(1), 23-28.
- Binark, M. (2007). Sanal uzamda oyun kültürü ve dijital oyunlar. *Report presented at the Internet Conference in Turkey*, [Date of access: 20.06.2023]. Access address: <http://inettr.org.tr/inetconf11/bildiri/89>.
- Binark, M., & Bayraktutan Sütcü, G. (2008). Dijital oyun kültürü ve Türkiye'de gençliğin internet kafe kullanım pratikleri. *Digital Game Industry and Game Developers Workshop and Panel in Turkey*, [Date of access: 20.06.2023]. Access address: <https://docplayer.biz.tr/16727386-Turkiye-de-dijital-oyun-sektoru-ve-oyun-gelistiricileri-calistay-ve-paneli-14-mart-2008-istanbul-genel-degerlendirme.html>
- Bogost, I. (2010). *Persuasive games: The expressive power of videogames*. MIT Press.
- Bozkurt, A. (2014). Homo ludens: Dijital oyunlar ve eğitim. *Eğitim Teknolojileri Araştırmaları Dergisi*. 5 (1), 1-21.
- Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö.E., Karadeniz, Ş., & Demirel, F., (2020). *Eğitimde bilimsel araştırma yöntemleri* (14th edition). Pegem Academy.
- Büyükcuslu, F. (2017). *Z kuşağının iş yaşamından beklentileri konusunda bir araştırma*. [Unpublished master's thesis]. Bahçeşehir University.
- Cheng, M.T., & Annetta, L.A. (2012). Students' learning outcomes and learning experiences through playing a Serious Educational Game. *Journal of Biological Education*, 46(4), 203-213. <https://doi.org/10.1080/00219266.2012.688848>
- Cheng, M.T., She H. C., & Annetta L.A. (2014). Game immersion experience: Its hierarchical structure and impact on game-based science learning. *Journal of Computer Assisted Learning*, 31, 232-253. <https://doi.org/10.1111/jcal.12066>
- Cheng, M.T., Su, T., Huang, W.Y., & Chen, J.H. (2014). An educational game for learning human immunology: What do students learn and how do they perceive? *British Journal of Educational Technology*, 45(5), 820-833. <https://doi.org/10.1111/bjet.12098>
- Çakıroğlu, Ü., Çebi, A., & Akkan, Y. (2009). Bilgisayar oyunlarının eğitim amaçlı kullanımına yönelik öğretmen görüşleri. *Report presented at the 9th International Conference on Educational Sciences*, pp.6-13,

Ankara.

- Catak, G. (2011). Oynarken tasarlamak: Dijital tasarım oyunları. *Sigma*, 3, 385-391.
- Çetin Aydın, G., & Başol, O. (2014). X ve Y kuşağı: Çalışmanın anlamında bir değişme var mı? *Electronic Journal of Vocational Colleges*, 4(4), 1-15. <https://doi.org/10.17339/ejovoc.41369>
- Clark, D., Nelson, B., Sengupta, P., & D'Angelo, C. (2009). Intended and unintended Learning in SURGE. *Results presented at the Technology Enhanced Learning in Science*.
- Creswell, J. W. (2009). *Research design: Qualitative, quantitative and mixed methods approaches* (3th edition).
- Daşdemir, İ., & Doymuş, K. (2012). Fen ve teknoloji dersinde animasyon kullanımının öğrencilerin akademik başarılarına, öğrenilen bilgilerin kalıcılığına ve bilimsel süreç becerilerine etkisi. *Pegem Eğitim ve Öğretim Dergisi*, 2(3), 33-42. <https://doi.org/10.14527/C2S3M4>
- Demirel, Ö. (2002). *Öğretme sanatı: Öğretimde planlama ve değerlendirme*. Pegem Academy.
- Deterding, S., Dixon, D., Khaled, R. & Nacke, L. (2011). From game design elements to gamefulness: defining "gamification". Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments. pp. 9-15. <https://doi.org/10.1145/2181037.2181040>
- Dinç, M. (2012). Türkiye dijital oyunlar raporu. [Date of access: 24.10.2022]. Access address: <https://docplayer.biz.tr/643513-Turkiye-dijital-oyunlar-federasyonu-mevlut-dinc.html>.
- Dolunay, A., & Karamustafaoğlu, O. (2021). Fen bilimleri öğretmenlerinin eğitsel oyunlar hakkında görüşleri: "En süratli ses" oyunu. *Uluslararası Türk Eğitim Bilimleri Dergisi*, 2021(16), 48-69. <https://doi.org/10.46778/goputeb.872860>
- Dönel Akgül, G., & Kılıç, M. (2020). Fen bilgisi öğretmen adaylarının eğitsel dijital oyunlar ve kodu uygulamasına yönelik görüşleri. *Fen Bilimleri Öğretimi Dergisi*, 8(2), 101-120.
- Echeverria, A., Garcia-Campo, C., Nussbaum, M., Gil, F., Villalta, M., Amestica, M., & Echeverria, S. (2011). A framework for the design and integration of collaborative classroom games. *Computers & Education*, 57(1), 1127-1136. <https://doi.org/10.1016/j.compedu.2010.12.010>
- Ericsson. (2012). ConsumerLab generation Z. [Date of access: 01.10.2023]. Access address: <https://www.pcquest.com/ericsson-consumer-lab-reveals-digital-lives-gen-z-india>.
- Eroğlu, B. (2019). Dijital video oyunları ve eğitim: Minecraft eğitim sürümü. *Anadolu Öğretmen Dergisi*, 3(1), 56-64. <https://doi.org/10.35346/aod.568427>
- Erten, P. (2019). Z kuşağının dijital teknolojiye yönelik tutumları. *Gümüşhane Üniversitesi Sosyal Bilimler Dergisi*, 10(1), 190-202.
- Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education* (8th edition). McGraw-Hill.
- Gee, J. P. (2009). *Deep learning properties of good digital games: How far can they go? In Serious games* (pp. 89-104). Routledge. <https://doi.org/10.4324/9780203891650-15>
- Gelibolu, M. F. (2013). Eğitsel dijital oyunların teknolojisi, türleri, sınıflandırılması, derecelendirilmesi ve eğitimde kullanılabilme potansiyeli. M. A. Ocak (Eds.), *Eğitsel dijital oyunlar: Kuram, tasarım ve uygulama içinde* (pp.70-104). Pegem Academy.
- Güler, H., Şahinkayası, Y., & Şahinkayası, H. (2017). Öz bakım becerileri eğitiminde bilişim teknolojileri kullanımına ilişkin okul öncesi öğretmen adaylarının görüşleri: Kilis ili örneği. *Journal of Current Researches on Social Sciences*, 7(3), 433-456.

- Gündoğdu, C. (2021). *Dijital oyun kavramına yönelik: Bir meta-sentez betimleme*. [Unpublished master's thesis]. Bozok University.
- Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in Human Behavior*, 54(2016) 170-179. <https://doi.org/10.1016/j.chb.2015.07.045>
- Harris, J. (2001). The effects of computer games on young children: A review of the research. *Journal of American Academy of Child Adolescent*, (72), 22.
- Herodotou, C. (2018). Mobile games and science learning: a comparative study of 4 and 5 years old playing the game angry birds. *British Journal of Educational Technology*, 49(1), 6-16. <https://doi.org/10.1111/bjet.12546>
- Horzum, M. B. (2011). İlköğretim öğrencilerinin bilgisayar oyunu bağımlılık düzeylerinin çeşitli değişkenlere göre incelenmesi. *Eğitim ve Bilim*, 36(159), 56-68.
- Ilgaz, C., & Abay Cansabuncu, İ. (2020). Türkiye’de yeni medya ortamı ve dijital oyun olgusu. *Yeni Medya Elektronik Dergisi*, 4(1), 1-9. <https://doi.org/10.17932/IAU.EJNM.25480200.2020.4/1.1-9>
- Jull, J. (1999). A Clash Between Game and Narrative. [Date of access: 21.06.2023]. Access Address: <http://www.jesperjuul.net/thesis>.
- Karal, H., Fiş Erümit, S., & Çimer, A. (2010). Bitkilerde üreme konusunda bilgisayar destekli öğretim materyalinin tasarlanması ve değerlendirilmesi. *Türk Fen Eğitimi Dergisi*, 7(2), 158-174.
- Karamustafaoğlu, O., & Kılıç, M. F. (2020). Eğitsel oyunlar üzerine yapılan ulusal bilimsel araştırmaların incelenmesi. *Atatürk Üniversitesi Kazım Karabekir Eğitim Fakültesi Dergisi*, (40), 1-25. <https://doi.org/10.33418/ataunikkefd.730393>
- Karataş, Z. (2015). Sosyal bilimlerde nitel araştırma yöntemleri. *Manevi temelli sosyal hizmet araştırmaları dergisi*, 1(1), 62-80.
- Kapil, Y., & Roy, A. (2014). A critical evaluation of generation Z at workplaces. *International Journal of Social Relevance & Concern*, 2(1), 10-14.
- Kırıkkaya E. B., & Şentürk, M. (2018). Güneş sistemi ve ötesi ünitesinde artırılmış gerçeklik teknolojisi kullanılmasının öğrenci akademik başarısına etkisi. *Kastamonu Eğitim Dergisi*, 26(1), 181-189. <https://doi.org/10.24106/kefdergi.375861>
- Kirriemuir, J., & McFarlane, A. (2004). Literature review in games and learning. Report No. 8, NESTA Future Lab Series. [Date of access: 01.10.2023]. Access Address: http://www.nestafuturelab.org/research/lit_reviews.htm.
- Koparan, T. (2021). Yükseköğretimde dijital oyun tabanlı öğrenme ortamından yansımaların incelenmesi. *Yükseköğretim ve Bilim Dergisi*, 11(3), 503-515. <https://doi.org/10.5961/jhes.2021.470>
- Köseoğlu, F., & Kavak, N. (2001). Fen öğretiminde yapılandırıcı yaklaşım. *Gazi Üniversitesi Gazi Eğitim Fakültesi Dergisi*, 21(1).
- Kukul, V. (2013). *Oyunla ilgili tarihsel gelişim ve yaklaşımlar: Eğitsel dijital oyunlar*. Pegem Academy.
- Kurt, M. C. (2016). *Dijital ortamlarda toplumsal katılım anlayışı: Sosyal eylem platformları üzerine bir inceleme*. [Unpublished master's thesis]. Marmara University.
- Lieberman, D.A., Fisk, M. C., & Biely, E. (2009). Digital games for young children ages three to six: From research to design. *Computers in the Schools*, 26(3), 299-313.

- <https://doi.org/10.1080/07380560903360178>
- Lester, J. C., Spires, H. S., Nietfeld, J. L., Minogue, J., Mott, B. W., & Lobene, E. V. (2014). Designing game-based learning environments for elementary science education: A narrative-centered learning perspective. *Information Sciences*, 264, 4-18.
- Levickaite, R. (2010). Generations X, Y, Z: How social networks form the concept of the world without borders (The Case of Lithuania). *Limes*, 3(2), 173-183.
- Liu, E. Z., & Chen, P. K. (2013). The effect of game-based learning on students' learning performance in science learning—A case of “conveyance go”. *Procedia-Social and Behavioral Sciences*, (103) 1044-1051. <https://doi.org/10.1016/j.sbspro.2013.10.430>
- Li, M. G., & Tsai, C.C. (2013). Game-based learning in science education: A review of relevant research. *Journal of Science Education and Technology*, 22, 877-898. <https://doi.org/10.1007/s10956-013-9436-x>
- Lin, Y. H., & Hou, H. T. (2015). Exploring young children's performance on and acceptance of an educational scenario-based digital game for teaching route-planning strategies: A case study. *Interactive Learning Environments*, 1-14. <https://doi.org/10.1080/10494820.2015.1073745>
- McCall, J. (2022). *Gaming the past: Using video games to teach secondary history*. Taylor & Francis. <https://doi.org/10.4324/9781003272229>
- McMahan, A. (2013). Immersion, engagement, and presence: A method for analyzing 3-D video games. In *the video game theory reader* (pp.67-86). Routledge.
- Mieczakowski A., Goldhaber T., & Clarkson, J. (2011). Culture, communication a change: Reflections on the use and impact of modern media and technology in our lives. University of Cambridge Engineering Design Centre.
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: a sourcebook of new methods*. Sage Publications.
- Miller, L. M., Chang, C.-I., Wang, S., Beier, M. E., & Klisch, Y. (2011). Learning and motivational impacts of a multimedia science game. *Computers & Education*, 57, 1425–1433. <https://doi.org/10.1016/j.compedu.2011.01.016>
- Mul, J. D. (2008). *Siber uzayda macera dolu bir yolculuk*, Translation: Ali Özdamar. Kitap Publishing.
- Nitsche, M. (2008). *Video game spaces: Image, play, and structure in 3D worlds*. MIT Press.
- Özer, F. (2020). İlkokul öğrencilerinin dijital oyun tercihlerinin eğitsel bir perspektiften incelenmesi. *Anadolu University Journal of Education Faculty*, 4(4), 380-398. <https://doi.org/10.34056/aujef.801943>
- Pala, F. K., & Erdem, M. (2011). Dijital oyun tercihi ve oyun tercih nedeni ile cinsiyet, sınıf düzeyi ve öğrenme stili arasındaki ilişkiler üzerine bir çalışma. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi*, 12(2), 53-71.
- Papadakis, S. (2018). The use of computer games in classroom environment. *International Journal of Teaching and Case Studies*, 9(1), 1-25. <https://doi.org/10.1504/IJTCS.2018.090191>
- Prensky, M. (2001). *Fun play and games what makes games engaging*. *Digital Game- Based Learning* (p. 1-31). McGraw-Hill.
- Pusey, M., & Pusey, G. (2015). Using Minecraft in the Science Classroom. *International Journal of Innovation in Science and Mathematics Education*, 23(3), 22-34.
- Razak, A. A., Connolly, T., & Hainey, T. (2012). Teachers' views on the approach of digital games based learning

- within the curriculum for excellence. *International Journal of Game-Based Learning*, 2(1), 33-51. <https://doi.org/10.4018/ijgbl.2012010103>
- Riopel, M., Nenciovici, L., Potvin, P., Chastenay, P., Charland, P., Sarrasin, J. B., & Masson, S. (2020). Impact of serious games on science learning achievement compared with more conventional instruction: An overview and a meta-analysis studies in science education, 55, 169–214. <https://doi.org/10.1080/03057267.2019.1722420>.
- Sabırlı, Z. E. (2018). *Dijital eğitsel oyunların eğitimde kullanımının farklı değişkenler açısından incelenmesi*. [Unpublished master's thesis]. Selçuk University.
- Schaeffer, J. (2001). A gamut of games. *AI Magazine*, 22(3), 29-29.
- Sanchez, J., & Olivares, R. (2011). Problem solving and collaboration using mobile serious games. *Computers and Education*, 57, 1943-1952. <https://doi.org/10.1016/j.compedu.2011.04.012>
- Sarı, A., & Altun, T. (2016). Oyunlaştırma yöntemi ile işlenen bilgisayar derslerinin etkililiğine yönelik öğrenci görüşlerinin incelenmesi. *Turkish Journal of Computer and Mathematics Education*, 7(3), 553-577. <https://doi.org/10.16949/turkbilmat.277871>
- Sarıçam, U. (2019). Dijital oyun tabanlı STEM uygulamalarının öğrencilerin STEM alanlarına ilgileri ve bilimsel yaratıcılığı üzerine etkisi: Minecraft örneği. [Unpublished master's thesis]. Marmara University.
- Savaş, S., Güler, O., Kaya, K., Çoban, G., & GüzeL, M. S. (2021). Eğitimde dijital oyunlar ve oyun ile öğrenme. *International Journal of Active Learning*, 6(2), 117-140.
- Şahin, M. (2015). *Oyunlaştırılmış oyun temelli öğrenmenin öğrencilerin fen bilimleri dersi başarılarına ve derse yönelik tutumlarına etkisi*. [Unpublished master's thesis] Bahçeşehir University.
- Toran, M., Ulusoy, Z., Aydın, B., Deveci, T., & Akbulut, A. (2016). Çocukların oyundan yararlanabilmesi için annelerin değerlendirilmesi. *Kastamonu Eğitim Dergisi*, 24(5), 2263-2278.
- Türnüklü, A. (2000). Eğitimbilim araştırmalarında etkin olarak kullanılabilir nitel bir araştırma tekniği: Görüşme kuram ve uygulamada eğitim yönetimi, 24(24), 543-559.
- Tüzün, H. (2006), Türkiye’de internet konferansı, TOBB, ETÜ. [Date of access: 21.06.2023]. Access Address: http://inet-tr.org.tr/inetconf11/kitap/_inet06.pdf
- Tüzün, H., & Bayırtepe, E. (2007). Oyun tabanlı öğrenme ortamlarının öğrencilerin bilgisayar dersindeki başarıları ve öz yeterlik algıları üzerine etkileri. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 33, 41-54.
- Usta, N. D., & Güntepe, E. T. (2019). Dijital oyun tasarlanmanın öğrenmeye etkisi. *Bingöl Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 9(18), 1213-1232. <https://doi.org/10.29029/busbed.562553>
- Uşun, S. (2004). *Bilgisayar destekli öğretimin temelleri*. Nobel Publishing.
- Ülker, Ü., & Bülbül, H. İ. (2018). Dijital oyunların eğitim seviyelerine göre kullanılma durumları. *Tünav Bilim Dergisi*, 11(2), 10-19.
- West, D. M., & Bleiberg, J. (2013). *Education technology success stories*. Center for Technology Innovation at Brookings. [Date of access: 30.09.2023]. Access Address: <https://www.brookings.edu/research/education-technology-success-stories/>
- Wouters, P., Nimwegen, C., Oostendorp, H., & Spek, E. D. (2013). A Meta-analysis of the cognitive and motivational effects of serious games. [Date of access: 21.09.2023]. Access Address: http://ocw.metu.edu.tr/pluginfile.php/11786/mod_resource/content/1/A%20Meta -

Analysis%20of%20the%20Cognitive%20and%20Motivational%20Effects%20o
f%20Serious%20Games.


Yengin, D. (2010). *Dijital oyunlarda şiddet kavramı: Yeni şiddet*. [Unpublished doctoral thesis] Marmara University.

Yıldırım, A., & Şimşek, H. (2021). *Sosyal bilimlerde nitel araştırma yöntemleri*. (12th edition). Seçkin Publishing.

Yıldız, S., & Zengin, R. (2021). Dijital ve sınıf içi eğitsel oyunlarla gerçekleştirilen fen eğitiminin okul öncesi öğrencilerinin bilişsel gelişim düzeylerine etkisi. *Ekev Akademi Dergisi*, (86), 497-512. <https://doi.org/10.17753/Ekev1904>

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Appendix. Interview Form

Hello teacher, I am Neslihan Durmuş. I am doing my master's degree at Erciyes University, Institute of Educational Sciences, Department of Science Education. Thank you for interviewing with me and contributing to my research. I am conducting the research to determine the views of science teachers who using digital games in science teaching. For this purpose, I execute interviews with science teachers who using digital games in their lectures. I will ask you 6 questions within the scope of the purpose and problem of my research. The interview will take approximately 15-20 minutes. I will use a voice recorder during the interview. The reason why I use a voice recorder is to put on paper your views regarding the questions completely and without changing the purpose. Only the researchers will have access to the recordings of the interview. Additionally, the voice recording will not be shared anywhere or anyone.

Demographic features

1. Your place of duty
2. Your teaching experience
3. University you graduated from and year of graduation
4. The digital games which you use in your lectures
5. Frequency of using these games

Interview Questions

1. What do you think about digital games?
 - i. What do you think about the positive effects of digital games?
 - ii. What do you think about the negative effects of digital games?
2. What do you think about the use of digital games in science education?
 - a) What do you think about the educational side of digital games?
3. Are there any effects the digital games which you use in your lectures have any effect on students? If so, what effect does it have?
 - i. Does it have a positive effect?
 - ii. Does it have any negative effects?
4. Is there any difference between science teaching with digital games and science teaching without digital games? What are these differences, if any?
5. Is there any relevance between digital games which you use in your lectures and science learning outcomes? If so, what kind of relevance is there?
6. If you had to design a digital game for a science lecture, what kind of game would you design for which subject?
 - i. What grade level would you design it for?