

The Impact of Digital Educational Games on Primary School 4th Grade Students' Science Learning Anxiety and Happiness at School

Mehmet Sena Atas¹, Mahmut Ayaz², Serhat Şihman³, Metin Tunçekin⁴, Yusuf Kasap⁵, Mehmet Emin Yılmaz⁶

ABSTRACT

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The purpose of the current study is to investigate the impact of digital educational games on primary school 4th grade students' science learning anxiety and their happiness at school. The study was carried out with the participation of 36 primary school 4th grade students in İpekyolu district of Van. There were 17 students in the experimental group and 19 students in the control group. The study employed a quasi-experimental design that included pre-test and post-test measurements, with a control group. In the experimental group, the science lesson was conducted through digital educational games and in the control group, the science lesson was conducted without the use of digital educational games. In the collection of the data, the Science Teaching Scale and the Happiness at School Scale were used. Data analysis in the study involved the utilization of statistical tests of the Mann-Whitney U-test and the Wilcoxon signed-rank test. The findings of the study showed that digital educational games decreased 4th grade elementary school students' anxiety about learning science and increased their happiness at school. There was no difference between the pre-test and post-test scores in the control group. The study revealed that it would be beneficial to use digital educational games in the teaching of primary school students, especially in Science and other courses.

Keywords: Digital educational games, technology, anxiety, happiness at school

¹Ministry of National Education, Turkey, mehmetsenaatas@hotmail.com 0000-0002-2041-1523

² Ministry of National Education, Turkey, mahmutzaya@hotmail.com 0000-0001-9010-0002

³ Ministry of National Education, Turkey, masallahsihman65@gmail.com 0000-0002-8926-7523

⁴ Ministry of National Education, Turkey, mtuncekin@gmail.com 0009-0005-3200-7041

⁵ Ministry of National Education, Turkey, yusufkasap5806@hotmail.com 0000-0002-5114-1175

⁶ Ministry of National Education, Turkey, emin3330111@gmail.com 0000-0002-0667-8029

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INTRODUCTION

Using technology in the classroom has become increasingly important in modern education. Technology has the potential to make learning more interactive, engaging and fun for students. It provides opportunities for multimedia presentations, interactive simulations, educational games and virtual reality experiences that can attract students' attention and increase their motivation to learn (Uşun, 2004; Şimşek, 2015). Technology provides interactive and engaging learning materials that attract students' attention. With the use of visual and auditory elements, learning experiences become more engaging and increase student engagement (Alpar et al., 2007; Yumuşak & Aycan, 2002). Technology can personalize learning to suit different learning styles, needs and speeds. It provides students with the opportunity to deliver content that meets their individual goals and can adapt the learning process to the needs of the student. Technology improves students' collaborative skills and communication abilities. With the development of technology, digital educational games have gained importance (Akpınar, et al., 2005; Özer, 2020).

Digital educational games are the latest games that use educational purposes and help students learn while having fun (Çankaya & Karamete, 2008). These games are used to support various learning objectives and for students to learn effectively. Digital educational games make learning fun for students (Bayırtepe & Tüzün, 2007). The games use motivational elements such as rewards, levels, leaderboards, etc. to further stimulate experiences and increase motivation for achievement. It is of great importance to use digital educational games while teaching primary school students who are in the play age. Digital educational tools enrich the learning experience by providing visual and audio content. Students can understand and retain topics more effectively through texts, images, videos and audios. Teaching by playing games with students can break down prejudices against subjects such as science and mathematics. It can reduce learning anxiety towards these subjects (Can & Türkmen, 2017; Hong, Cheng, Hwang, Lee, & Chang, 2009; Oblinger, 2006). Anxiety is an emotional response to a real or potential danger, worry, or uncertainty. Anxiety can be related to many different situations or events and can affect a person physically, mentally and emotionally. Anxiety can cause a person to feel insecure, uneasy or worried (Başer, 1998; Coşkun, 1998; Erbaş & Küçük, 2012; İnanç, 1997; Ünlü, 2001).

Science learning anxiety is a state of worry and stress that students experience in science courses or science-related subjects. This type of anxiety can arise when students participate in science-related activities and when they are faced with expectations for exams or performance (Mallow & Greenburg, 1983). Anxiety about learning science can be influenced by different factors including students' expectations of success, lack of self-confidence, false beliefs, and coping skills. This anxiety can negatively affect students' motivation to learn, interfere with the learning process and negatively affect their achievement in science (Raymond, 2003). Anxiety can reduce students' interest in science courses and decrease their motivation to learn. Students may avoid participating in science-related activities or experience feelings of hopelessness due to anxiety. Anxiety about learning science can negatively affect students' performance in exam or performance situations. Intense anxiety can distract students, impair memory function, and make it difficult for them to cope with performance expectations such as tests or presentations. Anxiety about learning science can undermine students' belief in their own abilities. When they

feel unconfident in their own abilities, students may avoid taking risks, hesitate to ask questions, and stay away from participation (Oludipe & Awokoy, 2010). Anxiety about learning science can increase students' stress levels and negatively affect their overall sense of well-being. Students may experience physical and emotional symptoms due to anxiety and develop a negative attitude towards science courses. Reducing students' anxiety towards science lessons may help students to be happy at school or in class.

The happiness of primary school students at school is of great importance for their overall development and learning processes. Happy students may have a greater motivation towards school and learning. Children who are happy at school nurture their sense of curiosity, participate more willingly in the learning process and develop an attitude towards success (Ceylan, 2007). A happy environment enables students to focus their attention and facilitates learning. Children achieve better learning results in an environment where they feel safe and comfortable. Students who are happy at school digest information with a clearer mind, have more learning experiences and develop better understanding and application skills. Students who are happy at school are more active in social interactions. A positive environment is important for making good social connections, developing friendships and using empathy skills. Happy children are more emotionally stable and have stronger self-esteem. Students who are happy at school attend school regularly and do not suffer from absenteeism (Kıldan, 2007). A happy school environment makes children eager to come to school and encourages their continuous active participation in the learning process (Chiohn & Fraser, 2009). The primary school covers a period in which children start their basic education life. A happy school experience shapes children's attitudes towards school and positive expectations for their future educational life. A good start helps students to achieve more motivation and success in their future educational life. For these reasons, primary school students' happiness at school positively affects both their academic achievement and their overall development (Aydın, et al., 2019).

Studies on school happiness and science learning anxiety in primary school students address important issues that affect students' academic achievement and emotional well-being (Alkan & Bayri, 2017). In the study investigating the correlation between science learning anxiety and school happiness in primary school students, it was found that there was an inverse relationship between science learning anxiety levels and school happiness. That is, students with higher science learning anxiety had lower school happiness (Müezzın & Özata, 2019). Additionally, the study revealed a negative correlation between higher levels of science learning anxiety and lower levels of social and emotional skills among students (Margolis & McCabe, 2004). The correlation between science learning anxiety and academic success in primary school students was evaluated. It was shown that students with high levels of science learning anxiety had lower academic success. In addition, a negative correlation was found between science learning anxiety and achievement in math and science courses (Müezzın & Özata, 2019).

These studies emphasize that there is a significant correlation between science learning anxiety and school happiness in primary school students. High levels of science learning anxiety can affect students' school happiness and negatively affect their academic achievement. Therefore, it is important to develop appropriate strategies to reduce students' science learning anxiety and increase their school happiness (Bryan, et al., 2011; Yenice, et al., 2012).

Addressing school happiness and science learning anxiety in primary school students are important factors in supporting their happiness and academic success in the teaching process. Happy students are more likely to have better mental health and overall well-being (Cavas, 2011). When students feel positive, supported and engaged in their school environment, this can contribute to their emotional and psychological development. Students who experience happiness are more likely to exhibit higher levels of motivation to learn and actively engage in the educational process. They are likely to attend class, complete assignments and take on challenges with enthusiasm. This positive attitude towards learning increases their academic progress. A happy school environment fosters positive relationships between students, teachers and staff. Strong connections contribute to a sense of belonging, support and social-emotional development. These relationships can act as a buffer against stress and challenges, making students feel safe and supported. Happiness at school helps students develop resilience and effective coping skills. They are better equipped to cope with setbacks, challenges and academic pressures. Positive experiences and a supportive environment enable students to bounce back from challenges and persist in their learning journey. A happy school experience can have long-lasting effects on students' future success. It lays the foundation for a positive attitude towards education, self-confidence and lifelong learning. Anxiety can prevent students from participating in science education. It can lead to avoidance of science-related activities, reduced participation and even negative attitudes towards the subject. By addressing anxiety, students can feel more comfortable and engage in science learning (Engin-Demir, 2009; Glynn, et al., 2005). Anxiety about learning science can erode students' confidence in their ability to succeed in science. By alleviating anxiety, students can develop a stronger belief in their own abilities, leading to improved self-efficacy and a willingness to tackle scientific challenges (Bryan, et al., 2011; Cavas, 2011; Yenice, et al., 2012; Engin-Demir, 2009; Glynn, et al., 2005). By prioritizing school well-being and addressing science learning anxiety, educators can create supportive environments that enhance students' well-being, engagement, and success in science education. It fosters a positive attitude towards learning and lays the foundation for their future academic and personal success. The current study aimed to determine the impact of digital educational games on primary school students' science learning anxiety and happiness at school:

The fourth-grade primary school students in the experimental and control groups;

- a) Is there a significant difference between science learning anxiety scores?
- b) Is there a significant difference between their happiness at school scores?

METHOD

Research Design

This study aims to investigate the impact of digital educational games on science learning anxiety and happiness at school among fourth-grade students in primary schools. This study was conducted using experimental research method. Experimental research is the sole type of research that enables the testing of hypotheses in order to establish cause-and-effect relationships. It represents the strongest chain of reasoning when examining the connections between variables. In experimental research, the researcher tries to determine the effects of

independent variables on dependent variables. The objective is to assess the cause-effect relationship between these variables through testing (Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2009). Since this study was carried out with pre-existing, ready-to-use groups and random assignment was not possible, the quasi-experimental design including pretest-posttest and control group was used. Quasi-experimental designs are utilized when it is not feasible to achieve random selection of participants (Fraenkel, Wallen, & Hyun, 2012).

Study Group of the Research

The research comprised two classes, each consisting of fourth-grade students from a public school in Van province during the fall term of the 2022-2023 school year. A total of 36 primary school students were included from these classes in the study. The number of students in the experimental group is 17 while the number of students in the control group is 19. In the study, 10 (58.82%) of the participants in the experimental group are female and 7 (41.17%) are male; 7 (36.84%) of the participants in the control group are female and 12 (63.15%) are male. Parental consent was obtained for this study through a written form.

Data Collection Tools

Wordwall: Wordwall is an online platform that empowers educators to generate personalized and interactive learning materials. With Wordwall, teachers can easily design engaging and enjoyable learning materials that are interactive in nature. It hosts a variety of learning activities including vocabulary, quizzes, puzzles, matching games, flashcards, memory games and more. These materials increase classroom interaction and encourage students to actively participate. Wordwall allows teachers to customize the materials according to their needs and their students' learning goals. Teachers can create interactive slides that include a variety of elements such as text, images, audio, video and interactive components. They can also customize visual elements such as color, theme, font, etc. Materials created in Wordwall can be easily shared and downloaded by teachers. Wordwall provides statistical data to monitor and evaluate students' performance. Teachers can track students' progress, analyze their responses and provide feedback on their performance. Wordwall is a user-friendly platform that helps teachers create an interactive and fun learning environment in the classroom. It facilitates teachers to create, share and evaluate learning materials. However, you may need to create a free account to use all the features. Wordwall can be accessed from this website <https://wordwall.net/en-us/community/games>.

Science Learning Anxiety Scale

The scale was developed by Kağıtçı and Kurbanoğlu (2013) and has 18 items and one dimension. Expert opinion was taken for content validity studies. Exploratory factor analysis was performed to determine construct validity. Factor analysis revealed a unidimensional structure. The factor loadings of the 18 scale items ranged from 0.411 to 0.708, collectively accounting for 37% of the total variance of the scale. The internal consistency coefficient of the scale was calculated to be 0.895. The test-retest reliability coefficient, which is another reliability test, was determined as 0.853.

Happiness at School Scale

The Happiness at School Scale developed by Gündoğan and Akar (2019) consists of 9 items and 2 sub-dimensions. The first sub-dimension is referred to as “happiness at school” while the second sub-dimension is labelled as “unhappiness at school”. The cronbach alpha coefficient for the total reliability of the scale is 0.76, the cronbach alpha coefficient for the first sub-dimension of the scale is 0.68 and the cronbach alpha coefficient for the second sub-dimension of the scale is 0.68. The Cronbach alpha coefficients calculated for the reliability test show that the reliability of the sub-dimensions of the scale and the overall scale is ensured.

Data Collection Process

The students in the experimental group were taught with digital educational games related to the nutrients unit on the Wordwall website after the science lessons, while in the control group, digital educational games were not played after the science lessons. The experimental group students were taught the lessons in their own classrooms but used the computer lab for the digital learning games. The study lasted for 6 weeks in the 2021-2022 academic year. Students in the experimental group played digital educational games for a total of 12 hours, 2 hours per week.

Data Analysis

Non-parametric methods were employed in this study due to the group-level participant count being below 30, and the Shapiro-Wilk test indicating a p-value of less than 0.05 ($p=0.04$), indicating departure from normal distribution. In this context, the Wilcoxon Signed-Rank Test was employed to assess the significance of differences between the mean scores of the pretest and posttest in both the experimental and control groups. Additionally, the Mann-Whitney U-test was utilized to determine the significance of differences between the posttest mean scores of the experimental and control groups. In the interpretation of the statistical analysis results, a significance threshold of 0.05 was accepted. In this study, digital learning games were the independent variable and school happiness and science learning anxiety were the dependent variables. Furthermore, effect sizes (r) were computed to evaluate the impact of the independent variable on the dependent variable. Effect sizes of 0.10, 0.30, and 0.50 were considered as indicators of small, medium, and large effect sizes, respectively (Cohen, 1988). The data obtained from the scales were analyzed using the SPSS 21 software program.

Internal and External Validity

Regarding the effect of subject characteristics, which is one of the important factors in ensuring the internal validity of the research, care was taken to ensure that the experimental and control groups were identical and the group selection was randomized. The fact that the data in the experimental and control groups were collected by the same person is a factor that eliminates the threat to internal validity. The other factor that threatens the internal validity of the research is the bias of the data collector. To eliminate this, an observer was present in the classroom in addition to the researcher. However, it can be said that internal validity was ensured due to the selection of data collection tools, validity and reliability of the tools, not losing subjects during the research and meeting expectations. Finally, the research was limited to 6 weeks to eliminate

the threat of immaturity. External validity of the research refers to the generalizability of the results (Fraenkel, Wallen, & Hyun, 2012). The findings of this study have the potential for generalization to a broader population under conditions similar to the conditions and environment of the study. In addition, the sample sizes of the experimental and control groups were kept relatively balanced to ensure comparability.

FINDINGS

Table 1 presents the results of the Mann-Whitney U-test conducted on the pretest scores of the happiness at school scale to determine if there were any significant differences between the experimental and control groups of fourth-grade primary school students.

Table 1. U-Test Results According to Happiness at School Pre-Test Scores of Experimental and Control Groups

Group	n	Mean rank	Sum of ranks	<i>U</i>	<i>p</i>
Experimental	17	18.44	313.50	160.500	.975
Control	19	18.55	352.50		

As seen in Table 1, the fourth-grade students in the experimental group obtained an average score of 21.82 on the pre-test questions related to “Happiness at School” whereas the control group obtained an average score of 21.52. The analysis of the Mann Whitney U-test results concluded that there was no significant difference between the scores of the experimental and control groups on the "Happiness at School" pre-test questions ($u=160.50, p>.05$).

Table 2 provides the results of the Mann-Whitney U-test conducted on the post-test scores of fourth-grade students in the experimental and control groups, aiming to determine if there were any significant differences between the two groups.

Group	n	Mean rank	Sum of	<i>U</i>	<i>p</i>
Experimental	17	24.21	411.50	64,00	.002
Control	19	13.39	254.50		

According

According to the findings in Table 2, the average score for the post-test questions related to “Happiness at School” among fourth-grade students in the experimental group was 24.52, whereas the average score for primary school students in the control group was 21.89. The analysis of the Mann-Whitney U-test indicated a significant difference between the post-test scores of the “Happiness at School” questions for the experimental and control groups

($u=64.00$, $p<.05$). These results lead to the conclusion that game-based digital learning effectively contributes to increasing the happiness at school of 4th grade primary school students. Furthermore, the effect size (r) analysis using Mann Whitney U test revealed that the effect size was -0.51 . We can say that the effect size has a large effect. In other words, the effect size is high. The obtained result suggests that there is a significant difference between the post-test scores of the questions assessing happiness at school among fourth-grade students in the experimental and control groups. Based on these findings, it can be concluded that the implementation of digital game-based learning had a positive effect on the happiness at school of fourth-grade primary school students in the experimental group. This result becomes even more evident when we compare the pre and post-test results of the experimental and control groups. Table 3 shows the results of the Wilcoxon signed-rank test for the happiness at school test of primary school students.

Table 3. Comparison of the pretest and posttest scores of the happiness at school scale for the experimental and control group students

	Posttest- Pretest	N	Rank Average	Rank Sum	z	p
Experimental	Negative Ranks	2	13.00	36.00	-2,29	0.017*
	Positive Ranks	15	8.47	127.00		
	Ties	0				
Control	Negative Ranks	10	8.70	87.00	-0,323	0.747
	Positive Ranks	9	11.44	130.00		
	Ties	0				

* $p<0.05$

As seen in Table 3, there exists a significant difference between the pretest and posttest scores of the students in the experimental group ($z=-2.297$, $p<.05$). When the rank means and sum of ranks of the difference scores are examined, it is seen that the difference is inclined towards positive ranks, indicating a favourable outcome in favour of the posttest. However, no significant difference was found between the pretest and posttest scores of the students in the control group. ($z=-0.323$, $p>.05$).

Table 4 presents the results of the Mann-Whitney U-test conducted on the pre-test scores of the Science Learning Anxiety Scale to assess if there were any significant differences between the experimental and control groups of fourth-grade primary school students.

Table 4. U-Test Results According to the Science Learning Anxiety Scale Pre-Test Scale Scale Pre-Test Scores of the Experimental and Control Group Students.

Group	n	Mean rank	Sum of	<i>U</i>	<i>p</i>
Experimental	17	18.47	314,00	161.00	.987
Control	19	18.53	352,00		

As can be seen in Table 4, the average score for fourth-grade students in the experimental group on the Science Learning Anxiety Scale is 39.41, whereas the average score for fourth-grade students in the control group is 39.94. The Mann-Whitney U-test indicated that there was no statistically significant difference between the pre-test results of science learning anxiety between the experimental and control groups ($u=161.00, p>.05$).

Table 5 displays the results of the Mann-Whitney U-test conducted on the posttest scores of fourth-grade students in both the experimental and control groups, aiming to ascertain whether there is a significant difference between the two groups.

Table 5. U-Test Results According to Science Learning Anxiety Posttest Scores of Experimental and Control Group Students

Group	n	Mean rank	Sum of	<i>U</i>	<i>p</i>
Experimental	17	13.68	260,00	70,00	.003
Control	19	23.88	406,00		

As can be seen in Table 5, the average score of the students in the experimental group on the science learning anxiety posttest questions is 37.73, while the average score of the students in the control group is 48.35. The analysis of the results of the Mann-Whitney U-test revealed that there exists a significant difference between the posttest scores of science learning anxiety among the experimental and control groups ($U=70.00, p<.05$). From these results, it was concluded that digital learning games were effective in reducing science learning anxiety among the experimental group students. Furthermore, according to the results, when the effect size (r) was analyzed for Mann Whitney U-test, the effect size was -0.48. It can be said that the effect size has a medium-sized effect. Based on these findings, it can be concluded that there is a moderate level of difference between the post-test scores of the questions assessing science learning anxiety among fourth-grade students in the experimental and control groups. Moreover, this result becomes clearer when the pretest and posttest scores of the experimental and control groups are compared. Table 6 shows the Wilcoxon test results for the anxiety about learning science test.

Table 6. Comparison of Science Learning Anxiety Pre-Test and Post-Test Scores of the Experimental and Control Group Students

	Posttest- Pretest	N	Rank Average	Rank Sum	z	p
Experimental	Negative Ranks	14	10.14	142.00	-3,102	0.002*
	Pozitive Ranks	3	3.67	11.00		
	Ties	0				
Control	Negative Ranks	9	11.50	103.50	-0,342	0.732
	Pozitive Ranks	10	8.65	86.00		
	Ties	0				

* $p < 0.05$

Table 6 shows that there exists a significant difference between the pretest and posttest scores of the students in the experimental group ($z = -3.102, p < .05$). Upon analyzing the rank averages and sum of ranks of the difference scores, it is observed that the difference favours negative ranks, that is, the pretest. Obtaining a high score on the anxiety scale signifies a higher level of anxiety, whereas obtaining a low score indicates a lower level of anxiety. However, No significant difference was found between the pretest and posttest scores of the students in the control group ($z = -0.323, p > .05$).

CONCLUSION AND DISCUSSION

In this study, the impact of digital educational games on fourth grade primary school students' learning anxiety and happiness at school were investigated. In this direction, firstly, it was sought to answer the question of whether there existed a significant difference between the happiness at school scores of the fourth grade primary school students in the experimental and control groups. It was determined that there was a significant difference in favour of the experimental group in the posttest scores. Therefore, it was concluded that digital game-based learning positively affected the happiness at school of primary school 4th grade students in the experimental group. Similar to the result of this study, Digital games can be attractive and engaging tools for children. Games can make learning fun, increase motivation and attract students' attention. Therefore, digital game-based learning can help students feel happier at school (Arioğlu & Uzun, 2008; Bakar Tüzün & Çağıltay, 2008; Özerbaş & Erdoğan, 2015). Digital games can increase primary school students' motivation towards learning (Yavuzyılmaz, 2018). Games incentivize students through reward systems, levels and achievements. This helps students to work harder and achieve success (Erdoğan & Karataş, 2016). Digital games can make the learning experience more engaging and interactive (Ural, 2009; Papastergiou, 2009). Games with visual and auditory stimuli can make learning more fun by attracting students' attention. This can make students happier at school (Coşkun, Akarsu & Karaiper, 2012; Savaş & Gülüm, 2014; Karamustafaoğlu & Kaya, 2013; Önen, Demir & Şahin, 2012; Bayırtepe & Tüzün, 2007). Digital games can adapt to different learning styles and speeds. Each student has a unique learning style and digital games can better adapt to students' individual learning needs.

Thus, students are more likely to succeed, which increases their sense of happiness (Savaş, Güler, Kaya, Çoban & Güzel, 2021). Digital game-based learning can cause students to spend more screen time. Excessive screen time can lead to some health problems, lack of social interaction and sleep problems. Therefore, it is important to keep students' screen time under control (Green & Bavelier 2003, Prot et al. 2014). In conclusion, it can be argued that digital game-based learning can positively affect 4th grade primary school students' happiness at school. However, the advantages and disadvantages of this approach should be taken into account and it is important to strike the appropriate balance according to the individual needs of students.

The study also aimed to determine whether there was a significant difference between the science teaching anxiety scores of fourth-grade primary school students in the experimental and control groups. It was determined that there was a significant difference in favour of the experimental group students in the posttest scores. Therefore, it was concluded that digital game-based learning reduced the science learning anxiety of the experimental group students. Of course, it can be considered as a very positive finding to conclude that digital game-based learning reduces science learning anxiety of primary school 4th grade students. Digital games can make the learning process more interactive and fun. Through games, students have the opportunity to actively learn science topics by exploring, experimenting or solving problems. This interactive and enjoyable experience can increase students' motivation towards science, which can reduce their learning anxiety (Özerbaş & Erdoğan, 2015). Digital games can also contribute to the creation of collaborative learning environments. By playing the games with friends or classmates, students can support each other and experience learning together. This supportive environment can help students experience science in a more positive way and reduce their learning anxiety (Bayırtepe & Tüzün, 2007; Yıldız, Şimşek, & Aras, 2017).

The above points are based on the evidence that digital game-based learning can reduce primary school 4th grade students' science learning anxiety. However, it is important to consider other factors and wait for the results of larger-scale studies. It is also important to note that digital game-based learning is not only a single learning method, but should be used in combination with various teaching strategies.

Suggestions

Although this study investigated the impact of digital learning games in general, it could also analyze the impact of specific types of games (e.g. interactive simulations, puzzles, quiz games, story-based games, etc.) on students' anxiety and well-being in school science classes. This study could also analyze how long students engage in digital educational games and the impact of this time on their anxiety and well-being in science classes at school. Since the duration of game engagement has certain thresholds, the impact of different durations can be evaluated by comparing groups of students above and below these thresholds. This study can investigate how digital learning games affect students' learning strategies and skill development in science. It can be investigated which strategies students use while playing games and what effects the games have on students' problem solving, critical and creative thinking skills. While evaluating the impact of digital learning games, the importance of teachers' and parents' involvement in the process can also be investigated. The potential of games to create a sense of cooperation

and competition among students and their effects on friendships and classroom interaction can be investigated. Based on the results of the study, long-term impact studies can be conducted. It can be examined how students' regular use of digital educational games over a long period of time affects their anxiety about learning science and their happiness at school. Such studies can provide important data to better understand the impact of games. These recommendations offer different perspectives and methods to more comprehensively examine the impact of digital educational games on fourth grade students' science anxiety and happiness at school. Future research of this kind can help improve the education system and provide students with a more positive learning experience.

DATA AVAILABILITY

Ethical Rules: This study was conducted in accordance with ethical principles.

Authors Contributions: All authors contributed to the study's conception, design, data collection, analysis, and manuscript preparation. All authors read and approved the final manuscript.

Conflict of Interest: The authors declare that they have no conflict of interest related to this study.

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Data Availability: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

- Akpınar, E., Aktamış, H., & Ergin, Ö. (2005). Fen Bilgisi dersinde eğitim teknolojisi kullanılmasına ilişkin öğrenci görüşleri. *The Turkish Online Journal of Educational Technology*, 4(1), 93-100.
- Alkan, İ., & Bayri, N. (2017). Fen öğrenmeye yönelik motivasyon ile fen başarısı arasındaki ilişki üzerine bir meta analiz çalışması. *Dicle Üniversitesi Ziya Gökalp Eğitim Fakültesi Dergisi*, (32), 865-874.
- Alpar, D., Batdal, G., & Avcı, Y. (2007). Öğrenci merkezli eğitimde eğitim teknolojileri uygulamaları. *HAYEF Journal of Education*, 4(1).
- Arıoğlu, S., & Uzun, T. (2008). Digital video technology in foreign language classes: A case study with 'lost'. *Dil Dergisi*, 142, 61-70.
- Aydın, B., Kara, E., & Günbey, M. (2019). İlkokul yıllarında öğrencileri mutlu ve mutsuz eden öğretmen davranışları ve bu davranışların etkileri. *Nevşehir Hacı Bektaş Veli Üniversitesi SBE Dergisi*, 9(1), 69-92.
- Bakar, A., Tüzün, H., & Çağıltay, K. (2008). Öğrencilerin eğitsel bilgisayar oyunu kullanımına ilişkin görüşleri: sosyal bilgiler dersi örneği. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 35, 27-37.
- Başer, E. (1998). *Uygulamaları Spor Psikolojisi*. Bağırhan Yayinevi: Ankara.
- Bayırtepe, E., & Tüzün, H. (2007). The effects of game-based learning environments on students' achievement and self-efficacy in a computer course. *H H. U. Journal of Education*, 33, 41-54.
- Bryan, R. R., Glynn, S. M., & Kittleson, J. M. (2011). Motivation, achievement, and advanced placement intent of high school students learning science. *Science Education*, 95(6), 1049-1065.
- Büyüköztürk, Ş., Çakmak, E. K., Akgün, Ö.E., Karadeniz, Ş., & Demirel, F. (2012). *Bilimsel araştırma yöntemleri*. Pegem Akademi Yayıncılık, Ankara.
- Can, M. Z., & Türkmen, B. (2017). Bilgisayar oyunlarının yabancı dil eğitimine katkısının araştırılması: Anadili Türkçe olan 100 yükseköğretim öğrencisi üzerinde yapılan araştırma örneği. *Tarih Okulu Dergisi*, 10(31), 399-435.
- Çankaya, S., & Karamete, A. (2008). Eğitsel bilgisayar oyunlarının öğrencilerin matematik dersine ve eğitsel bilgisayar oyunlarına yönelik tutumlarına etkisi. *Mersin Üniversitesi Eğitim Fakültesi Dergisi*, 4(2), 115- 127.
- Cavas, P. (2011). Factors affecting the motivation of turkish primary students for science learning. *Science Education International*, 22(1), 31-42.
- Ceylan, G. (2007). *Öğretmen-öğrenci etkileşiminin sınıfatmosferine etkisi (Aksaray ili Örneği)*. (Yayınlanmamış Yüksek Lisans Tezi). Selçuk Üniversitesi Sosyal Bilimler Enstitüsü. Konya.
- Chionh, Y. H., & Fraser, B. J. (2009). Classroom environment, achievement, attitudes and self-esteem in geography and mathematics in Singapore. *International Research in Geographical and Environmental Education*, 18(1), 29-44.
- Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences (2nd ed.)*. Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.
- Coşkun, H., Akarsu, B. & Karaiyer, A.İ. (2012). Bilim öyküleri içeren eğitsel oyunların fen ve teknoloji dersindeki öğrencilerin akademik başarılarına etkisi. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi (KEFAD)*, 13(1), 93- 109.

- Coşkun, M. (1998). Samsun İl Merkezinde Yaşayan Yaşlıların Sürekli Kaygı Düzeyleri ve Bazı Sosyoekonomik Etmenleri. (Yayımlanmamış Uzmanlık Tezi). Ondokuz Mayıs Üniversitesi, Samsun.
- Engin-Demir, C. (2009). Factors influencing the academic achievement of the Turkish urban poor. *International Journal of Educational Development*, 29, 17–29.
- Erbaş, M. K., & Küçük, V. (2012). Üst düzey basketbolcularda durumluk kaygı düzeylerinin farklı değişkenlere göre karşılaştırılması. *Selçuk Üniversitesi Beden Eğitimi ve Spor Bilimleri Dergisi*, 14, 257-261.
- Erdođdu, F., & Karataş, F. Ö. (2016). *Fen eğitiminde oyunlaştırmanın farklı değişkenler üzerindeki etkilerinin incelenmesi*. Hoca Ahmet Yesevi Yılı Anısına Uluslararası Türk Dünyası Eğitim Bilimleri ve Sosyal Bilimler Kongresinde sunulan bildiri, Antalya.
- Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education (Edisi Kedelapan ed.)*. (S. Kiefer, Penyunt.) New York City: McGraw-Hill Companies.
- Glynn, S., Aultman, L., & Owens, A. (2005). Motivation of learn in general education programs. *Journal of General Education*, 54(2), 150-170.
- Green, C. S., & Bavelier, D. (2003). Action video game modifies visual selective attention. *Nature*, 423, 534–537.
- Gündođan, A. & Akar, C. (2019). Happiness scale at school for primary school students: Validity and reliability study. *Türk Akademik Yayınlar Dergisi (TAY Journal)*, 3 (1) ,61-75.
- Hong, J.C., Cheng, C.L., Hwang, M.Y., Lee, C.K., & Chang, H.Y. (2009). Assessing the educational values of digital games. *Journal of Computer Assisted Learning*, 25, 423-437.
- İnanç, B. (1997). Kaygı ve Stres. *Ç. Ü. Eğitim Fakültesi Dergisi*, 2 (16), 9-14
- Kağıtçı, B., & Kurbanođlu, N. İ. (2013). Fen ve Teknoloji Dersine Yönelik Kaygı Ölçeğinin Geliştirilmesi: Güvenirlik ve geçerlik çalışması. *Türk Fen Eğitimi Dergisi*, 10(3), 98-107.
- Karamustafaođlu, O., & Kaya, M. (2013). Eğitsel oyunlarla “yansıma ve aynalar” konusunun öğretimi: yansımali koşu örneđi. *Araştırma Temelli Etkinlik Dergisi*, 3(2), 41-49.
- Kıldan, A. O.(2007).Okulöncesi eğitim ortamları. *Kastamonu Eğitim Dergisi*, 15(2),501-510.
- Mallow, J. V. & Greenburg, S. L. (1983). Science anxiety and science learning. *The Physics Teacher*, 95-99.
- Margolis, H. & McCabe, P. P. (2004). Self-Efficacy a key to improving the motivation of struggling learners. *The Clearing House*, 77(6), 241-249.
- Müezzın, E. E., & Özata, B. Ç. (2019). Ortaöğretim öğrencilerinde fen öğrenmeye yönelik kaygı ve motivasyon ilişkisi. *Kıbrıs Türk Psikiyatri ve Psikoloji Dergisi*, 1(1), 14-21.
- Oblinger, D.G. (2006). Games and learning: Digital games have the potential to bring play back to the learning experiences. *Educause Quarterly*, 29(3), 5–7.
- Oludipe, D., & Awokoy, J. O. (2010). Effect of cooperative learning teaching strategy on the reduction of students' anxiety for learning chemistry. *Journal of Turkish Science Education*, 7(1),30-36.
- Önen, F., Demir, S., & Şahin, F. (2012). Fen öğretmen adaylarının oyunlara ilişkin görüşleri ve hazırladıkları oyunların değerlendirilmesi. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi (KEFAD)*, 13(3), 299-318.

- Özer, F. (2020). İlkokul öğrencilerinin dijital oyun tercihlerinin eğitsel bir perspektiften incelenmesi. *Anadolu Üniversitesi Eğitim Fakültesi Dergisi (AUJEF)*, 4(4), 380-398.
- Özerbaş, M. A., Erdoğan, B. H. (2015). Dijital sınıf uygulamasına ilişkin öğrenci görüşleri. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi (KEFAD)*, 16(1), 357-369
- Papastergiou, M. (2009). Digital Game-Based Learning in high school Computer Science education: Impact on educational effectiveness and student motivation. *Computers & Education*, 52(1), 1-12.
- Prot, S., Anderson, C. A., Gentile, D. A., Brown, S. C., & Swing, E. L. (2014). *The positive and negative effects of video game play*. In Media and the well-being of children and adolescents. Oxford University Press.
- Raymond R. W. (2003). The development of an instrument to assess chemistry perceptions. Submitted to the Graduate Faculty of Texas Tech University in Partial Fulfillment of the Requirements for the Degree of, Ph.D., 22-23.
- Savaş, E., & Gülüm, K. (2014). Geleneksel oyunlarla öğretim yöntemi uygulamasının başarı ve kalıcılık üzerine etkisi. *Trakya Üniversitesi Sosyal Bilimler Dergisi*, 16(1), 175-194.
- 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
- Şimşek, Ü. (2015). *Sosyal bilgiler öğretmen adaylarının eğitimde teknoloji kullanımına ilişkin tutum ve görüşlerinin incelenmesi*. (Yüksek Lisans Tezi). Aksaray Üniversitesi Sosyal Bilimler Enstitüsü).
- Ünlü, S. (2001). *Psikoloji*. Eskişehir: Anadolu Üniversitesi, Açık Öğretim Fakültesi Yayınları.
- Ural, M. N. (2009). *Eğitsel bilgisayar oyunlarının eğlendirici ve motive edici özelliklerinin akademik başarıya ve motivasyona etkisi*. (Doktora Tezi). Anadolu Üniversitesi, Eğitim Bilimleri Enstitüsü, Eskişehir
- Uşun, S. (2004). *Bilgisayar Destekli Öğretimin Temelleri*. Ankara: Nobel.
- Yavuzylmaz, M. (2018). Eğitsel oyun destekli takım-oyun-turnuva yönteminin 5.sınıf öğrencilerinin “elektrik” konusundaki akademik başarılarına ve motivasyonlarına etkisi. (Yüksek Lisans). Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.
- Yenice, N., Saydam, G., & Telli, S. (2012). İlköğretim öğrencilerinin fen öğrenmeye yönelik motivasyonlarını etkileyen faktörlerin belirlenmesi. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi*, 13(2), 231-247.
- Yıldız, E., Şimşek, Ü., & Aras, H. (2017). Eğitsel Oyun Yönteminin Öğrencilerin Sosyal Becerileri, Okula İlişkin Tutumları ve Fen Öğrenimi Kaygıları Üzerine Etkisi. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education* 11(1), 381-400.
- Yumuşak, A., & Aycan, Ş. (2002). Fen bilgisi eğitiminde bilgisayar destekli çalışmanın faydaları; Demirci (manisa)’de bir örnek. *M.Ü. Atatürk Eğitim Fakültesi Eğitim Bilimleri Dergisi*, (16), 197-204.