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RESEARCH ARTICLE

The Effect of Supporting Science Education with Gamified E-Learning Environments on Motivation and Achievement

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ABSTRACT

In today's world, where technology is advancing at an unprecedented rate and information is increasing exponentially, it is essential to closely follow developments to achieve success in science education. Engaging learners actively throughout the learning process becomes even more crucial to fostering individuals who are inquisitive, research-oriented, and capable of independent learning. Designing new learning environments for the new generation of learners, known as 'digital natives,' has become inevitable. In this context, e-learning, which has emerged as a product of the digital transformations of our era, refers to the implementation of education via electronic media channels. Additionally, the concept of gamification, which has gained popularity since 2010, initially aimed towards strengthening the connection between digital systems and users and motivate them, but it has also started to find its place in the field of education. This study investigates the impact of supporting students in science education with a gamified e-learning environment on their academic achievement and motivation. It is expected that the findings of this research, conducted with elementary-level students, will guide the integration of gamification into science education curricula. The study was carried out using a mixed-methods approach that combines both quantitative and qualitative methods. A pre-test post-test quasi-experimental design was used to collect data with an academic achievement test and a motivation scale in addition to qualitative data obtained through interviews. The results of the study indicated that supporting students with a gamified e-learning environment enhanced their academic achievement and motivation compared to the methods suggested by the curriculum.

INTRODUCTION

In recent years, we have witnessed numerous changes such as an increased need for information, changes in communication methods, and the diversification and acceleration of these interactions due to technological advancements. These developments have opened the door to several innovations in the field of education as well. The limitations that restricted education to physical classroom settings have been removed, leading to transformations that enable the execution of educational activities in digital environments while creating new learning opportunities. The term *e-learning and gamification* are two of the concepts that are commonly accepted in the field of education. E-learning is defined as the process of obtaining knowledge through electronic means, has been discussed in the literature with various interpretations. According to Govindasamy (2002), e-learning is the delivery of instruction via electronic media channels such as the internet and multimedia elements. Alternative terms such as web-supported education, internet-based education, and online learning are also used interchangeably with e-learning (Khan, 2000). Although there are minor differences between these terms, they are generally used synonymously (Yalın et al., 2008; Moore et al., 2011). The concept of e-learning, which eliminates temporal and spatial constraints, has increased accessibility to information (Balcı, 2011). The advantages of e-learning environments include equality of opportunity, continuous access to information, and reduced instructional costs (Özgür, 2011). Due to these benefits, e-learning is utilized as a supportive component not only in distance learning applications but also in blended learning environments (Özgür, 2011).

In e-learning gamification is also gaining popularity as it is considered a motivating learning environment. Deterding et al. (2011) define gamification as the use of game elements in non-game contexts or applications. The terms gamification and game are often confused and used interchangeably; however, they represent different structures. While a game is generally defined as an activity carried out primarily for fun or leisure (Aral et al., 2001), gamification involves an infrastructure that incorporates memory buffering, motivation, cognitive architecture, autonomous self-management, distributed practice, social learning theory, guiding elements, and flow within the context of learning and teaching (Kapp, 2012; Seaborn and Fels, 2015).

The use of gamification is a promising approach as it creates motivating learning opportunities to students and it receives a significant attention from education community. Simões et al. (2013) highlight that information and communication technologies (ICT) are commonly employed in the gamification of learning environments. Consequently, studies exploring the combined effects of e-learning and gamification are typically conducted with students from computer and instructional technology education departments, resulting in samples predominantly composed of higher education students (Dicheva et al., 2015). In addition, there are limited studies in science education in relation to gamification in e-learning environments and there is a clear need for more research on employing necessary gamification elements organized in accordance with the science education process. Therefore, this study aims to investigate the effectiveness of gamification in science education. It is anticipated that examining the effects of supporting science education with gamified e-learning environments on learners' academic achievement and motivation will provide significant findings for the literature. The research question for this study "How do gamified e-learning environments impact the academic achievement and motivation of eighth-grade students in the science unit on 'Simple Machines'?"

Gamification

According to research, gamification is an effective method for encouraging desired behaviors in individuals (Lee & Hammer, 2011; Tu et al., 2015). Certain elements need to be considered for gamification to be effectively used in learning environments. Including the theoretical foundations upon which gamification is based in the design process is one example of these elements. The most important element in gamification is motivation, and the behaviors that arise depending on motivation are the focus of gamification. There are three models proposed regarding gamification designs: the Fogg Behavior Model, Malone and Lepper's Intrinsic Motivation Model, and Self-Determination Theory.

a) Fogg Behavior Model, which explains the causes of behavior change, includes three key elements: motivation, ability, and trigger. For a behavior change to be observed in an individual, these three elements must be present simultaneously (Fogg, 2009).

b) Malone and Lepper's Intrinsic Motivation Model, developed by Malone (1981) and derived from educational computer games, was later revised by Malone and Lepper (1987) with four elements of intrinsic motivation classification: challenge, fantasy, curiosity, and control.

c) Self-Determination Theory which is developed by Deci and Ryan (2000), offers a perspective on issues related to intrinsic and extrinsic motivation. While the source of intrinsic, or self-directed, motivation is the individual themselves, the source of extrinsic motivation is the external environment outside the individual (Bozkurt & Genç-Kumtepe, 2014). In Self-Determination Theory, three universal fundamental psychological needs that humans inherently possess are discussed: autonomy, competence, and relatedness. These needs must be nurtured to enable individuals to realize their potential.

Design elements also play a significant role in how learners interact with the environment and thus success. (Erümit ve Karakuş, 2015). The three accepted models includes; a) the Octalysis Design Model, presents an octagonal gamification framework, b) the MDE Design Model, describes gamification processes that emerge through the interaction of elements known as mechanics, dynamics, and aesthetics and c) the Pyramid Design Model categorizes gamification elements into dynamics, mechanics, and components.

2. METHOD

This study utilizes a mixed research design, which uses both quantitative and qualitative methods (Clark & Creswell, 2011; Baki & Gökçek, 2012). The convergent parallel mixed design, one of the mixed research methods, was employed in this study. According to this design, quantitative and qualitative data are collected simultaneously, and the interpretations of the analyses of quantitative and qualitative data are presented in related manner at the end of the research (Creswell & Clark, 2011). In this regard, quantitative data was collected through academic achievement test and motivation scale, while qualitative data were gathered through interviews.

2.1.Participants/Sample

The sample of the study consists of 115 eighth-grade students (%46,9 male, %53.1 female) studying at a public school in a major city during the 2021-2022 academic year. These students were distributes to four different classes. To determine the experimental and control groups, classes with similar characteristics were selected by considering the average grades of students in their seventh-grade science classes. For the purposes of the study three groups were established; Group 1 (G1) received instruction through e-learning environment with gamification components, Group 2 (G2) received instruction through e-learning environment without any gamification component and Group 3 (G3) was instructed with the current curriculum. There were 30 students in G1, 30 students in G2 and 50 students in G3.

2.2 Design and Instruction

For the study an e-learning environment with gamification components for the simple machines unit was designed by one of the researchers. The learning environment used in this study utilizes the Pyramid Design Model developed by Werbach & Hunter (2012) since it is considered more suitable for the targeted age group as well as the science content, simple machines. The Pyramid Design Model allows a flexible design structure and inclusion of necessary elements but not all. A learning management system (LMS) was used for the integration of pyramid design model-based teaching unit with elements such as avatar, feedback, collaboration and levels. The unit simple machines are taught for 3 weeks in the curriculum. During this period selected groups were either taught with an e-learning environment with gamification component or e-learning environment without any gamification component. Control group was taught with materials and directions included in the curriculum. An image from the unit is provided in Figure 1.

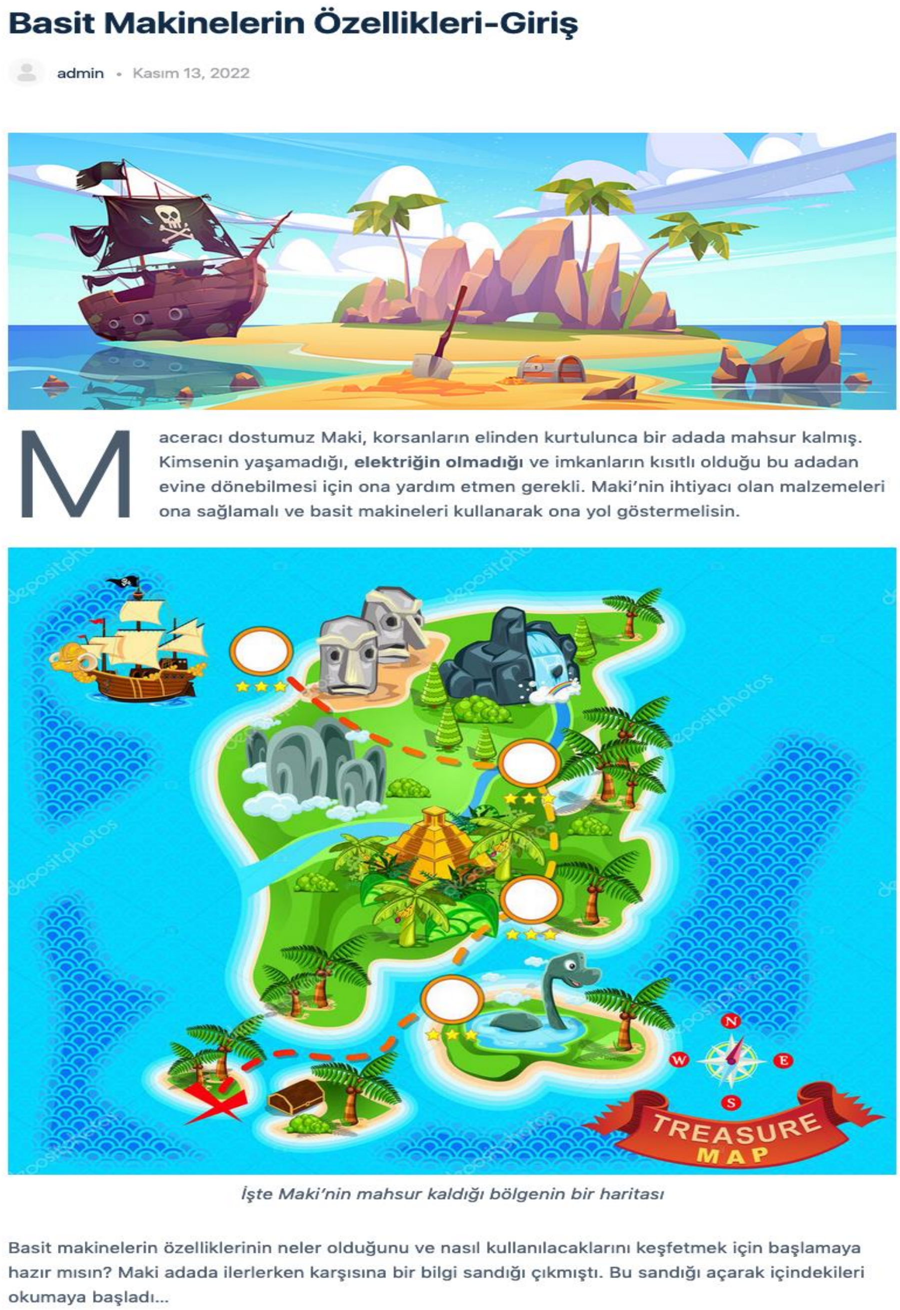

Figure 1. An image from the e-learning environment – Introduction to Simple Machines

2.3. Data Collection Tools

In line with the research objectives, this study includes an academic achievement test, a motivation scale, and a semi-structured interview protocol form. At the beginning and end of the study, both the experimental and control groups were given the "Simple Machines Academic Achievement Test (SMAAT)" as a pre-test and post-test, which was validated and tested for reliability by Altıparmak (2019). The test includes 19 items and Cronbach alpha values are reported between .60-.90 for subscales and .88 for the overall test. The second measurement tool used in the study was the "Motivation Scale for Learning Science (MSLS)," which was developed by Tuan, Chin & Sheh (2005) and adapted to Turkish by Yılmaz & Çavaş (2007). The adapted version includes 33 items and includes 6 subscales. The Likert type scale Cronbach alpha values range between .54 ve .85 for subscales and .85 for overall scale. MSLS was administered to the groups as a pre-test and post-test. In this context, changes in the academic achievements and motivation towards science learning of the participating students were examined.

In the second phase of the research, which was the qualitative research phase, a "Semi-Structured Interview Protocol" was used to allow students to express their opinions and experiences related to the subject to strengthen the weaker aspects of the findings obtained in the quantitative section. Some of the questions asked during the interviews were How would you evaluate the e-learning process you experienced? What problems did you encounter during the e-learning process? and how did conducting the science class in this way affect your participation in the lesson? The students' views on the gamified e-learning environment were investigated during this phase.

2.4. Data Analysis

The analysis of the quantitative data collected in the study was conducted using the statistical software SPSS 24.0, and the results were evaluated at a 95% confidence level. An independent sample t-test was used to analyze the academic achievement levels within the groups using the Simple Machines Academic Achievement Test (SMAAT) data. And to analyze the academic achievement levels between groups (G1, G2, and G3), ANOVA and post-hoc tests were used. The quantitative data obtained from the Motivation Scale for Learning Science (MSLS) were analyzed using the ANOVA test to examine the motivation scores between groups. Data collected semi-structured interviews were first transcribed and analyzed using descriptive analysis identifying emerging codes.

3. FINDINGS AND DISCUSSION

3.1. Findings on the Simple Machines Academic Achievement Test

Prior to the instruction each group received the Simple Machines Academic Achievement Test (SMAAT) and pre-test mean score on the Simple Machines Academic Achievement Test (SMAAT) for the group of students supported by gamified e-learning environment was 7.54, the group of students supported by a non-gamified e-learning environment had a pre-test SMAAT mean score of 6.83. The group using only the current curriculum had a pre-test SMAAT mean score of 6.75. Students' responses were also analyzed based on item to identify which topics are most difficult for students. Questions in regard to identifying simple machines, giving examples to simple machines and stating benefits and uses of simple machines were found to be answered wrong by the students in pre-test.

After the post-test student mean scores were calculated as follows; the SMAAT mean score for the group supported by a gamified e-learning environment was 12.9, the post-test SMAAT mean score for the group supported by a non-gamified e-learning environment was 10.83. The group using only the current curriculum had a post-test SMAAT mean score of 8.93. As seen from the results G1 showed a higher increase in post-test mean scores followed by G2 and then G3. Questions item based analysis for the post-test data also revealed difficulties regarding spinning wheels content of the unit.

Further analyses were conducted to analyze the pre-test and post-test results. According to the results of the ANOVA test conducted to compare the pre-test academic achievement scores of the experimental groups (G1 and G2) and the control group (G3), no statistically significant difference was found in the pre-test SMAAT scores between the control group and the experimental groups, G1 and G2 ($p > 0.05$).

ANOVA analysis was also conducted to analyze the post-test academic achievement scores of the experimental groups (G1 and G2) and the control group (G3) and a statistically significant difference was found. To be able to determine the nature of this difference a post-hoc analysis was conducted. Analysis comparing post-test results (Table 3) revealed a statistically significant difference between groups. According to the Tukey post-hoc test results, there is a statistically significant difference between the group G1 and G3 favoring the group supported by gamified e-learning ($\bar{x}$G1 = 12.90; $\bar{x}$G3 = 8.93).

Table 1. SMAAT pre-and post-test results

	Group	N	Mean	SD	F	p	Post Hoc
BMABT pre-test score	G_1	30	7,54	2,725	0,781	0,460	-
	G_2	30	6,83	3,228			
	G_3	50	6,75	2,764			
BMABT post-test score	G_1	30	12,90	4,286	11,054	0,000*	1-3
	G_2	30	10,83	3,405			
	G_3	50	8,93	3,630			

*p<0,05

G_1: gamified e-learning environment group

G_2: non-gamified e-learning environment group

G_3: current curriculum group

3.2. Findings on the Motivation Scale for Learning Science

Descriptive analysis was initially conducted to analyze data from the Motivation Scale for Learning Science (MSLS). Due to missing data some of the students were excluded from the analysis. A total of 96 students' responses were included in the analysis.

The maximum score on the Motivation Scale for Learning Science (MSLS) is 165. The pre-test mean scores on the Motivation Scale for Learning Science (MSLS) were also analyzed for each group. For the group supported by a gamified e-learning environment the mean score was 120.782. The pre-test MSLS mean score for the group supported by a non-gamified e-learning environment was 127.31, while the group using current curriculum had a pre-test MSLS mean score of 116.851.

After the instruction, the MSLS mean score for the group supported by a gamified e-learning environment was 135.087. The post-test MSLS mean score for the group supported by a non-gamified e-learning environment was 133.115 and the group using current curriculum had a post-test SMAAT mean score of 109.723. As seen from the results G1 showed a higher increase in post-test mean scores followed by G2 and then G3. An interesting finding of the post-test analysis is while for G1 and G2 the post-test scores are higher than pre-test scores, for G3 post-test scores were found to be lower than pre-test scores.

Table 2. MSLS pre- and post-test results for each group

	Group	N	Mean	SS	F	p	Post Hoc
MSLS pre-test scores	G_1	23	120,78	20,63	3,398	0,038*	2-3
	G_2	26	127,31	14,36			
	G_3	47	116,85	15,14			
MSLS post-test scores	G_1	23	135,09	13,91	33,704	0,000*	1-3 2-3
	G_2	26	133,12	16,77			

	G_3	47	109,72	13,59			

*p<0,05

G_1: gamified e-learning environment group

G_2: non-gamified e-learning environment group

G_3: current curriculum group

ANOVA analysis indicated a statistically significant difference based on pre-test Motivation Scale for Learning Science (MSLS) between groups (p > 0.05). Tukey post- hoc analysis was conducted to determine the nature of difference and a statistically significant difference was reported between G2 non-gamified e-learning environment and G3 current curriculum group. No statistically significant difference was found for G1-G2 and G1-G3 comparisons.

ANOVA analysis was also conducted to analyze the post-test scores of the Motivation Scale for Learning Science (MSLS) between groups and a statistically significant difference was found. To be able to determine the nature of this difference a post-hoc analysis was conducted. Analysis comparing post-test results revealed a statistically significant difference between groups. According to the Tukey post-hoc test results, there is a statistically significant difference between the groups G1 and G3 favoring the group supported by gamified e-learning and a statistically significant difference between the groups G2 and G3 favoring the group supported by non-gamified e-learning group.

3.3. Findings from the Interviews

Qualitative data was analyzed to determine students' interest in gamified e-learning environments and gather their opinions on this topic. Students were asked the following questions: "How would you evaluate the e-learning process you experienced? and How did you feel while using the website?" In response, to this question following codes were identified from students' responses: fun/enjoyable, appropriate (with current trends and modern times), necessary, contemporary, supportive (in terms of student learning), and motivating. Students indicated that studying science in a gamified e-learning environment made the lesson more enjoyable, that even those who were hesitant to participate became involved, that science was made more tangible, and that their motivation and engagement increased.

An example of students' comments is presented below.

"This is nice. Normally at school when learning in class it is boring. This way with computers and technological equipment it is more fun. More affective. We are in an age like this so ……" S1.

"I really liked the fact that someone did something extra to make us study. I'm motivated…" S2

As second question students were asked, "What problems did you encounter during the e-learning process?" Students' responses were coded as a) lack of technology / access and b) barriers created by family members. Technological access is found to be a significant issue. Some students do not have computers and use their mobile phones to access e-learning environments which can be difficult to do so, and some do not have internet access or have limited access and struggle to complete the tasks and assignments. But as students stated asynchronized learning environments make it easy to tackle internet access related issues. The second barrier students reported to be originated from parents. Some of the parents were thinking that their children were playing games and were trying to interfere with the process. None of the students reported any difficulty regarding the e-learning environment used during this research.

Students were also asked to evaluate the gamification components and content according to their experience with the unit. Students' responses were analyzed, and the following emerging codes were found. Regarding gamification components the identified codes were earning points, avatars using story and feedback. According to students, earning points created a competitive environment which was in the end motivating for their learning. Using avatars made them feel like they are using social media, so it was easy and familiar for them. During the instruction using a story to present the content was enjoyable and motivating and receiving feedback increased their achievement. Some of the students stated.

"*I liked earning points most. Because I was competing with my friends and that was good, so I was trying to complete more tasks. I also liked the profile feature. I was also seeing my friends' profiles ….*" S7*.*

"I liked the story most. It was fun. Other than that... after completing assignment, it gives you the answer and you can solve it again…. I solved the questions again….and it was also nice that we get points when we watch something…." S8.

The last question inquired about students' suggestions on what can be changed to make the design better. Students suggested adding a leaderboard to the website as a game element which would allow them to see their friends' scores during the process. The score board feature was intentionally left out from the design to prevent a competitive environment but as students stated being able to see other students scores has a motivational factor and encouraged them to complete more activities.

4. DISCUSSION

Using gamified e-learning environments is considered a motivational approach in teaching, supporting students' academic achievement. This study examines how using gamified e-learning environments supports student learning in a science context. As presented in the findings, using a gamified e-learning environment was found to be effective to enhance students' academic achievement as well motivation.

Students' statements show that this environment allowed them to learn science more actively and that the Simple Machines unit, which includes physics topics, was presented more tangibly through this environment. They stated that they better understood related concepts, types of simple machines, and their operating principles in the unit. It is believed that the gamification elements (points, badges, levels, etc.) used in the gamification process, which differ from traditional educational elements, positively affect academic achievement. Similar findings have been obtained in other studies examining the impact of gamification on academic achievement in e-learning environments. Domínguez et al. (2013) reported that students in systems where gamification was integrated achieved higher academic success than those in groups without gamification elements. In two separate studies, Su and Cheng (2013 and 2015) investigated the impact of gamification in mobile learning environments for science education and found that gamification positively influenced learning. Similarly, Ibanez et al. (2014) examined the effects of gamification in coding education and identified positive impacts on learning. However, some studies have shown that gamification has no effect on academic achievement. These findings suggest more focused studies are needed to examine the influence of gamification in e-learning environments, especially in science education.

As seen from the results, an increased motivation observed in students taught by a gamified e-learning environment. Results also suggests that they remained engaged in the gamification process and had the desire to perform the targeted behavior. The interesting finding of this study though was the decrease of motivational scores among students who were in the control group. This may be due to how the current generation perceive things. Today's youths are highly interested in social media and actively use it as a part of their daily life, and they are highly motivated when similar approaches are taken in teaching. However, lack of such an approach may be perceived as a cause for a decrease of motivation as observed in this study. However more studies are needed for a definitive conclusion.

Participants of this study reported that they find learning environments motivating when stories, avatars and scoring approaches are used and they find receiving feedback useful. According to them gamified e-learning environments are fun, instructive, modern, and enjoyable. Any element that can relate to social media is a familiar ground for them and makes learning easy. Competition through scoring systems and using leaderboards has a positive influence on their motivation. Buckley and Doyle (2017) noted that rewards like points in gamified environments enhance extrinsic motivation. Other studies also suggest using gamification elements in learning environments to create positive feelings that enhance student motivation (Hanus & Fox, 2015; Kapp, 2012). Furthermore, gamification allows students to try multiple times without fear or worry about making mistakes, which also boosts their motivation (Lee & Hammer, 2011). Students also mentioned that their family members sometimes thought they were playing games when using gamified e-learning environments. This suggests that while students understood the difference between games and gamification, this distinction was not yet recognized by those around them.

This study is limited to a small group of students and a single unit of science content, simple machines. However, it is believed to have merit considering other studies on gamification and e-learning. This study not only contributes to the field with its results but also with educational materials developed for the purpose of the study. Development of gamified e-learning environments for other science content and examining their effectiveness with larger groups are recommended for future research.

REFERENCES

Aral, N., Gürsoy, F., & Köksal, A. (2001). Okul öncesi eğitiminde oyun. Ya-Pa Yayınları.

Altıparmak, T. (2019). The effects of SCAMPER technique activities in the 8th grade simple machines unit on students' academic achievement, motivation and attitude towards science lessons. Aksaray University, Aksaray.

Baki, A., & Gökçek, T. (2012). Karma yöntem araştırmalarına genel bir bakış. Elektronik Sosyal Bilimler Dergisi, 11(42), 1-21.

Balcı, B. (2011). E-öğrenme sistemindeki başarı faktörleri. G. T. Yamamoto, U. Demiray, & M. Kesim (Eds.), Türkiye'de E-öğrenme (pp. 385-397). Efil Yayınevi.

Bozkurt, A., & Genç-Kumtepe, E. (2014). Oyunlaştırma, oyun felsefesi ve eğitim: Gamification. Akademik Bilişim 2014 (pp. 147-156). Mersin Üniversitesi, Mersin.

Buckley, P., & Doyle, E. (2014). Gamification and student motivation. Interactive Learning Environments, 24(6), 1162-1175. https://doi.org/10.1080/10494820.2014.964263

Clark, V. P., & Creswell, J. W. (2011). Designing and conducting mixed methods research (Vol. 3, pp. 93-94). Sage.

Creswell, J. W. (2014). Qualitative, quantitative and mixed methods approaches: Research design (4th ed.). University of Nebraska, Lincoln.

Creswell, J. W., & Clarck, V. L. (2011). Karma yöntem desen seçimi (Çev. A. Delice). Ankara: Anı Yayıncılık.

Deci, E. L., & Ryan, R. M. (2000). The 'what' and 'why' of goal pursuits: Human needs and the self-determination of behavior. Psychological Inquiry, 1, 227–268. https://doi.org/10.1207/S15327965PLI1104_01

Deterding, S., Sicart, M., Nacke, L., O'Hara, K., & Dixon, D. (2011). Gamification: Using game-design elements in non-gaming contexts. Proceedings of the 2011 annual conference extended abstracts on human factors in computing systems (pp. 2425-2428). ACM.

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in education: A systematic mapping study. Educational Technology & Society, 18(3).

Domínguez, A., Saenz-De-Navarrete, J., De-Marcos, L., Fernández-Sanz, L., Pagés, C., & Martínez-Herrálz, J. J. (2013). Gamifying learning experiences: Practical implications and outcomes. Computers & Education, 63, 380-392. https://doi.org/10.1016/j.compedu.2012.12.020

Erümit, S. F., ve Karakuş, T., 2015, Eğitim ortamlarına yeni bir yaklaşım : Oyunlaştırma. B. Akkoyunlu, & H. F. Aytekin İşman içinde, Eğitim Teknolojileri Okumaları, 2015, Ankara: TOJET, 401s.

Fogg, B. J. (2009). A behavior model for persuasive design. Proceedings of the 4th International Conference on Persuasive Technology (pp. 26-29). California.

Govindasamy, T. (2002). Successful implementation of e-learning: Pedagogical considerations. The Internet and Higher Education, 4, 287-299. https://doi.org/10.1016/S1096-7516(01)00071-9

Hanus, M. D., & Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. Computers and Education, 80, 152-161. https://doi.org/10.1016/j.compedu.2014.08.019

Kapp, K. M. (2012). The gamification of learning and instruction: Game-based methods and strategies for training and education. CA: John Wiley & Sons.

Khan, B. (2000). A framework for web-based learning. Educational Technology Publications.

Lee, J. J., & Hammer, J. (2011). Gamification in education: What, how, why bother? Academic Exchange Quarterly, 15(2), 146-147.

Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. Cognitive Science, 5(4), 333-369.

Malone, T. W., & Lepper, M. R. (1987). Making learning fun: A taxonomy of intrinsic motivations for learning. In Snow, R. E., & Farr, M. J. (Eds.), Aptitude, learning, and instruction (Vol. 3, pp. 223-253). Lawrence Erlbaum Associates.

Moore, J. L., Dickson-Deane, C., & Galyen, K. (2011). e-Learning, online learning, and distance learning environments: Are they the same? Internet and Higher Education, 14, 129-135. https://doi.org/10.1016/j.iheduc.2010.10.001

Özgür, H., 2011, Syracuse Modeli İle E-Öğrenme Ortami İçin Tasarlanmiş Bir Dersin Öğrencilerin Başarisina Etkisi: "Trakya Üniversitesi Eğitim Fakültesi Örneği" . (Unpublished dissertation) Trakya Üniversitesi.

Seaborn, K., & Fels, D. I. (2015). Gamification in theory and action: A survey. International Journal of Human-Computer Studies, 74, 14-31. https://doi.org/10.1016/j.ijhcs.2014.09.006

Simões, J., Redondo, R. D., & Vilas, A. F. (2013). A social gamification framework for a K-6 learning platform. Computers in Human Behavior, 29, 345-353. https://doi.org/10.1016/j.chb.2012.06.007

Su, C., & Cheng, C. (2013). A mobile game-based insect learning system for improving the learning achievement. Procedia - Social and Behavioral Sciences, 42, 42-50. doi:10.1016/j.sbspro.2013.10.305

Su, C. H., & Cheng, C. H. (2015). A mobile gamification learning system for improving the learning motivation and achievements. Journal of Computer Assisted Learning, 31(3), 268-286. https://doi.org/10.1111/jcal.12088

Tu, C. H., Sujo-Montes, L. E., & Yen, C. J. (2015). Gamification for learning. In Papa, R. (Ed.), Media rich instruction (pp. 203-217). Springer International Publishing.

Tuan, H. L., Chin, C. C., & Sheh, W. Y. (2005). The development of a questionnaire to measure students' motivation towards science learning. International Journal of Science Education, 27(6), 634-659. https://doi.org/10.1080/0950069042000323737

Werbach, K. ve Hunter, D. (2012). For the Win: How game thinking can revolutionize your business. Wharton Digital Press.

Yalın, H. İ., Atasoy, B., Uluyol, Ç., Kılıç Çakmak, E., Çakır, H., Ocak, M. A., & Güyer, T. (2008). İnternet temelli eğitim (1st ed.). (H. İ. Yalın, Ed.). Nobel Yayıncılık.

Yılmaz, H., & Çavaş, P. H. (2007). Fen öğrenimine yönelik motivasyon ölçeğinin geçerlik ve güvenilirlik çalışması. İlköğretim Online, 6(3), 430-440. Retrieved from http://ilkogretim-online.org.tr