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The Effect of Gamification on Math Achievement, Motivation, and Learning Strategies in Flipped Classrooms

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ABSTRACT

The aim of this research is to examine the effect of the gamification elements usage in the flipped classroom model on students' academic success, motivation, and learning strategies in the 9th grade mathematics course clusters subject. The method of the study is a quasi-experimental research design with a pretest/post-test control group. The sample of the study comprises 38 vocational high school students who attend 9th grade. The experimental process was conducted for five weeks in the mathematics lesson on "Clusters." Motivated Strategies for Learning Questionnaire (MSLQ) and achievement tests were used as data collection tools. According to the results of the research, while gamification did not make a significant difference in academic achievement and motivation, it caused a significant difference in the elaboration and peer learning dimensions of the learning strategies scale. Although this is not reflected in academic success in the research, it is considered to contribute positively to student performance. In addition, taking the group as the basis instead of the individual in the design of gamification is thought to prevent negativities, such as anxiety and jealousy, that may develop because of gamification, as well as contribute positively to student performance.

Key words: Gamification, Mathematics achievement, Motivation, Flipped classrooms

INTRODUCTION

The rapid change in information and communication technology (ICT) forces learning–teaching processes to change as it does in every field. The reason for this change is not only ICT but also Generation Z students, who are today's students (Rortman, 2016). According to Seemiller and Grace (2017), for Generation Z students to receive quality education, it is important to know their general characteristics. They also state that videos and group work that are to be used in the learning processes of Generation Z will positively affect student engagement. Similarly, Vero and Puka (2017) state that the learning process should provide tools that are creative, stimulating, and applicable to the real life of the student.

In line with these recommendations, Flipped Classroom (FC) offers an important opportunity. FC is defined as a process wherein what needs to be done in the classroom is done at home, and what needs to be done as homework is done in the classroom (Bergmann & Sams, 2012). The starting point of the FC model began in 2007, when Jonathan Bergmann and Aaron Sams, two chemistry teachers living in Colorado, dealt with students who frequently missed classes for various reasons. Bergmann and Sams began recording their lessons and publishing them on YouTube for students to access. Students watching course videos for repetition or preparatory purposes before the exam constitutes an essential stage in the progress of the FC (Bergmann, 2011). Learners using FC can access course content outside of school and conduct homework or activities in the classroom, rather than learning the course subjects just in the classroom and doing homework at home.

Motivation, one of the basic components of quality education, is as essential-as the method used in learning–teaching processes (Palmer, 2007). Gamification in the context of motivation has attracted the attention of the academic world since 2010 (Kim, 2015). Deterding, Dixon, Khaled, and Nacke (2011), to whom the literature commonly attributes the definition of the concept of gamification, express gamification as "the use of game design elements outside the context of the game." Due to this notion, the objective of gamification is not to build a new universe like the one in the game and transport the user there but to adapt the aspects of the game to the real world and capture comparable feelings without abandoning reality (Arkun-Kocadere & Samur, 2016).

The pandemic period that affects the whole world is thought to lead to some permanent changes in learning–teaching processes. The most important of these can be expressed as the greater involvement of distance education in formal education. At this point, the FC model emerges as one of the important alternatives. However, in the implementation of the model, it is very important for the work meant to

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be done at home to be carried out diligently by the students. At this juncture, using gamification to increase student motivation may contribute to the successful implementation of the FC. Therefore, the aim of the study is to examine the effect of the use of gamification elements on students' academic achievement, motivation, and learning strategies in the FC model.

LITERATURE REVIEW

Flipped Classroom

The FC model is one of the innovative learning models in Active Learning Theory (Alsancak & Sırakaya, 2017). In the FC model, asynchronous video lessons and problem-solving activities based on active and group work on the exercise problems given as homework are enabled in the classroom (Bishop & Verleger, 2013). Learners first access information and then work. Thus, classroom time is allocated for discussions, analysis, and problem-solving activities (Youngkin, 2014). The change brought by FC was summarized by Abeysekera and Dawson (2015) as the change in the use of time in the classroom, the use of time outside the classroom, and the realization of activities in the classroom through active learning, collaborative learning, and problem-solving.

Bishop and Verleger (2013) state the two basic elements of FC as in-class activities and outside-of-the-class activities. While video lessons are exemplified as outside activities, active learning activities also constitute in-class activities. Students work on their course content where and when they want, with outside activities based on their learning speed (Kurtz et al., 2014). Active learning processes with in-class activities make students more willing (Sage & Sele, 2015). According to Turan and Göktaş (2014), the preparation of lesson videos imposes an additional burden on teachers, but according to Bishop and Verleger (2013), the use of student-centered learning theories such as problem-based learning, cooperative learning, and peer-assisted learning make the lessons more engaging and permanent. For example, Fredriksen (2020) defined the FC model as a way to make realistic mathematics education applicable to undergraduate courses.

Although Johnson and Renner (2012) stated that FC has no meaningful impact on academic success, and Alten et al. and Kester (2019) argued that it has no impact on student satisfaction, the studies of Cheng et al. (2019) and Akçayır and Akçayır (2018) report FC's positive results in general. Academic achievement and positive attitudes toward the lesson (Pierce & Fox, 2012; Tune et al., 2013; Guo, 2019), motivation increase (Mason et al., 2013; Chen et al., 2014; Thai et al., 2017), development of critical thinking skills (Kong, 2014), increase in student satisfaction (Touchton, 2015; Awidi & Paynter, 2019), positive effect on student–student and student–faculty member interaction (Nwosisi et al., 2016), and students taking responsibility for their own learning (Şengel, 2016) can be given as an example of the positive results of FC applications.

Gamification

According to Zichermann and Cunningham (2011), gamification is the adaptation of game dynamics and system to real-life problem-solving processes. Although gaming is the basis of gamification, the use of game elements integrates it with the learning–teaching process. With the widespread use of technology in recent years, the use of game elements through ICT has come to the fore in the gamification process.

Werbach and Hunter (2012) describe gamification as a structure consisting of three categories: dynamics, mechanics, and components. The dynamics that form the roof of the gamification system are created through mechanics and components. The dynamics of the elements are formed, such as constraints, emotions, progression, narration, and relationships, which are easy to define but not thought to be easy to form. Mechanics are among the dynamics and components in the gamification category, consisting of elements such as chance, competition, cooperation, transactions, feedback, and challenges that carry the action forward and create player loyalty. The components, which are the first stage of gamification, are concrete items, used in games, such as badges, avatars, levels, points, and leaderboards,

Based on a systematic literature review conducted by Zainuddin et al. (2020), gamification may enhance students' motivation and engagement, improve academic performance, promote interaction and socialisation, and offer opportunities for students to develop autonomous learning skills. In addition, Aguiar-Castillo et al. (2020) suggest that gamification can contribute to students' pro-deep-learning approaches, and Putz et al. (2020) draw attention to the positive effect of gamification on knowledge retention. Bai et al. (2020) state their four reasons behind the students' gamification preferences. These include increasing enthusiasm, providing feedback about performance, meeting students' recognition needs, and encouraging goal setting. However, they also emphasize that gamification can cause anxiety or jealousy.

HYPOTHESIS DEVELOPMENT

In gamification studies, the increase in motivation and engagement toward the lesson is expressed as a result of many studies (Jackson & McNamara, 2013; Licorish et al., 2018). In addition, Zou (2020) states that skills, self-confidence, and learning performance have also improved. Because of their systematic literature review, Koivisto and Hamari (2019) express noticeable numbers of opposite results as well as positive results regarding the effectiveness of gamification in general. In light of these results, we put forth our hypothesis that:

- There is a significant difference between the FC group and the gamified FC group in terms of motivation.

It is stated that student performance increases in FC where gamification is applied (Huang & Hew, 2018). The reason for this is the increase in pre-class participation according to Jo et al. (2018), and according to Zauniddin (2018), this is because basic psychological needs such as competence,

autonomy, and relatedness are met. Rashid and Akram (2019) state that high motivation shows a significant positive correlation with all learning strategies except for "seeking help" and that medium and low motivation levels show a positive significant correlation with learning strategies other than "effort regulation." In this context, we hypothesize that:

- There is a significant difference between the FC group and the gamified FC group in terms of learning strategies.

According to Fanelli (2013), Buckley and Doyle (2014), and Yildirim (2017), gamification-based teaching embraces have a favourable effect on achievement among students. According to Özdener (2018), while gamification does not show significant improvements in achievement in school, it does have a good influence on students spending more time with course materials. Similarly, Çakıroğlu et all. (2017) state that gamification increases academic achievement because it positively affects students' course engagement. In this context, we hypothesize that:

- There is a significant difference between the FC group and the gamified FC group in terms of academic achievement.

METHOD

Research Design

The aim of this research is to explore the effect of the use of gamification elements in the FC model on students' academic success and learning strategies in the 9th grade mathematics course clusters subject. The method of the study is a quasi-experimental research design with a pretest/posttest control group.

Participants

The participants of the study comprise 38 Vocational High School students who attended 9th grade. The experimental process was conducted for five weeks in the fall semester mathematics course of the 2019–2020 academic year on the "Clusters" subject. A total of 20 students participated in the experimental group (gamified FC) and 18 students in the control group (FC). The experimental group had 9 female students and 11 male students, while the control group included 6 female students and 12 male students.

Research Instruments and Processes

The experimental process took five weeks, including the first week of introduction. A total of 7 lecture videos with an average duration of 3 minutes were shared with students each week through WhatsApp groups and the education information network EBA. To understand whether the students in the experimental and control groups watched the videos during application of the lesson, the students were asked questions. Students who did not watch the videos were included in the activities after watching the videos in a separate place in the classroom. In the experimental process, groups of 4–5 people were formed to carry out classroom activities. Groups tried to resolve/work on activities called "Dessert making," "Selfie," "Cells," and "Parent meeting."

Gamification elements were used in the experimental group. Watching a course video is defined as 2 points, attendance in the course is defined as 1 point, working to complete the event is defined as 2 points, and diligently working to complete the event is defined as 3 individual points. In addition, when the activity was completed successfully, 4 points were given to each group. The sum of individual scores and activity completion scores constitutes the group score. The improvement in individual and group scores is visualized with the progress bar prepared with Google Sheet. Individual scores are prepared, such that only the student can see, and they are only shared with the student. This post also includes comments on the development of the student. The progress of the group was shared with all students on a leaderboard prepared using Google Documents. A quiz was prepared at the end of the experimentation. The quiz was formulated on paper in the control group, and quiz-based learning platform Kahoot was used in the experimental group.

The main difference between the experimental and the control groups is the gamification activities applied as an intervention program. The points and leaderboard were used at all stages of the research process. This way, it is aimed to reach competition, reward, cooperation, and feedback mechanics. However, the use of group points is considered important in reducing the negative impact of competition and increasing the function of cooperation mechanics.

First research instrument

The "Motivated Strategies for Learning Questionnaire (MSLQ)" developed by Pintrich et al. (1993) was adapted into Turkish by Karadeniz et al. (2008). The MSLQ is a combination of motivation and learning strategies scales. The motivation scale consists of six subscales and the learning strategies scale consists of nine subscales. The MSLQ scale uses a 7-point Likert type rating ranging from "Not at all true for me" (1) to "Very true of me" (7). This scale has a modular structure, and the points to be obtained from each of the sub-factors can be used separately, depending on the purpose of use of the practitioner.

Second research instrument

"Scale of Determining Learning Situations About Clusters", developed by Uğurel and Moralı (2010) was used to measure the academic achievement levels of students within the scope of the study. The achievement test consists of 49 items developed on the basis of the achievements of the clusters sublearning area in the mathematics curriculum and Bloom taxonomy.

Data Analysis

Shapiro-Wilk test was performed to check whether the data were normally distributed. Due to the fact that the data did not have a normal distribution according to the test results ($p<.05$), Mann Whitney-U test and Wilcoxon non-parametric tests were used to analyze the data. The effect size of the factors showing a significant difference was calculated

using the formula of Z value divided by the square root of the sample number (Pallant, 2016).

Ethics

The research was approved by Aydın Adnan Menderes University Educational Research Ethics Committee (reference number: 08.04.2019, 84982664-050.01.01/22822).

RESULTS

In terms of academic achievement, motivation, and learning strategies, there is no significant difference between the experimental and control groups' pretest scores. In other words, it is reasonable to conclude that the experimental and control groups were almost similar. Under subheadings, the results for motivation, learning strategies, and academic achievement are presented individually.

Motivation

The results of the Mann–Whitney U test conducted to find out whether there is a significant difference between post-test scores on the motivation scale of the students in the experimental and control groups are given in Table 1.

The findings of the motivation scale post-test scores of the experimental and control groups are presented in Table 1, and there is no significant difference among the groups in any factors of the scale ($p > .05$). In other words, it can be mentioned that the experimental process does not change the motivation of the students.

Learning Strategies

Table 2 shows the results of the Mann-Whitney U test performed to determine whether there is a significant difference between the experimental and control group students' learning strategies scale post-test scores.

According to Table 2, where the comparison results are presented according to the factors of the learning strategies scale, elaboration ($U = 103.50$, $p = .025$, $r = .36$) and peer learning ($U = 108.50$, $p = .036$, $r = .34$), it is seen that there is a significant difference in favor of the experimental group ($p < .05$). The effect size of both factors showing a significant difference was found to be .364 for elaboration and .341 for the peer learning. In this context, a moderate effect size is seen in the elaboration and peer learning dimensions.

Academic Achievement

Table 3 provides the test results, which were utilised to de-termine whether there is a significant difference between the academic achievement post-test scores of the experimental and control groups of students.

Although the average of the experimental group rank scores, when compared with that of the academic achievement post-test scores given in Table 3, was 5.86 points higher, this difference was found not to be significant. In other words, the experimental process did not make a difference in the participants' academic achievement ($p > .05$).

DISCUSSION

Academic achievement increase is indicated by Gündüz and Akkoyunlu (2020), Zou (2020), and Uz Bilgin and Gül (2020) in their studies that cover flipped classrooms and gamification. In addition, Tenorio et al. (2016) report that it significantly reduces the time for students to complete their homework, and the use of gamification increases the entry of students into the system by 64% and the number of written reports by 11%. Nevertheless, the experimental process did not make a significant difference in academic achievement. At this point, the bias formed by the sample of students with low academic success can be expressed as the reason for which the experimental process does not make a difference in academic success, on the basis of the observations of the

Table 1. Motivation scale post-test scores test results

Factors	Groups	N	Mean Rank	Sum of Ranks	U	p
Instrinsic goal orientation	Experimental	20	18.38	367.50	157.50	0.509
	Control	18	20.75	373.50		
Extrinsic goal orientation	Experimental	20	21.15	423.00	147.00	0.328
	Control	18	17.67	318.00		
Task value beliefs	Experimental	20	19.48	389.50	179.50	0.988
	Control	18	19.53	351.50		
Control beliefs for learning	Experimental	20	20.88	417.50	152.50	0.414
	Control	18	17.97	323.50		
Perceptions of self-efficiacy	Experimental	20	19.85	397.00	173.00	0.838
	Control	18	19.11	344.00		
Test anxiety	Experimental	20	19.18	383.50	173.50	0.849
	Control	18	19.86	357.50		

Table 2. Learning strategies scale post-test results

Factors	Groups	N	Mean Rank	Sum of Ranks	U	p
Rehearsal	Experimental	20	20.90	418.00	152.00	0.411
	Control	18	17.94	323.00		
Organization	Experimental	20	21.68	433.50	136.50	0.202
	Control	18	17.08	307.50		
Elaboration	Experimental	20	23.33	466.50	103.50	0.025
	Control	18	15.25	274.50		r=0.364
Critical thinking	Experimental	20	21.93	438.50	131.50	0.156
	Control	18	16.81	302.50		
Metacognitive self regulation	Experimental	20	21.90	438.00	132.00	0.160
	Control	18	16.83	303.00		
Help Seeking	Experimental	20	21.55	431.00	139.00	0.228
	Control	18	17.22	310.00		
Effort Management	Experimental	20	19.80	396.00	174.00	0.859
	Control	18	19.17	345.00		
Peer Learning	Experimental	20	23.08	461.50	108.50	0.036
	Control	18	15.53	279.50		r=0.341
Time and Study Environment Management	Experimental	20	19.15	383.00	173.00	0.837
	Control	18	19.89	358.00		

Table 3. Achievement post-test results

Groups	N	Mean Rank	Sum of Ranks	U	p
Experimental	20	22.28	445.50	124.500	0.101
Control	18	16.42	295.50		

researchers. Also, Sanchez et al. (2020) state that the effects of gamification last for a short period of time and can only be beneficial for higher performing individuals. In addition, Kyewski and Kramer (2018) state that gamification has less effect on motivation and performance than is generally assumed to be the case. De-Marcos, Garcia-Lopez, and Garcia-Cabot (2016) state that the positive effect of gamification diminishes after five weeks.

Zainuddin et al. (2019) express the positive effect of gamification on motivation as being due to meeting the innate psychological need for competence, autonomy, and relationship. In addition, Zou (2020) and Aşıksoy (2018) report similar results. However, Sailor et al. (2017) state that gamification alone will not meet psychological needs and that certain game design elements have certain psychological effects. According to Mekler et al. (2017), game elements do not have a significant effect on competence or intrinsic motivation. In other words, score, level, and leaderboard are external motivators and only affect the quality of performance positively. In the current study, a similar result was encountered when the experimental process was evaluated in the context of motivation. However, this result is similar to the positive but indirect effect of gamification on application-oriented information as stated by Sailer and Sailer (2020).

This similarity can be explained by a significant difference in favor of the experimental group in the elaboration and peer cooperation factors of the learning strategies scale according to the post-test scores of the experimental and control groups. Elaboration, according to Pintrich (2003), is a cognitive strategy that includes skills such as summarizing and interpreting and is more complex than repetition. Weinstein and Mayer (1986) state that the elaboration strategy includes activities such as explaining, summarizing, creating analogies, productive notetaking, and answering questions. They explain that the aim of these activities is to integrate new knowledge with what is existing. In other words, this goal is to transfer information from long-term memory to working memory and to integrate it with new information. Weinstein et al. (2011) state that the simplest form of elaboration is explanation and summarization. More elaborate types of elaboration, on the other hand, necessitate greater cognitive effort and more complex thought processes. As a result, greater knowledge and more accessible memory structures are obtained for both simple memory tasks and higher-level thinking tasks such as problem solving, application, and analysis. Peer learning, on the other hand, refers to learning with the help of friends or a study group. According to Boud et al., Cohen, and Sampson (1999), peer learning is vital for the formation of lifelong learning skills, such as collaboration, reflection, exploration of ideas, communication, and learning to learn. Lisi (2002) stated that the primary purpose of peer learning is the development of academic skills, such as listening and communication, as well as the development of in-depth learning through discussion and exchange of ideas. In this context, both factors with significant differences are considered quite important. Although

research results do not indicate a significant difference in academic achievement, a significant difference in elaborating and peer learning contributes to achieving or motivating academic success.

In addition, designing gamification activities on a group basis rather than on an individual one, in order not to cause an unnecessary competition, is thought to directly contribute to the results of this research work. Each student received points for their activities; however, these scores were awarded only as feedback to the students themselves. The total score of the students in the groups was determined to be the group score, and the group scores were shared with the class. Therefore, group scores are thought to have a beneficial impact on elaboration and peer learning. This positive effect is thought to cause students to be active in group activities and to contribute positively to the elaboration dimension. Considering the peer learning dimension, as suggested by Gündüz and Akkoyunlu (2020), students with low engagement can be persuaded to participate in activities using gamification strategies. Uz Bilgin and Gül (2020) emphasize the positive effect on group harmony scores. On the elaboration dimension, the study findings are consistent with the conclusion of Lo and Hew (2020) that gamified FC promotes cognitive interaction better than the other two approaches do, according to traditional learning and online independent study. In addition, Huang, Hew, and Lo (2019) state that students in the FC learning group developed with gamification produced higher quality works in pre-class thinking activities than those in the nongamified FC learning group did. The result of the study shows that a similar situation may occur not only in pre-class activities but also in classroom activities.

Based on the researchers' classroom experiences, it can be claimed that new tasks excite students and that although they are in an environment with a new school and new friends, their peer relationships are positively affected, and they are happy with their scores. The fact that students are eager and excited to attend the lesson is another indicator that they enjoy the process being implemented. Thus, it can be stated that the positive communication process and the targeting of group success positively affect participation in classroom activities. Therefore, Morschheuser et al.'s (2019) finding that competitive gamification design between teams ranks first in terms of enjoyment and participation, and recommendability is a point to be considered in the development of gamification practices in education.

CONCLUSION

According to the results, gamification did not affect academic achievement and motivation significantly but caused a significant difference in the two factors of learning strategies: elaboration and peer learning. The significant difference observed in the elaboration dimension has a positive impact on students' cognitive skills. Similarly, the significant difference observed in the peer learning dimension positively affects social skills, such as communication and cooperation. This social impact positively affects student performance. In addition, the fact that this contribution is presented in a sample with low academic success is an important result in determining the effect of gamification on student performance. The gamification design in the experimental process is important in the formation of this significant difference. During the research work, group results were emphasized instead of individual results so as not to cause negative feelings, such as anxiety and jealousy, that gamification can cause.

The study was carried out with a small group of students with low academic achievement. First, similar studies can be repeated with larger samples. In addition, it is recommended that experimental studies with different K-12 groups reveal the effects of gamification. However, Huang et al. (2020) state that different gamification components have different effects on learning outcomes. Considering that only points and leaderboards are used in this research study, it may be recommended that research be conducted to determine the effects of gamification elements more clearly. The effect of gamification elements on students' performance can be studied using data collection methods, such as focus group interviews. In addition, considering the criticism of gamification, studies comparing the results of gamification activities for groups and individuals contribute to the literature.

Although gamified FC did not make a significant contribution to students' academic achievement or motivation, it made a significant difference in their learning strategies. The effect of group activities on this contribution should not be ignored. In addition, group activities will play an important role in preventing competition that may occur due to gamification. In that sense, interaction and cooperation through group activities make learning processes more enjoyable and positively affect student engagement.

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