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The Effects of Activities Enriched with Game Elements in Mathematics Lessons

Los efectos de las actividades enriquecidas con elementos de juego en las lecciones de matemáticas

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ABSTRACT

Differentiated instruction is a form of teaching. The content, processes, products, or learning environment can be differentiated with respect to students' readiness to learn, interests, and learner profiles. Enrichment, one of the differentiation strategies, can be described as the student's intensive work on any subject or area. Using game elements can also impact students' achievement, mathematics attitude, and motivation. The aim of this study was to investigate the influence of activities enriched with game elements on students' learner profiles in mathematics lessons and their achievement, motivation, and attitudes. This current study used the quantitative quasi-experimental approach with 24 6th-grade students during two weeks. The Learner Profile Scale was used on the students and then mathematics activities with game elements were prepared for experimental group. An Academic Achievement Test and Attitude and Motivation Towards Mathematics Scales were used as data collection tools before and after the implementation of activities enriched with game elements. Mann Whitney U Test is used to analyse the differences between experimental and control group. Wilcoxon Signed Rank Test is used to analysed the difference pre- and post-test both experimental and control group. According the result significant point for students' academic achievement, motivation and attitude is found as .229, .002 and .043 respectively. Effect size is calculated for students' academic achievement, attitudes and motivation as .34, .58 and .58 respectively. As a result of this study, the use of enriching game elements had positive and larger effect on students' motivation, and attitude in mathematics lessons. Although the differences between experimental and control group is not found significantly for the student's achievement, there is a difference between pre- and post-test and the size of effects is calculated as medium. Hence, the educational gamify activities should be design by considering the students' types.

KEYWORDS Differentiated instruction; gamification; mathematics teaching; player type.

RESUMEN

La instrucción diferenciada es una forma de enseñanza. El contenido, los procesos, los productos o el entorno de aprendizaje se pueden diferenciar con respecto a la disposición para aprender, los intereses y los perfiles de aprendizaje de los estudiantes. El enriquecimiento, una de las estrategias de diferenciación, se puede describir como el trabajo intensivo del estudiante en cualquier materia o área. El uso de elementos del juego también puede afectar al rendimiento, la actitud matemática y la motivación de los estudiantes. El objetivo de este estudio fue investigar la influencia de las actividades enriquecidas con elementos de juego en los perfiles de aprendizaje de los estudiantes en lecciones de matemáticas y su rendimiento, motivación y actitudes. Este estudio utilizó el enfoque cuasi-experimental cuantitativo con

24 estudiantes de sexto grado durante dos semanas. Se utilizó la Escala de Perfil de Aprendiz en los estudiantes y luego se prepararon actividades matemáticas con elementos de juego para el grupo experimental. Se utilizó un Test de Rendimiento Académico y Escalas de Actitud y Motivación hacia las Matemáticas como instrumentos de recolección de datos antes y después de la implementación de actividades enriquecidas con elementos lúdicos. La prueba U de Mann Whitney se utiliza para analizar las diferencias entre el grupo experimental y el de control. La prueba de rango con signos de Wilcoxon se utiliza para analizar la diferencia antes y después de la prueba, tanto en el grupo experimental como en el de control. Según el resultado, el punto significativo para el rendimiento académico, la motivación y la actitud de los estudiantes se encuentra en .229, .002 y .043 respectivamente. El tamaño del efecto se calcula para el rendimiento académico, las actitudes y la motivación de los estudiantes como .34, .58 y .58 respectivamente. Como resultado de este estudio, el uso de elementos de juego enriquecedores tuvo un efecto positivo y mayor en la motivación y actitud de los estudiantes en las lecciones de matemáticas. Si bien las diferencias entre el grupo experimental y el de control no fue significativa para el rendimiento de los estudiantes, existe una diferencia entre el pre y post test con un tamaño de los efectos medio. Por lo tanto, las actividades educativas de gamificación deben diseñarse considerando los tipos de estudiantes.

PALABRAS CLAVE Enseñanza de las matemáticas; instrucción diferenciada; ludificación; tipo de jugador.

1. INTRODUCTION

Games may be older than culture and playing games in itself presuppose the existence of a society (Huzinga, 1955). A number of significant philosophers agree that games have been an important phenomenon in learning and teaching throughout human history (Sezgin, 2016). It can thus be claimed that game-playing is a very ancient aspect of society. According to Huzinga (1955), play is a voluntary activity, and universal. Suits (1967) defined a game as a voluntary activity designed to overcome inessential obstacles. Because games are voluntary activities, they may affect participants' happiness, motivation, and creativity, and also increase achievement in an academic context. It has been pointed out that gamification, which is using game elements in non-gaming contexts, can enhance an individual's experiences and sense of belonging (Deterding et al., 2011; Domínguez et al., 2013; Hanus, & Fox, 2015; Karataş, 2014; Kim, & Lee, 2015; Yıldırım, & Demir, 2014; Werbach, 2013). Challenges, rewards, levels, and point-scoring are examples of some "game elements" (Toda et al., 2019). It is important to make the learning process a journey; this can be done by using gamification to promote motivation and commitment in order to provide the conceptual understanding and ensure that learning experiences are deep and sustainable (Sezgin et al., 2018).

Previous studies of "gamification" in education focused on students' motivation and attention in lessons (Abramovich et al., 2013; Alsawaier, 2018; Bayram, & Çalışkan, 2019; Bell, 2014; Harrold, 2015; Meşe, & Dursun, 2018). Although gamification uses game elements, Buckley and Doyle (2016) stated that gamification has negative effects when it is considered solely as a process that motivates students by using "rewards". Similarly, some studies have shown that using "points" or "badges" has negative effects on students' motivation (Hakulinen et al., 2015; Hanus, & Fox, 2015). Gamification, on the other hand, tends to adapt the system to the users' desires, goals, and personalities (Bergmann et al., 2017). Players' interests, willingness to participate, and opinions cannot be ignored. Santos et al. (2021) argued that the gamification design should be considered as user types. This is why game elements should be selected with reference to the target audience. In this way, any gamification in education should be adapted to student's needs, goals, and characteristics because the target audience is students in a school environment. Since the players are students in a classroom, the students' "player types" need to be determined in order to select appropriate game elements. However, the current player types scales are not able to fully represent the student's profile in the class. If a player type scale is used to determine a player's type with regard to game-playing, a learner profile scale should also be used to identify how students function in the school environment. The learning environment can thus be designed to meet the individual student's needs, interests, and specific learner profile.

Differentiation is one of the most effective methods to meet students' individual needs. Differentiated instruction is based on addressing students' readiness to learn, interests, and learning profiles using differentiated content, products, or learning environments (Tomlinson, 2001). Differentiation consists of several components. In this study, "enrichment" was used as a component of differentiation. Enrichment can be expressed as an optional practice that can be used to prevent students from losing attention to the content they already know (Cutts, & Moseley, 2001). Thus, it was expected that it would have a positive effect on students in this study. It was considered that identifying appropriate game elements according to students' needs and personalities and enriching lessons with these elements would have positive effects.

This study investigated the effect of mathematics activities enriched with game elements (MAEGEs) on middle-school students' mathematics achievement, motivation, and attitudes towards mathematics lessons. It was necessary to know the students' player types in order to select the appropriate game elements that would motivate them. However, since the player type scale (Andersen, & Downey, 2001) relate to online games and the questions are related to these kinds of games, the student's responses to the questions may not have reflected their profile. For this reason, using any player type scale for games in Education was not considered sufficient to determine the students' player types for each participant in education. For this reason, the Learner Profile Scale (Galiç, & Yıldız, 2020) was used to determine the students' player types in the school environment. Learner Profile Scale determines students' player types without using the player types scale in order to prepare gamification activities according to the target audience's player types. Learner Profile Scale can be used in gamification applications in education during the design of the activities. Also, it can be used to determine the students' profiles to identify them or follow their academic development. The Learner Profile Scale is associated with Bartle's player types:

1. *Achievers* are interested in acting in the world. The game is a stimulating environment for them to succeed in something.
2. *Explorers* are interested in interacting with the world. They want to keep following the sense of wonder during the game. Other players are not interested in the game unless there is a resource to discover.
3. *Socializers* are interested in interacting with other players. They usually want to communicate with others, meet people, and know more about them. The game is just a tool to interact with the players.
4. *Killers* are interested in acting with the players. They want to show their superiority over others to feel better. The game is not fun unless it affects a real person for them.

There are several game elements to motivate players according to their player type such as collecting, power, research, levels for achievers; imagination, learning, and completing for explorers; collaboration, communication, role-playing for socializers and competitions, challenges, and strategy for killers.

The purpose of the study was to investigate the effects of MAEGEs selected with respect to students' player types as identified by the Learner Profile Scale on the student's achievement, motivation, and attitudes toward mathematics lessons. The following three research questions were answered in the study:

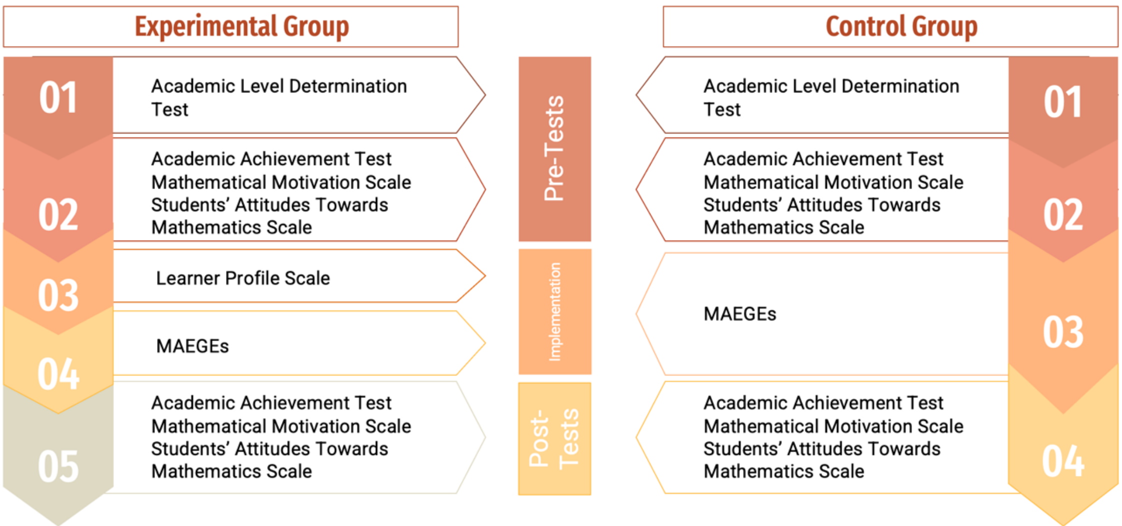
1. What is the effect of activities enriched with game elements on students' achievement in mathematics lessons?
2. What is the effect of activities enriched with game elements on students' motivation toward mathematics lessons?
3. What is the effect of activities enriched with game elements on students' attitudes towards mathematics lessons?

2. MATERIAL AND METHOD

2.1. Research Design

This current study used the quantitative quasi-experimental approach. The matching-only design group was used from among the quasi-experimental designs because of non-randomization. In this design "the researcher still matches the subjects in both groups on certain variables'' (Fraenkel, & Wallen, 2003). One of the researchers was the mathematics teacher of the experimental group. Another class from the same school was assigned as the control group because the students were at the same academic level as the experimental group. Each group was formed of 6th-grade students. The path of the study is given in Figure 1.

FIGURE 1. Path of the study



Although there was no randomization, the Academic Level Determination Test (ALDT) was performed with both groups to ensure that the mathematics academic level of the groups was equal. For this purpose, the ALDT was analyzed using the Mann-Whitney U Test. The result of the ALDT analysis is given in Table 1.

TABLE 1. Mann-Whitney U Test Analysis of Academic Level Determination Test

Groups	Measurement	N	X	U	z	p
Experimental Group	ALDT	12	14.08	53.000	-1.108	.268
Control Group		12	10.92			

As seen in Table 1, there was no significant difference between averages of the experimental (14.08) and control group (10.92) ($p(24) = .268$; $p > 0.05$). This result proved that there was no difference between groups before the implementation according to their academic level in mathematics. Thus, nonrandomization did not affect the implementation and the results of this study. To determine the appropriate game elements, the learner profiles of the students in the experimental group needed to be identified. The Learner Profile Scale was therefore applied to the students (Galiç, & Yıldız, 2020). The experimental group was found to be made up of students with the following player types: 40 % "Killers", 30 % "Achievers", 20 % "Socializers", and 10 % "Explorers". MAEGEs were designed according to the results of the scale. Two of these activities are given in Table 2.

TABLE 2. Two Examples of Mathematics Activities during Implementations

Activity	Learning Outcomes	Game Elements	Duration
Relay Race	Operations with Fractions	Collaboration Competition	20 min
Where is the Place?	Operations with Fractions	Challenges Mission	40 min

When the age of the students in this study was considered, it was felt that applying all pre-tests on the same day may affect the results. Therefore, the pre-tests were planned for different days, but the same tests were applied to both groups on the same day. The Mathematics Motivation Scale (Aktan, & Tezci, 2013) and the Students' Attitude Towards Mathematics Scale (Önal, 2013) was first applied on the same day to both groups, while the Academic Achievement Test was applied on the next day. After the pre-test, MAEGEs was implemented for two weeks in the experimental group. Each activity was about a fraction unit. The post-test was applied after the implementation.

Ethical approval for this study was obtained from Hacettepe University Ethics Committee (35853172-300 on 21.01.2020).

2.2. Participants

Twenty-four 6th-grade students participated in this study. The participants are shown in Table 3.

TABLE 3. Participants

Group / Gender	Female	Male	Total
Experimental Group	5	7	12
Control Group	9	3	12
Total	**14**	**10**	**24**

2.3. Instruments

The Learner Profile Scale (Galiç, & Yıldız, 2020), the Academic Achievement Test, the Academic Level Determination Test (ALDT), the Mathematics Motivation Scale (Aktan, & Tezci, 2013), and the Students' Attitudes Towards Mathematics Scale (Önal, 2013) were used to collect quantitative data. To determine whether there had been any change or not, these scales were applied before and after the implementation of MAEGEs.

2.3.1. Academic Level Determination Test

The ALDT was designed by the researchers to evaluate the academic level of the experimental and control group before implementation. Each question was selected as related to topics in the units. Students had previously taken in the semester before they began the unit on fractions. The test included 10 questions designed with reference to the related literature. These questions were chosen from sample questions in national and international exams in order to ensure reliability and validity. Each question scored 10 for the correct answer and 0 for the wrong answer. The highest obtainable score for the scale was 100, while the lowest was 0.

2.3.2. Learner Profile Scale

The aim of this scale, which was developed by Galiç and Yıldız (2020), is to identify the learner profile of any person or group. It has 35 items on a 5-point Likert-type scale. The Learner Profile Scale identifies seven specific profiles: reflector (six items), inquirer (five items), collaborator (three items), researcher (four items), problem-solver (four items), and self-confidence (two items). The score for each item is between 1 and 5. The Cronbach's alpha coefficient of the scale was .912.

2.3.3. Academic Achievement Test

To assess the student's academic achievement with regard to the "fractions'' unit, the Academic Achievement Test was developed by researchers. The Academic Achievement Test was applied to the control and experimental groups before and after the implementation of MAEGEs. The test included 10 questions designed with reference to the related literature. These questions were chosen from sample questions in national and international exams in order to ensure reliability and validity. Each question scored 10 for the correct answer and 0 for the wrong answer. The highest obtainable score for the scale was 100, while the lowest was 0.

2.3.4. Mathematical Motivation Scale

The aim of this scale, which was developed by Aktan and Tezci (2013), is to determine middle-school students' motivation toward mathematics. It has 27 items and is a 5-point Likert-type scale. The internal consistency of this scale is between .84 and .94 and the item-total correlation is between .62 and .89.

2.3.5. Students' Attitudes Towards Mathematics Scale

The aim of this scale, which was developed by Önal (2013), is to determine students' attitudes toward mathematics This scale consists of four factors such as interest, anxiety, study, and necessity. It has 22 items in a form of a five-point Likert scale. The Cronbach's alpha coefficient was .90. Items are pointed between 1 and 5. Thus the score on this scale can get the highest 110 and the lowest 22 points.

2.4. Data Analysis

Since the number of participants is lower than 30, the assumptions of normal distribution was not provided. Therefore, Mann-Whitney U test is used to analyse the non-normal continuous data for the differences between two independent groups At the beginning of the implementation, the Mann-Whitney U test was applied to the ADLT to observe the differences between the groups. The Mann-Whitney U test is used when the researcher wishes to analyze ranked data for nonparametric tests (Fraenkel, & Wallen, 2003). The effect size shows the size of the differences between groups to comprehend the result (Cohen, 1992). Hence, the effect size is calculated for each problem question. According to Cohen (1992), the criteria for effect size is given as following. If effect size is:

- less than 0.3 then it has a small effect
- between 0.3 and 0.5 then it has a medium effect
- greater than 0.5 then it has a large effect

Before the implementation, the Academic Achievement Test, Mathematics Motivation Scale, and Students' Attitude Towards Mathematics Scale were applied to each group. The differences between pre- and post-test should be important to analyze in both experimental and control group. The Wilcoxon signed-rank test is used since the data for pre- and post-test was from dependent samples which is defined ranoomly and data are the non-normal continuous . The same process was repeated for the control group and experimental group individually. Data were tested at a .05 level of significance in this study.

3. RESULTS

This study investigated the effect of MAEGEs on students' achievement, attitudes, and motivation in mathematics lessons. In this section findings related to each research, and the problem is presented.

3.1. The Effects of MAEGEs on Students' Academic Achievement

To assess the students' prerequisite knowledge and readiness to learn, the Academic Achievement Test was applied. The Mann-Whitney U test was used to analyze data. No significant difference between the groups was observed in the ALDT. The results are given in Table 4.

TABLE 4. Mann-Whitney U Test Analysis of Pre-test of Academic Achievement

Groups	Measurement	N	X	U	z	p
Experimental Group	AAT Pre-test	12	12.00	78.000	.353	.724
Control Group		12	13.00			

As seen in Table 4, there was no significant difference between the average scores of the experimental group (X=12.00) and the control group (X=13.00) (p(24)=.724; p>0.05). According to this result, the student's academic achievement in both groups was equal. Therefore, it can be argued that any future differences between groups were likely to relate to the implementation.

The Academic Achievement Test was given to both groups after implementation to examine the effect of the MAEGEs on the student's achievement in mathematics. The result of the Wilcoxon signed-rank test for each group is given in Table 5.

TABLE 5. Wilcoxon Signed-rank Test Analysis of the Academic Achievement Test (AAT)

Groups	Measurement	N	X	Sd	p
Experimental	AAT Pre-Test	12	50.83	17,30	.004
	AAT Post-Test	12	81.67	16,42	
Control	AAT Pre-Test	12	54.17	20,66	.016
	AAT Post-Test	12	74.17	15,05	

In Table 5 the average scores for the Academic Achievement Test which was performed with both groups are given as both pre-and post-test. There was a significant difference between the pre-test (X=50.83) and the post-test (X=81.67) in the average scores of the experimental group (p(12)=.004; p<0.05). Similarly, there was a significant difference between the pre-test (X=54.17) and post-test (74.17) in the control group (p(12) = .016; p<0.05). This result shows that the MAEGEs and lecture-based mathematics lessons contributed significantly to the student's academic achievement. Therefore, to answer the first research question: MAEGEs positively affected the student's academic achievement in mathematics.

Table 6 shows the results of data analysis to examine the difference between both groups with regard to the student's academic achievement.

TABLE 6. Mann-Whitney U Test analysis of Post-test of Academic Achievement Test (AAT)

Groups	Measurement	N	X	U	Z	p
Experimental Group	AAT Post Test	12	14.21	51.500	-1.202	.229
Control Group		12	10.79			

Table 6 shows the results of students' academic achievement after the implementation of the MAEGEs and lecture-based mathematics lessons. According to Table 5, there was a difference between the average of the experimental group (X=14.21) and the control group (X=10.79) yet this difference was not significant (p(24)= .229; p>0.05). This result shows that the MAEGEs contributed to students' academic achievement at least in the lecture-based mathematics lessons. Since the effect size is calculated as 0.34, MAEGES can be interpreted as have a medium effect on student's academic success.

3.2. The Effects of MAEGEs on Students' Motivation

To determine students' motivation toward mathematics lessons in experimental and control groups, the Mathematical Motivation Scale was applied before the implementation. The results are given in Table 7.

TABLE 7. Mann-Whitney U Test analysis of the Pre-test of Mathematical Motivation Scale (MMS)

Groups	Measurement	N	X	U	z	p
Experimental Group	MMS Pre-test	12	14.12	52.500	-1.129	.259
Control Group		12	10.88			

As seen in Table 7, there was no significant difference between the averages of the experimental group (X=14.12) and the control group (X=10.88) (p(24)=.259; p>0.05). According to this result, the student's motivation in both groups was equal. Therefore, it can be argued that any possible differences between groups would be related to the implementation.

The Mathematical Motivation Scale was applied to the experimental and control group after implementation to examine the effect of the MAEGEs on the student's motivation toward mathematics lessons. The result of the Wilcoxon signed-rank test is given in Table 8.

TABLE 8. Wilcoxon Signed-rank Test Analysis of Mathematical Motivation Scale (MMS)

Groups	Measurement	N	X	Sd	p
Experimental Group	MMS Pre-test	12	55.67	8.24	.002
	MMS Post-test	12	107.92	11.26	
Control Group	MMS Pre-test	12	53.17	5.37	.002
	MMS Post-test	12	99.50	10.01	

Table 8 shows the averages for the Mathematical Motivation Scale both before and after implementation. There was a significant difference between the pre-test (X= 55.67) and post-test (X=107.92) in the averages of experimental group (p(12)= .002; p<0.05). Similarly, there was a significant difference between the pre-test (X=53.17) and post-test (X=99.50) in the control group (p(12)= .002; p<0.05). This result shows that MAEGEs and lecture-based mathematics lessons contributed significantly to students' motivation toward mathematics lessons.

Table 9 shows the result of data analysis to investigate the difference between groups in terms of students' motivation toward mathematics lessons after the implementation.

TABLE 9. Mann-Whitney U Test Analysis of Post-test of Mathematical Motivation Scale (MMS)

Groups	Measurement	N	X	U	z	p
Experimental Group	MMS Post-test	12	15.42	37.000	-2.026	.043
Control Group		12	9.58			

As seen in Table 9, there was a significant difference between the averages of the experimental group (X=15.42) and the control group (X=9.58) (p(24) = .043; p<0.05). This result shows that MAEGEs contributed to students' motivation toward mathematics lessons more than lecture-based mathematics lessons. Since the effect size is calculated as 0.58, MAEGES can be interpreted as have a large effect on student's motivation.

3.3. The Effects of MAEGEs on Students' Attitude

To determine the students' attitudes towards mathematics lessons, the Students' Attitudes Towards Mathematics Scale was applied to both groups before the implementation. The results are given in Table 10.

TABLE 10. Mann-Whitney U Test Analysis of Pre-test of Students' Attitudes Towards Mathematics Scale (SATMS)

Groups	Measurement	N	X	U	z	p
Experimental Group	SATMS Pre-test	12	13.42	61.000	-.635	.525
Control Group		12	11.58			

As seen in Table 10, there was no significant difference between the average of the experimental group (X=13.42) and the control group (X=11.58) (p(24)= .525; p> 0.05). According to this result, the experimental and control groups were equal with regard to the students' attitudes towards mathematics lessons. Thus, it can be argued that any possible differences between the groups after the application of MAEGEs would be related to the implementation.

The Students' Attitudes Towards Mathematics Scale has applied again to the experimental and control groups after the implementation to examine the effect of the MAEGEs on the students' attitudes towards mathematics lessons. Table 11 shows the results of the Wilcoxon signed-rank test for each group.

TABLE 11. Wilcoxon Signed-rank Test Analysis of Students' Attitudes Towards Mathematics Scale (SATMS)

Groups	Measurement	N	X	Sd	P
Experimental Group	SATMS Pre-test	12	48.33	12.42	.003
	SATMS Post-test	12	88.64	15.74	
Control Group	SATMS Pre-test	12	44.42	11.48	.002
	SATMS Post-test	12	78.23	14.28	

Table 11 presents the averages for the Students' Attitudes Towards Mathematics Scale both before and after the implementation. According to the results, there was a significant difference between the averages of the experimental group pre-test (X= 48.33) and post-test (X=88.64) (p(12)= .003; p<0.05). Similarly, there was a significant difference between the pre-test (X=44.42) and post-test (X=78.23) in the control group (p(12)=.002; p<0.05). This result shows that MAEGEs and lecture-based mathematics lessons contributed significantly to students' attitudes towards mathematics lessons.

Table 12 shows the difference between experimental and control groups in terms of the student's attitudes toward mathematics lessons after the implementation.

TABLE 12. Mann-Whitney U Test Analysis of Post-test of the Students' Attitudes Towards Mathematics Scale (SATMS)

Groups	Measurement	N	X	U	z	p
Experimental Group	SATMS Post-test	12	15.42	37.000	-2.026	.043
Control Group		12	9.58			

As seen in Table 12, there was a significant difference between the averages of the experimental group (X=15.42) and control group (X=9.58) (p(24) = .043; p>0.05). This result shows that MAEGEs contributed to students' attitudes towards mathematics lessons more than lecture-based mathematics lessons. Since the effect size is calculated as 0.58, MAEGES can be interpreted as have a large effect on student's attitudes.

4. DISCUSSION

This study investigated the effect of MAEGEs on students' academic achievement, motivation, and attitude towards mathematics lessons. Understanding the student's "player types" was necessary to determine the appropriate game elements for the experimental group. Since the game environment was the classroom, and the players were students in the school, it was necessary to determine the learner profiles of the students. After the player types had been determined using their Learner Profile Scale (Galiç, & Yıldız, 2020) without using any player type scale, the game elements required for the experimental group were then identified and the MAEGEs were designed. These activities were applied to the 6th-grade students as they studied fractions for a period of two weeks. Instruments were applied to both groups before and after the implementation in order to observe the effect of the MAEGEs on academic achievement, attitudes, and motivation.

The results of this study show that MAEGEs and lecture-based mathematics lessons contributed significantly to students' academic achievement significantly. MAEGEs had a positive effect on the students' mathematics academic achievement. This result is consistent with other studies on gamification (Bal, 2019; Chen et al., 2018; Harrold, 2015; Türkan, 2019; Welbers et al., 2019; Yürük, 2019). No difference was observed in the post-test Academic Achievement Tests for the experimental and control groups. This result shows that MAEGEs contributed to students' academic achievement at least in the lecture-based process. This result is consistent with the study by Samur (2015). According to the school's "Differentiation Policy", all lessons had to be differentiated. Nevertheless, the "Differentiation Policy" may have affected the results.

MAEGEs contribute to students' motivation towards mathematics lessons more than lecture-based mathematics lessons. This result is consistent with the literature (Bayram, & Çalışkan, 2019; Bell, 2014; Chen et al., 2018; Domínguez et al.; 2013; Harrold, 2015; Karamert, & Kuyumcu Vardar, 2021; Samur, 2015; Şahin et al; 2017; Türkan, 2019). On the other hand, this result is not consistent with some research (Meşe, & Dursun, 2018; Polat 2014). Unlike in other studies, determining the player types of the students in the experimental group and selecting appropriate game elements is thought to have had a positive effect in this study. While some researchers (Hakulinen et al., 2015; Hanus, & Fox, 2015) claimed the negative effects of gamification, the effect size is found as a larger effect for students' motivation and attitudes in this study. Hence, it can be claimed that if educator prepare the lesson according to the students' player types, the gamification has a positive effect during the learning process. As Buckle and Doyle (2016) mentioned that gamification means more than using badges in education. Since gamification path depends on the students' personalities (Bergmann et al., 2017), the students should be well-known before creating a gamification environment to select the appropriate game elements.

According the result of this study, the effect size of MAEGE's has medium on students' academic achievement. Marín Suelves et al. (2021) argued that video games provide students to develop their cognitive and creative aspects. Thus, the effect of MAEGE's may be expected to increase as the extension of implementation duration.

The results of this study showed that MAEGEs contributed to students' attitudes towards mathematics lessons more than lecture-based mathematics lessons. According to the results of studies by Bal (2019), Polat (2014), Türkan (2019), and Yürük (2019) gamification affects students' attitudes positively. Hence the result in this study is consistent with previous research.

5. CONCLUSIONS

This study investigated the effect of MAEGEs chosen according to middle-school students' learner profiles on their academic achievement in a "fractions unit", as well as their motivation and attitudes towards mathematics lessons. The study found that MAEGEs positively affected the student's academic achievement, motivation, and attitudes. Although the results indicated that students' motivation and attitudes towards mathematics were better in the experimental group, no differences were observed between the groups' academic achievements. It can be argued that these activities were more effective than lecture-based mathematics lessons in the student's motivation and attitudes toward mathematics lessons. The MAEGEs was implemented for a period of two weeks. Increasing the duration of implementation may also have a positive effect on students' academic achievement, motivation, or attitudes in mathematics lessons. It can be also stated that MAEGEs designed according to students' learner profiles positively affect students' academic achievement, attitudes, and motivation in mathematics lessons. Santos et al. (2021) recommended that the gamification design should be personalized to obtain better result since the differences between different studies about gamification is related to the gamification design. In this study, educational gamification environment adapted to the students and the result shows that gamification has positive effects on students. In addition, it can be argued that such enrichment activities can be used not only for gifted students but also for all students in a mixed-ability classroom.

5.1. Limitations and future lines of research

The following recommendations for future research can be made: the effects of using game elements with respect to students' player types could be researched for different topics, different disciplines, or students of different grades. Game elements could also be used in differentiation instructions.

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