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Abstract

The aim of this study was to determine effectively teaching acquisitions which algebraic expressions sub-learning take place in algebra learning field to sixth-grade students by using educational games in addition available teaching methods and the student perspectives on the mathematics lesson. The research's study group consisted of 31 sixth graders from two village middle schools in the province of Niğde's central district. One of the mixed research approaches, exploratory sequential design, was selected since it was better in accordance with the study's objectives. Both groups took the attitude scale as a pre-test before the application. The experimental group was then taught mathematics using educational games, whereas the control group received no intervention and was simply taught using the techniques found in the present curriculum. Both groups were given the attitude scale as a post-test after the application. Qualitative information was acquired by asking the experimental group's students their opinions of the method after it had been used. Since the collected quantitative data had a normal distribution, comparisons between groups were made using the independent sample t-test, while comparisons within groups were made using the dependent sample t-test. The qualitative data that was collected was analyzed using content analysis. The results of the study showed that employing educational games to teach mathematics significantly changed the attitudes of the experimental group members toward the topic, or, to put it another way, positively impacted them. After taking into account the students' perceptions of the process, it was determined that the use of educational games during the lesson raised interest, motivated students, increased their participation in the lesson, helped them understand the subject, and the students enjoyed the process.

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Research Article

The Effect of Teaching Algebraic Expressions with Educational Games on Sixth-Grade Students' Attitudes towards Mathematics *

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Abstract

The aim of this study was to determine effectively teaching acquisitions which algebraic expressions sub-learning take place in algebra learning field to sixth-grade students by using educational games in addition available teaching methods and the student perspectives on the mathematics lesson. The research's study group consisted of 31 sixth graders from two village middle schools in the province of Niğde's central district. One of the mixed research approaches, exploratory sequential design, was selected since it was better in accordance with the study's objectives. Both groups took the attitude scale as a pre-test before the application. The experimental group was then taught mathematics using educational games, whereas the control group received no intervention and was simply taught using the techniques found in the present curriculum. Both groups were given the attitude scale as a post-test after the application. Qualitative information was acquired by asking the experimental group's students their opinions of the method after it had been used. Since the collected quantitative data had a normal distribution, comparisons between groups were made using the independent sample t-test, while comparisons within groups were made using the dependent sample t-test. The qualitative data that was collected was analyzed using content analysis. The results of the study showed that employing educational games to teach mathematics significantly changed the attitudes of the experimental group members toward the topic, or, to put it another way, positively impacted them. After taking into account the students' perceptions of the process, it was determined that the use of educational games during the lesson raised interest, motivated students, increased their participation in the lesson, helped them understand the subject, and the students enjoyed the process.

Keywords: Mathematics teaching, educational game, attitude towards mathematics, algebraic expressions

1. INTRODUCTION

Mathematics, which has been in our lives since the first days of human history, has been the cornerstone for individuals, nations and states to develop themselves. So much so that the ability to provide answers for the issues at the core of all forms of technology and personal development is crucial. This is exactly where mathematics and the ability to do mathematics come into play. Many different definitions have been made for mathematics, which has a place in people's lives from the day they are born until the last moment of their lives. As Baykul (2009) states, the definitions made were in line with people's interest and needs. The common point of these definitions is that mathematics is a universal language and we encounter it at every moment of life. Particularly when schooling is taken into account, it is evident that students find mathematics, a fundamental course, to be abstract and challenging to learn (Köğce, 2021). According to Aydın (2018), who states that research on

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mathematics reveals that it is difficult to break such prejudices because the dominant thought in most of the students is that mathematics is a course that is difficult or even impossible to do, assuming that the reason for the failure is due to the student without looking at the root of the existing problem causes the understanding of the mathematics course to become more complicated. It can be said that the main reasons underlying the existence of these thoughts are that students are not eager to learn, try to learn by memorising, do not actively participate in the learning process, get bored with the lesson because they cannot perform meaningful learning, and give their attention elsewhere. It is the main desire of mathematics teachers to attract the energy of students to the lesson.

A large part of a person's life is spent in school, in education and training. Early introduction to school allows students to play off their built-up energies, which they then expend by playing games. For some, play is thought to be laughing, having fun, having a pleasant time, while for others it is thought to look at life from different perspectives, discovering while having fun, and developing intelligence (Güneş, 2015). According to Yavuzer (2019), who defines the game in the focus of education, the game is that the child learns the subjects that he cannot learn with the help of someone else, thanks to hisown acquisitions, without thinking about the result, thanks to the movements he makes with the aim of having fun.

While teaching mathematics, which is seen as difficult and complex by students, environments should be created to enable students to participate actively and willingly in the process, to internalise the acquired knowledge, and especially to concretise the concepts that remain abstract. Because, thanks to these environments, students can learn the content that they cannot make sense of by hearing from others, and they can make it meaningful by having fun (Aykaç & Köğce, 2019). One of the ways to create such an environment is to bring the games that students enjoy greatly into the school boundaries as educational games. Açıkgöz (2003) stated that including games during the lesson will make the lessons interesting, and at the same time, students' motivation towards the lesson will increase. Aykaç and Köğce (2021), on the other hand, defined the educational game as a set of activities that lead to the targeted achievements of the lesson in a pleasant way that enables students to actively participate in the learning process physically and spiritually. In this way, the student will achieve learning by feeling happier and enjoying himself with active participation and by discovering the information through hisown experiences instead of receiving it directly from the teacher. At the same time, since the student will realise that he can access the information himself and concretise the abstract mathematical concepts through the game, he will get rid of the negative perceptions he has against the mathematics course (Yeşilkaya, 2013).

One of the points emphasised in the mathematics curriculum (Ministry of National Education [MoNE], 2018), which has a constructivist education approach at its centre, is the preparation of environments where students can discover knowledge, interact with each other and share their ideas while searching for solutions to questions and problems. Educational games to be used in learning environments are among the activities that serve this purpose. These activities are very important in terms of helping students discover the fun side of mathematics by enjoying the process in line with the understanding adopted by the current mathematics curriculum, as well as enabling students to learn the subjects in the mathematics course by participating in the process mentally and physically.

Since algebra, which is one of the fields of mathematics, is a difficult field to be understood by students, it is very important to enrich the learning process in order to understand and make sense of the subject. Because algebra is encountered in many areas of our lives and it is necessary to learn algebra both to progress in mathematics education and to continue higher education (Ersoy, 1997). In other words, we can say that algebra is the key to success in mathematics and other courses. While defining algebra, Altun (2016) used the expression of language built on equations written with variables whose value is not certain but can be expressed with the help of symbols. In more general terms, we can say that algebra is a branch of mathematics that enables the use of numbers and symbols

to transform the relationships between them into equations and general expressions in mathematics (Ünlü, 2021). The reason why algebra is so important in mathematics teaching is that it enables students to analyse mathematical situations and helps them to know and understand the world (National Council of Teachers of Mathematics [NCTM], 2000).

When the mathematics curricula at all levels in our country are examined, it is seen that the development of affective characteristics is as important as the acquisition of mathematical knowledge and skills, and therefore it is also important that the attitude to be developed towards mathematics is positive. In other words, it is very important for students to see mathematics as a field worth dealing with, useful and perceptible. Students' caring about mathematics, believing that mathematics develops thinking skills, appreciating the benefits it provides, enjoying dealing with mathematics and being willing to learn mathematics can be considered as the reasons for their positive attitude towards mathematics. It can be concluded that the fact that students who show all these positive characteristics are successful in mathematics lessons is the result of this mutual relationship between success and attitude (Tarım & Artut, 2016).

Most of the students do not favour mathematics activities because they are afraid of making mistakes. In studies on fear and anxiety towards mathematics, it is observed that as children's experiences in mathematics increase, their negative attitudes decrease. Although the role of the school and the teacher is very important in this, it is not possible to increase mathematics achievement unless this negative attitude changes (Altun, 2014).

The measures that teachers can take to help students develop positive attitudes towards mathematics can be listed as follows.

- Instead of making students memorise the concepts of operations and solution methods, emphasis should be placed on their understanding of these concepts.
- Homework in maths lessons should not be long and tedious; short assignments that encourage students to do research should be preferred.
- The teacher should make it clear that there are many ways to arrive at the correct answer and should find the different solutions of the students valuable.
- Sufficient time should be given for students to perform operations, draw shapes and solve problems, and students should not be worried about not being able to complete the task.
- The mistakes made by the students while performing operations should be tolerated, and studies should be carried out to show the correct way to correct these mistakes without offending or hurting the students.
- Students should be given opportunities and environments should be prepared for them to express their own thoughts.
- Care should be taken to ensure that students who learn faster and have good achievement do not block students who learn more slowly.
- Student groups should be formed in a heterogeneous way and students should be given the opportunity to discuss the topics with each other, and each student should be ensured to participate in the lesson.
- Students should be made aware of the enjoyable and relaxing side of mathematics and gamified activities should be allowed in mathematics teaching (Altun, 2014).

When the definitions for attitude are analysed, it is seen that there is no common acceptance. This is because researchers are influenced by different theories, which has led to the emergence of different definitions. However, if we focus on the common point of the definitions, attitude can be defined as a person's positive or negative emotional, mental, behavioural reaction to a concept, another person, a situation or an object. Since attitude has the ability to affect and change behaviours, its effect

on success has also been focused on. In other words, it was deemed worthwhile to investigate how important it is for a person to develop a positive attitude towards a subject at the point of being successful in a subject. In this context, students' attitudes towards courses have been considered as one of the factors affecting their success in those courses (Tarım & Artut, 2016).

Uysal-Koğ (2007) stated that students' attitudes towards mathematics are a factor that has a significant effect on their academic achievement and that an individual's negative attitude towards a field such as mathematics, which has a connection between its subjects, will reduce the student's interest in this course. Bayturan (2004), on the other hand, stated that students' attitudes towards mathematics is an important factor that shapes their behaviours towards the course, has a share in motivating them and can be considered as a determinant of personal impressions such as liking or disliking mathematics.

In the light of all this information, it is thought that teaching algebraic expressions, which is one of the first subjects that students encounter with abstract thinking when considering their education life, with educational games can positively affect students' attitudes towards mathematics course. In this context, in this study, it was aimed to determine the effect of teaching the acquisitions in algebraic expressions sub-learning area of algebra learning area by using educational games on sixth-grade students' attitudes towards mathematics and students' opinions about the process. Along with this aim, it is thought that the result to be obtained will be useful for teachers and mathematics educators who want to benefit from educational games in educational environments in order to set an example.

The problem of this research seeks an answer to the question "What is the effect of educational game-supported teaching of algebraic expressions in the mathematics curriculum on students' attitudes towards mathematics?" based on this problem, the aims of the research are shaped as follows.

1. Are the pre-attitude scores of the experimental group students who received educational game support compared to the control group students who received instruction in line with the current curriculum significantly different?
2. Is there a discernible difference in the students' final attitude ratings between the experimental group, who got educational game-supported instruction, and the control group, who received instruction in line with the current curriculum?
3. Do the pre- and last-Attitude scores of the experimental group pupils who got game-supported instruction geared toward mathematics courses significantly differ from one another?
4. Do the pre-attitude and last-Attitude scores of the control group pupils, who were taught using the current curriculum, show a statistically significant difference?
5. What thoughts do the experimental group students have regarding the application procedure after receiving game-based learning?

2. METHOD

2.1. Research Model

One of the mixed research approaches, exploratory sequential design, was applied in this study. Researchers gather and analyze quantitative data first in the exploratory sequential design, and then they gather qualitative data to supplement the quantitative data they have already collected (Büyüköztürk, Kılıç-Çakmak, Akgün, Karadeniz & Demirel, 2021; Creswell, 2021). To supplement these data, qualitative data were then obtained after the quantitative data, for this reason. Quantitative data were obtained using a semi-experimental methodology with an unequalized control group for the pretest and posttest. A questionnaire for interviews was used to gather qualitative data.

2.2. Universe and Sample

The sixth graders enrolled in Niğde public secondary schools for the 2022–2023 academic year are the study's target audience. The study's sample consists of sixth graders from two secondary

schools in the central area of Niğde province with equivalent physical conditions. This study featured a total of 31 sixth graders, with 12 students in the experimental group and 19 students in the control group.

2.3. Data Collection Tools

Within the scope of this study, quantitative and qualitative data were collected.

Quantitative information was gathered using the Attitude Scale towards Mathematics Course (ASTMC) created by Yetgin (2019). The ASTMC employed in the study has six sub-factors and 29 scale items. According to professional assessments, the sub-factors are avoidance, optimistic attitudes, prejudice and anxiety, system, observation, and experience. The table below lists the sub-factors under which each of the scale's 29 items is classified.

Table 1. Distribution of the items in ASTCM according to sub-factors

Sub Factor	*Scale Item Number*
Avoidance	7, 10, 14, 16, 17, 19, 20, 24, 25
Positive Attitudes	1, 2, 27, 28
Anxiety and Prejudice	5, 12, 13, 15, 18, 21, 23, 29
System	9, 11, 22
Observation	3, 26
Experience	4, 6, 8

Prior to the use of the ASTMC in the study, the researcher carried out a pilot study with 19 seventh-grade students and the reliability coefficient was calculated. While analysing the data, the items in the scale that indicate positive expressions were scored as "strongly disagree" option 1, "disagree" option 2, "agree" option 3, "strongly agree" option 4 points; while the items that indicate negative expressions were scored as "strongly disagree" option 4, "disagree" option 3, "agree" option 2, "strongly agree" option 1 point. The scale's Cronbach's Alpha value was computed as 0.782 as a result of the study performed using the scores received, and it was decided that the scale was valid and reliable. By receiving the required authorization from the scale owner, the ASTMC was utilized in this context as a pre- and post- test in both the experiment group and the control group prior to and after the implementation in the study. While analysing the scale items, scoring was done as in the pilot study. As a result, the score that was lowest on the 29-item attitude scale was 29, and the score that was highest was 116.

In the collection of qualitative data, the eight-question Student Opinion Form (SOF) developed by Can (2022) in consultation with experts and teachers in the field of mathematics education was used. This form is given in Table 2 below.

Table 2. Student opinion form (SOF)

	Student Opinion Form Questions
1	Did the teaching with games contribute to you? If you think it contributed, what kind of contributions did it make?
2	Were you happy to teach maths with games? Why?
3	How did teaching mathematics with games affect your interest and attitude towards mathematics?
4	Have you ever taught mathematics with games in your lessons? How are mathematics lessons in which mathematics is taught with games different from mathematics lessons in which mathematics is not taught with games?
5	Would you like mathematics teaching with games to be done in other mathematics subjects? If you want it to be done in other subjects, briefly explain which subject you would like this subject to be.
6	How did the maths lessons taught with games affect your participation and motivation?
7	Did the maths lessons with games give you different perspectives?
8	How do you think maths lessons supported by games will affect your success in your lessons?

With the quantitative data from the ASTMC, it was intended to support the qualitative data from the SOF. In this instance, the SOF was used with the experimental group of students once the application was completed in the research with the requisite approval from the form owner.

2.4 Data Collection

In the study, the sixth-grade algebraic expressions topic was taught with the help of educational games in the experimental group and with the methods in the current curriculum in the control group. In both experimental and control groups, the teaching of 3 objectives of the algebraic expressions topic in the mathematics curriculum was completed in 10 lesson hours and the study lasted for 2 weeks.

Prior to application to the experimental and control groups, the ASTMC was employed as a pre-test. After the application was finished, ASTMC was administered once more to both groups as a post-test. Additionally, Can's SOF was made available to students in the experimental group so that their thoughts of the process could be ascertained.

2.5. Analysing the Data

After carrying out a normality analysis in the SPSS program to solve the sub-problems of the research, it was discovered that the pre- and post-test attitudes results were normally distributed. This was accomplished by contrasting the pre and post-test scores' skewness and kurtosis scores with those found in the Shapiro-Wilk test. It was concluded that parametric tests can be used in comparisons between groups or within groups. As a result, the results of the pre- and post-tests within the groups were compared using the dependent sample t-test, and the control and experimental groups were compared using the independent sample t-test. With a 95% confidence interval, the analyses were performed using the SPSS 27 package program ($p < 0.05$).

While analysing the qualitative data, content analysis was performed with the data obtained from the SOF developed for the opinions of the students in the experimental group towards educational games. The data obtained from the SOF were coded first by the researcher and then by two academicians. In order to determine the reliability of these data coded by different people, the percentage of agreement between the coders was calculated with the formula [Similar opinion / (Similar opinion + Different opinion) x 100] (Miles & Huberman, 1994). The percentage of agreement calculated in the study was found to be 79% and since this rate was more than 70%, it was concluded that the results of the analysis would be reliable. After the categories were determined according to the similarities or differences between the codes, the sub-codes expressed by each code were created. Instead of using the names of the 12 students in the experimental group in the study, each of them was labelled as: S1, S2, S3,..., S12. The results were tabulated by looking at the frequency percentage of the data obtained in line with the answers given by the students.

3. FINDINGS

3.1. Descriptive Statistics of the tests Used in the Research Process

In the studies conducted, firstly, it is checked whether the scores obtained on a continuous variable show a normal distribution or not. One of the methods used for this is to look at the values of descriptive statistics such as skewness coefficient (skewness) and arithmetic mean. The analysis's premise is that the results shouldn't differ from average in terms of scores. When the skewness coefficient is between -2 and +2, which is the range for this purpose, it is assumed that the scores do not stray considerably from normal. In addition, another method of determining whether the data is normally distributed is to utilise the tests applied by looking at the size of the groups. Kolmogorov-Smirnov test is used if the group size is greater than 50, while Shapiro-Wilk test is used if the group size is less than 50. If the p value produced from the analysis using these tests is higher than 0.05, it is assumed that the data acquired are normally distributed and do not significantly deviate from normal. Depending on the sub-problems of the study, it is decided whether to use parametric or nonparametric tests depending on whether the distribution is normal or not (Büyüköztürk, 2021; George & Mallery, 2010).

In this context, in line with the information above, the Shapiro-Wilk test was used in the normality value calculations since the number of students in the study was less than 50. In the research process, the arithmetic averages ($\overline{X}$), standard deviation (SD), kurtosis and skewness values of the scores obtained from the Attitude Scale Towards Mathematics Lesson (ASTMC) applied to the experimental and control groups as pre-test and post-test and the p values obtained from the normality test were calculated and these values are given in the tables below.

Table 3. Descriptive statistics of experimental and control groups

Groups	*Test*	$\overline{X}$	*SD*	*Kurtosis*	*Skewness*	*Shapiro-Wilk (p)*
Experiment (N=12)	ASTMC Pre-attitude	73,25	7,605	-,381	-,844	,128
	ASTMC Last-Attitude	94,67	7,512	,184	-,125	,990
Control (N=19)	ASTMC Pre-attitude	72,47	9,800	-,850	-,177	,584
	ASTMC Last-Attitude	70,16	10,095	1,511	-,088	,354

Table 4. Descriptive statistics of attitude scale sub-factors of experimental and control groups

Test	*Groups*	*Attitude Scale Sub Factors*	$\bar{X}$	*SD*	*Kurtosis*	*Skewness*	*Shapiro-Wilk (p)*
ASTMC Pre-attitude	Experimental Group (N=12)	Positive Attitudes	9,08	1,832	-,953	-,253	,269
		Observation	4,75	1,138	,425	,139	,158
		Experience	7,17	1,899	-1,255	,193	,087
		Anxiety and Prejudice	21,00	4,243	,428	-,926	,196
		Avoidance	24,42	3,343	-,735	-,086	,893
		System	6,83	1,801	-,666	,409	,287
	Control Group (N=19)	Positive Attitudes	9,21	2,275	,377	-,290	,402
		Observation	4,00	1,856	-,430	,543	,055
		Experience	7,00	2,285	-,130	,406	,815
		Anxiety and Prejudice	18,05	3,979	-,647	,217	,750
		Avoidance	25,68	3,728	-1,359	,234	,080
		System	8,53	2,195	-,965	,084	,309
ASTMC Last-Attitude	Experimental Group (N=12)	Positive Attitudes	13,67	1,073	,905	,804	,146
		Observation	5,83	1,403	-1,097	,351	,187
		Experience	7,25	1,960	,474	-,679	,264
		Anxiety and Prejudice	27,83	3,040	-,260	-,393	,822
		Avoidance	30,08	2,937	1,923	-1,389	,059
		System	10,00	1,758	-,504	-,602	,133
	Control Group (N=19)	Positive Attitudes	8,37	2,891	-1,298	,082	,214
		Observation	3,95	1,649	,441	,675	,062
		Experience	7,37	1,950	,867	,774	,223
		Anxiety and Prejudice	18,00	4,372	,192	,348	,839

	Avoidance	25,00	3,972	-1,046	-,143	,458
	System	7,47	1,926	,318	,436	,556

In line with the statistical information in Table 3 and Table 4, it is seen that the p values are greater than 0.05 as a result of examining the pre-test and post-test scores applied to the groups and the sub-dimensions in the attitude scale. For this reason, it was concluded that the data showed normal distribution, and in the analysis of the data in accordance with the sub-problems, independent (unrelated) sample t-test was used in comparisons between the experimental and control groups, and dependent (related) sample t-test was used in cases requiring comparison of the groups within themselves. According to the p value obtained from the t-test, it was decided whether there was a significant difference between the compared quantities.

While the p value obtained from the tests used is less than 0.05 indicates that the result is a significant difference, this does not provide information about the degree of significance. Another statistic utilised in the interpretation of the results when comparing the mean scores is the effect size. The Cohen-d value, which allows interpretation of how far the compared averages diverge from each other, is the value commonly used in effect size calculations. The d value, which can potentially take values between $-\infty$ and $+\infty$, is expressed as small, medium and large effect size with values of 0.2, 0.5 and 0.8, respectively, regardless of its sign (Büyüköztürk, 2021).

For this reason, if the p-value obtained from the tests used showed a significant difference, Cohen-d value was also calculated in order to reveal the effect size of the difference and to make more accurate comments, and answers to the sub-problems were sought and comments were made accordingly.

3.2. Findings of the first sub-problem

The data to be used to answer the first sub-problem of the study, "Is there a significant difference between the pre-test attitude scores of the experimental group students who received educational game supported education and the control group students who received education according to the current curriculum towards mathematics course?", were obtained from the pre-test of ASTMC applied to both groups, and since the data conformed to the normal distribution, the independent sample t-test was used to compare the pre-test attitude scores. The results of the analyses are given in Table 5.

Table 5. Independent sample t-test analysis of experimental and control group students' pre-attitude scores of ASTMC

Groups	*N*	$\bar{X}$	*SD*	*df*	*t*	*p*
Experiment	12	73,25	7,605	29	,233	,817
Control	19	72,47	9,800			

*p < 0,05

When Table 5 is analysed, it is seen that the experimental group ASTMC pre-attitude mean score is 73.25, while the control group ASTMC pre-attitude mean score is 72.47. Since the p value indicated as the significance level was greater than 0.05, it was found that the ASTMC pre-attitude scores between the groups did not differ significantly [t (29) = ,233 and p> 0.05]. With the findings obtained here, it can be concluded that the attitudes of the experimental group students and the control group students towards mathematics before the application were equivalent to each other.

The change in the scores of the sub-factors in the attitude scale was also analyzed in order to more thoroughly investigate the impact of the applied method on students' attitudes toward

mathematics. The pre-attitude sub-factor scores of the experimental and control group students in the ASTMC were compared using an independent sample t-test. The results of the analyses are given in Table 6.

Table 6. Independent sample t-test analysis of the experimental and control group students' sub-factors of the pre-attitude test sub-factors of the ASTMC

Attitude Scale Sub Factors	*Groups*	*N*	$\bar{X}$	*SD*	*t*	*df*	*p*
Positive Attitudes	Experiment	12	9,08	1,832	-,163	29	,872
	Control	19	9,21	2,275			
Observation	Experiment	12	4,75	1,138	1,307	29	,202
	Control	19	4,00	1,764			
Experience	Experiment	12	7,17	1,899	,211	29	,835
	Control	19	7,00	2,285			
Anxiety and Prejudgement	Experiment	12	21,00	4,243	1,959	29	,060
	Control	19	18,05	3,979			
Avoidance	Experiment	12	24,42	3,343	-,958	29	,346
	Control	19	25,68	3,728			
System	Experiment	12	6,83	1,801	-2,235	29	,073
	Control	19	8,53	2,195			

*p < 0,05

When Table 6 is carefully analyzed, it can be observed that the p value, which indicates the significance level of the disparity in the results of the control and experimental group of students on each sub-factor of the attitude scale, is greater than 0.05 for each sub-factor. This indicates that there is not a significant disparity in the pre-attitude ratings of the ASTMC between the groups.

In accordance to the analyses, there was no discernible difference between the control and experimental groups of students' attitudes towards mathematics prior to instruction in terms of positive attitudes, observation, experience, anxiety and prejudice, avoidance, and system sub-factors, or put another way, the groups' attitudes were comparable.

3.3. Findings of the second sub-problem

The data to be used to answer the second sub-problem of the study, "Is there a significant difference between the post-test attitude scores of the experimental group students who received educational game supported education and the control group students who received education according to the current curriculum towards mathematics course?" were obtained from the post-test of ASTMC applied to both groups, and the independent sample t-test was used to compare the post-test attitude scores since the data conformed to the normal distribution. The results of the analyses are given in Table 7.

Table 7. Independent sample t-test analysis of experimental and control group students' ASTMC final attitude scores

Groups	*N*	$\bar{X}$	*SD*	*df*	*t*	*p*	*Cohen-d*
Experiment	12	94,67	7,512	29	7,224	,000	2,664
Control	19	70,16	10,095				

*p < 0,05 ; **d > 0,8

When Table 7 is analysed, it is seen that the mean final attitude score of the experimental group ASTMC was 94.67, while the mean final attitude score of the control group ASTMC was 70.16. Since the p value indicated as the significance level was less than 0.05, it was determined that the ASTMC final attitude scores between the groups differed significantly [t (29) = 7.224 and p <0.05]. Since the result was found to be significant, the Cohen-d value, which reveals the effect size, was also calculated and found to be 2.664.

With regard to last-Attitude scores, the experimental group in the ASTMC significantly outperformed the control group (d > 0.8), favoring the experimental group, according to all of these findings. This finding suggests that using educational games to teach mathematics significantly and favorably influences students' attitudes toward the subject.

The change in the results of the component factors in the scale for attitude was also analyzed in order to more thoroughly investigate the impact of the applied method on students' attitudes toward mathematics. The overall attitude sub-factor results of the control and experimental group students were compared using an independent sample t-test. Table 8 presents the findings of the analyses.

Table 8. Independent sample t-test analysis of the sub-factors of the final attitude test sub-factors of the final attitude test of the experimental and control group students

Attitude Scale Sub-Factors	*Groups*	*N*	$\bar{X}$	*SD*	*t*	*df*	*p*	*Cohen-d*
Positive Attitudes	Experiment	12	13,67	1,073	6,059	29	,000	2,234
	Control	19	8,37	2,891				
Observation	Experiment	12	5,83	1,403	3,278	29	,003	1,209
	Control	19	3,95	1,649				
Experience	Experiment	12	7,25	1,960	-,164	29	,871	
	Control	19	7,37	1,950				
Anxiety and Prejudice	Experiment	12	27,83	3,040	6,803	29	,000	2,508
	Control	19	18,00	4,372				
Avoidance	Experiment	12	30,08	2,937	3,814	29	,001	1,406
	Control	19	25,00	3,972				
System	Experiment	12	10,00	1,758	3,676	29	,001	1,355
	Control	19	7,47	1,926				

*p < 0,05 ; **d > 0,8

When Table 8 is closely examined, it becomes clear that there is a significant difference in the final attitude scores of the ASTMC between the groups because the p value, which indicates the significance level of the difference between the scores of the experimental and control group students on the positive attitudes, observation, anxiety and prejudice, avoidance, and system sub-factors of the attitude scale, is less than 0.05 for each sub-factor. The Cohen-d values indicating the effect size were also calculated because the result was significant, and it was discovered that these values were larger than 0.8, indicating that the effect size was at a high level. It was determined that there was no discernible difference in the scores between the groups for the experience sub-factor.

In light of the results, it can be concluded that using educational games to teach mathematics made a significant and effective difference in favor of the experimental group in the sub-factors of positive attitudes, observation, anxiety and prejudice, avoidance and system, but did not make any difference at all in the sub-factors of negative attitudes, avoidance and system, avoidance, and system.

3.4. Findings of the third sub-problem

The data to be used to answer the third sub-problem of the research, "Is there a significant difference between the pre-attitude and last-Attitude scores of the experimental group students who received educational game supported education towards mathematics course?" were obtained from the pre and last-Attitude test of ASTMC applied to the experimental group, and since the data conformed to the normal distribution, the dependent sample t-test was used to compare the pre and post-test attitude scores. The results of the analyses are given in Table 9.

Table 9. Dependent sample t-test analysis of experimental group students' pre-attitude and last-attitude scores of ASTMC

Tests	*N*	$\bar{X}$	*SD*	*df*	*t*	*p*	*Cohen-d*
Pre-Attitude	12	73,25	7,605	11	-7,716	,000	2,227
Last-Attitude	12	94,67	7,512				

*p < 0,05 ; **d > 0,8

When Table 9 is analysed, it is seen that the mean pre-attitude score of the experimental group ASTMC is 73,25 and the mean last-Attitude score is 94,67. Since it is seen that the p value specified as the significance level is less than 0.05, it is concluded that the pre and last-Attitude scores of the experimental group students' ASTMC pre and last-Attitude scores show a significant difference [t (11) =-7.716 and p <0.05]. Since the result was found to be significant, the Cohen-d value, which reveals the effect size, was also calculated and found to be 2,227. From all of these results, it can be inferred that the ASTMC pre-attitude and last-Attitude scores of the experimental group students differ in favor of the last-Attitude and have a significant effect at a high level (d> 0.8), favoring the last-Attitude. This finding suggests that using educational games to teach mathematics has a positive and beneficial effect on improving the students' attitudes toward the subject among the experimental group.

The change in the scores of the sub-factors in the attitude scale was also analyzed in order to more thoroughly examine the impact of the applied method on students' attitudes toward mathematics. The ASTMC pre and last-Attitude sub-factor scores of the experimental group students were compared using a dependent sample t-test. Table 10 presents the analysis' findings.

Table 10. Dependent sample t-test analysis of the experimental group students' sub-factors of ASTMC

Attitude Scale Sub-Factors	*Tests*	*N*	$\bar{X}$	*SD*	*t*	*df*	*p*	*Cohen-d*
Positive Attitudes	Pre-Attitude	12	9,08	1,832	-6,004	11	,000	1,733
	Last-Attitude	12	13,67	1,073				
Observation	Pre-Attitude	12	4,75	1,138	-1,946	11	,078	
	Last-Attitude	12	5,83	1,403				
Experience	Pre-Attitude	12	7,17	1,899	-,108	11	,916	
	Last-Attitude	12	7,25	1,960				
Anxiety and Prejudice	Pre-Attitude	12	21,00	4,243	-5,250	11	,000	1,515
	Last-Attitude	12	27,83	3,040				
Avoidance	Pre-Attitude	12	24,42	3,343	-5,696	11	,000	1,644
	Last-Attitude	12	30,08	2,937				
System	Pre-Attitude	12	6,83	1,801	-7,181	11	,000	2,073
	Last-Attitude	12	10,00	1,758				

*p < 0,05 ; **d > 0,8

When Table 10 is examined in detail, it is seen that the p value showing the significance level of the difference between the scores of the experimental and control group students in the positive attitudes, anxiety and prejudice, avoidance and system sub-factors in the attitude scale is less than 0.05 for each sub-factor, so it is seen that the final attitude scores of the ASTMC between the groups show a significant difference. Since the result was significant, Cohen-d values showing the effect size were also calculated and it was seen that these values were greater than 0.8, that is, the effect size was at a large level. For the sub-factor of experience by observation, it was concluded that the scores between the groups did not differ significantly.

Considering the findings obtained, it can be concluded that, as a result of the examination of the pre and last-Attitude scores of the experimental group students towards mathematics on the basis of sub-factors, it can be concluded that mathematics teaching with educational games created a significant and effective difference in favour of the last-Attitude in the sub-factors of positive attitudes, anxiety and prejudice, avoidance and system, but it did not create any effect in the sub-factors of observation and experience.

3.5. Findings of the fourth sub-problem

The data to be used to answer the fourth sub-problem of the study, "Is there a significant difference between the pre-attitude and last-Attitude scores of the control group students who received education according to the current curriculum towards mathematics course?", were obtained from the pre and last-Attitude test of the ASTMC administered to the control group, and since the data conformed to the normal distribution, the dependent sample t-test was used to compare the pre and post-test attitude scores. The results of the analyses are given in Table 11.

Table 11. Dependent sample t-test analysis of control group students' pre-attitude - last-attitude scores of ASTMC

Tests	*N*	$\bar{X}$	*SD*	*df*	*t*	*p*
Pre-Attitude	19	72,47	9,800	18	,888	,386
Last-Attitude	19	70,16	10,095			

*p < 0,05

When Table 11 is analysed, it is seen that the mean pre-attitude score of the control group ASTMC is 72,47 and the mean last-Attitude score is 70,16. Since the p value specified as the level of significance is greater than 0.05, it is seen that the control group students' pre-attitude and last-Attitude scores of the ASTMC do not differ significantly [t (18) = ,888 and p > 0.05]. With this finding, it can be thought that mathematics teaching with the applications in the current curriculum did not have any effect on the attitudes towards mathematics of the students in the control group.

As a result of the analysis, it was found that mathematics education according to the current curriculum had no effect on the mathematics attitudes of the control group students; however, in order to see whether there was any change between the scores of the sub-factors in the attitude scale, the score changes between the sub-dimensions were also analysed. Dependent sample t-test was used to compare the ASTMC pre and last-Attitude sub-factor scores of the control group students. The results of the analyses are given in Table 12.

Table 12. Dependent sample t-test analysis of the control group students on the sub-factors of ASTMC

Attitude Scale Sub-Factors	*Tests*	*N*	$\bar{X}$	*SD*	*t*	*df*	*p*
Positive Attitudes	Pre-Attitude	19	9,21	2,275	1,068	18	,300
	Last-Attitude	19	8,37	2,891			
Observation	Pre-Attitude	19	4,00	1,764	,112	18	,912
	Last-Attitude	19	3,95	1,649			
Experience	Pre-Attitude	19	7,00	2,285	-,552	18	,588
	Last-Attitude	19	7,37	1,950			
Anxiety and Prejudice	Pre-Attitude	19	18,05	3,979	,045	18	,965
	Last-Attitude	19	18,00	4,372			
Avoidance	Pre-Attitude	19	25,68	3,728	,817	18	,425
	Last-Attitude	19	25,00	3,972			
System	Pre-Attitude	19	8,53	2,195	1,617	18	,123
	Last-Attitude	19	7,47	1,926			

*p < 0,05

When Table 12 was examined in detail, it was found that the p value showing the significance level of the difference between the pre-test and post-test attitude scores of the control group students in all sub-factors in the attitude scale was greater than 0.05 for each sub-factor, and it was found that the pre and last-Attitude scores of the control group students for all sub-factors did not differ significantly.

In line with the analyses, as a result of the examination of the control group students' pre-attitude - last-attitude scores towards mathematics on the basis of sub-factors, it was determined that mathematics teaching in accordance with the current curriculum did not have any effect on positive attitudes, observation, experience, anxiety and prejudice, avoidance and system sub-factors.

3.6. Findings of the fifth sub-problem

The data to be used to answer the fifth sub-problem of the research, "What are the opinions of the experimental group students who received educational game supported education about the application process?" were obtained with the Student Opinion Form applied to obtain the opinions of the experimental group students about the process of mathematics teaching with educational games. Content analysis was made in line with the answers received from the students and the results are given in Table 13.

Table 13. Content analysis of data obtained from SOF

Category	*Codes*	*f*	*%*
Impact on / contribution to learning	Being fun and catchy	12	%100
	Gaining a different perspective	11	%92
	Ensuring effective learning	12	%100
Contribution to interest / motivation	Ensuring happiness	12	%100
	Increasing motivation	12	%100
	Increasing participation in the lesson	11	%92
The effect / contribution of teaching with educational games	Making the lesson more fun and understandable	12	%100
	Requesting the teaching of other subjects with educational games	11	%92

When Table 13 is analysed, it is seen that only three of the responses of the twelve experimental group students to the SOF consisting of eight questions were negative. These opinions were "Honestly, I cannot say that I gained a different perspective. Because I already liked mathematics.", "I do not participate in the lesson much. But when the games were played, I gave all my excitement to the game." and "I don't want all subjects to be done with games. I usually like to solve questions in the mathematics lesson." It is seen that both of the negative opinions stated here are actually due to the student's love for the mathematics lesson, and one opinion shows that the student does not want to participate in the lesson because he is timid, but he is excited during the lesson taught with educational games. Considering all these situations, it shows that the students enjoyed the mathematics teaching using educational games, had fun during the process, were more active and felt happy.

When we look at the opinions of the students about the mathematics lessons using educational games, it is seen that almost all of them have positive opinions. We can think that all these positive opinions are also related to the increase in students' attitudes towards mathematics. For this reason, it can be said that educational games reflect positively on students' thoughts and attitudes towards the course.

4. DISCUSSION and CONCLUSION

The purpose of this study was to ascertain the impact that employing educational games while teaching mathematics had on the attitudes of the pupils. The ASTMC used as the pre-attitude revealed that the experimental group's students had a mean attitude of 73.25, whereas the control group's students had a mean attitude of 72.47. The p value indicating the significance level of the pre-attitude scores was 0.817. When pre-attitude scores are taken into account, these results indicate that there is no significant difference between the groups; in other words, the groups' attitudes were similar before the program was implemented. The mean attitude of the experimental group students was 94,67, while that of the control group students was 70,16, according to the ASTMC used as the final attitude after application. The p value indicating the significance level of the final attitude scores was 0,000, and the Cohen-d value indicating the effect size was 2,664. These results demonstrate that mathematics instruction utilizing educational games improved the attitude scores of the experimental group while

mathematics instruction following the current curriculum resulted in a decline in the attitude scores of the control group's students. The results of this study show that instructional games can improve students' attitudes toward mathematics in a short amount of time, whereas emotional traits like attitude require time to develop.

When the literature was analyzed, it became clear that other research had produced outcomes comparable to those of this one. Çopur (2021) conducted a study to investigate the impact of virtual game-supported mathematics teaching on 54–66-month-old children's mathematics liking levels and to reveal how it had an effect on children's liking for mathematics and their thoughts towards mathematics. They came to the conclusion that the experimental group's kids felt positively about math while it was being used, which means that the process had a positive impact on kids' math enthusiasm. Similar to this, in Galiç' (2020) study, learner profiles of the students were established, and the impact of mathematics activities enhanced with game elements chosen in accordance with these profiles on students' attitudes and motivation toward the course was examined. After data gathered from the application were analyzed, it was found that mathematics activities enhanced with game elements had a positive impact on students' attitudes. When the test results from the experimental and control groups were compared, it was found that using educational games to teach mathematics had a positive impact on people's attitudes toward this subject. Soydan (2019) conducted a study in which he examined the effect of teaching the acquisitions in the seventh-grade mathematics course on operations with integers using educational games on students' attitudes toward mathematics.

Analyzing the studies from the worldwide literature revealed that the outcomes were consistent. In the study carried out by Van Putten, Blom, andVan Coller (2022), they investigated the impact of mathematics teaching to sixth-grade students by creating game-based worksheets on students' performance in mathematics courses as well as the effect on students' attitudes. It was found that the experimental group students' understanding of the course was positively affected by the study at the conclusion of the study. Similarly, Chen, Jamiatul Husnaini and Chen's study (2020) found that using cooperative games to teach students helped them establish favorable attitudes toward the subject.

On the other hand, studies whose findings did not coincide with those of this study were also discovered when the literature was examined. For instance, Can (2022) examined the impact of teaching the seventh-grade polygons subject with educational games enriched on math achievement as well as the change in students' attitudes, and came to the conclusion that the use of games in math instruction had no impact on students' attitudes toward the subject after implementation. Similar findings were made by Demir and Bilgin (2021), who discovered that using games to teach arithmetic had little impact on students' views toward the subject. Again, when results relating to attitude were analyzed at the conclusion of the study done by Dönmez, Dönmez, Kolukısa and Yılmaz (2021) utilizing a game-based teaching strategy, no appreciable change in the attitudes of individuals in the experimental-control groups was discovered. There was no discernible variation in the attitudes of students throughout the studies of Gün, Işık and Şahin (2021), and Çalışkan (2019) it was determined.

The variations in the attitude scale's sub-dimensions were also examined in this study in order to more precisely pinpoint how students' attitudes changed. When the students' pre-attitude scores were analyzed, it became clear that the experimental and control group students had similar attitudes in the sub-dimensions of the attitude scale dealing with positive attitudes, observation, experience, anxiety and prejudice, avoidance, and system. When the final attitude scores were analyzed, it was found that the experimental group students' higher scores revealed a significant change in the positive attitudes, observation, anxiety and prejudice, avoidance, and system sub-dimensions compared to the scores of those in the control group, but did not produce a significant difference in the experience sub-dimension. It was also determined that the effect size value in the sub-dimensions exhibiting significant differences was high. With the exception of the experience sub-dimension, it was determined that teaching mathematics to students using educational games had a favorable impact on

their views in all other aspects. Similar to this outcome, Can (2022) explored the impact of educational games on students' attitudes toward mathematics and also sought to ascertain how the impact on sub-dimensions was. The analyses revealed that while there was no significant difference between the experimental-control groups' attitude ratings and their scores for the anxiety sub-dimension, there was a significant difference between the two groups' scores in this sub-dimension. In light of this, it was determined that educational games lessen pupils' anxiety levels.

After the arithmetic lessons were taught via educational games, the experimental group students' opinions of the procedure were gathered by using the SOF to ask open-ended questions of the students.

Regarding the influence of educational games on learning, it was observed that all students reported finding the process enjoyable, memorable, positive, and that they understood the subject better. Only one student reported that they were unable to gain a different perspective, whereas the opinions of all other students were that they did. This case demonstrates that almost all of the students agree that educational games have a good impact on learning. Similar to this, Baki (2022) also used game-based mathematics instruction and came to the conclusion that the students thought the method was enjoyable and helpful. In order to teach students about the coordinate system, Martin, Mendoza and Martin (2016) created a game. At the conclusion of the process, instructor and student opinions were gathered. The students claimed that learning was efficient because of the game, despite the teachers' claims that the games used to teach the subject were an effective learning design.

Regarding the impact of educational games on interest and motivation, it was noted that every student said the process made them happy and boosted their motivation. Only one student said it had no impact on my participation in the lesson, whereas every other student said their participation in the lesson increased. This situation demonstrates that practically all students hold positive perceptions regarding their interests and motivations. This outcome is consistent with Baki's (2022) findings that group game play helped students encourage one another's learning and that game-based mathematics instruction boosted students' engagement in the lesson. At the conclusion of his investigation into the use of educational games in the classroom, Özden (2022) sought teacher comments. He came to the conclusion that educational games can be used and used in the classroom. Similar findings were made by Çubukluöz (2019), who used mathematical games to help students overcome their learning challenges. Some of his pupils even began to enjoy the course as a result of the greater course success, according to Çubukluöz (2019).

Only one student responded that they did not want to teach every subject with games, whereas all of the other students expressed the opinion that they would like to teach every subject with games. It was observed that all of the students thought the lesson was more enjoyable and intelligible. Additionally, it is important to note that in the interview with the student who did not want to cover every subject using games, the student stated that he did not want to do so since he loved mathematics so much and wanted to solve problems all the time. All of these viewpoints demonstrate that the majority of students are in favor of teaching mathematics lessons through educational video games. According to Yağmur (2020), who sought to determine the impact of the game he designed, the students found the games to be both educational and enjoyable, and they expressed a desire for more game-based activities to be included in the lessons. His findings are similar to those of this study.

As a consequence, it is clear that the students have good opinions and that the use of educational games in the lesson stimulates their interest, motivates them, promotes their involvement in the lesson, and enhances their understanding of the material. Students were playing instructive games throughout the process and did not even want to go outside for recess. In this direction, it is concluded that teaching mathematics through educational games increases participation in the lesson, allows students to pay attention to the lesson, allows students to learn by doing and experiencing since it makes the student active in the process, allows students to learn the benefits of the lesson by having fun, and as a

normal result of all these situations, it actively contributes to increasing students' attitudes towards mathematics.

In the light of these results, the following suggestions are presented in order to provide ideas for researchers who will conduct studies related to the subject;

- This study was conducted in the sixth-grade algebraic expressions subject and it was concluded that educational games significantly benefited students' attitudes. For this reason, the effect of educational games on student attitudes in other subjects in the mathematics course and at different grade levels can be investigated.
- In this study, mathematics teaching using educational games was compared with mathematics teaching using the methods in the current curriculum. Educational games can be compared with other methods and their effects on students' attitudes can be compared.
- This study was carried out with 12 students because the school where the researcher worked was a small village school. In another study where the number of students in the experimental group is higher, the effect of educational games can be re-examined by making use of the educational games used in this study.
- The educational games used in this study are in concrete form. In another study, digital games can be developed and a study can be conducted on the same subject and the effect on students' attitudes can be analysed.
- Considering that the opinions received from the students at the end of the process in this study included positive statements such as that they found the process fun, their willingness to participate in the lesson increased, and they were always willing to have games in the lessons, it can be suggested that teachers should include educational games in their lessons.

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Ethics Committee Decision

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