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Digital Game Applications on Mathematics Achievement of Students at Risk of Mathematics Learning Difficulty

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Abstract: In this study, the effect of four operations-based digital game applications on the basic mathematics skills of students at risk of math learning difficulties was examined. In this context, the study was designed as a mixed research method. Quantitative and qualitative methods were used in two separate interactive phases following an exploratory design scheme. The study was conducted with seven 5th grade students from two primary schools in two provinces in the Mediterranean region. A pre-test was administered to the students and a 10-session intervention was conducted. Finally, a post-test was administered after the intervention. Participants' responses to the pre-test and post-test were analysed. Shapiro-Wilk test and Wilcoxon signed-rank test were used to analyse quantitative data, and descriptive analysis technique was used to analyse qualitative data. At the end of the study, semi-structured interviews were conducted with the parents of the students. The results of the study showed that the intervention positively affected the academic achievement of the students and the interviews with the parents supported this result. At the end of the study, it can be said that mathematics education with students at risk of mathematics learning difficulties gave positive feedback in the learning domain of numbers and operations, and it may be useful to carry out applications in other learning domains.

Keywords: Mathematics Learning Disability, Dyscalculia, Mathematics Instruction, Digital-Based Instruction, Teaching Through Games, Mathematics Achievement

Matematik Öğrenme Güçlüğü Riski Altındaki Öğrencilerin Matematik Başarısına Yönelik Dijital Oyun Uygulamaları

Öz: Çalışmada dört işlem tabanlı dijital oyun uygulamalarının matematik öğrenme güçlüğü riski taşıyan öğrencilerin temel matematik becerileri üzerindeki etkisi incelenmiştir. Bu bağlamda çalışma karma araştırma yöntemi olarak tasarlanmıştır. Nicel ve nitel yöntemler, keşfedici bir tasarım şemasını takiben iki ayrı etkileşimli aşamada kullanıldı. Araştırma, Akdeniz bölgesindeki iki ilde iki ilköğretim okulunda öğrenim gören yedi 5. sınıf öğrencisi ile yürütülmüştür. Öğrencilere ön test uygulanmış ve 10 oturumluk müdahale gerçekleştirilmiştir; son olarak uygulamadan sonra son test uygulanmıştır. Katılımcıların ön test ve son teste verdikleri cevaplar analiz edilmiştir. Nicel verilerin analizinde Shapiro-Wilk testi ve Wilcoxon işaretli sıralar testi, nitel verilerin analizinde ise betimsel analiz tekniği kullanılmıştır. Çalışma sonunda öğrenci velileri ile yarı yapılandırılmış görüşmeler yapılmıştır. Araştırma sonuçları, müdahalenin öğrencilerin akademik başarılarını olumlu yönde etkilediğini ve velilerle yapılan görüşmelerin de bu sonucu desteklediğini göstermiştir. Araştırma sonunda matematik öğrenme güçlüğü riski taşıyan öğrencilerle yapılan matematik eğitiminin sayılar ve işlemler öğrenme alanında olumlu geri bildirimler verdiği diğer öğrenme alanlarında da uygulamalar yapılmasının yararlı olabileceği söylenebilir.

Anahtar Sözcükler: Matematik Öğrenme Güçlüğü, Diskalkuli, Matematik Öğretimi, Dijital Tabanlı Öğretim, Dijital Oyunla Öğretim, Matematik Başarısı

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For some students, perceiving mathematics and achieving success in this course can be very difficult. Various factors, such as the failure of students, who are in a tangible mood, to understand the mathematics-an abstract course, the methods and techniques used by teachers, and students' mathematics anxiety are seen as the reasons for this (Mutlu & Akgün, 2019). Moreover, learning disability, whose prevalence is 10% to 20% in the world, is also a reason for experiencing difficulties in mathematics (Başar & Göncü, 2018). The most widely accepted definition of learning disability, where the level of achievement and intelligence do not go proportionally, is the difficulty in listening, speaking, thinking, reading, writing, and mathematical computing, caused by the improper development of one or more psychological processes that are fundamental in understanding and using written and spoken language (Yell et al., 2006). Learning disabilities are divided into reading difficulties (dyslexia), writing difficulties (dysgraphia), and mathematics learning difficulties (dyscalculia) (American Psychiatric Association [APA], 2013). Students with mathematics learning difficulties get lower scores and make more operational mistakes than peers with typical development (Altındağ Kumaş & Ergül, 2017; Pesova et al., 2014).

Students with mathematics learning difficulties experience difficulties in perceiving mathematical concepts and methods (National Joint Committee on Learning Disabilities [NJCLD], 2000). The criteria used for identifying such students are the child's mathematics achievement measured by standard mathematics achievement tests is at least two years behind the level of his/her age, and he/she falls within 5-10% of age-appropriate standard arithmetic achievement tests (Olkun, 2014). However, it should be noted that the mentioned criteria are not sufficient to diagnose the issue, as the intelligence tests and standard achievement tests are still not based on a general criterion (Kuruyer et al., 2019). Being at risk of mathematics learning disability (predisposition to dyscalculia) is defined as having trouble in counting quickly, estimating larger quantities, comparing quantities, using counting and different representations, and performing basic number processing tasks, as well as in the numbers and operational information (Olkun, 2014). Regarding academic failure, the absence of cognitive, psychomotor, and affective characteristics in relevant developmental areas indicates the presence of mathematics learning disability symptoms. The risk group for mathematics learning disability is students who do not have successful mathematics results and have not been diagnosed with learning disabilities (Pesova et al., 2014). Being at risk should not qualify as having a learning disability without a proper diagnosis, even if a confrontation occurs. At-risk students are likely to need many types of support and services, but they do not have the difficulties and diagnoses that require an Individualized Education Program (IEP).

Many at-risk or typical students make systematic and consistent mistakes when solving story problems. Teachers often assume them as careless mistakes. However, this may not always be the case. Therefore, it is essential to identify operational errors to provide effective teaching that addresses different student needs (Ashlock, 2010). Studies in the literature reveal that children with mathematical difficulties make more mistakes than those with typical development in arithmetic calculations (Andersson, 2010; Hanich et al., 2001; Geary, 2004; Geary et al., 2007; Jordan & Hanich, 2000; Jordan et al., 2003). The National Council of Teachers of Mathematics (NCTM, 2000) considers computation one of the mathematics curriculum's critical skills. It is reported that students would experience difficulties in other areas of mathematics if they do not gain proficiency in computation skills (Riccomini, 2005; Tolar et al., 2009).

Analyzing error patterns in students' four-operation skills is a valuable assessment tool. In this way, appropriate and effective interventions will be better planned by identifying the error patterns of the students, and equal opportunities will be provided for all students to be successful in mathematics (Luneta & Makonye, 2010; Riccomini, 2005). If these error patterns or misconceptions are not corrected at an early stage of learning, they may become permanent and affect students' acquisition of higher-level mathematical skills (Ashlock, 2010; Khan & Chishti, 2011). The early identification of error patterns through error analysis and the creation of necessary intervention plans is a way to reduce performance differences, especially those between students with mathematical difficulties and those with typical development (O'Connell, 1999).

The most common errors that occur in four operations (Jordan & Hanich, 2000) are shown in Table 1.

Table 1. Common errors that occur in four operations

Error Type	Examples
The wrong operation - making a different operation instead of the actual one	6 x3 2
Miscalculation - getting the wrong result.	34 +53 88
Concept of zero - errors made regarding the value of zero in operations	34 +50 80
Subtracting the lesser number from the greater number	34 −56 22
Misunderstanding of place value - computation made without considering place value	10 + 9 91
Omission - not answering the question, leaving it halfway, or answering randomly	-

The chance of learning can be increased by using different and effective methods for students at all levels (Cohen et al., 2007). Digital-based instruction is a method used in mathematics teaching. The use of computer games as an educational tool attracts the attention of many researchers (Prensky, 2001). Educational computer games provide convenience to reach the goals in the curriculum (Akpınar, 1999). In addition, educational computer games reduce anxiety and fears, provide freedom in the classroom, and create an enjoyable environment (Akın & Atıcı, 2015). According to Mowery (2019), assistive technology is an effective resource for motivating at-risk students. Students love technology, so providing them with the opportunity to use it at school can help them stay engaged and excited.

Students learn better when active and in control of the process (Akın & Atıcı, 2015). Doing frequent practices has positive results in students with special learning difficulties to reduce the effect of slow working memory (Mousavi et al., 2012). As they allow all these, digital-based instruction and computer-based games are thought to be helpful in the education of students who have learning difficulties in reading, writing, and mathematics (Alakoç, 2003; Ke & Grabowski, 2007; Kebritchi et al., 2010). However, the effect of educational computer applications on the development of the academic skills of students at risk of mathematics learning disability was not adequately analysed in the literature (Benavides-Varela et al., 2020).

Educational and potentially mouldable technological factors should be used for permanent mathematics learning of children at risk of learning disabilities who fall behind their peers (Morgan et al., 2016). As it is widely known, in many studies, multi-sensory teaching strategy among the four experimentally validated teaching strategies aimed at ensuring that students with significant learning difficulties receive appropriate assessment and intervention services, explaining their learning characteristics and increasing teaching intensity proves the importance of teaching mathematics with digital games (Witzel & Mize, 2018). Therefore, digital-based interventions are appropriate for assisting children with specific mathematical needs and providing them with additional opportunities to perform mathematical tasks in an alternative technological context (Mohd Syah et al., 2016; Benavides-Varela et al., 2020). The application of digital games in children with dyscalculia for 15 minutes a day for two weeks provided significant results (Walcott & Romain, 2019). It has been concluded that digital games and technology facilitate both mathematics teaching and reinforcement (Çay et al., 2020). However, there are also studies on the negative effects of digital games on children. Although digital games have educational, social, and therapeutic benefits, studies have been conducted can lead to digital game addiction when played uncontrolled and aimlessly (Griffiths, 2008; Keskin & Aral, 2021), that they spend less time on their academic studies (Dikmen et al., 2022) and that their academic achievements may decrease (Schulz van Endert, 2021). In the study conducted by Delebe (2020) on the subject and in which 505 secondary school students participated, digital game addiction and academic success were associated, it was seen that there was an inversely proportional relationship between students' game addiction and academic success. In their study examining the effect of computer games on students' learning, Akın and

Atıcı (2015) reported that educational computer games reduce anxiety and fears and create an enjoyable classroom environment that provides freedom. Another study concluded that frequent practice had positive results on accelerating the slow working memory of students with special learning difficulties (Mousavi et al., 2012). Number disorientation and arithmetic processing confusion, which are common in children with dyscalculia, are significantly reduced by intervention with computer games (Mohd Syah et al., 2016). Digital-based instruction and computer-based games can be helpful, especially in the education of students with learning difficulties (Kebritchi et al., 2010). This literature review shows that the studies in the literature often include students with learning difficulties; the effect of educational computer applications on at-risk students' development of academic skills has not been analysed sufficiently.

In recent years, the awareness of learning disabilities and mathematics disability, which is a part of it, has been observed to increase gradually in Turkey and the world (Acar & Hiğde, 2018; Aydın, 2021; Koç & Koç, 2019; Mutlu et al., 2022; Öztürk et al., 2019). On the other hand, there are various problems in diagnosing and intervening learning and mathematics difficulties in Turkey. In Turkey, there are a limited number of tools for diagnosing mathematics difficulties due to the little knowledge of the concept of mathematical difficulties, and many of the students continue their education only under the diagnosis of learning disability. When individuals are diagnosed with mathematical difficulty, they usually cannot get enough support to implement an intervention program (Ketenoğlu Kayabaşı, 2019). Another problem is that teachers receive insufficient training on mathematics difficulties during their undergraduate education and in-service training (Baldemir et al., 2022; Kuruyer et al., 2019).

According to Vygotsky, knowledge is made sense of and interpreted in socio-cultural environments. For effective problem solving, students cannot learn mathematics by watching. Students need to interact directly with their environment and participate both physically and mentally. Only in this way - through concrete experiences - can students construct their own concepts (Olkun & Toluk, 2003). Studies have shown that knowing and learning mathematics is a social and cultural process (Cobb et al., 1997; Cobb & Baursfeld, 1995). In recent years, due to the pandemic and natural disasters, face-to-face education has been interrupted and education was carried out online. In recent years, many successful or promising educational technology applications have been developed for mathematics intervention programs. Studies show that digital-based interventions have a moderate but significant positive impact on mathematics (Benavides-Varela et al., 2020). Digital-based interventions for children with math learning difficulties resulted in higher math achievement compared to control groups (e.g., face-to-face instruction, paper, and pencil exercises, etc.) (Li & Ma, 2010). Furthermore, it seems more effective to use video games to increase the effectiveness of math interventions in dyscalculic children (Bevavides-Varela et al., 2020). Video games can also be used in mathematics education, linking entertainment with educational goals, and teaching the subject by encouraging children's desire to win (Stultz, 2013). Video games can be used not only to alleviate visible difficulties, but also to support fundamental weaknesses that may go unnoticed.

This experimental study examines the effect of a digital-based intervention program on the basic math skills of students who are at risk of mathematics learning difficulties. The study aimed to improve at-risk children's mathematics skills through digital-based intervention and increase teachers' awareness of the applications related to the mathematics learning difficulty. As the literature is reviewed, (Terzioğlu et al., 2019; Kunwar et al., 2021; Öztürk et al, 2019) this study is also considered important in filling the lack of intervention programs for children at risk of mathematics learning difficulties. During the 2020-2021 academic year the education was carried out through distance education due to the COVID-19 pandemic. Due to the transition to distance education in the COVID 19 pandemic, it has become difficult for students with learning difficulties to access information (Filiz & Güneş, 2022; Görgün & Balıkçı, 2021). The obligation to transfer education to the digital environment interactively has arisen. From this point of view, the study was thought to contribute to distance education in a period where its importance is gradually increasing.

Method

Research Design

This study was conducted using a mixed research method, in which quantitative and qualitative research methods are used simultaneously or sequentially. The results obtained from quantitative and qualitative research are then combined and interpreted (Patton, 1990; Tashakkori & Tedlie, 2003). The quantitative and qualitative parts of the study were carried out in two separate interactive stages according to the explanatory design scheme. Firstly, quantitative data and then qualitative data were collected and analysed. (Patton, 1990; Tashakkori & Tedlie, 2003).

Quantitative data were analysed in SPSS 22. Based on the research questions, the number of correct operations, types of errors, and the number of errors in four-operation questions before and after the intervention were compared using descriptive analysis.

In the qualitative part of the study, semi-structured interviews were conducted with the parents of the students. Interview questions were prepared by the researchers. Expert opinions were obtained from three experts holding a PhD degree in special education and one expert holding a PhD degree in Turkish Education. The questions were rewritten according to the suggestions of the experts' and were ready for implementation. Two questions were asked to determine opinions of the parents' about the digital-based intervention program. These are;

1. What do you think about the provided training?
2. What difficulties did you and your child face during the training?

7 parents, consisting of 2 fathers and 5 mothers, participated in the study. Data was collected by phone calls and recorded. The researchers explained the purpose of the study to the parents, stating that they should answer the questions sincerely during the interview to achieve this purpose. The interviews lasted between 4 minutes 3 seconds and 18 minutes 34 seconds.

Sample Group

The study was carried out with seven students at risk of mathematics learning disabilities, continuing their 5th-grade education in two state secondary schools in the Mediterranean region of Turkey. Before starting the research, the ethics committee decision and necessary permissions from Provincial Directorate of National Education were obtained. Criterion sampling, one of the purposive sampling techniques, was used in the sample selection. A teacher questionnaire was administered to the teachers who play a critical role in the preliminary identification of students with mathematics learning difficulties. A readiness test based on 4th and 5th-grade achievements was applied to the students identified by the teachers. Students below the average were selected and included in the study. All the students participating in the research are 11 years old, three of them are girls and four of them are boys. Six of the fathers are working, one is retired. One of the mothers is a worker, one is a farmer, and the other 5 are not working. While the average age of fathers is 40, the average age of the mothers is 38.8.

Data Collection Tools

Teacher Questionnaire

It is a 35-item form prepared for elementary math teachers in line with experts' opinions (3 experts in special education and 3 experts in mathematics education) to identify students at risk of mathematics learning difficulties. The survey determined whether the achievements of the 4th-grade (1st and 2nd semester of the 2019-2020 academic year) and 5th-grade mathematics course (until December of the 2020-2021 academic year) were gained according to the teachers' opinion. The "Lawshe technique" was used for the content validity of the items. The Lawshe technique requires a minimum of 5 and a maximum of 40 expert opinions. Expert opinions on each item; “the item measures the targeted construct”, “the item is related to the construct but unnecessary”, It is graded as “the item does not measure the targeted construct”. “In addition to content validity, expert opinions can be graded for purposes such as the intelligibility of the item and its suitability for the target audience. In this way, the opinions of the experts on any item are collected and the content validity rates are obtained. Content validity ratios (CVR) are obtained by the ratio of the number of experts expressing their "required" opinion on any item to the total number of experts expressing their opinion on the item, minus 1" (Yurdugül, 2005). In this study, since the opinions of 15 experts were taken, the Scope Validity Criterion was considered as "0.62". The questionnaire was completed for all 5th grade students in schools identified by the researchers who were considered to be at risk of learning difficulties in mathematics.

Readiness Test

10 students, determined by the opinions of teachers and experts, were subjected to the readiness test prepared according to the 4th and 5th grade achievements. The test, which consists of 25 questions, was prepared by taking expert opinions (three elementary school mathematics teachers, three academicians) to determine the 4th and 5th grade achievements of the students. The test was conducted as a pilot application to a group of 20 people and the results were examined. 5 questions were removed from the test and reliability analysis was conducted for the remaining 20 questions. The KR-20 value in the application question was found to be 0.76. The test was personally administered by the researchers. When the test results were evaluated, it was decided that the students who fell below 50 points were at risk of learning difficulties in mathematics, and the sample was determined as 7 people.

Pre-Test, Post-Test

It is a test consisted of 24 questions, applied before and after the intervention. It was created by taking experts' opinions (2 secondary school mathematics teachers, 2 academicians). 2 researchers reviewed the questions prepared according to the grade level of the children three times. The first time, the questions were reviewed, and some questions inappropriate for the grade level were eliminated. Questions requiring written operations were placed on a single page in a vertical format. A total of 6 questions were prepared, 3 of which were addition and subtraction problems, and 3 were multiplication and division problems. The specified error types were taken into consideration while preparing the questions. More than one type of error might occur in a question. The error list was created in the error analysis process by considering the error types specified in the literature (Table 2). Researchers have administered the tests.

Table 2. Error list

Error Types
Wrong operation
Miscalculation
Concept of zero
Subtracting the lesser number from the greater number
Misunderstanding of place value
Omission
Total Number of Errors

(Jordan & Hanich, 2000)

Implementation

In the implementation phase, the mathematics curriculum was reviewed first. The games suitable for the 4th and 5th grade mathematics curriculum achievements were identified to determine digital educational games to be used in the study. Universal design model was used in the process of choosing the games so that the chosen game can be played by every individual easily (King-Sears, 2009, as cited in Alkan, 2021).

In the process of the game selection, allocated time for each game, the game's appropriateness for their age, not being sexist, not being violent, being entertaining and instructive, and including target achievements were carefully decided. One of the online mathematics games containing self-evaluation and feedback is mathplayground.com. That site contains more than 100 online mathematics games online for kinder garden until sixth grade students. The mathematics game materials are multiple diverse, addition and subtraction games, multiplication games and activities and division games. At the same time, there is material for self-evaluation and feedback systems in this online mathematics game. These systems are very crucial for teachers for portfolio assessment, which shows the progress of the students. In addition, game content was primarily related to the subject, and at the same time, the elements of the games made the games seem visually better. Then, it was decided which games to be used in the study by taking experts' opinions (2 academicians who are experts in their fields and 2 teachers). A 10-day implementation plan has been prepared for these games. Before the implementation, the researchers ran the games and tried to spot potential problems. The first and second games was about finding the sum of two single digit numbers. The third game was about the sum of 2 two-digit numbers. The fourth game was about subtraction with single digit numbers. The fifth game was about multiplying two single digit numbers. The sixth game was about finding the other factor when given one of the factors of the chosen number (like 12, 18). The seventh game was about dividing a two-digit number by a one-digit number. The eighth game was a fun game about guessing the outcome of the given operation. The ninth game was a game of marking the factors of the given number from the matrix type table. The tenth game was the game of finding the difference of single digit numbers.

Table 3. Implementation order of digital games

Day	Games
1	https://www.mathplayground.com/ASB_JetSkiAddition.html
2	https://www.mathplayground.com/ASB_JetSkiAddition.html
3	https://www.mathplayground.com/ASB_Canoe_Puppies.html
4	https://www.mathplayground.com/ASB_MinusMission.html
5	https://www.mathplayground.com/ASB_PenguinJumpMultiplication.html
6	https://www.mathplayground.com/math_lines_multiplication.html
7	https://www.mathplayground.com/ASB_Pony_Pull_Division.html
8	https://www.abcya.com/games/math_man
9	https://www.mathplayground.com/multiplication_blocks.html
10	https://www.mathplayground.com/ASB_Sailboat_Subtraction.html

Students played games on their tablets or mobile phones in their homes under the supervision of researchers. The students participating in the research could understand the English words in the games (Figure 1, Figure 2).

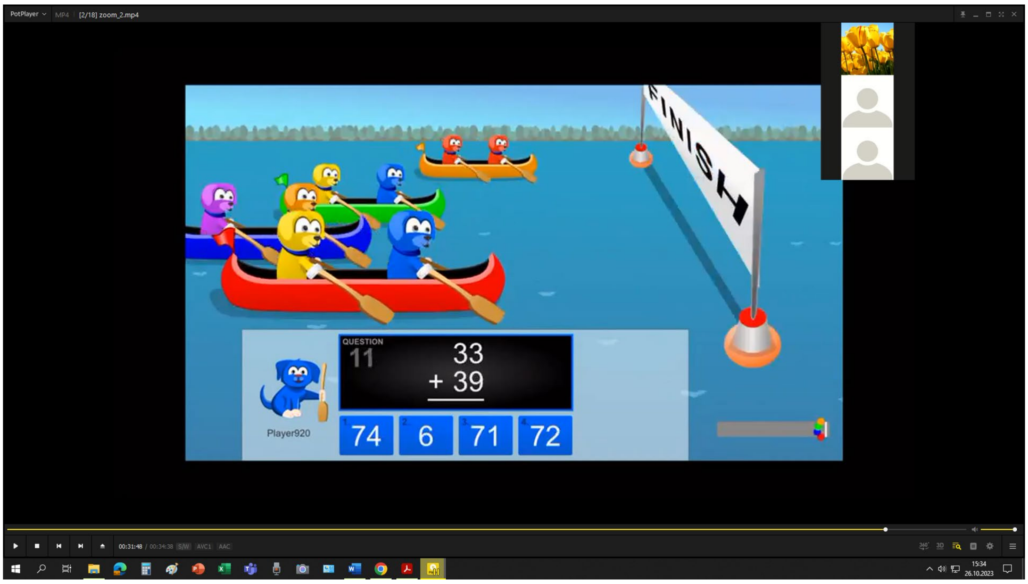

Figure 1. Examples about addition games (https://www.mathplayground.com/ASB_Canoe_Puppies.html)

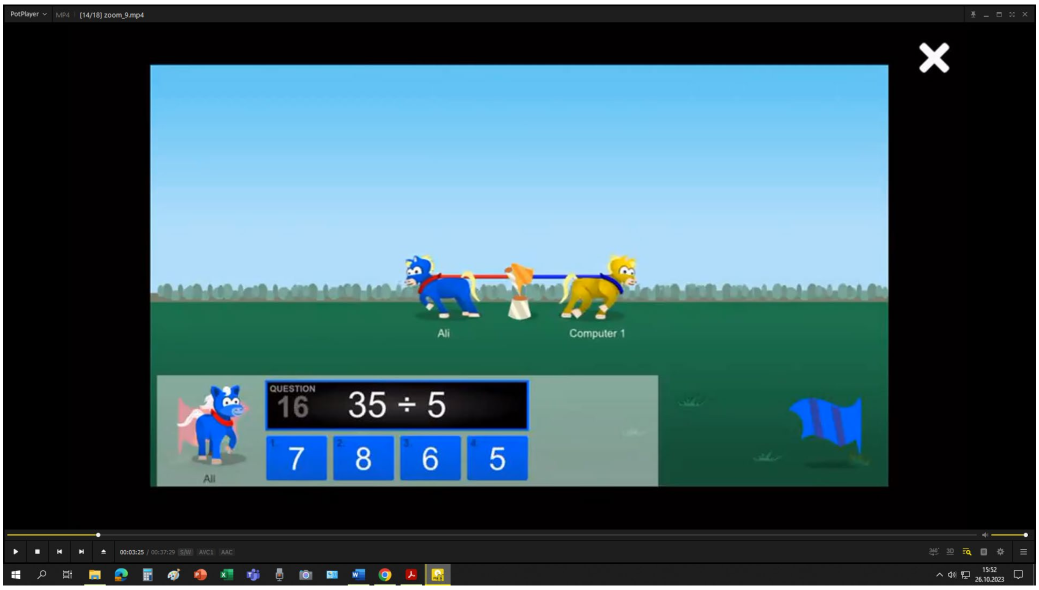

Figure 2. Examples about division games (https://www.mathplayground.com/ASB_Pony_Pull_Division.html)

However, before starting the game, researchers provided information about it, played it a few times, and clarified the points that were not understood (because the games were in English). Students were asked to note the scores they obtained while playing the game, ensuring that they sufficiently practiced (30-40 minutes). Then, the operation questions answered by the students were examined to determine whether they contained the errors in the list given in Table 2. Then, each operation performed by the students was analysed. The number and types of errors and the correct number of operations were determined regarding the errors described above. Since the number of students was small, item analysis was not performed, and expert opinion was sought. After the error analysis of all questions, reliability checks were made. Inter-observer reliability was calculated from the formula (Reliability: Agreement / (Agreement + Disagreement)). The reliability was found to be 98%. The two raters discussed several disagreements and reached a consensus (Miles & Huberman, 1994).

Data Analysis

Analysis of Quantitative Data

A readiness test consisting of 20 questions covering the 4^{th}- and 5^{th}-grade mathematics curriculum was applied to 10 students who were thought to have mathematics learning difficulties by their mathematics teachers. The students answered open-ended questions; then, the 2 researchers evaluated the questions separately and compared the results. Differently evaluated questions were reviewed and agreed upon. Since the number of participants was small, item analysis was not performed, and expert opinion was sought. Readiness test scores ranged between 7 and 77 out of 100 (Table 3). The cut-off point of the open-ended questions in the readiness test was determined by the expanded Angoff method. The experts decided on the student's score for satisfactory-unsatisfactory answers, considering the criteria in the rubric for each item in the test. In this process, they used the expert opinion form developed by the researchers. There are 2 sections in the expert opinion form to indicate students' scores for satisfactory-unsatisfactory answers for each item. The experts expressed their opinions in two different stages; thus, they filled one of the sections reserved for the items at each stage. Quantitative data obtained from the extended Angoff standard-setting method were analysed. The experts estimated how many points the students at the border of satisfactory-unsatisfactory could get for each item and noted the estimation results. The arithmetic mean of the scores given by the experts was calculated for each item. The sum of these arithmetic means gave the cut-off score. As a result of the evaluation, it was decided to include seven students who scored 50 (cut-off point) and below in the readiness test (Table 4).

Table 4. Readiness test result

Student	Score
S1	7
S2	14
S3	14
S4	28
S5	35
S6	35
S7	42
S8	53
S9	56
S10	77
Mean	36.10

Pre-test/post-test was applied to 7 students included in the study. The test, consisting of 20 questions, was prepared by considering the achievements in the numbers and operations learning domain of the 5th-grade mathematics curriculum. After preparation, the opinions of expert mathematics teachers and academicians were taken. The mean of the pre-test was 37.14, and the mean of the post-test was 51.71 (Table 5).

Table 5. Pre-test / Post-test results

Student	Pre-test	Post-test
S2	55	50
S3	25	60
S4	35	45
S5	35	40
S7	35	55
S1	33	40
S6	42	72
Mean	37.14	51.71

However, since the pre-test was not normally distributed and the number of people was very small, the Wilcoxon signed-rank test, which is a non-parametric parametric method, was used in the analysis of the data. According to the results of the Shapiro-Wilk test the p-value was .26 and the skewness value of the pre-test data was 1.13, the kurtosis value was 2.29; so, the pre-test data was not normally distributed. Normality was checked with the Shapiro wilk and kurtosis coefficients. the skewness value of the post-test data was 0.80, the kurtosis value was 0.03. According to the results of the Shapiro-Wilk test p-value was .56, so the data was normally distributed.

Analysis of Qualitative Data

Descriptive analysis, one of the qualitative data analyses, was used to analyse the data. In the descriptive analysis, the data are summarized and interpreted according to the previously determined themes (Yıldırım & Şimşek, 2011). In this study, the themes were determined beforehand based on the questions asked about the digital-based intervention program. The parents participating in the study were coded as S1, S2, S3, ... according to their children's codes. Their opinions are presented in the findings section. The data obtained from the written form were analysed and coded separately by the researchers. For the consistency of the codes used by the researchers, the agreement of opinion was checked, and the reliability of the study was calculated by applying the Miles and Huberman formula (1994) [Reliability: Agreement / (Agreement + Disagreement)], and the reliability of the study was found to be 89%. The agreement between expert and researcher evaluations being close to 90% indicates the desired level of reliability (Miles & Huberman, 1994). To ensure the confirmability of the study, direct statements from the participants were included.

Findings

Quantitative Findings

Table 6. *Descriptive* analysis of Pre-Test and Post-Test

	Pre-test		Post-test	
Error types	N	%	N	%
Wrong operation	6	24	0	-
Miscalculation	3	12	2	25
Concept of zero	6	24	3	37.5
Subtracting the lesser number from the greater number	1	4	1	12.5
Misunderstanding of place value	3	12	0	-
Omission	6	24	2	25
Total Number of Errors	25	100	8	100
Number of Correct Operations	29	48.33	45	75.0

Regarding the results in Table 6, the number of correct operations of the students before the intervention was 29 out of 60, and it increased to 45 after the intervention. The most common mistakes before the intervention were incorrect operation, errors related to "zero," and leaving the process unfinished/blank. After the intervention, incorrect operation and misunderstanding of place value did not occur.

Table 7. Non-Parametric Wilcoxon Signed Ranks test table

		N	Mean Rank	Sum of Ranks	z	p
Post-test Score-Pre-test Score	Negative Ranks	0[a]	.00	.00	-2.371	.018
	Positive Ranks	7[b]	4.00	28.00		
	Equal Ranks	0[c]				
	Total	7				

Table 8. Distribution of errors by operations

	Pre-test				Post-Test			
	Addition	Subtraction	Multiplication	Division	Addition	Subtraction	Multiplication	Division
Wrong operation	1	2	3	-	-	-	-	-
Miscalculation	-	-	1	1				
Concept of zero	1	2	1	2	-	-	1	2
Subtracting the lesser number from the greater number	-	1	-	-	-	1	-	-
Misunderstanding of place value	-	-	3	-	-	-	-	-
Omission	-	-	3	3	-	-	-	2

Regarding the pre-test data in Table 8, the errors were concentrated in the multiplication and division operations. Errors related to the concept of zero were seen in all operations in the pre-test, but they only appeared in division and multiplication after the intervention. Misunderstanding of place value error was only seen in the multiplication before the intervention.

Qualitative Findings

General Thoughts on The Training

All the parents participating in the study (S1, S2, S3, S4, S5, S6, S7) stated that they were very satisfied with the training and would like to participate again. All parents said that their children both played games and did mathematical operations during the training, and thus they never got bored in this process. Most parents (S4, S3, S6, S5, S2, S7) pointed out that their children gained practicality in mathematical operations and used the operations in daily life. In addition, most parents (S4, S6, S5, S2, S7) stated that their children's self-confidence in mathematics and motivation to study increased. S7's mother said that her child's situation set an example for her siblings and positively affected them. In addition, most parents (S6, S5, S2, S7) stated that they allowed their children to play games on tablets and phones for a certain period. They were pleased that their children played educational games such as this under the supervision of a teacher.

Regarding the subject, S6's father said, "*She has a mobile phone, but we still give limited technology to my daughter. Let my daughter play educational games under the control of teachers.*"

S5's father expressed his thoughts as "*...for the first time I saw that tablet and computer can be useful. So, I am not dissatisfied. I have never seen him play educational games on the computer before*."

S2's mother said, "*We saw a difference in the child; for example, when we went to the grocery store, he could not make simple calculations in his mind before, he was constantly finger-counting, now it has gotten a little faster*."

Difficulties Encountered in The Training Process

Most of the parents participating in the study stated that technical problems arose from the tablet and the internet during the training (S4, S6, S7, S2, S1). The remaining parents (S3 and S5) said they did not encounter any difficulties. The opinions of the parents on the subject are given below.

S6's father expressed his thoughts as, "*The only problem that we had was related to the internet connection, the tablet; we didn't receive the sound, we couldn't make ourselves heard. We had these kinds of simple technical problems*."

S3's mother said, "*No, we did not have any problems, there was no problem, neither for my child nor for me. It was excellent.*"

Conclusion, Discussion, and Recommendations

The incorrect operation was the most frequent error type in the study before the intervention. Incorrect operation errors indicate that children have difficulty switching from one operation to another (Jordan & Hanich, 2000). This error was reported to be usually associated with poor counting strategy (Geary, 1996; Geary et al., 2000), careless behavior (Hecht & Vagi, 2010), or visuospatial errors (Raghubar et al., 2009). Another common type of error has emerged from the concept of place value. Like previous studies, students who had mathematical difficulties before the intervention had failed to understand the concept of place value while performing multi-digit operations (Jordan & Hanich, 2000; Raghubar et al., 2009). Students made mistakes such as moving the carry to other places, borrowing tens, and subtracting the lesser number from the greater one in any case instead of borrowing ten while subtracting a greater number from a lesser one. Students often counted on the fingers at the beginning of the intervention; however, they reduced it towards the end. The findings coincide with the results of Öztürk et al. (2019)'s research which analyses the effects of the application of number talks to the students and the development of sense of number in these secondary school students. After the intervention, a decrease was observed in students' operational errors. Students were also asked to express their answers aloud during the intervention. They immediately corrected some errors while reading and answering the questions aloud. This fact is parallel to the findings of Öksüz and Gürefe (2021) who stated that students could see the simple mistakes they make if they were encouraged to speak. Öksüz and Gürefe aimed to analyse the socio-mathematical norms that the teachers try to set up in the classroom. At the end of the study, the opinions of both students and parents about the intervention were positive, which can be interpreted as qualitative and quantitative findings supporting each other.

The importance of digital game-based learning, an innovative approach that allows students to gain the targeted gains in education through computer technologies, is increasing day by day (Kimet al., 2009, as cited in Gök, 2021). Studies in the last decades have shown the positive effect of digital applications on students' math skills (Benavides-Varela et al., 2020). Various studies determined that learning with digital-based games is fun, ensures focusing on the task, motivates students, and increases achievement (Byun & Joung, 2018; Chen et al., 2012; Çankaya & Karamete, 2009). Digital-based applications help children reach their potential, as they allow them to leverage their strengths and bypass areas of difficulty. Being interested in children, computer and game-based learning activities increase their intrinsic motivation (Hassinger-Das et al., 2017). Using games in mathematics instruction has a moderately positive effect on academic achievement in Turkey.

Computer games have advantages such as enhancement and improvement by continuing to play at school or home (Turgut & Doğan Temur, 2017). Besides, children who have difficulties with math skills are overly dependent on their parents, siblings, friends, and teachers for help with their homework. Using digital-based instruction may also enable children to experience success by working independently (Stanberry & Raskind, 2009). Therefore, all these explain the decrease in children's errors and the increase in the number of correct operations after the intervention. The teaching activities of mathematics teachers are generally shaped around a fixed curriculum and according to the average level of the class. Studies have shown that students at risk of mathematics learning are more cheerful when learning with a digitally designed curriculum instead of notebooks, books, pencils (Higgins et al., 2016). As the applications and games in the form of software improve these students' sense of numbers, they can also be used to increase students' speed and accuracy (Walcott & Romain, 2020). In addition, according to Walcott and Romain (2020), these students should continue their education by playing digital games alone in their spare time, improving their addition and subtraction skills. Teachers' use of digital games can also significantly reduce the common confusion among students in the math risk group (Mohd Syah et al., 2016). For this reason, it is of great benefit for teachers and students to consider educational digital games not only as a game but also as an essential supplementary curriculum or complementary curriculum for some student groups (Korkusuz & Karamete, 2013).

If the contents of digital games are well matched with course outcomes, they can be very beneficial for students (Ocak, 2013). In addition to increasing the cognitive, affective, and motor skills of the students, digital games can also contribute to the development of the student's information technology skills. Digital games provide information, reminders, memorization, etc. It can enable the giving of facts, rules, and practical examples. Digital games give students the opportunity to make mistakes, allowing students to find the truth from their mistakes. Having the opportunity to make mistakes can also increase the motivation of the student. Digital games allow students with introspective thinking to show the entire process of information processing steps. In this way, students will have the opportunity to perceive the difficult or difficult to understand subject easily (Felicia, 2009).

The findings of the study show that digital game-based intervention positively affected the achievement of students at risk of math learning difficulties. Thus, it can be concluded that digital-based interventions may be appropriate tools that can help children with specific mathematical needs and provide additional opportunities for them to perform mathematical tasks in a technological context as an alternative. The use of digital learning materials by parents and children will continue to expand in the coming years as access to and availability of new technologies increases. However, further research is needed to determine the effectiveness of digital interventions and the positive and negative feedback.

Digital-based instruction can be an effective intervention in mathematics for students at risk of learning disabilities. For the intervention to be effective, it is recommended to implement it with teacher interaction and combine it with other interventions. As a result of the study, it can be said that digital-based instruction supports the mathematics skills of students at risk of mathematics difficulties. However, the extent of digital-based game applications was not clarified in the study (i.e., as a primary teaching tool or in addition to classroom teaching). Therefore, additional studies are needed to test the intervention's effectiveness and support traditional classroom instruction.

The lack of a complete experimental design and the absence of a control group limits the generalization of this study's results. One of the limitations is that two schools from the provincial center and one from a district center participated in the study. Another limitation may be that the students were selected from socio-economically middle level families. For future studies, it is crucial to analyse which effects are due to the intervention and which are due to general attention or other motivational factors. The study was carried out with seven 5th-grade students for ten days. Future studies should be conducted with more students and different class groups should last longer, and the permanence of the interventions should be tested.

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References

Acar, E., & Hiğde, A. (2018). Matematik öğrenme güçlüğüne sahip ilkokul öğrencisinin sınıf ortamında incelenmesi. *Batı Anadolu Eğitim Bilimleri Dergisi, 9*(2), 102-119.

Akın, F. A., & Atıcı, B. (2015). Oyun tabanlı öğrenme ortamlarının öğrenci başarısına ve görüşlerine etkisi. *Turkish Journal of Educational Studies, 2*(2), 75-102.

Akpınar, Y. (1999). *Dijital tabanlı eğitim ve uygulamalar.* Anı Publishing.

Alakoç, Z. (2003). Technological modern teaching approaches in mathematics teaching. *The Turkish Online Journal of Educational Technology, 2*(1), 43-49.

Alkan, S. (2021). Matematiksel dijital oyun tasarlama ve oyun mekanikleri. M. Taştepe ve N.C. Aksoy (Ed.), *Oyun ve matematik eğitimi* içinde (ss.319-340). Nobel Yayınları.

Altındağ Kumaş, Ö., & Ergül, C. (2017). Examination of addition and subtraction performances of students with and without learning disabilities. *International Online Journal of Educational Sciences, 9*(3), 806-820. https://doi.org/10.15345/iojes.2017.03.016

American Psychiatric Association [APA]. (2013). *Diagnostic and statical manual of mental disorders (DSM-5)*. American Psychiatric Publishing.

Andersson, U. (2010). Skill development in different components of arithmetic and basic cognitive functions: Findings from a 3-year longitudinal study of children with different types of learning difficulties. *Journal of Educational Psychology*, *102*(1), 115-134. https://doi.org/10.1037/a0016838

Ashlock, D. (2010, August). Automatic generation of game elements via evolution. In *Proceedings of the 2010 IEEE Conference on Computational Intelligence and Games* (pp. 289-296). IEEE. https://ieeexplore.ieee.org/abstract/document/5593341

Aydın, A. (2021). Activity for teaching mathematics for students with learning disabilities with analogy method: Division with and without a remainder topic. *Journal for Mathematics Education and Teaching Practices, 2*(1), 41-46.

Baldemir, B., İç, Ü., & Tutak, T. (2022). İlköğretim matematik öğretmen adaylarının diskalkuliye ilişkin görüşleri. *Bolu Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi, 22*(1), 485-505. https://dx.doi.org/10.17240/aibuefd.2022..-998739

Başar, M., & Göncü, A. (2018). Clearing misconceptions of primary school teachers about learning disabilities and evaluation of teacher opinions. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *33*(1), 185-206. https://doi.org/10.16986/HUJE.2017027934

Benavides-Varela, S., Callegher, C. Z., Fagiolini, B., Leo, I., Altoe, G., & Lucangeli, D. (2020). Effectiveness of digital-based interventions for children with mathematical learning difficulties: A meta-analysis. *Computers & Education*, *157*, 103953. https://doi.org/10.1016/j.compedu.2020.103953

Byun, J., & Joung, E. (2018). Digital game-based learning for K–12 mathematics education: A meta-analysis. *School Science and Mathematics*, *118*(3-4), 113-126. https://doi.org/10.1111/ssm.12271

Chen, Z. H., Liao, C. C., Cheng, H. N., Yeh, C. Y., & Chan, T. W. (2012). Influence of game quests on pupils' enjoyment and goal-pursuing in math learning. *Journal of Educational Technology & Society*, *15*(2), 317-327.

Cobb, P., & Bauersfeld, H. (1995). *The emergence of mathematical meaning: Interaction in classroom cultures.* Psychology Press.

Cobb, P., Gravemeijer, K., Yackel, E., McClain, K., and Whitenack, J. W. (1997). Mathematising and symbolizing: the emergence of chains of signification in one first-grade classroom. In D. Kirshner & J. A. Whitson (Eds.), *Situated cognition: Social, semiotic, and psychological perspectives* (pp. 151–233). Lawrence Erlbaum Associates, Inc.

Cohen, L., Manion, L., & Morrison, K. (2007). Observation. *Research Methods in Education, 6*, 396-412. https://doi.org/10.4324/9780203029053

Çankaya, S., & Karamete, A. (2009). The effects of educational computer games on students' attitudes towards mathematics courses and educational computer games. *Procedia-Social and Behavioral Sciences*, *1*(1), 145-149. https://doi.org/10.1016/j.sbspro.2009.01.027

Çay, E., Yıkmış, A., & Sola Özgüç, C. (2020). Experiences and opinions of special education teachers regarding the use of technology. *Journal of Qualitative Research in Education, 8*(2). https://doi.org/10.14689/issn.2148-624.1.8c.2s.9m

Delebe, A. (2020). *Ortaokul öğrencilerinde dijital oyun bağımlılığı ile bazı fiziksel parametreler ve akademik başarı durumları arasındaki ilişkinin incelenmesi* [Unpublished master's thesis]. Ömer Halisdemir Üniversitesi.

Dikmen, M.; Tuncer, M., & Vural, M. (2022). The relationship between digital game addictions and academic achievements of high school students. *International Social Mentality and Researcher Thinkers Journal, 8*(58), 684-693. http://dx.doi.org/10.31576/smryj.62163

Felicia, P. (2009). *Digital games in schools: Handbook for teachers*. European Schoolnet.

Filiz, T., & Güneş, G. (2022). Öğrenme güçlüğü yaşayan ilkokul öğrencilerinin pandemi sürecindeki matematik öğrenme ve öğretme deneyimlerine bir bakış. *e-Kafkas Journal of Educational Research, 9*(1), 20-50. https://doi.org/10.30900/kafkasegt.990761

Geary, D. C, Hoard, M. K, Byrd-Craven, J., Nugent, L., & Numtee, C. (2007). Cognitive mechanisms underlying achievement deficits in children with mathematical learning disability. *Child Development, 78*(4), 1343-1359. https://doi.org/10.1111/j.1467-8624.2007.01069.x

Geary, D. C. (1996). Sexual selection and sex differences in mathematical abilities. *Behavioral and Brain Sciences. 19*(2), 229-247. https://doi.org/10.1017/S0140525X00042400

Geary, D. C. (2004). Mathematics and learning disabilities. *Journal of Learning Disabilities, 37*(1), 4-15. https://doi.org/10.1177/00222194040370010201

Geary, D. C., Saults, S. J., Liu, F., & Hoard, M. K. (2000). Sex differences in spatial cognition, computational fluency, and arithmetical reasoning. *Journal of Experimental Child Psychology, 77*(4), 337-353. https://doi.org/10.1006/jecp.2000.2594

Gök, M. (2021). Dijital Oyun Tabanlı Öğrenme: tanımı, modelleri ve matematik eğitimde bir örnek uygulama. M. Taştepe ve N.C. Aksoy (Ed.), *Oyun ve matematik eğitimi* içinde (ss.351-365). Nobel Yayınları.

Görgün, B., & Balıkçı, Ö. (2021). COVID-19 salgınında özel öğrenme güçlüğü olan bireylere, ailelerine ve öğretmenlerine sunulan destekler. *İnönü Üniversitesi Eğitim Fakültesi Dergisi, 22*(2), 988-1014. https://doi.org/10.17679/inuefd.929520

Griffiths, M. D. (2008). Videogame addiction: Further thoughts and observations. *International Journal of Mental Health and Addiction, 6*(2), 182-185. https://doi.org/10.1007/s11469-007-9128-y

Hanich, L. B., Jordan, N. C., Kaplan, D., & Dick, J. (2001). Performance across different areas of mathematical cognition in children with learning difficulties. *Journal of Educational Psychology, 93*(3), 615-626. https://doi.org/10.1037/0022-0663.93.3.615

Hassinger-Das, B., Toub, T. S., Zosh, J. M., Michnick, J., Golinkoff, R., & Hirsh-Pasek, K. (2017). More than just fun: A place for games in playful learning. *Journal for the Study of Education and Development, 40*(2), 191-218. https://doi.org/10.1080/02103702.2017.1292684

Hecht, S. A., & Vagi, K. J. (2010). Sources of group and individual differences in emerging fraction skills. *Journal of Educational Psychology, 102*(4), 843–859. https://doi.org/10.1037/a0019824

Higgins, K., Crawford, L., & Silvestri, S. (2016). Student perceptions of an online mathematics curriculum designed for students with learning difficulties. *Social Welfare: Interdisciplinary Approach, 2*(6), 108-123. https://doi.org/10.21277/sw.v2i6.258

Jordan, N. C., & Hanich, L. B. (2000). Mathematical thinking in second-grade children with different forms of LD. *Journal of learning disabilities, 33*(6), 567-578. https://doi.org/10.1177/002221940003300605

Jordan, N. C., Hanich, L. B., & Kaplan, D. (2003). Arithmetic fact mastery in young children: A longitudinal investigation. *Journal of Experimental Child Psychology, 85*(2), 103-119. https://doi.org/10.1016/S0022-0965(03)00032-8

Ke, F., & Grabowski, B. (2007). Gameplaying for maths learning: cooperative or not? *British Journal of Educational Technology, 38*(2), 249-259. https://doi.org/10.1111/j.1467-8535.2006.00593.x

Kebritchi, M., Hirumi, A., & Bai, H. (2010). The effects of modern mathematics computer games on mathematics achievement and class motivation. *Computers & Education, 55*(2), 427-443. https://doi.org/10.1016/j.compedu.2010.02.007

Keskin D., A., & Aral, N. (2021). Oyun bağımlılığı: güncel bir gözden geçirme. *Bağımlılık Dergisi, 22*(3), 327-339. https://doi.org/10.51982/bagimli.880679

Ketenoğlu Kayabaşı, Z. E. (2019). *Sınıf öğretmenlerinin okuma güçlüklerine ilişkin görüş ve uygulamaları* [Yayınlanmamış doktora tezi]. Gazi Üniversitesi.

Khan, S. B., & Chishti, S. H. (2011). Learners'errors: supporting learners for participating in mathematics classroom. *International Journal of Academic Research, 3*(1), 229-239.

Koç, B. & Koç, İ. (2019). Action research on teaching addition and subtraction to an illiterate student with dyscalculia. *Eğitimde Nitel Araştırmalar Dergisi, 7*(2), 710-737.

Korkusuz, M. E., & Karamete, A. (2013). Eğitsel oyun geliştirme modelleri. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi, 7*(2), 78-109. https://doi.org/10.12973/nefmed203

Kunwar, R., Shrestha, B. K., & Sharma, L. (2021). Are teachers aware of mathematics learning disabilities? Reflections from basic level schoolteachers of Nepal. *European Journal of Educational Research, 10*(1), 367380. https://doi.org/10.12973/eu-jer.10.1.367

Kuruyer, H. G., Çakıroğlu, A., & Özsoy, G. (2019). Sınıf öğretmeni adaylarının okuma ve matematik güçlüklerine ilişkin pedagojik farkındalıklarının ve öğretimsel bakış açılarının belirlenmesi. *Kastamonu Eğitim Dergisi*, *27*(4), 1659-1678. https://doi.org/10.24106/kefdergi.3229

Li, Q., & Ma, X. (2010). A meta-analysis of the effects of computer technology on school students' mathematics learning. *Educational Psychology Review*, *22*, 215-243. https://doi.org/10.1007/s10648-010-9125-8

Luneta, K., & Makonye, P. J. (2010). Learner errors and misconceptions in elementary analysis: a case study of a grade 12 class in south Africa. *Acta Didactica Napocensia*, *3*(3), 35-46.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage.

Mohd Syah, N. E., Hamzaid, N. A., Murphy, B. P., & Lim, E. (2016). Development of computer play pedagogy intervention for children with low conceptual understanding in basic mathematics operation using the dyscalculia feature approach. *Interactive Learning Environments*, *24*(7), 1477-1496. https://doi.org/10.1080/10494820.2015.1023205

Morgan, P. L., Farkas, G., Hillemeier, M. M., & Maczuga, S. (2016). Science achievement gaps begin very early, persist, and are largely explained by modifiable factors. *Educational Researcher*, *45*(1), 18-35. https://doi.org/10.3102/0013189X16633182

Mousavi, S., Radmehr, F., & Alamolhodaei, H. (2012). The role of mathematical homework and prior knowledge on the relationship between students' mathematical performance, cognitive style and working memory capacity. *Electronic Journal of Research in Educational Psychology*, *10*(3), 1223-1248.

Mowery, K. (2019). *The Most Effective Teaching Strategies for At Risk Students with Mathematical Learning Disabilities.* Education: Student Scholarship & Creative Works. https://jayscholar.etown.edu/edstu/14

Mutlu, Y., & Akgün, L. (2019). Using computers for developing arithmetical skills of students with mathematics learning difficulties. *International Journal of Research in Education and Science*, *5*(1), 237-251.

Mutlu, Y., Çalışkan, E. F., & Yasul, A. F. (2022). We asked teachers: do you know what dyscalculia is? *International Online Journal of Primary Education*, *11*(2), 361-378. https://doi.org/10.55020/iojpe.1067560

National Council of Teachers of Mathematics [NCTM]. (2000). *Principles and standards for school mathematics.* NCTM.

National Joint Committee on Learning Disabilities [NJCLD]. (2000). Professional development for teachers. A report from the National Joint Committee on Learning Disabilities (NJCLD). *Learning Disability Quarterly*, *23*(1), 2-6. https://doi.org/10.2307/1511095

Ocak, A. M. (2013). *Eğitsel dijital oyunlar*. Pegem A.

O'Connell, P. J. (1999). *Adults in Training: An International Comparison of Continuing Education and Training.* Organization for Economic Cooperation and Development. https://files.eric.ed.gov/fulltext/ ED449346.pdf

Olkun, S. (2014). Öğrenme güçlüğü yaşayan çocukların gelişim özellikleri. S. Yıldırım Doğru (Ed.) *Matematik öğrenme güçlükleri/diskalkuli* içinde (ss. 211-225). Eğiten Kitap.

Olkun, S., & Toluk, Z. (2003). *İlköğretimde etkinlik temelli matematik öğretimi.* Anı Yayıncılık.

Öksüz, H., & Gürefe, N. (2021). 5. Sınıf matematik öğretmenlerinin öğrenme güçlüğüne sahip öğrencilerin bulunduğu sınıfta oluşturmayı amaçladığı sosyomatematiksel normlar. *Cumhuriyet Uluslararası Eğitim Dergisi*, *10*(2), 601-626. https://doi.org/10.30703/cije.742571

Öztürk, M., Durmaz, B., & Can, D. (2019). The effect of number talks on number senses of dyscalculic middle school students. *Kastamonu Education Journal*, *27*(6), 2467-2480. https://doi.org/10.24106/ kefdergi.3337

Patton, M. Q. (1990). *Qualitative evaluation and research methods.* SAGE Publications.

Pesova, B., Sivevska, D., & Runceva, J. (2014). Early intervention and prevention of students with specific learning disabilities. *Procedia-Social and behavioral sciences*, *149*, 701-708. https://doi.org/10.1016/j. sbspro.2014.08.259

Prensky, M. (2001). Digital natives, digital immigrants' part 2: Do they really think differently? *On the Horizon*, *9*(6), 2-6. https://doi.org/10.1108/10748120110424843

Raghubar, K., Cirino, P., Barnes, M., Ewing-Cobbs, L., Fletcher, J., & Fuchs, L. (2009). Errors in multi-digit arithmetic and behavioral inattention in children with math difficulties. *Journal of Learning Disabilities*, *42*(4), 356-371. https://doi.org/10.1177/0022219409335211

Riccomini, P. J. (2005). Identification and remediation of systematic error patterns in subtraction. *Learning Disability Quarterly*, *28*(3), 233-242. https://doi.org/10.2307/1593661

Schulz van Endert, T. (2021) Addictive use of digital devices in young children: Associations with delay discounting, self-control, and academic performance. *Plos One* *16*(6), e0253058. https://doi.org/10.1371/journal.pone.0253058

Stanberry, K., & Raskind, M. H. (2009). *Assistive Technology for Kids with Learning Disabilities: An Overview.* LD Online. https://www.readingrockets.org/article/assistive-technology-kids-learning-disabilities-overview

Stultz, S. L. (2013). The effectiveness of computer-assisted instruction for teaching mathematics to students with specific learning disabilities. *The Journal of Special Education Apprenticeship*, *2*(2), 1-13.

Tashakkori, A., & Teddlie, C. (2003). Issues and dilemmas in teaching research methods courses in social and behavioural sciences: US perspective. *International Journal of Social Research Methodology*, *6*(1), 61-77. https://doi.org/10.1080/13645570305055

Terzioğlu, I., Curaoğlu, O., & Yıkmış, A. (2019). Descriptive analysis of research using computer assisted instruction in the development of mathematical skills of students with special learning difficulty. *Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi*, *19*(1), 371-382. https://doi.org/10.17240/aibuefd.2019.19.43815-450711

Tolar, T.D., Lederberg, A.R., & Fletcher, J.M. (2009). A structural model of algebra achievement: Computational fluency and spatial visualization as mediators of the effect of working memory on algebra achievement. *Educational Psychology*, *29*(2), 239-266. https://doi.org/10.1080/01443410802708903

Turgut, S., & Doğan Temur, Ö. (2017). The effect of game-assisted mathematics education on academic achievement in Turkey: A meta-analysis study. *International Electronic Journal of Elementary Education*, *10*(2), 195-206. https://doi.org/10.26822/iejee.2017236115

Uygun, N. (2019). *Action research on developing a support education program for a fourth-grade student with risk of dyscalculia* [Unpublished doctoral dissertation]. Necmettin Erbakan University.

Walcott, P., & Romain, N. (2019). Using digital games to enhance the mathematical skills of children with dyscalculia. *Journal of Education and Development in the Caribbean*, *18*(2), 88-110. https://doi.org/ 10.46425/j418025822

Witzel, B., & Mize, M. (2018). Meeting the needs of students with dyslexia and dyscalculia. *Southeastern Regional Association of Teacher Educators, 27*(1), 31-39. https://www.srate.org/JournalEditions/Volume27-1/Witzel_Mize_Manuscript.pdf

Yell, M. L., Shriner, J. G., & Katsiyannis, A. (2006). Individuals with disabilities education improvement act of 2004 and IDEA regulations of 2006: Implications for educators, administrators, and teacher trainers. *Focus on Exceptional Children*, *39*(1), 1-24. https://doi.org/10.17161/foec.v39i1.6824

Yıldırım, A., & Şimşek, H. (2005). Sosyal bilimlerde nitel araştırma yöntemleri. Seçkin Yayıncılık.

Yurdugül, H. (2005). *Using content validity indices for content validity in scale development studies*. In Proceedings of the XIV. National Conference on Educational Science, 28-20 September 2005 (pp.1-6). Pamukkale University. https://yunus.hacettepe.edu.tr/~yurdugul/3/indir/PamukkaleBildiri.pdf