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An Application Example for The Teaching Fractions with the Developed Digital Fraction Transparency Material

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Abstract
The aim of the current study is to investigate the effects of digital teaching materials on 4th graders' academic achievement on fractions subject and attitudes towards mathematics and computers. The study was planned with a pretest and posttest control group design. The participants of the study were 60 students studying in a public elementary school in Karabağlar district of İzmir province. Through a pilot study, groups were selected to administer an academic achievement test to all fourth classes in the school. Initial analyses suggested A and E classes" achievement scores did not differ significantly; thus, these classes were included in the study. Class A with 32 students was randomly selected as the experimental group. 55% (n = 33) of the participants were male and 45% (n = 27) were female. The experimental group received technology-enhanced presentations, whereas the control group had traditional presentations from the same teacher. Participants had access to interactive digital materials within course hours on the classroom computer. The study took four weeks (16 course hours). Data were collected through fractions achievement test, mathematics attitude scale and computer attitude scale. Results revealed no significant differences between achievement and computer attitudes scores of the groups. However, the mathematics attitudes scores show significant differences between groups.

Keywords: Elementary Education, Fractions, Teaching Material, Digital Fraction Transparency

1. Introduction

Changes made in the education system, changing curricula, changes in national assessment exams and success exams repeated worldwide revealed the importance of mathematics lessons. The Evaluation of Educational Achievement (IEA) makes comparative measurements in science and mathematics education worldwide and creates reports that offer a holistic perspective from these measurements. Trends in International Mathematics and Science Study (TIMMS) exam result reports are one of them. The TIMMS exam, held worldwide, provides detailed information about the students' knowledge and skill levels and levels and the educational programs and outputs of the countries. According to the TIMMS 2016 preliminary report published by the Ministry of National Education (MoNE), Turkey ranks 36th among 49 countries in terms of 4th-grade level math achievement average. Students with an intermediate level of mathematics proficiency can understand fractions and integers, solve simple figure and table problems, and animate two-dimensional drawings in three dimensions (MoNE, 2016). According to the results, students should be supported in mathematics education to move Turkey to higher levels. It can be said that supporting students on integers and fractions will increase student success even higher.

It is frequently stated in the literature that the subject of fractions is difficult and complex. Birgin and Gürbüz (2009) stated that fraction teaching includes the concepts of part-whole relationship and comparison, but the frequent emphasis on algebraic representation for understanding numbers and concepts leaves behind the meaning of comparison of fractions. As a result, they emphasized that fractions are hard to understand. Orhun (2007) stated that primary school students had difficulties in terms of four operations in fractions, ordering fractions and expressing them visually. In addition, students experience difficulties in learning fractions on the number line by dividing them into whole or parts (Bright, Behr, Post, & Wachsmust, 1988).

According to Tutak (2009), concretization is important in making knowledge permanent and meaningful. Models and shapes should be used when dealing with fractions. The figures and models drawn help solve the problem by concretizing the question and making it easier to understand (Biber, Tuna, & Aktaş, 2013; Kocaoğlu, 2010). The use of visual materials in fraction teaching also contributes to the understanding of fractions, enables students to participate actively in the learning process, increases their motivation and interest, and supports the development of problem solving and critical thinking skills (Dede & Argün, 2003; İnan 2006; Tutak, 2019). In the literature, there are studies on how virtual manipulatives can be used in teaching fraction concepts by primary school teachers (Reimer & Moyer, 2005; Suh, Moyer & Heo, 2005). One of the organizations serving in this field is the National Council of Teachers of Mathematics (NCTM). This council allows primary school teachers to access, explore and develop lessons for free (https://www.nctm.org).

As can be seen, it is important to support the mathematics course content with supplementary materials. Mathematics education also aims to raise individuals who are faced with a problem, think creatively to solve this problem, research, and benefit from all kinds of technological environments they have to reach information (Bulut, 2005). It is important to support the technological competencies of individuals with these characteristics. McNeil and Jarvin (2007) point out in their studies that the child does not come into the world with abstract thinking capacity. Instead, they say they should construct concepts through interactions with concrete objects in their environment. Tools and methods used in fractions also contribute to concretization and visualization.

This study aims to find a solution to the concretization and understanding problem in teaching and learning fractions. Physical fraction transparencies used in the concretization of fractions can be used to convey fraction issues to learners. However, the insufficient number of this material makes it difficult to use in crowded classrooms. It is important to transfer this material to a more durable and easily accessible environment. In the studies conducted, it has been observed that there is a deficiency in transferring such materials to the computer environment on fractions. An easy-to-use digital teaching material that supports students in this field has been designed, and its use in the teaching environment has been examined.

The aim of this study is to examine the effect of computer-aided instruction (CAI) material developed for the acquisition of addition and subtraction in fractions and fractions on primary school 4th-grade students' learning and attitudes towards computers and mathematics. Therefore, answers to the following three questions have been sought.

1. Is there a significant difference between the pre-and post-CAI academic achievements of the experimental and control groups?
2. Is there a significant difference between the pre-and post-CAI attitudes towards computers of the experimental and control groups?
3. Is there a significant difference between the pre-and post-CAI attitudes towards the mathematics of the experimental and control groups?

2. Method

This research has been designed in conformity with the quasi-experimental design with the pretest-posttest control group in order to examine the effect of the computer-aided teaching material for fractions on primary school fourth-grade students' learning, attitudes towards computer and mathematics. In order to examine the effect of the intervention applied to the experimental group in the design, the results obtained from the pretest and posttests are compared (Büyüköztürk, 2013). Due to the nature of educational environments, researchers have to work with predefined classes in most studies (Creswell, 2009). Since working with ready-made classes in this study, too; in other words, since the participants cannot be randomly assigned to the experimental and control groups, the study is qualified as quasi-experimental. Table 1 shows the representation of the study on the experimental design.

Table1: Symbolic representation of the research design

Group	Pretest	Transaction	Posttest
G_1 Experimental Grou	O_1 Success test and attitude scales	X Use of computer-aided teaching materials	O_3 Success test and attitude scales
G_2 Control Group	O_2 Success test and attitude scales		O_4 Success test and attitude scales

In Table 1, the dependent variables of the research are the scores the students got from the fractional achievement test, the computer attitude scale, and the mathematics attitude scale. The independent variable is the presentation style of mathematics teaching. In order to see the effect of the education prepared on the dependent variables of interest, the experimental group was instructed with computer-aided teaching materials; traditional teaching was provided to the control group.

2.1 Study Group

Participants of the study are 60 students studying in a state school in Karabağlar district of İzmir province. In order to determine the participant groups, an academic achievement test was applied to all fourth-grade students in the school. As a result of this application, it was determined that there was no significant difference between achievement test scores of A and E classes. From these groups, A (n = 32) class randomly was the experimental group; Class E (n = 28) was also determined as the control group. 55% (n = 33) of the participants are male and 45% (n = 27) are female students.

2.2 Data Collection Tools

In order to collect data in this study; "Fraction Success test" developed by the researchers within the scope of the study, "Mathematics Attitude Scale" edited by Nazlıçiçek and Erktin (2002) and "Computer Attitude Scale" developed by Aşkar and Orçan (1987) were used.

First, in the development of the Fraction Success test, a table of indications in which 4th-grade attainment and levels are expressed was prepared. Test items were written in accordance with this table of indicators. The achievement test, consisting of 27 questions in total, was evaluated by four experts. The pilot implementation of the achievement test was conducted with a total of 180 5th grade primary school students who had previously learned this subject in a primary school in Izmir Province. With this application, item difficulty and item discrimination indexes of the items in the test were obtained. The questions numbered 2, 3, 5, 15, 17, 18, 26 were excluded from the test, depending on the low item discrimination, the inclusion of other questions about the target in the test, or the expert opinion. In addition, in line with the expert opinion, questions 1, 4, 12, 13 were corrected and added to the test, and an achievement test of 20 items was obtained. In this final version of the achievement test, the test difficulty value was calculated. The difficulty of the test was found to be 0.55. For the reliability of the test, the Kuder-Richardson 20 (KR20) formula was used. As a result of the KR20 calculation, the value of the 20-item test was calculated as 0.75. According to this result, the test has a near high level of reliability.

2.3 Experimental Application Process

The experimental application process includes the preparations before the experiment and the implementation of the experimental process. These are stated under three titles as digital fraction transparent software, introducing the tool to the mentor and performing the experimental application.

2.4 Digital Fraction Transparency (DFT) Software

The software that will help comprehend the teaching of fractions in mathematics was developed using the flash program. The researcher's knowledge of the use of the program and the program's tool support is effective in choosing this program. Figure 1 shows the image of the "digital fraction transparent" software.

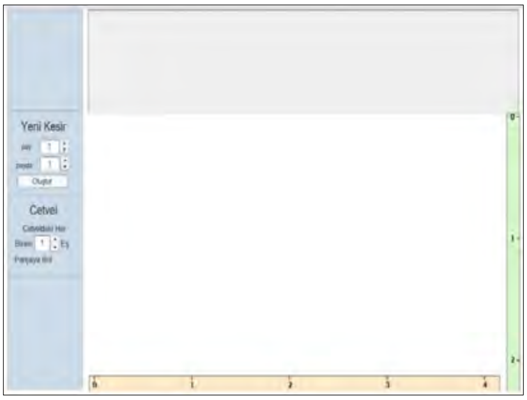

Figure 1: Main screenshot of the digital fraction transparency software

The digital fraction transparency software consists of a single file with a size of 65 KB, which is very small and does not require installation. It can be easily reproduced by copying method and shared conveniently and quickly via removable disks and e-mail. Copying or downloading it to the computer is sufficient to use the material. Theoretically, it works compatible with all browsers with Flash player installed.

As shown in Figure 2, the use of real fraction transparencies printed on transparencies in the classroom is performed by overhead projector devices. Transparencies are presented by the teacher to the whole class at the same time. For it to be used, it is necessary to purchase the material in concrete and provide overhead projector devices that are not currently in use in schools. These are very difficult to obtain, especially in schools in rural areas.

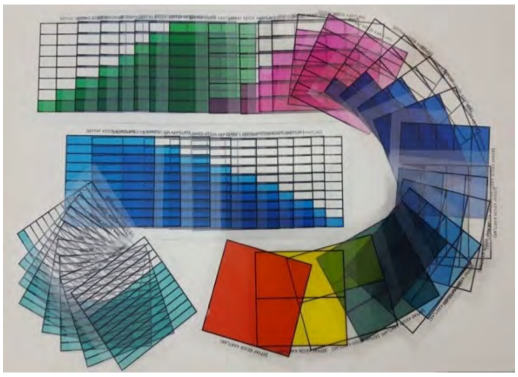

Figure 2: True fraction transparencies

It is very easy to deliver the developed digital fraction transparent software to students with computers and projection devices or interactive boards found in almost all schools in our country and to concretize fraction issues and does not require any additional cost. By using appropriate web infrastructures, it may be possible for students to work with DFT by using Information Technologies Classrooms at schools or even personal computers, tablets and smartphones at home. Thus, individual learning can also be followed by teachers.

DFT was not designed for fraction gains only for primary school 4th-grade students under study. DFT is an effective tool in teaching many fraction gains in the curricula of primary schools. DFT software consists of a single interface, and all operations are performed on this page. There are four main areas in the interface of the software (Figure 3). There is a "New Fraction" area at the top of the blue zone on the left and a "Ruler" area at the bottom. The gray area at the top right is used as the "Question writing area," and the white area at the bottom right is used as the "Free study area." In Figure 3, the usage areas of the software on the interface are indicated.

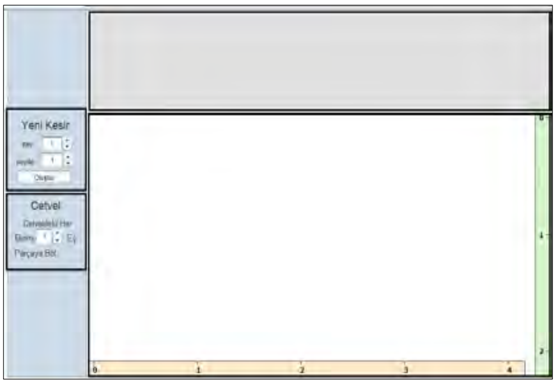

Figure 3: Sections of the digital fraction transparent

The "numerator" and "denominator" values of the fraction transparent to be created are entered separately in the "New Fraction" field, which is used to create digital fraction transparencies, and when the "Create" button is clicked, the fraction transparencies of the desired value are created. Figure 4 shows the creation of simple fractions with DFT.

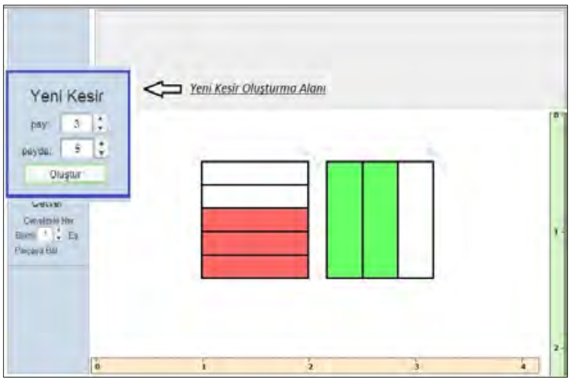

Figure 4: Simple fractions creation using the new fraction creation area

Fraction transparencies can be divided into at least one and at most 20 identical parts. Each of the fraction transparencies created is automatically colored differently. There can be a maximum of 6 fraction transparencies in the free study area. The "X" symbol on the left-bottom corners is used to delete the digital fraction transparent, and the direction arrows in the right-upper corners are used to rotate it (Figure 4). In order to clear all fractions from the work area, the browser page is refreshed, or the "F5" key is pressed on the keyboard. All transparencies can be moved, rotated, overlapped and intersected with each other.

In Figure 5, the answer to the question "Find $\frac{2}{3}$ of the simple fraction $\frac{1}{2}$ by creating fraction transparencies? " is shown.

- User creates pre-requested $\frac{1}{2}$ and $\frac{2}{3}$ fractions
- Rotates the fraction transparent of $\frac{1}{2}$
- Positions two fraction transparencies on top of each other
- The blue region formed as a result of the intersection ($\frac{2}{6}$) is the desired answer.

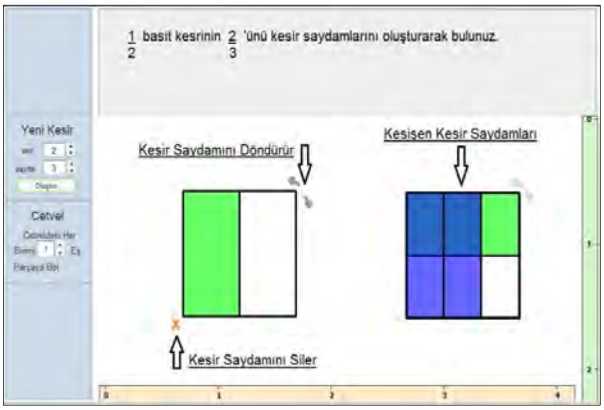

Figure 5: Rotation, intersection movements and deletion of fraction transparencies

If you want to obtain transparencies that are segmented and have no color in any area, the numerator value should be entered as "0". Compound fractions can also be created when fractions with the numerator value greater than the denominator value are created. First of all, the numerator and denominator values should be increased by the numerator value, then the denominator value should be reduced, and the transparent should be created in this way (Figure 6).

Figure 6 shows the use of digital fraction transparencies in the process of comprehending compound fractions. $\frac{7}{4}$ With the compound fraction visual, it is ensured that the compound fraction is larger than a whole number. Uncolored (divided into four equal parts) fraction transparent is placed in the uncompartmented part of the compound fraction $\frac{7}{4}$. In this way, it also enables to see $\frac{3}{4}$ of the remainder from an integer part of the fraction. With this study, it is possible to switch from compound fractions to mixed fractions.

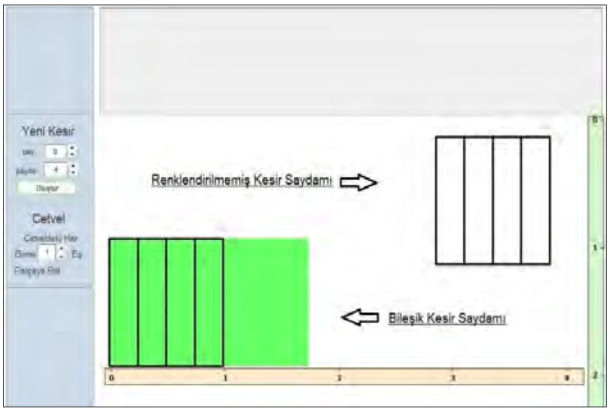

Figure 6: Compound fraction transparent and uncolored fraction transparent

The ruler section is used to divide the ruler tools at the bottom and right sides of the free study area (Figure 3). This tool represents the number line in mathematics. Users control how many equal parts they will divide between each integer on the ruler tool from this field. For example, in Figure 7, the ruler tool is divided into five equal parts.

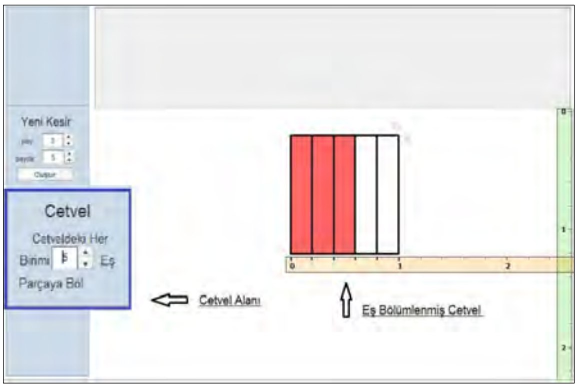

Figure 7: Segmented and moved ruler

Rulers can be used in concretization activities such as showing fractions on a number line, discovering common denominators in fractions, adding and subtracting fractions, discovering compound fractions, and seeing mixed fractions by moving them within the free study area and using them with fraction transparencies. For example, in Figure 8, fractions with denominators 2 and 3 have the common denominator of 6. The question writing area is the area projected onto the whiteboard with the projector or left blank for the teacher to write the questions on the image on the interactive whiteboard (Figure 4).

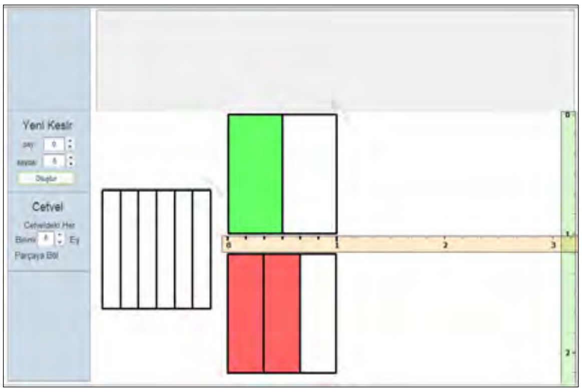

Figure 8: Discovering the common denominator

In this area, the teacher can write questions about the achievement in that study. When the software is used with suitable web infrastructure, appropriate questions from the question bank or question engine to be developed can be transferred to this area according to the user's progress speed and level, and the user can interact with this area. For example, using the question writing area in Figure 9, the student is asked to compose the unit fractions given in a mixed manner and order them in descending order.

Figure 9: Question posed to the student and answer given using the question writing area

The free working area is the free space where the created fraction transparencies and ruler tools are moved and where the created expressions and questions are answered (Figure 4). There can be a maximum of 6 fraction transparencies in the free study area. This area can detect fraction transparencies, directions, colors, movements, movement and division numbers of rulers created when DFT software is used with a suitable web infrastructure. Thus, the positions of the created fraction transparencies and the existing rulers with respect to each other can be detected and compared between the questions in the question area thanks to the developed algorithm. All actions in the free study area can be saved in the database to the user account. The free study area is shown in Figure 10. The use of the teaching material may differ according to the activity examples of the lesson. Students may be asked to read the fraction transparencies to be created with the DFT software and express the fraction by writing. Informing the teacher about this teaching material to be used during the lesson is another step.

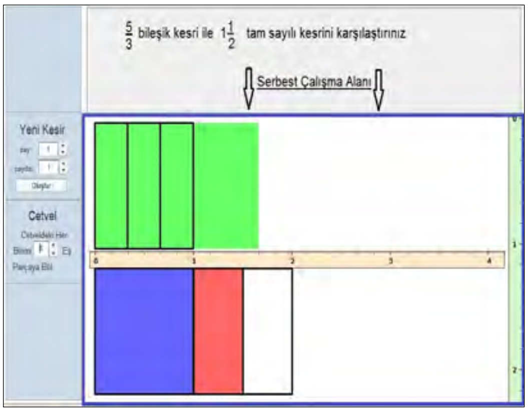

Figure 10: Use of free study area

2.5 Introducing the Tool to the Mentor

After the mentor was informed about turning on the computer, projecting the image with a projection device, and making the program operational, the teaching material started to be explained. The training was given on creating and deleting fraction transparencies, rotating and positioning fraction transparencies, intersecting fraction transparencies, segmenting and positioning the ruler tool, and using fraction transparencies with the ruler tool, respectively. During the training, the teacher was allowed to use the tool and the questions asked about the use of the material were answered.

2.6 Performing the Experimental Application

The experimental process took a total of four weeks. In the first week of the study, each data collection tool was applied as a pretest. At the end of four weeks, each of the data collection tools was applied again as a posttest. The applications of all data collection tools are planned in a way that does not hinder mathematics lessons. DFT software was used by the teacher to support the lesson for a total of 16 lesson hours. With the help of a projection device, the information on the computer was reflected on the whiteboard for the whole class to see. The distribution of the subject of fractions by weeks and the use of the software are shown in Table 2.

Table 2: Achievements regarding the sub-learning domains of fractions, addition and subtraction in fractions.

Learning Domain	Sub-Learning Domain	Course Hours	Achievements
Numbers	Fractions	2	Names fractions whose numerator and denominator are the most two-digit natural number, obtaining from the fraction units.
Numbers	Fractions	2	Displays fractions whose numerator and denominator are with a maximum of two digits on the number line.
Numbers	Fractions	2	Compares the fractions.
Numbers	Fractions	2	Sorts up to four equal denominators in ascending or descending order.
Numbers	Fractions	2	Sorts up to four fractions with equal numerators and different denominators in ascending and descending order.
Numbers	Fractions	2	Determines a specified simple fraction of a plurality.
Numbers	Addition in Fractions	1	Adds up fractions with equal denominators.
Numbers	Subtracting Fractions	1	Subtracts fractions with equal denominators.
Numbers	Addition and Subtraction in Fractions	2	Solves and sets up problems requiring addition and subtraction with fractions.

According to Table 2, it can be stated that there are equal application times for the achievements. The process that starts with the representation of fractions continues with the ordering of fractions and ends with addition and subtraction in the fractions.

2.7 Data Analysis

Various statistical techniques were used in the analysis of the study data. Descriptive statistics were used to provide information about the study group and the scores obtained from the tests. In the process of developing the achievement test, item difficulty and item discrimination indices were calculated in order to evaluate the items. In order to examine the reliability of the final form, the KR-20 coefficient was calculated.

T-Tests were used to answer the research questions. Since the experimental and control groups could not be formed randomly, the control and experimental groups' scores from the dependent variables were compared at the first stage. When no significant difference was observed in this comparison, the achievement scores were calculated by subtracting the pretest scores from the posttest scores, and the differentiation of these scores was examined. Normality tests and variance equivalence tests were carried out to examine the conditions of the research data to meet the prerequisites of these tests. In addition, since more than one test was used to answer a question, Bonferoni correction was applied to avoid Type 1 error when interpreting the results (Huck, 2012).

3. Results

In this part of the research, the results obtained from the appropriate data analysis method of sub-problems are included. Finding from the question "Is there a significant difference between the pre-and post-CAI academic achievements of the experimental and control groups?" Descriptive statistics of the scores the groups got from these tests are reported in Table 3.

Table 3: Descriptive statistics of the scores obtained by the experimental and control groups in the Achievement test.

		$\bar{X}$	*ss*	*Median*	*Kurtosis*	*Skewness*
Pretest	*Experimental*	8,47	3,33	8	-,85	,13
	Control	7,11	3,31	7	2,94	1,20
Posttest	*Experimental*	14,25	2,86	14,5	-,91	-,19
	Control	12,96	3,64	13	-1,45	-,06

According to Table 3, the posttest scores of the Experimental and Control groups are higher than the pretest scores. The pretest score of the experimental group is 8,47, while the posttest score is 14,25. Similarly, while the pretest score of the control group was 7,11, the posttest score was determined as 12,96. Below, the statistical significance of the observed increases within the groups differentiating between groups is analyzed.

Before these tests, the normal distribution condition required for the tests to be applied was examined. More than one technique was employed to examine the normal distribution prerequisite. First, kurtosis and skewness values of the scores were examined. For this purpose, in line with the recommendations of George and Mallery (2010), it was observed that the scores were within the ± 2 range. As seen in Table 4, most of the coefficients obtained are within this range. It is observed that only the pretest score of the control group is outside this range. Another technique used for testing normality assumptions is the Shapiro Wilk test. This test is used when the number of participants in the groups is below 50 (Akbulut, 2010). Since this test does not give significant results, it can be said that the pretest and posttest scores of the experimental and control groups meet the normal distribution conditions. Finally, by examining histograms, PP and QQ plots, it was concluded that achievement test scores were normally distributed.

After this point, the differentiation of the pretest scores of the experimental and control groups was examined. When the results of the t-Test for independent samples are analyzed, it is concluded that the Levene test is meaningless; in other words, variance equivalence was achieved between the groups. Besides, it was observed that the pretest scores of the groups did not differ statistically significantly ($t_{(58)}$= 1.58; p> .05).
Then, the achievement scores of the groups were calculated, and the differentiation of these scores was examined. Descriptive statistics regarding the calculated achievement scores are presented in Table 4.

Table 4: Comparison of achievement scores of experimental and control groups

	Group	*N*	$\bar{X}$	*SS*	*t*	*SD*	*p*
Achievement scores	*Experimental*	32	5,78	3,14	,09	58	0,93
	Control	28	5,86	3,63			

In Table 4, the differentiation of achievement scores calculated over the scores obtained from the achievement test was analyzed with the t-Test for independent samples. As a result of the examination, it was seen that the achievement scores did not differ statistically significantly ($t_{(58)}$= - .09; p> .05). Finding from the question “Is there a significant difference between the pre-and post-CAI attitudes towards computers of the experimental and control groups?” Descriptive statistics of the scores the groups got from the computer attitude scale are reported in Table 5.

Table 5: Descriptive statistics of the scores of the experimental and control groups in the computer attitude scale

		$\bar{X}$	*ss*	*Median*	*Kurtosis*	*Skewness*
Pretest	*Experimental*	83,39	13,60	81	-,38-	,16
	Control	95,63	15,02	96	-,21	- ,72 -
Posttest	*Experimental*	82,62	15,34	82	-,62	-,01
	Control	96,60	17,12	99	,87	-,96

According to Table 5, it is seen that the control group's computer attitude score was high at the beginning and end of the application. While the pretest score of the experimental group was 83,39, the posttest score was 82,62. While the pretest score of the control group was 95,63, the posttest score was determined as 96,60. The differentiation of achievement scores of the Experimental and Control groups has been examined below.

Before these tests, the normal distribution condition required for the tests to be applied was examined. First of all, it is seen that all skewness and kurtosis values are in the range of ± 2. This situation indicates that the distribution is close to normal (George & Mallery, 2010). It is seen that the Shapiro-Wilk test results also do not show a significant difference (Akbulut, 2010). Finally, by examining histograms, PP and QQ plots, it was concluded that the scores of the computer attitude scale were normally distributed.

When the results of the t-Test for independent samples are analyzed (Table 6), it is concluded that the Levene test is meaningless; in other words, variance equivalence was achieved between the groups.

Table 6: Comparison of the experimental and control groups' attitude achievement scores towards the computer.

	Group	N	$\bar{X}$	SS	t	SD	p
Achievement scores	*Experimental*	31	0,77	20,74	0,28	56	0,78
	Control	27	0,96	26,54			

The differentiation of achievement scores calculated based on the computer attitude scale scores was examined using the t-Test for independent samples. As a result of the examination, it was seen that the achievement scores did not differ statistically significantly ($t_{(58)} = -.09$; $p > .05$). Finding from the question "Is there a significant difference between the pre-and post-CAI attitudes towards the mathematics of the experimental and control groups?" Descriptive statistics of the scores the groups got from the mathematics attitude scale are reported in Table 7.

Table 7: Descriptive statistics of the scores the experimental and control groups got from the Mathematics attitude scale

		$\bar{X}$	*ss*	*Median*	*Kurtosis*	*Skewness*
Pretest	*Experimental*	88,71	9,06	91	-,91	-,50
	Control	90,37	5,57	91	-, 1,11	-,02
Posttest	*Experimental*	86,32	13,84	92	1,71	-1,45
	Control	89,37	7,98	91	,02	,02

As seen in Table 7, the mathematics attitude score of the control group remained high at the beginning and end of the application. A small decrease was observed in the mathematics attitude scale scores of both groups. While the pretest score of the experimental group was 88,71, the posttest score was 86,32. The pretest score of the control group was 90,37, while the posttest score was 89,37. The differentiation of achievement scores obtained from the mathematics attitude scale among groups is examined below.

Before these tests, the normal distribution condition required for the tests to be applied was examined. First of all, it is seen that all skewness and kurtosis values are in the range of ± 2. This situation indicates that the distribution is close to normal (George & Mallery, 2010). It is seen that the Shapiro-Wilk test results also do not show a significant difference (Akbulut, 2010). Finally, by examining histograms, PP and QQ plots, it was concluded that mathematics attitude scale scores show normal distribution.

After this point, the differentiation of the achievement scores of the attitudes towards the mathematics of the experimental and control groups was examined using the t-Test for independent samples (Table 8). According to the results, it was observed that the Levene test is meaningless; in other words, the variance equivalence requirement was met between the groups.

Table 8: Comparison of the mathematics attitude achievement scores of the experimental and control groups

	Group	N	$\bar{X}$	SS	t	SD	p
Achievement scores	*Experimental*	31	2,93	16,53	2,11	56	0,04
	Control	27	-6,26	16,64			

As a result of the examination, it is seen that the achievement scores differ statistically significantly ($t_{(56)}= 2.11$; $p < 0.05$). Accordingly, as a result of the experimental application, a decrease was observed in both groups' attitudes towards mathematics. Besides, it can be said that the decrease observed in the control group is higher than in the experimental group.

4. Conclusion and Discussion

This study was carried out to determine the effect of primary school 4th-grade students' learning the mathematics lesson fractions subject using the teaching material developed within the CAI scope on students' academic achievement, computer and mathematics attitudes. The results obtained as a result of the analysis of the data are expressed in order.

As a result of the t-test analysis performed to answer the question "Is there a significant difference between the pre-and post-CAI academic achievements of the experimental and control groups?" that is the first sub-problem for which an answer was sought in the study, no statistically significant result was found between the experimental and control groups. This finding supports the study of Yiğit and İpek (2015), who stated that dealing with fourth-grade fractions with CAI increased student performance, but there was no statistically significant difference. Uygun (2008) could not find a significant difference between the experimental and control groups in the CAI-supported fraction teaching he conducted with fourth graders. However, this study differs according to the study of Yücel Yumuşak's (2014) experimental study on the subject of fractions with primary school fourth-grade students, which found a significant difference in academic success between control and experimental groups. Similarly, Tutak (2018) stated that students' success would be increased using visual materials in fraction teaching in the fourth grade. Studying the subject of fractions in the fifth grade, Erdağ (2011) determined that cartoon-supported mathematics teaching makes students' knowledge permanent. Lee and Ferrucci (2012) also observed that virtual manipulatives increase success. Yurniwati and Purnamasari (2018), on the other hand, presented various technological applications to increase students' mathematics achievement and achieved success in students' concretizing the subject of fractions.

As a result of the t-test analysis performed to answer the question "Is there a significant difference between the attitudes towards computers of the experimental and control groups before and after the BDI application?" that is the second sub-problem for which an answer was sought in the study, no statistically significant result was found between the experimental and control groups. This finding supports Uygun's (2008) study that although the experimental group's attitude towards computers is high, there is no significant difference between the control group and the fourth-grade students' attitudes towards computers. However, it differs according to the study of Pilli and Aksu (2013) that they found a significant difference between the attitudes of the experimental and control groups towards the CAI application.

As a result of the t-test analysis performed to answer the question "Is there a significant difference between the mathematics attitudes of the experimental and control groups before and after the BDI application?" that is the third sub-problem of the study, for which an answer was sought in the study, no statistically significant result was found between the experimental and control groups. This finding supports Yıldız's (2009) finding that primary school students have high attitudes towards mathematics. Similarly, Tutak (2018) observed a significant difference in the students' mathematics attitudes in favor of the experimental group as a result of the experimental application in which he discussed teaching fractions. Pilli and Aksu also found a significant difference between the groups in the mathematics attitudes of fourth-grade students. However, the finding of this study differs according to Uygun's (2008) study that there is no significant difference in mathematics attitudes of primary school fourth-grade students between the experimental and control groups. When Lee and Chen (2015) evaluated the mathematics attitudes of students using virtual manipulatives, they found that there was no significant difference between the groups.

The most important difference that distinguishes the DFT software developed for this study and used in the study from fraction teaching materials and software in web environments is its ability to concretize almost all the fraction achievements in the MoNE mathematics program and the US's fraction teaching standards (Common

Core, 2019). The most important difference that distinguishes the DFT software from other similar software is that it can concretize fractions, the number line, and dividing the number line into sections simultaneously. At the same time, this software allows you to position fraction transparencies and number lines with each other. In this way, it can reduce students' wrong learning and misconceptions. Besides, its ability to be used as an effective tool for the rapid detection of misconceptions in students can be seen as a feature that distinguishes it from other software. Another difference is that it can be associated with databases in line with the infrastructure possibilities when necessary, creating data repositories where students' movements on this software can be observed and using these data for various studies, and it can be seen as an important advantage.

5. Recommendations

In line with the research findings, suggestions for researchers who want to work in the field of computer-assisted mathematics teaching are as follows:

- Fraction teaching work with DFT was carried out with the 4th-grade students. A similar study can be carried out in other levels of primary education.
- The difficulties in understanding fraction subjects can be investigated with fraction teaching studies supported by qualitative methods from which students' opinions are taken.
- Long-term scientific studies that aim to detect and prevent misconceptions in fraction subjects with DFT can be planned.
- A similar study can be done with the experimental and control group classes in which the same teacher attends mathematics lessons.
- Scientific research can be planned in which digital fraction transparent software is used in teaching fraction subjects to students with individual differences.
- DFT software can be applied to each student in information technology classes with a computer for fraction achievements at various levels, and its effect can be investigated.
- In terms of web-based use, researches, including distant education studies, can be organized. Flipped-face learning studies can be conducted.
- DFT software can be used to convey fraction achievements at individual speeds with appropriate infrastructure, question repository and teaching algorithm.
- In conveying the mathematics teaching program's achievements, more emphasis should be placed on technology-supported applications, and teachers' technology competencies should be supported by professional development activities.

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