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Research Article

The Effect of Teaching Data Processing Learning Domain with VUstat Software Activities on Students' Academic Achievement and Retention of Knowledge

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Abstract

The main purpose of the study is to examine the effect of teaching the Data Processing learning domain with VUstat software supported activities on the academic achievement and retention of sixth grade students. The sample of the study, in which the pretest-posttest paired control group design was used, consisted of 45 sixth grade students, 23 in the experimental group and 22 in the control group. The Data Processing Achievement Test, which was developed by the researchers and consisted of 25 questions, was used to collect data for the purpose of the study. As a result of the study, it was revealed that VUstat software activities were effective in ensuring the retention of knowledge, but they were not effective on students' achievement. At the end of the study, some suggestions were made for the researcher's experiences and future research.

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Introduction

As a result of the increasing importance of knowledge, the concept of 'knowledge' and the understanding of 'science' are changing and technology is advancing. In order to adapt to these changes and developments, the skills expected from individuals are also changing. As in every field, these changes are reflected in the field of education (Ministry of National Education [MoNE], 2013) and the use of technology has become a necessity for education. Especially mathematics is one of the most important courses in which technology is integrated into the teaching process (Akkoç & Yeşildere İmre, 2015).

When technology-supported mathematics teaching is mentioned, many different concepts of mathematics come to the forefront, and statistics concepts have an important place among them. Statistics is a discipline that has applications in almost all fields related to

scientific methods of collecting data, organizing, summarizing, presenting in appropriate tables and graphs and analyzing these data to make them more understandable, and making logical decisions and drawing valid conclusions based on these analyzes (Romeijn, 2017). In the information and communication age, with the effect of the richness of data around us, statistical literacy (Koparan, 2015), which includes understanding and using the tools and basic language of the statistics discipline, has gained importance, and the necessity of training individuals in this direction has been emphasized in the literature (Akkoç & Yeşildere İmre, 2015; Guidelines for Assessment and Instruction in Statistic Education (GAISE), 2005) and this has been emphasized in reports on both mathematics and statistics education (GAISE 2005, 2016; NCTM, 2000).

The fact that the nature of statistics is separate from mathematics has revealed that statistics topics in mathematics curricula should be shaped by focusing on different teaching methods. As a result, the answer to the question of how statistics teaching in schools should be in order to raise statistically literate individuals has started to be sought (Groth, 2007 as cited in Batur, Baydar, & Güven, 2019). Van de Walle, Karp, and Bay-Williams (2012) state that doing statistics requires more than the process of calculating the arithmetic mean or creating a circle graph. In addition, the researchers emphasized that in order to learn and do statistics, learners need to be meaningfully involved, from asking questions to interpreting results. For this purpose, linking technology with the mathematics teaching-learning process is considered important for meaningful and active learning to take place. As a matter of fact, it is seen that the curricula of many countries including New Zealand, Singapore, England and Turkey address the importance of statistical literacy, doing statistics and technology in the domain of Data Processing learning.

Over the last quarter century, statistics education research has emphasized the need for reform in statistics teaching with an increasing number of studies in this field. However, despite the emphasis on reforms in teaching, studies on the teaching and learning of statistics are unrelated and scattered (Zieffler, Garfield, Alt, Dupuis, Holleque, & Chang, 2008). Despite many studies, statistics is still a discipline that needs significant improvements in the education of students (Garfield & Ben-Zvi, 2008). As a matter of fact, Gürakar (2010) also stated that it is important to reveal the methods that help students learn statistics. When the literature is examined, it is noteworthy that although studies on statistics teaching have increased in recent years, especially in our country, studies on the use of technology in

statistics teaching, in general at all grade levels (Koparan & Kaleli-Yılmaz, 2014; Selçuk, 2016) and in particular at the secondary school level (Balkan, 2013; Kimsesiz, 2019), are quite limited.

Today's technology is rapidly changing and developing, creating new opportunities for meaningful mathematics teaching in general and statistics teaching in particular. Different technologies, especially different software, support different stages of the modeling and problem solving process; they allow students to better understand mathematical situations by allowing multiple representations (numerical, algebraic, graphical, etc.) and to experience different ways of thinking and evaluate their results more quickly. On the other hand, considering that with the appropriate and effective use of these technologies, students can use the time they will save from long operations by working on real mathematical problems in the reasoning and creative thinking process (MoNE, 2013; 2018); it is thought that it is important to teach the learning outcomes related to the domain of Data Processing learning in the secondary school mathematics course curriculum with the computer-assisted teaching method. The GAISE (2016) report recommends that the technological tools to be selected for teaching should provide ease of data entry, support specific pedagogical goals, be easy to access, transfer data in multiple formats, and provide transition between multiple representations. Probability Explorer, Tinkerplots, Fathom, and VUstat are among the software that have a more pedagogical focus in teaching probability and statistics (Selçuk, 2016). Among these software, VUstat software, which is suitable for secondary school level learning outcomes (Akkoç & Yeşildere-İmre, 2015), has advantages such as aiming to teach statistics directly (Yenilmez, 2016) and having a Turkish version unlike other software. When studies on statistics teaching in the literature are examined, it is seen that the software used has a positive impact on students' success and learning (Balkan, 2013; Kimsesiz, 2019). In the literature, fewer studies have been conducted on the effect of the software used in teaching statistics on the permanence of knowledge (e.g. Kimsesiz, 2019). In this context, the aim of this study is to examine the effect of teaching the Data Processing learning domain with VUstat software supported activities on the academic achievement and retention of sixth grade students. The main problem of the research can be expressed as *"Is there a significant difference between the academic achievement and retention test scores of the students in the experimental group and the control group?*". The sub-problems of the research are as follows:

1. Is there a statistically significant difference between the Data Processing Achievement Test pretest-posttest-retention test scores of the control group students?
2. Is there a statistically significant difference between the Data Processing Achievement Test pretest-posttest-retention test scores of the experimental group students?
3. Is there a statistically significant difference between the Data Processing Achievement Test posttest scores of the experimental and control group students?
4. Is there a statistically significant difference between the achievement retention test scores of the experimental and control group students?

Method

Research Model

In this study, which aims to examine the effect of the use of computer software (VUstat) on students' mathematics achievement and retention in teaching the Data Processing learning domain in the 6th grade mathematics course curriculum, a pretest-posttest paired control group design, one of the quasi-experimental designs, was used. In paired designs, two of some groups are matched on certain variables, and these matched groups are randomly assigned to the experimental and control groups (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2012).

The general design of this research with pretest-posttest paired control group used in the study is given in the table below.

Table 1. Research design

Group	Pretest	Experimental Procedure	Posttest	Retention Test
Experimental Group	Data Processing Achievement Test	Computer assisted instruction (VUstat software)	Data Processing Achievement Test	Data Processing Achievement Test
Control Group		Teaching in line with the traditional teaching method		

As seen in Table 1, the Data Processing Achievement Test was administered to the students in both the experimental and control groups as pretest and posttest. While computer-assisted instruction was carried out in the experimental group, the lessons were carried out traditionally in the control group. Six weeks after the implementation, the Data Processing Achievement Test was administered to the students in the experimental and control groups once again as a retention test.

Equivalence of Groups

Two groups that were equivalent in terms of math achievement, which is the dependent variable in the study, were included in the study. The findings regarding the equivalence of the pretest scores of the experimental and control groups are given in Table 2.

Table 2. Mann Whitney U test results regarding pretest scores

Test	Group	N	$\overline{X}$	Sx	Rank Mean	Rank Sum	U	p
Achievement	Experimental Group	23	20.91	9.00	22.57	519.00	243.000	.819
	Control Group	22	22.91	10.29	23.45	516.00		

The mean scores of the students in the experimental group in the pretest of the achievement test were X = 20.91, while the mean scores of the students in the control group were X = 22.91. When the Mann Whitney U test results were analyzed, it was determined that there was no significant difference between the pretest scores of the experimental and control group students (U=243.000; p>.05). This finding shows that the groups are equivalent in terms of math achievement.

Research Group

The sample of the study consisted of 45 (23 experimental and 22 control) sixth grade students studying in two different branches of a secondary school in Acıgöl district of Nevşehir province in the 2021-2022 academic year. Detailed information about the research group is given in the table below.

Table 3. Distribution of students in the experimental and control groups by gender

Group	Gender		Total
	Female (n)	Male (n)	
Experimental Group	10	13	23
Control Group	11	11	22

Data Collection Tool

The data of the study were collected through the Data Processing Achievement Test (DAT). DAT was developed by the researchers to measure students' achievement in the 6th grade Data Processing learning domain. In the Data Processing learning domain, there are two learning outcomes in the Data Collection and Evaluation sub-learning domain and three learning outcomes in the Data Analysis sub-learning domain, totaling five learning outcomes. The achievement distributions are given in Table 4.

Table 4. Distribution of learning outcomes in the data processing learning domain

Learning Domain	Sub-Learning Domain	Learning Outcomes
M.6.4. Data Processing	M.6.4.1. Data Collection and Evaluation	M.6.4.1.1. Formulates research questions that require comparing two groups of data and obtains appropriate data
		M.6.4.1.2. Shows the data of two groups with a binary frequency table and a column graph.
	M.6.4.2. Data Analysis	M.6.4.2.1. Calculates and interprets the gap of a data group.
		M.6.4.2.2. Calculates and interprets the arithmetic mean of a data group.
		M.6.4.2.3. Uses arithmetic mean and range to compare and interpret the data of two groups.

Multiple-choice questions were prepared for four of the five learning outcomes listed in Table 4. The first learning outcome, "*Formulates research questions that require comparing two groups of data and obtains appropriate data.*" was tested with multiple choice and open-ended questions in line with expert opinions.

The steps followed in the development of the achievement test are as follows:

1. Writing the items: The items in the achievement test were written by the researchers. The number of questions for each learning outcome was prepared at different levels of the cognitive domain, taking into account the relevant learning outcome and the number of questions directly proportional to the duration (lesson time). In the first stage, a total of 56 questions were created, six open-ended and fifty multiple-choice items. While the items were being prepared, questions for each learning outcome were prepared by the researcher by examining the previous curricula (MoNE, 2009, 2013), Programme for International Student Assessment (PISA) questions, MoNE achievement tests, and the questions in the sixth grade textbooks and auxiliary resources that continue to be published in line with the learning outcomes in the 2018 mathematics course curriculum. The prepared items were associated with the learning outcomes and a specification table was created and Bloom's Taxonomy was taken into consideration at this stage.

2. Reviewing the items: In order to determine whether the items were appropriate for the relevant outcome, whether they were appropriate for the student level, and whether they were comprehensible, the opinions of six experts (four from mathematics education, one from measurement and evaluation, and one from Turkish education) and three mathematics teachers were consulted. After the necessary corrections were made about the items in line

with the expert opinions and suggestions, a 35-question trial test form consisting of 32 multiple choice and 3 open-ended items was created to measure the five learning outcomes in the Data Processing learning domain.

3. Conducting the trial application: The test form of the achievement test, which was finalized in line with the expert opinions, was applied to 200 middle school 7th grade students.

4. Estimation of item statistics and item selection: Item difficulty and discrimination indices were calculated for the 32 multiple-choice items of the achievement test.

Four items with an item discrimination index below 0.30 (items 1, 2, 23 and 27) were removed from the test. Of the remaining items, items of medium difficulty were selected for the final test (Tekin, 2000; Turgut, 1992). Students' responses to the open-ended items were scored using a rubric. For scoring, the five dimensions (most correct answers, far correct answers, incorrect answers, blank answers, and other [meaningless - irrelevant] answers) specified by Kutlu, Yalçın, and Pehlivan (2010) in their study were used and the distribution of students' answers was determined and a rubric was prepared. The answers in the rubric were created before the open-ended items were read, and the students' answers were also examined before the papers were read to ensure consistency with the answers given by the students (Kutlu, Yalçın, & Pehlivan, 2010). In order to determine the reliability of the scoring of the open-ended items, the agreement between the raters was examined. For this purpose, the responses of 200 students to the open-ended items were scored by three raters and the agreement between the raters was analyzed by Kendall's coefficient of agreement. Kendall's coefficient of concordance is a correlation coefficient used to calculate reliability when there are more than two raters (Martin & Bateson, 1992; cited in Tavşancıl, 2002). Kendall's agreement coefficients are given in Table 5.

Table 5. Kendall's coefficients of concordance

Item	W	χ 2	p
33	.913	52.063	.000*
34	.813	48,601	.000*
35	.797	45,409	.001*

In Kendall's coefficient of agreement, the degree of consistency between raters is expected to be close to 1 and at least 0.80 (Szymanski & Linkowski, 1993). Therefore, the 33rd and 34th items with the highest agreement coefficient were selected for the final scale.

As a result of the statistical analyzes, the test was finalized and made ready. The achievement test consists of a total of 25 questions, 2 open-ended and 23 multiple-choice questions.

Data Analysis

TAP (Test Analysis Program) was used to estimate the item statistics of the achievement test. SPSS 22.0 program was used in the reliability studies of the DAT and in testing the research questions. The significance level (p) was taken as 0.05. The methods used in the analysis of the data are given below respectively.

Friedman test was used to answer the research questions "Is there a significant difference between the Data Processing Achievement Test pretest, posttest and retention test scores of the experimental group?" and "Is there a significant difference between the Data Processing Achievement Test pretest, posttest and retention test scores of the control group?". Friedman test is a nonparametric alternative of repeated values one-way analysis of variance (Kalaycı, 2010).

Mann Whitney U test was used to answer the research questions "Is there a significant difference between the posttest scores of the experimental and control groups on the Data Processing Achievement Test?" and "Is there a statistically significant difference between the achievement retention test scores of the experimental and control group students?". Mann Whitney U test tests whether the scores obtained from two unrelated samples differ significantly from each other (Büyüköztürk, 2009). In cases where there is a significant difference, the Glass Rank Biserial Correlation Coefficient (r), which is the effect size method recommended for the Mann Whitney U test statistic, was calculated. r value of 0.1 is considered as a small effect, 0.3 as a medium effect and 0.5 as a large effect (Field, 2009; cited in Cevahir, 2020). Glass Rank Biserial Correlation Coefficient was calculated using the formula given by Wendt (1972).

Implementation Process

Prior to the study, an achievement test (DAT) to be used in implementation was developed and activities to be used during the course were prepared (see also Appendix). While preparing the activities, literature (Akkoç & Yeşildere-İmre, 2015; Kimsesiz, 2019; MoNE, 2009, 2013; Özpınar & Gökçek, 2021) and the opinions of three mathematics educators and three secondary school mathematics teachers were used. Before the implementation DAT was applied as a pretest to the students in the experimental and

control groups. The main implementation was carried out in two classes, one experimental and one control group, in the 6th grade of a public secondary school. Teaching in both groups was carried out by the same teacher. In the experimental group, lessons were taught in the informatics room with VUstat software and activities prepared in accordance with the learning outcomes of the learning domain. Before the implementation VUstat software was introduced to the students in the experimental group in the informatics room and student questions were answered. The process, which includes teaching the software and performing activities in the experimental group, lasts 3 weeks and 21 lesson hours. During the implementation process, students carried out the activities individually or in groups of two. In the control group, the lessons were taught in accordance with the mathematics textbook and existing methods, and question-answer and discussion methods were also included in the lessons. The implementation process in the experimental and control groups started and was completed simultaneously.

Figure 1. Experimental group teaching environment

After the application, DAT was re-applied to the experimental and control groups as a posttest. Six weeks after the posttest applied in the study, DAT was once again administered to the students in the experimental and control groups as a retention test in order to determine the effect of the VUstat software used in teaching mathematics during the application process on the permanence of what was learned.

Findings

In this section, the sub-problems identified in order to clarify the main problem of the research will be presented under separate headings.

Findings Related to the First Sub-Problem of the Research

The first sub-problem of the study is *"Is there a statistically significant difference between the Data Processing Achievement Test pretest-posttest-retention test scores of the students in the*

control group?". The results of the analysis conducted to answer this sub-problem are given in Table 6.

Table 6. Friedman test results of the control group students' DAT pretest-posttest-retention test scores

Measurements	$\overline{X}$	S_x	Mean Rank	χ^2	Sd	p	Significant Difference
Pretest	22.91	10.29	1.00				Pretest-Posttest Pretest-Retention Test Posttest-Retention Test
Posttest	48.64	16.06	2.95	42.091	2	.000*	
Retention Test	39.82	17.27	2.05				

*p<0.05

When Table 6 is examined, it is seen that there is a significant difference between the pretest, posttest and retention test scores of the control group students (p<0.05). In order to determine between which tests this significance was between, comparisons in groups of two were tested with Wilcoxon Signed Ranks Test. As a result of the analysis, it was determined that there was a significant difference between the pretest, retention test and posttest scores of the achievement test of the students in the control group in favor of the posttest scores, and between the pretest and retention test scores in favor of the retention test.

Findings Related to the Second Sub-Problem of the Research

The results of the analysis conducted to answer the sub-problem of the study expressed as *"Is there a statistically significant difference between the Data Processing Achievement Test pretest-posttest-retention test scores of the students in the experimental group?"* are given in Table 7.

Table 7. Friedman test results of the experimental group students' DAT pretest-posttest-retention test scores

Measurements	$\overline{X}$	S_x	Mean Rank	χ^2	p	Significant Difference
Pretest	20.91	9.00	1.00			Pretest-Posttest Pretest-Retention Test Posttest-Retention Test
Posttest	58.13	18.30	2.87	40.783	.000*	
Retention Test	54.74	19.12	2.13			

*p<0.05

When Table 7 is examined, it is seen that there is a significant difference between the scores of the experimental group students from the DAT pretest-posttest-retention test (p<0.05). In order to determine between which tests this significance was between, comparisons in groups of two were tested with Wilcoxon Signed Ranks Test. As a result of the analysis, it was determined that there was a significant difference between the pretest,

retention test and posttest scores of the achievement test in favor of the posttest scores and between the pretest and retention test scores in favor of the retention test.

Findings Related to the Third Sub-Problem of the Research

"Is there a statistically significant difference between the Data Processing Achievement Test posttest scores of the students in the experimental and control groups?" is the third sub-problem of the study and the results of the Mann Whitney U test conducted to clarify this problem situation are presented in the table below.

Table 8. Mann Whitney U test results regarding the DAT posttest scores of the experimental and control groups

Groups	N	$\overline{X}$	S_x	Mean Rank	Rank Sum	U	p
Experiment	23	58.13	18.30	26.28	604.50	177.500	.086
Control	22	48.64	16.06	19.57	430.50		

When Table 8 is examined, it is seen that the average of the scores of the experimental group in the last application of the achievement test is $\overline{X}$ =58.13, while the average of the scores of the control group is $\overline{X}$ =48.64. When the Mann Whitney U test results are analyzed, it is seen that although the scores of the experimental group are higher, this difference is not significant (U=177.500, p>0.05).

Findings Related to the Fourth Sub-Problem of the Study

The fourth sub-problem of the research is *"Is there a statistically significant difference between the achievement retention test scores of the experimental and control group students?"* and the results of the Mann Whitney U test conducted to clarify this problem situation are presented in the table below.

Table 9. Mann Whitney U test results regarding DAT retention test scores of experimental and control groups

Groups	N	$\overline{X}$	S_x	Mean Rank	Rank Sum	U	p	r
Experiment	23	54.74	19.11	27.78	639.00	143.000	.012*	0.565
Control	22	39.82	17.27	18.00	396.00			

When Table 9 is examined, it is seen that the average of the scores of the experimental group from the retention test of the achievement test is $\overline{X}$ =54.74 and the average of the scores of the control group is $\overline{X}$ =39.82. When the Mann Whitney U test results are examined, it is seen that there is a significant difference between the scores of the experimental group and the control group in favor of the experimental group (U=143.000,

p<0.05). The effect size value was found to be r=0.565. These findings reveal that the computer-assisted instruction method has a high level effect on students' retention.

Discussion and Conclusion

The achievements of the students in the experimental and control groups were first analyzed within and then between groups. At the end of the application, the relationship between the DAT retention scores of the experimental and control groups before, after and six weeks after the application was investigated. In line with the findings obtained, it was concluded that there was a significant difference between the DAT pretest-posttest-retention test scores of the control and experimental group students.

As a result of the analysis, it was revealed that there was a significant difference between the pretest and posttest achievement scores of the students in both groups, and when the pretest and posttest scores of the groups were taken into consideration, the values in both groups increased. These results show that the teaching activities carried out in both groups had a positive effect on student achievement, learning took place, that is, they were effective in increasing students' achievement. The findings of the studies conducted by Nwabueze (2006), and Genç (2010) also coincide with the results of this study.

Another result obtained from the research was that VUstat software activities had no effect on students' achievement. There was no significant difference between the posttest achievement scores of the students in the experimental and control groups. When the posttest achievement scores of the experimental and control groups were examined, it was revealed that although the achievement of the experimental group students was higher, this difference was not significant. This result can be interpreted as the difference between the posttest achievement scores of the groups was not statistically significant, so the computer-assisted instruction was not superior; however, the experimental procedure, computer-assisted mathematics instruction, led to a greater increase in the achievement of the students in the experimental group. In other words, it can be said that the application was more effective for the experimental group. The fact that there was no significant difference between the achievement posttest scores of the experimental and control groups may have different reasons, which are also encountered in some studies in the literature. The reasons for this situation may be that the students in the experimental group focused on technology rather than the content of the subject; that it was a short-term application, and that the students were not accustomed to group work (Özyalçın, 2020); physical conditions of the

application environment (Sakallı, 2013); difficulties in ensuring classroom management in courses taught in a laboratory environment (Gençoğlu, 2013) or software (Kimsesiz, 2019; Öner, 2009). Statistical software used in teaching may prevent the learning of some information in the process. In parallel with Kimsesiz's (2019) study, in the VUstat software-supported teaching of the Data Processing learning domain, the students reached the results directly because the software itself finalized the parts requiring procedural knowledge. Similarly, Öner (2009) stated in his study that the students in the experimental group where technology-assisted instruction was applied gave their answers to the activities organized on the computer and did not feel the need to take notes. Another factor may be that students find computer-assisted mathematics teaching as fun and this situation may override the educational dimension (Gençoğlu, 2013). In addition, the fact that some students did not have adequate computer skills and encountered problems caused by the computer during the applications (such as computer-induced or software not opening from the computer) may also be a reason for reaching this conclusion. Failure to achieve the expected increase in student achievement may be related to these issues. Since carrying out the application in a short time may have caused these negativities, it can be said that different results can be obtained in a long-term application if the students get used to the specified situations.

These results of the study support the results of some studies in the literature. Esen (2009) examined the effect of computer-assisted instruction in the teaching of Probability in 6th grades. When the achievement scores of all achievements were calculated in the light of the findings of the study, it was seen that teaching the subject with both computer-assisted instruction and traditional teaching method increased the learning success of the students. Although it was determined that computer-assisted instruction was more successful than the traditional method, the fact that the achievement scores were close to each other was evaluated by the researcher as computer-assisted instruction was not successful enough. Öner (2009) aimed to examine the effect of technology-assisted instruction on the achievement level, attitude and retention of 7th grade students in the teaching of Equations sub-learning domain of Algebra learning domain and found that the achievement level of the students increased. In addition, although there was no significant difference between the groups according to the method applied, it was observed that the achievement test posttest and achievement score averages of the control group students were lower than those of the experimental group students. Similarly, Tataroğlu (2009) aimed to determine how the use of

smart board for the subject of functions affected the achievement, attitudes towards mathematics course and self-efficacy levels of 10th grade students and found that the use of smart board did not create a significant difference between the experimental and control groups in terms of achievement. In another study (Kimsesiz, 2019), it was aimed to get students' opinions about the effect of teaching the 7th grade Data Analysis subject with VUstat software on academic achievement and retention and the experimental process, and as a result of the comparisons of the analyzes between the groups, it was concluded that VUstat software had no effect on students' achievement. There are different studies similar to this result in the literature (Gençoğlu, 2013; Klein, 2005).

As can be seen, at the end of the studies mentioned above, it was concluded that there was no statistically significant difference between the posttest scores of the experimental group and the control group, but the achievement scores of the experimental group were higher than those of the control group, which coincides with the achievement results of this study.

There are also studies in the literature that are not in parallel with these results. In his study, Çubuk (2004) examined whether there was a significant difference between the application of computer-assisted instruction and traditional teaching methods on the course achievement and attitudes towards mathematics of 8th grade students in the subject of Permutation and Probability; Andiç (2012) examined the effect of computer-assisted instruction of Permutation and Combination subject on the achievement levels and attitudes of 8th grade students; Balkan (2013) investigated the effect of computer-assisted instruction on the academic achievement and attitudes of 7th grade students in the sub-learning domain of Tables and Graphics, and as a result, in all three studies, it was found that computer-assisted instruction method increased students' achievement in mathematics course. In the literature, there are also different studies in which there is a significant difference between the posttest scores of the experimental and control groups in the studies examining the effect of technology or computer-assisted mathematics teaching on achievement (Altın, 2012; Nwabueze, 2006; Sakallı, 2013; Zengin, 2011).

On the other hand, another conclusion reached at the end of the study is that VUstat software activities have an effect on the retention of knowledge. There was a significant difference between the pretest, retention test and posttest scores of the achievement test of the students in both groups in favor of the posttest scores, and between the pretest and

retention test scores in favor of the retention test. This result is an indication that the application changed the achievement of the students in the experimental group positively and that this situation continued afterwards. In addition, when the retention test scores of the experimental and control groups were examined, it was revealed that there was a significant difference in favor of the experimental group. This result reveals that the teaching activities with VUstat software have a high level of effect on students' retention. Therefore, it can be interpreted that the lesson with computer-assisted mathematics teaching enabled students to remember their knowledge for a longer period of time and was more effective in increasing their achievement. The result of the study that there was no significant difference between the posttest achievement scores of the experimental and control groups, but there was a significant difference between the retention test scores overlaps with the results of Öner's (2009) study in which he examined the effect of technology-assisted instruction on the achievement level, attitude and retention of 7th grade students in the teaching of Equations sub-learning domain; while Kimsesiz's (2019) study in which he examined the effect of Data Analysis subject in the 7th grade mathematics course curriculum with VUstat software. The study of Kimsesiz (2019), which aims to reveal the effect of teaching the Data Analysis subject in the 7th grade mathematics course curriculum with VUstat software on achievement and retention, is in parallel with the result that there is no statistically significant difference between the posttest achievement scores of the experimental and control groups, but it does not overlap with the results regarding retention. In addition to these studies, there are also studies in the literature (Genç, 2010) that found significant differences between the posttest and retention test achievement scores of both groups in favor of the experimental group. Another study that reached a different conclusion was conducted by Genç and Öksüz (2016). At the end of their study, which aimed to reveal the effect of teaching the 5th grade Polygons and Quadrilaterals subject with dynamic mathematics software on achievement and retention, the researchers found a statistically significant difference between the achievement posttest scores of the experimental and control group students in favor of the experimental group; when they examined the retention level of the information in the students, they found that the experimental group students kept their knowledge about the subject in mind for longer.

Recommendations

It should be taken into consideration that statistical software used in teaching may prevent the learning of some information in the process. Therefore, in order for the students to understand the ideas contained in the operations, it should be ensured that the students first perform the operations with paper and pencil on the subjects that require operations and then check the accuracy of the results on the applications using the software. In addition, VUstat software was preferred for teaching statistics in this study. The effectiveness of technology-assisted instruction in general and VUstat software in particular can be investigated and compared at different grade levels. Studies can also be conducted using different software in teaching this subject and their effectiveness can be examined and compared. Also considering the short implementation period of the research, it is thought that longer-term applications may make a difference in the results.

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Author Contribution Statement

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Appendix

Class Level: 6th Grade

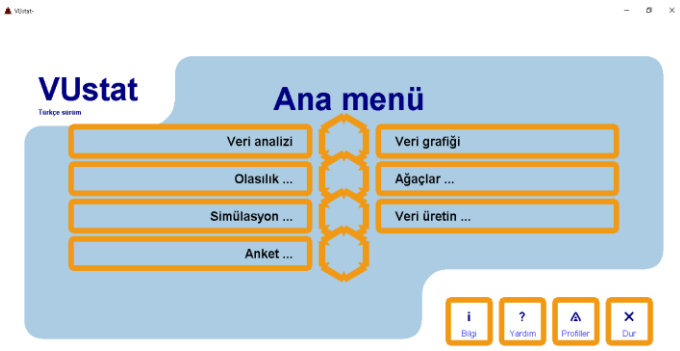
Learning Outcome: (M.6.4.1.1.) Formulates research questions that require comparing two groups of data and obtains appropriate data.

Purpose of the Activity: In this activity, the following are aimed by students using VUstat software.

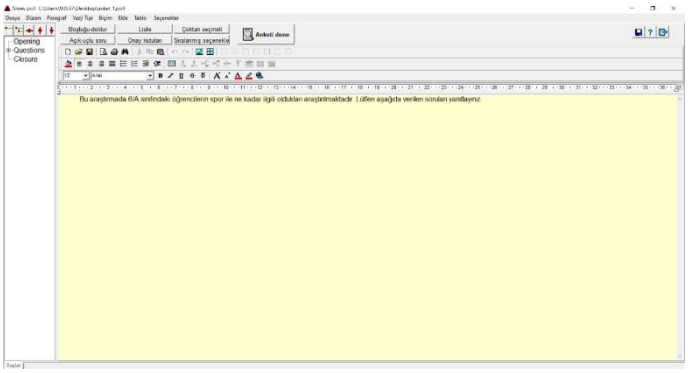
- Gaining experience in conducting surveys,
- Evaluating and interpreting the survey data obtained.

Explanations Regarding the Activity Menu and the Implementation of the Activity:

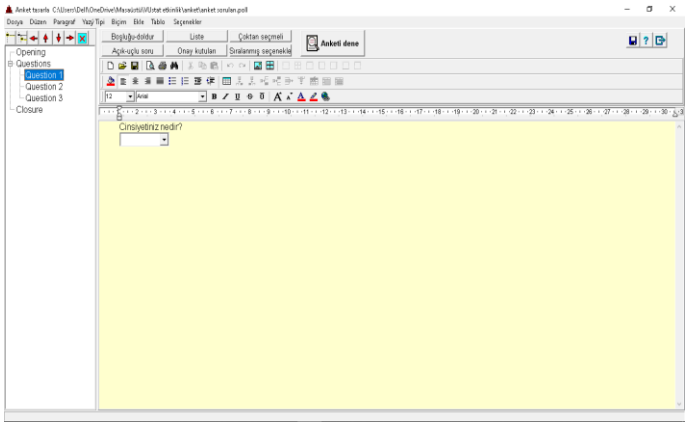
Open the VUstat software.



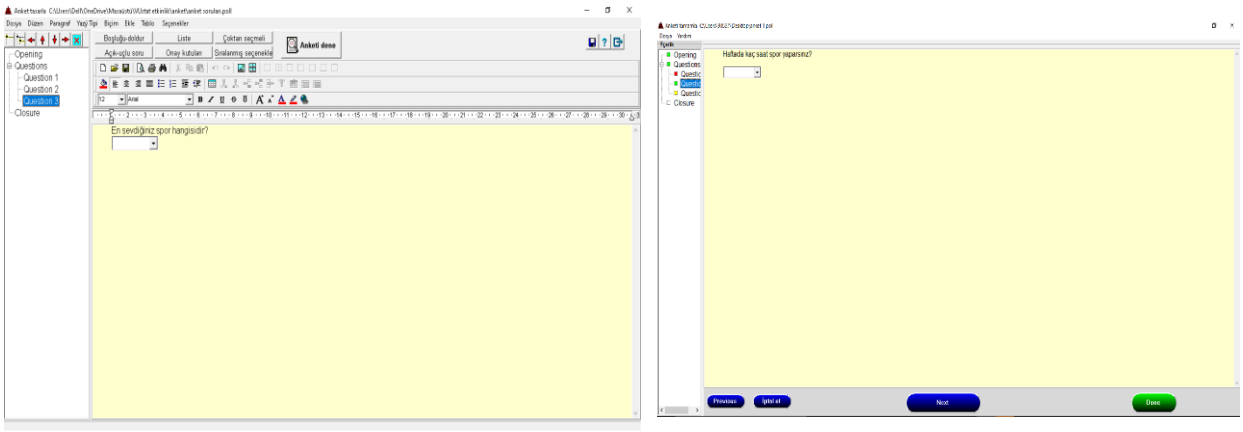
In this activity, the above screenshot is obtained by following the "**Survey→Design**" sequence from the main menu of the VUstat software. While in the "Opening" window, information about the research to be conducted is given as follows: "In this research, it is investigated how interested the students in class 6/A are in sports. Please answer the questions below."



When creating a question for the survey, click on "+ **Questions**". "Questions 1" coded "What is your gender?" question and the premises "Girl and Boy" are written from the "Checkboxes" button.

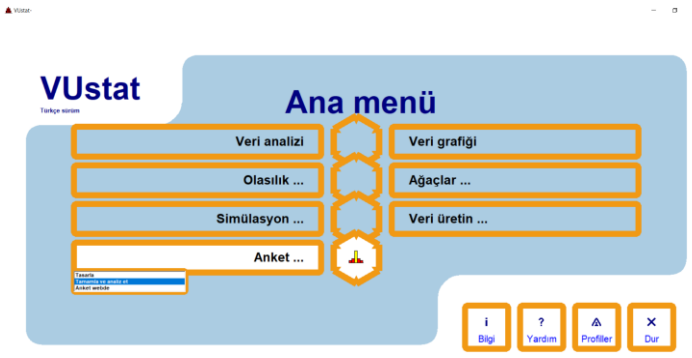


In the opened windows with the code "Questions 2 and Questions 3", the question "How many hours do you do sports a week?" question, "0, 1-29min, 30-59min and 1 hour or more" options from the "Checkboxes" button and "What is your favorite sport?" question, "Football, Basketball, Volleyball and Swimming" options are written from the "Checkboxes" button.

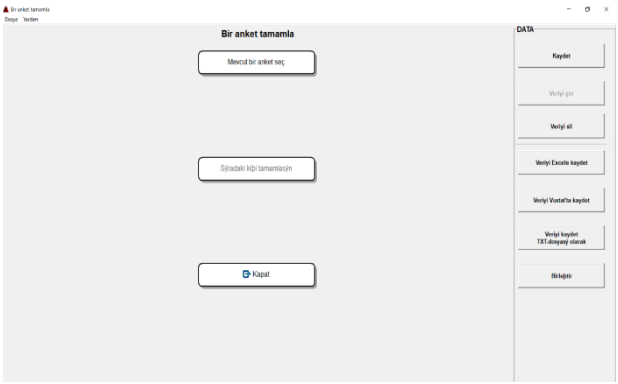


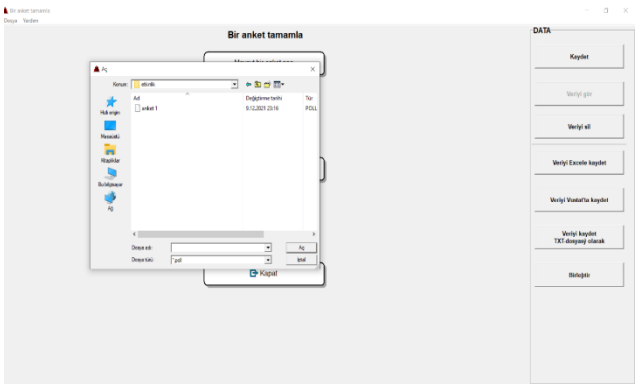
After completing the survey, the "**closure**" button is selected. The phrase "Thank you for participating in the survey" is written.

The survey is recorded and sent to students. Students to whom the survey is sent will be able to open the survey by following the order "**Survey→Complete and Analyze**".



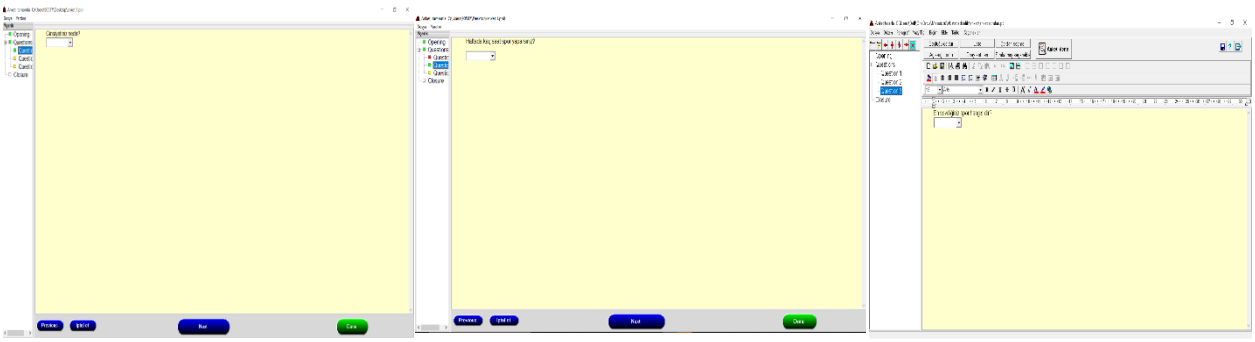
In the window that opens, follow the steps "**Select an existing survey→Survey questions file**" as seen in the screenshots below, and first press the "**Select an Existing Survey**" button and select the file named "**survey 1**". The survey is filled out by clicking the "**Publish survey**" button. All three questions are answered by clicking the "**Next**" command. The survey is terminated by clicking "**Done**".



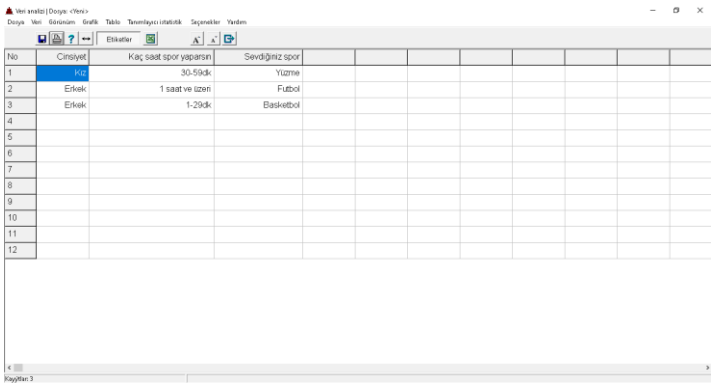


When the file named "**survey 1**" is selected, the screenshots that the students will see are as follows, respectively. Students first encounter the following statement: "In this research, it is investigated how interested the students in class 6/A are in sports. Please answer the questions below."

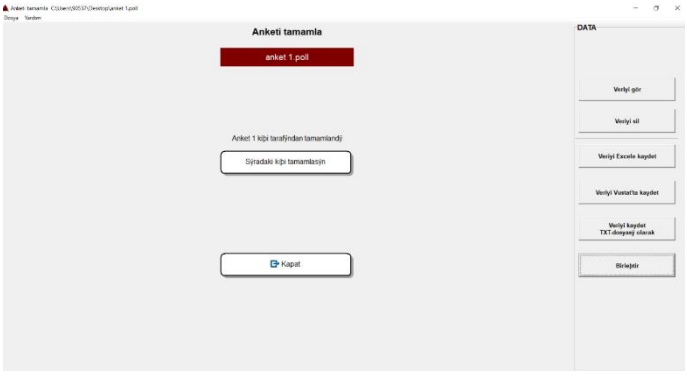
After reading each given statement, the "Next" button is pressed.



After completing the survey, click on the "Done" button. The image below appears.



After completing the survey, click on the "View data" button and all uploaded data will be seen in the VUstat "**Data Analysis**" window as in the screenshot below.



Explanation: The activity can be applied individually or in pairs in the classroom. When evaluating the survey data obtained, statistical calculations such as average and frequency tables are also used and students are asked to interpret the analyses. Students are then asked to create their own surveys, collect and interpret survey data using VUstat software.