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The impact of the techno-organic education model on the mathematical success rates and attitudes of students

O impacto do modelo de educação técnico-orgânico nas taxas de sucesso matemático e nas atitudes dos alunos


El impacto del modelo de educación tecnoorgánica en las tasas de éxito matemático y las actitudes de los estudiantes

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Abstract: Techno-organic education is an education model that allows children to gain the knowledge, skills, and values that are necessary for life by establishing a correct balance of natural and technological understanding. This research was conducted to examine the impact of the Techno-Organic Education Model on students' academic achievements and attitudes for math. For this purpose, the explanatory sequential mixed design was used to conduct this study. The study group consisted of 38 primary school students. Mathematics Course Achievement Test, Mathematics Attitude Scale and semi-structured interview form used as data collection tools. This research included a 4-week application within the scope of the Techno-Organic Education Model program which is developed by the researchers. For the analysis of the quantitative data, independent samples t-test; dependent samples t-test; Wilcoxon Signed Ranks Test, Mann Whitney U Test, and content analysis method were used. As a result; a statistically significant difference was revealed between pre-test and post-test scores for the success rate and attitude of the students in the experimental group, and there has also been a statistically significant difference between the post-test success and attitude scores of the experimental group and the control group. According to qualitative findings of the study; students think positively about the use of techno-organic education model in their courses, and they generally liked the applications and thought they weren't too difficult, and that this particular model increased their interest in the course.

Keywords: Mathematics in Primary School, Techno-Organic Education, Techno-Organic School.

Resumo: A educação tecno-orgânica é um modelo de educação que permite que as crianças adquiram os conhecimentos, habilidades e valores necessários para a vida, estabelecendo um equilíbrio correto entre a compreensão natural e tecnológica. Esta pesquisa foi conduzida para examinar o impacto do modelo de educação técnico-orgânica nas realizações acadêmicas dos alunos e nas atitudes em relação à matemática. Para tanto, utilizou-se o delineamento explicativo sequencial misto para a realização deste estudo. O grupo de estudo consistia em 38 alunos do ensino fundamental. Teste de Realização do Curso de Matemática, Escala de Atitude em Matemática e formulário de entrevista semiestruturada utilizados como instrumentos de coleta de dados. Esta pesquisa incluiu uma aplicação de 4 semanas no âmbito do programa Modelo de Educação Tecno-Orgânica que é desenvolvido pelos pesquisadores. Para

a análise dos dados quantitativos, teste t para amostras independentes; teste t de amostras dependentes; Foram utilizados o Wilcoxon Signed Ranks Test, o Mann Whitney U Test e o método de análise de conteúdo. Como resultado; uma diferença estatisticamente significativa foi revelada entre os escores do pré-teste e pós-teste para a taxa de sucesso e atitude dos alunos no grupo experimental, e também houve uma diferença estatisticamente significativa entre o sucesso do pós-teste e os escores de atitude do grupo experimental grupo e o grupo controle. De acordo com os resultados qualitativos do estudo; os alunos pensam positivamente sobre o uso do modelo de educação técnico-orgânico em seus cursos e, em geral, gostaram das aplicações e acharam que não eram muito difíceis, e que esse modelo específico aumentou seu interesse pelo curso.

Palavras-chave: Matemática na Escola Primária, Educação Tecno-Orgânica, Escola Tecno-Orgânica.

Resumen: La educación tecnoorgánica es un modelo educativo que permite a los niños adquirir los conocimientos, habilidades y valores necesarios para la vida mediante el establecimiento de un correcto equilibrio entre el entendimiento natural y tecnológico. Esta investigación se realizó para examinar el impacto del Modelo de Educación Tecnoorgánica en los logros académicos y las actitudes de los estudiantes hacia las matemáticas. Para ello, se utilizó el diseño mixto secuencial explicativo para realizar este estudio. El grupo de estudio estuvo formado por 38 alumnos de primaria. Prueba de rendimiento del curso de matemáticas, escala de actitud matemática y formulario de entrevista semiestructurada utilizados como herramientas de recopilación de datos. Esta investigación incluyó una aplicación de 4 semanas dentro del alcance del programa Modelo de Educación Tecnoorgánica que es desarrollado por los investigadores. Para el análisis de los datos cuantitativos, prueba t de muestras independientes; prueba t de muestras dependientes; Se utilizaron la prueba de rangos con signo de Wilcoxon, la prueba U de Mann Whitney y el método de análisis de contenido. Como resultado; Se reveló una diferencia estadísticamente significativa entre los puntajes previos y posteriores a la prueba para la tasa de éxito y la actitud de los estudiantes en el grupo experimental, y también ha habido una diferencia estadísticamente significativa entre los puntajes de éxito y actitud posteriores al examen experimental. grupo y el grupo de control. Según los hallazgos cualitativos del estudio; los estudiantes piensan positivamente sobre el uso del modelo de educación tecnoorgánica en sus cursos, y en general les gustaron las aplicaciones y pensaron que no eran demasiado difíciles, y que este modelo en particular aumentó su interés en el curso.

Palabras clave: Matemáticas en la Escuela Primaria, Educación Tecnoorgánica, Escuela Tecnoorgánica.

INTRODUCTION

Technological changes and developments make our lives easier. But, they also bring many problems (Plowman et al., 2010). Children who interact with television sets from an early age turn their interest to the internet, computers, and smartphones in a short time (Mertala, 2019; Valkenburg & Soeters, 2001). Children's encounter with the technological environment from an early age also affects their cognitive, physical, emotional and social development (Plowman et al., 2010; Ishaq et al., 2019).

It is important to have a hands-on teaching process in the natural environment for providing an effective and efficient learning environment for the children. According to researchers who investigated the advantages of green school areas, education in a nature-centered environment is more meaningful for students. Students can easily learn by processing, smelling, touching and even tasting the materials in

their environment. Outdoor education in green school areas can inspire students by motivating them who are having difficulty to learn in class (Ballantyne & Packer, 2002; Bentsen & Jensen, 2012). Organic education can be described as the process of the educational activities to give individuals the basic skills, knowledge, and behaviors necessary to ensure that they can establish strong relationships between school and life in a natural environment using vital experiences and natural educational tools, to ensure that they can healthily maintain their lives (Caviola et al., 2020; Mertala, 2019). Therefore, organic education liberates children from the dependence of technological tools, giving them a more effective, lasting and fun learning environment (Domoff et al., 2019; Mahmud et al., 2020).

Although organic education aims to protect the children from the harmful effects of technology, it also has a downside as it keeps them completely away from current social life trends. Therefore, it is important to enabling children to use the technologies which enables them to grow up as social individuals, consciously and in a controlled manner without keeping them away from it (Katz et al., 2019). The internet and computers should be considered as tools that will help the children to resolve the problems that they may encounter during the school term, providing information quickly and accurately (Hefner et al., 2019).

In today's society, a technology-assisted training model that can also benefit from nature is needed, to obtain the necessary knowledge, values, and skills for daily life. In line with this need, the techno-organic education model was developed as a process that covers all the educational activities to ensure that individuals gain the basic skills, knowledge, and behaviors necessary to ensure that they can establish strong relationships between school and life in a natural environment, use technology in a balanced manner, to maintain a balance between nature and technology. This education model offers students an education that combines the natural and technological methods (Domoff et al., 2019; Siregar et al., 2019).

Since it is one of the most important tools used in solving problems in our daily life as well as in science, mathematics is included in all levels and fields from pre-school education programs to higher education programs. The biggest task of teachers in teaching mathematical terms is to give due importance to the use of materials related to the mathematical terms that are taught. The experience created with materials enables students to abstract and construct information in their minds (Chiu et al., 2020; Katz et al., 2019). For this reason, the effect of using the Techno-Organic Education Model, which is an education model integrated with nature and technology-supported materials, on the academic achievement and attitudes of the students was examined.

The Internet and computers should be considered as tools that provide accurate access to information to make life easier (Mertala, 2019). The Techno-Organic Education Model enables children to use the internet and computers correctly and provides children a learning environment where different methods are synthesized.

In the Techno-Organic education model; the education model consists of the following sections: "Techno - Organic Education Area", "STEM Area", "Robotic Coding Area", "Techno-Organic Research-Review Area", "Techno-Organic Art Area", "Techno-Organic Zoo Area", "Techno-Organic Aquatic Living Center", "Techno-Organic Agricultural Area", "Techno-Organic Sightseeing Areas" and "Techno-Organic Gaming Area".

Techno-Organic education is a model that allows children to communicate with technology correctly. There are two main reasons for the development of such a model. The first reason is to ensure that children use technology in a controlled and conscious manner. In accordance with this reason, the controlled and conscious use of technology is associated with the correct orientation and use of the technology with appropriate limitations (Lieberman et al., 2009; Mahmud et al., 2020). The second reason is to establish the balance of nature and technology correctly and gain the knowledge, skills, and values that are necessary for the everyday lives of children. In accordance with this reason, the development of this model involves a lifelong nature and technology-assisted education. As a result, Techno-Organic Education is important for ensuring that children use technology in a controlled and conscious manner.

Purpose of Research

The purpose of this research is to examine the impact of the Techno-Organic Education Model on students' academic success levels and attitudes in mathematics. In accordance with the main purpose of the research, answers to the following research questions below were sought:

1. Does the Techno-Organic Education Model have a statistically significant effect on students' academic success rates in math?
2. Does the Techno-Organic Education Model have a statistically significant effect on students' attitudes in math?
3. Is there a significant difference between the academic achievements of the students between the ones who have been subjected to the Techno-Organic Education Model and the traditional educative methods?
4. Is there a significant difference between the attitudes of the students between the ones who have been subjected to the Techno-Organic Education Model and the traditional educative methods?
5. What are the views of 3rd-grade primary school students regarding the implementation process of the Techno-Organic Education Model?

METHOD

Explanatory sequential mixed design was used to conduct this study. The main reason for the use of the mixed model in this research is that qualitative and quantitative data have been used in combination to further strengthen the research. The mixed method is the combination

or integration of quantitative and qualitative research methods and data in a study. Explanatory sequential mixed method consists of a researcher conducting quantitative research in the first stage and analyzing its results and explaining these results in a more detailed way through a qualitative study (Creswell, & Poth, 2016).

Semi-experimental model was used in the quantitative dimension of the study. The pairings in the study groups of the study were formed by comparing the students' 2nd grade end-semester grades at the beginning of the implementation by determining the two closest classes as the experimental and control groups. Before the implementation, two third grade classes which are equivalent to each other, were determined as the experimental group and the control group via casting a ballot. While the "Techno-Organic Education Model" was implemented in the teaching of students in the experimental group, the traditional teaching approaches were used for the the control group students.

In the qualitative dimension of the research, phenomenologic method was used. The phenomenologic method is based on solid foundations and usually requires interviews (Creswell, & Poth, 2016). After the application of the study, semi-structured interviews were applied to students in the experimental group.

Study Group

The quantitative study group of the research consists of 38 students who attend the 3rd grade of the primary school in the Merkez district of Elazığ province in the first semester of the 2018-2019 academic year, and who were selected in accordance with their academic success. One of the two branches that formed the study group was identified by drawing lots as the control group and the other as the experimental group. A total of 19 students consisted of the experimental group of the study. The control group consisted of 19 students. The reason for choosing the particular classes for the experimental and control groups that make up the study group of the research is that the researchers measured the success levels of these two classes and found them to be similar by comparing the second-grade end-term grades of all the 3rd-grade students at the school before the research. In the qualitative dimension of the research, the study group consisted of 19 students who received an education with the Techno-Organic Education Model. These 19 students are in the experimental group, who are trained with the Techno-Organic Education Model.

Data Collection Tools

2 types of data collection tools were used to collect the quantitative data for the research. The first one is the "Mathematics Course Achievement Test" developed by the researcher in order to determine the impact of the Techno-Organic Education Model on students' academic achievements. The second one is the "Attitude Scale for Primary and Secondary

School Students” developed by Gülburnu & Yıldırım (2015) in order to determine the attitudes of the students towards mathematics. A semi-structured interview form was used to collect the qualitative data obtained from the research.

Mathematics Course Achievement Test

It is thought that one of the most frequently used tests in the measurement and evaluation dimension is the achievement test (Adıgüzel & Özdoğru, 2013; Şimşek & İpek, 2019). Multiple-choice tests have an important place among the tools used to measure the level of success. Multiple-choice tests are accepted to provide more reliable information than other tests, as they are measurement tools that have been proven to be adequacy in terms of psychometric qualities such as reliability and validity and whose rules are determined according to representative samples (Allen et al., 2020; Gülburnu & Yıldırım, 2015).

In order to determine the effect of Techno-Organic Education Model applied in mathematics course on students' academic achievement in the research, Mathematics Course Achievement Test was developed by the researchers. The Mathematics Course Achievement test used in the research was developed in 6 stages. In the first stage, the gains regarding the "Addition with natural numbers" sub-learning factor of the "Numbers and Operations" learning factor which is covered during the application in the 3rd grade mathematics course were established. The learning and sub-learning area was determined by examining the 3rd grade Mathematics curriculum in detail and by interviewing the 3rd grade teachers. In the development of the second phase of the achievement test, the researchers examined the gains of the "Addition with Natural Numbers" sub-learning factor and a pool consisting of 40 multiple choice test questions within the scope of these gains were created. Expert opinions have been consulted to ensure the validity of this 40-question pre-success test prepared in the third phase. As a result of the opinions received, the necessary arrangements have been made in the test questions. In the fourth stage, in order to carry out the analysis of the 40-question achievement test items, the pilot application of the test was applied to the 4th grade students, consisting of a total of 113 students studying in the same school in the first semester of the 2018-2019 academic year. In the fifth stage, analyzes were carried out using the SPSS 23 software in order to determine the difficulty and distinctiveness of each question of the test applied. In the success test, items with distinctiveness index value $\geq .40$ were used. Finally, as a result of the calculations related to the item analysis, the questions with an item discrimination index $< .40$ were removed and the number of questions was reduced to twenty items and the achievement test was finalized.

Attitude Scale for Math Course

“Attitude Scale for Primary and Secondary School Students” developed by Gülburnu & Yıldırım (2015) was used in the research in order to determine the attitudes of the students towards mathematics. This scale consists of 27 items of 5-point Likert type (“I Strongly Agree, I Agree, I am indecisive, I Disagree, I Strongly Disagree”) The total score of the scale consists of the sum of items scored by the responses given by the students. Positive items for attitude were graded as 5-4-3-2-1, and the negative items were graded as 1-2-3-4-5 which resulted as the final form of the scale. The data were subjected to Kaiser-Meyer-Olkin (KMO) value and the Bartlett Globality Test as a part of the validity studies. The KMO value of the 27-item scale was found to be (.888) and this shows that the sample is really good. In addition, the value of significance according to Bartlett globality test was found to be (.000). [$X^2 = 2550,101$, $p < .001$]. The Cronbach Alpha internal consistency coefficient has also been calculated to reveal the internal reliability of the scale. The Cronbach Alpha coefficient was found to be 0.880 for all items. Cronbach Alpha values were also calculated for the sub-factors. Cronbach Alpha internal reliability coefficients of the sub-factors of the Mathematics Attitude Scale for Primary and Secondary School Students are: For the 1st factor: 0.837, for the 2nd Factor: 0.735, for the 3rd factor: 0.742, for the 4th factor: 0.712 and for the 5th factor: 0.787. These values indicate that the scale is a reliable one (Gülburnu & Yıldırım, 2015).

Semi-Structured Interview Form

Interviews were conducted with students to strengthen the quantitative data obtained from the research with qualitative data. Semi-structured interview form were used to perform interviews. In preparing this interview form, firstly, a list of questions the Techno-Organic Education Model about was created. The created question list was examined by four primary school teachers teaching the 3rd grade in order to evaluate the accuracy of the questions in terms of clarity, spelling rules and suitability for the level of the student. As a result of the feedback received, it was determined that some questions should be made clearer, and the interview form were finalized by making necessary arrangements on the questions.

Data Collection Process

The students were evaluated according to the grade point average at the end of their 2nd grade and two classes with equivalent success levels were determined. Later on, one of the researchers attended the math courses with both the experimental and control groups in order to explain the addition of natural numbers and to

process the achievements. Throughout the pre-determined subjects and achievements in the curriculum, the researcher attended the mathematics courses of the experimental and control groups. The duration of the targeted achievements in the program was 4 weeks.

The researchers applied a mathematics attitude scale and a mathematics course achievement test to both control and experimental group students before starting the process of teaching the subject in both groups. During the application process, students who form the experimental group were taught in mathematics courses via the "Techno-Organic Education Model"; while students who form the control group were given the same courses via traditional methods. In the process of application in the experimental group; while the addition was being taught, the students were trained with the integration of both natural materials (walnuts, eggs, beans, etc.) and coding activities prepared by the SCRATCH software. While determining the relevant materials, organic materials suitable for the processing of the acquisitions in the sub-learning area were designed. With its easy-to-use, interactive structure and fun characters, SCRATCH is a tool where children can learn programming concepts and enjoy the lessons (Şimşek & İpek, 2019). It is also possible to develop applications such as educational simulations and calculators with the SCRATCH program (Flechier, 2019). For these reasons, the SCRATCH program was also used in addition to organic materials in the processing of all acquisitions in the sub-learning area. In the control group, however, students were taught using the activities present in the textbook (traditional, chalk, wood, smart board, etc.). When the period given for the targeted gains was finished, the experiment and control group students were once again subjected to the scale of attitude towards mathematics and the achievement test developed by the researcher. After the collection of quantitative data in the study, interviews were conducted with the students to reveal their views on the Techno-Organic Education Model. These interviews lasted about 5 to 10 minutes.

Analysis of Data

Mean (\bar{x}), percentage, frequency, standard deviation (ss) techniques were used to analyze and interpret the quantitative data obtained. In addition to these, it was determined whether the data obtained before starting the analysis of quantitative data showed a normal distribution. As a result of normality tests, dependent samples t-Test and Independent Samples t-Test from parametric tests; Wilcoxon Signed Rank Test and Mann Whitney U Test, which are non-parametric tests, were used for non-normally distributed groups. In the analysis of qualitative data, content analysis was performed. The notes and audio recordings obtained from the interviews were first transcribed in digital environment. The differences and similarities between the codings obtained from the answers were grouped. Thus, sub-themes and themes were created. The answers were evaluated by a pair of coders. The themes that both coders

created separately from each other were 96% equivalent to each other. Consensus was reached among the other 4%.

FINDINGS

Within the framework of this title, first of all, the effects of the Techno-Organic Education Model on the students' academic achievement in mathematics, the effect of the model on the students' attitudes towards the Mathematics lesson, the students who were applied the Techno-Organic Education Model and who were applied the traditional method, the differences between their academic achievement and attitudes towards the Mathematics lesson were analyzed in detail. Finally, the findings of primary school 3rd grade students regarding the implementation process of the Techno-Organic Education Model are included.

Findings on the Effect of Techno-Organic Education Model on Students' Mathematics Academic Achievement

It was examined whether there was a statistically significant difference between the scores obtained by the study group from the achievement test applied before and after the study was carried out. Data related to Dependent Samples t-Test performed for this purpose are given in Table 1.

Table 1

Findings on the effect of techno-organic education model on students' mathematics academic achievement

Group		N	\bar{x}	S	Sd	t	p	η^2
Experimental	Pre-test	19	8.5263	4.26052	18	-8.613	.000	.80
	Post-test	19	13.7368	4.45773				
Control	Pre-test	19	7.1053	3.03488	18	-6.026	.000	.66
	Post-test	19	9.6842	2.28650				

When Table 1 is examined, the average results of the math course achievement tests for both the experimental and control groups for pre-test and post-test scores were (experimental pre-test $x\# = 8.5263$; experimental post-test $x\# = 13.7368$; control pre-test $x\# = 7.1053$; control post-test $x\# = 9.6842$). When the Mathematics Course Achievement Test pre-test and post-test results for both the experimental and control groups were examined, the p-value was found to be .000 ($p=.000$; $<.05$). Based on this remark, there is a statistically significant difference between pre-test and post-test scores based on the achievement test results of the students in both the experimental and control groups. The value ($\eta^2 = .80$; $\eta^2 = .66$) which was calculated as a result of the statistics obtained from the pre-test and post-test scores of the students

in the experimental and control groups shows a rather substantial effect. (see: Pallant, 2016).

Findings Regarding the Effect of Techno-Organic Education Model on Students' Attitudes Towards Mathematics Lesson

It was examined whether there was a statistically significant difference between the scores taken from the scale of attitude before and after the study was implemented for the students in the experimental group. Data related to the Wilcoxon Signed Ranks Test carried out for this purpose are given in Table 2.

Table 2
Findings regarding the effect of techno-organic education model
on students' attitudes towards mathematics lesson students

Experimental	N	RankingAverage	RankingTotals	z	p	η^2
Negative Rank	3	11.00	33.00			
Positive Rank	14	8.57	120.00	-2.060	.039	.33
Equal	2					

When table 2 was examined, it was observed that the attitudes of the students in the experimental group towards mathematics course were positive. When the pre-test and post-test results of the experimental group mathematics course attitude scale were examined, it can be seen that ($z = 2.060$ and $p = .039$; $< .05$). Based on this remark, a statistically significant difference between the pretest and posttest scores for the attitudes of students in the experimental group towards mathematics was found. The size of the effect value ($r = .33$) which was calculated as a result of the statistics obtained from the pre-test and post-test scores of the mathematics attitude scale of the experimental group students shows a medium effect size (see: Pallant, 2016).

Findings Concerning the Differences Between the Mathematics Academic Achievement of the Students who received the Techno-Organic Education Model and the Students who received the Traditional Method

It was examined whether there was a statistically significant difference between the scores obtained from the achievement tests of the students in the experimental and control groups which were applied after the study was done. The data regarding the Independent Samples t-Test conducted for this purpose are given in Table 3.

Table 3

Findings concerning the differences between the mathematics academic achievement of the students who received the techno-organic education model and the students who received the traditional method

Post-test	N	\bar{x}	S	Sd	t	p	η^2
Experimental	19	13.7368	4.45773	36	3.526	.001	.25
Control	19	9.6842	2.28650				

When Table 3 is examined, it can be seen that the average of the experimental group students' Mathematics Course Achievement post-test scores ($\bar{x}=13.73$ for post-test); The average of the control group students' Mathematics Achievement posttest scores ($\bar{x} = 9.68$ for the post-test). When the experimental group and the control group Math Course Achievement Post-test results were examined, the p-value was found to be .001 ($p = .001$; $< .05$) Based on this remark, we can say that there was a statistically significant difference between the post-test scores according to the results of the Mathematics Course Achievement Test of the students in the experimental group and control group. The value ($\eta^2=.25$) calculated as a result of the statistics obtained from the post-test scores of the experimental group and control group students demonstrate a rather substantial effect.

Findings Concerning the Differences Between the Mathematics Attitude of the Students who received the Techno-Organic Education Model and the Students who received the Traditional Method

It was examined whether there was a statistically significant difference between the scores obtained from the attitude scale applied to the students in the experimental and control groups after the study was completed. Data from the Mann-Whitney U Test are included in Table 4.

Table 4

Findings concerning the differences between the mathematics attitude of the students who received the techno-organic education model and the students who received the traditional method

	N	Ranking Average	Rank Total	U	p	η^2
Experimental	19	25.61	486.50			
Post-Attitude Control	19	13.39	254.50	64.500	.55	.001
Total	38					

When Table 4 is examined, it can be seen that the mathematics attitude post-test scores of the students in the experimental group are ($SO=25.61$) and mathematics attitude post-test scores of the students in the control group are ($SO = 13.39$). The results of the Mann Whitney

U Test regarding the mathematics course attitude scale post-test scores of the experimental group and control group students are ($U = 64.500$ and $p = .001$; $< .05$). Based on this remark, a statistically significant difference was found between the experimental group and the control group students' mathematics attitude scale post-test scores. The effect size value ($\eta^2 = .55$) which was calculated as a result of the statistics obtained from the post-test scores of the mathematics course attitude scale of the experimental group and the control group students shows a rather substantial effect size.

Findings Concerning the Opinions of 3rd Grade Primary School Students on the Implementation Process of the Techno-Organic Education Model

Within the scope of this sub-title, detailed results of qualitative data analysis obtained from interviews with students in the experimental group and the findings obtained from these interviews are included.

Students were asked the question "What are your thoughts about the use of Techno-Organic Education in courses?". When the answers received were examined, it was seen that the views on the use of Techno-Organic Education in lessons were grouped under two themes as learning process and feelings. In the learning process; emphasis was placed on increasing success, facilitating learning, facilitating understanding, providing opportunity for repetition, both having fun and learning, developing imagination, and learning like games. Emphasis has been placed on those who are felt as beautiful, entertaining, useful, entertaining and pleasing. Examples of student opinions on this subject are as follows:

E5: *"I learn very well thanks to these activities. I think I'm going to do better on my exams."*

E8: *"I feel happy. And they're entertaining. We're both learning and having fun at the same time."*

Students were asked the question "What are the positive aspects of the use of Techno-Organic Education in mathematics courses?". These opinions are; were gathered under the headings of learning process and feelings. It was determined that the sub-themes of increasing success, providing understanding, learning with fun, experimenting with numbers were emphasized in the learning process that took the most load, and the ones felt were like making the math lesson popular, happy, very nice, fun, reminding the kindergarten, eating something and relaxing emphasis has been made. Examples of student opinions on this subject are as follows:

E15: *"When these kinds of activities are involved, I like math courses more."*

E14: *"Such activities need to be a part of our math courses, it makes things feel like eating, it improves my success. Both in terms of the courses and foods."*

Students were asked the question "What are the negative aspects of the use of Techno-Organic Education in mathematics courses?". When the answers received were examined, it was seen that all of the students stated

that there was no negative side of the model. Examples of opinions on this subject are:

E12: *"I have no negative opinion. I am pleased that these activities are being used."*

E15: *"I have no negative opinion. I didn't feel anything negative."*

Students were asked the question "How did Techno-Organic Education affect your interest in mathematics courses?". When the answers were examined, it was seen that the views on the effect of Techno-Organic Education on the interest in the mathematics lesson were emphasized as increasing the interest and participating in the lesson. Examples of students' opinions are given below.

E10: *"I think these activities have increased my interest in math courses even more."*

E4: *"These activities have increased my interest in mathematics. I'm more willing to learn in the classroom. I want to attend math classes."*

Students were asked the question, "Would you rather learn with Techno-Organic Education or other traditional methods?". When the answers were examined, it was seen that the students generally preferred to learn with the Techno-Organic Education Model. Examples of students' opinions are given below.

E1: *"I would like to learn with Techno-Organic Education, I mean I think it's better."*

E12: *"I prefer to learn with Techno-Organic Education. I loved the activities with scratch, eggs, and walnuts."*

The students were asked if they liked the activities? and if there was any activity that they'd rather be left out. When the answers received were examined, it was seen that the majority of the students stated that they liked the activities done with the Techno-Organic Education Model. Examples of students' opinions are as follows:

E7: *"I liked all the activities. There was no activity that I didn't like."*

E9: *"I liked them. They were really nice. I liked them all."*

The students were asked if they had any difficulty during the application of any of the activities. The majority of the students gave answers stating that they did not encounter any difficulties while performing the applications. It was observed that some of the students stated that they encountered some difficulties only in solving the problems while doing the applications. They were asked what particular difficulty they have encountered.

E14: *"I didn't have a hard time. I didn't have any difficulty at all."*

E1: *"I had some difficulty, but eventually I was successful. I just had a hard time solving some of the problems. But I still did most of it right. I read it, understood it and did it."*

At the end of the interview, students were asked if they wanted to add something. Students gave answers stating that they like these activities very much and that they always want to do such activities. Examples of these answers are included below.

E1: *"I want to continue the courses like this, I also want to participate in such activities in other courses as well."*

E18: *"These activities made me love math more, I wanted a math course to never end."*

CONCLUSION AND DISCUSSION

This study, which aimed to determine the impact of the Techno-Organic Education Model on students' academic achievements and attitudes in math courses, demonstrated a statistically significant difference between pre-test and post-test scores based on the achievement test results of the students. Another result obtained from the quantitative data of the study is that the Techno-Organic Education Model also created a significant difference between the academic achievements of the experimental group and the control group, which was subjected to traditional educative methods. Based on these results, it can be said that the Techno-Organic Education Model has a significant impact on the academic achievements of students in mathematics courses.

While the findings from this study reflect the results of alternative education researches on nature and technology in many ways, it also gives new perspectives to alternative education models in some topics. As similar studies point out (Çevik, 2018; Flechier, 2019; Ishaq et al., 2019; Siregar et al., 2019; Şimşek & İpek, 2019; Wang, 2013), the academic achievements of the students who are educated with the Techno-Organic Education Model found to be higher compared to those who receive an education with the traditional methods. However, this research offers an integrated education model, unlike other studies on nature and technology. This is thought to allow students to take advantage of the possibilities of both nature and technology by enabling them to pass on what they have learned at school into their everyday life experiences.

The findings suggest that the attitudes towards math of students being subjected to the Techno-Organic Education Model tend to be more positive and demonstrate a statistically significant difference. Another result from the study suggests a statistically significant difference in terms of attitudes towards the math course for the experimental group which was subjected to the Techno-Organic Education Model and the control group which was subjected to traditional methods. Based on these results, it can be said that the Techno-Organic Education Model has a significant effect on students' attitudes towards the math course.

However, as similar studies on alternative education point out (Gülhan & Şahin, 2016; Ishaq et al., 2019) it has been concluded that the attitudes towards the math course of students who received an education with the Techno-Organic Education Model have been more positive than those who receive an education with the traditional methods. This suggests that the Techno-Organic Education Model is useful for students to develop positive attitudes towards math courses.

Based on the quantitative findings obtained, it can be said that the Techno-Organic Education Model has a significant effect on the academic achievements and attitudes of students in mathematics courses. In this context, the integration of both natural and technological factors

in educational activities for a more effective learning experience was found to be important.

The first result obtained from interviews with students is related to the use of the Techno-Organic Education model in courses. Opinions regarding the use of the Techno-Organic Education model in courses are gathered under two titles, as “the learning process” and “feelings”. In the learning process; students emphasized “improved success rates, ease of learning, ease of understanding, repetitions, learning in a fun environment, development of imagination, and gameplay”. In the aspect of “feelings”, they emphasized the following terms: “nice, fun, useful, entertaining and happy”. Another qualitative result of the research is related to the positive aspects of the use of Techno-Organic Education in mathematics. These views were collected under the titles “learning process” and “feelings” once again. It was concluded that the most emphasized sub-themes were “increased success, increased understanding, learning by having fun, experimenting with numbers”, and feelings mentioned were “love towards the math course, happiness, very nice, fun, reminiscence of the pre-school era, eating and comforting feelings”. Another qualitative result of the research was related to the negative aspects of the use of Techno-Organic Education in mathematics. It was concluded that there has been no negative view on the use of Techno-Organic Education in mathematics. As a result of the research, it is observed that the effect of the Techno-Organic Education model on the interest in mathematics was increased interest and increased attendance to the course. Also, research on alternative education models and technology-supported educative models demonstrate similar results. In a study conducted by Yıldırım & Selvi (2018), it has been understood that through scientific, technologic, engineering and mathematic applications allowed students to learn by experience, and allowed them to form connections with their daily lives, facilitated easier learning experience and increased the academic success levels. A study by Sırakaya (2018) shows that students think education of coding would contribute positively to their creativity, rational thinking, problem-solving skills, and success levels.

The results of the choice of Techno-Organic Education in Learning emphasized the topics of Techno-Organic Education and Techno-Organic Education and other activities. The results for the activities made as a part of Techno-Organic Education were collected in two different headings. The results for the students' enjoyment of the activities made were generally positive. The results for the second heading which is about the difficulties the students encountered during the activities held as a part of the techno-organic education model was mostly negative. And some difficulty mentioned was only for some of the problems introduced during the courses. The results of other opinions on the implementation process of the Techno-Organic Education Model imply that students loved these activities and want such activities to be a part of their curriculum all the time.

When the qualitative and quantitative data obtained from the research are evaluated together, it can be seen that the quantitative and qualitative dimension of the research supports each other.

SUGGESTIONS

- Educators can use the Techno-Organic Education Model to make it easier to understand the subject matter during the teaching of subjects and to increase the interest in the course.
 - Techno-Organic education areas can be created in schools.
 - By working together with the Ministries of Education and universities, projects for the implementation of the Techno-Organic Education Model can be developed.
 - Researchers can apply the Techno-Organic Training Model to different courses and different class levels.

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