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The Effect of Context-Based STEM Activities on Secondary School Students' Scientific Literacy and STEM Motivation*

Bağlam Temelli STEM etkinliklerinin Ortaokul Öğrencilerinin Bilimsel Okuryazarlık ve STEM Motivasyonları Üzerine Etkisi

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ABSTRACT: The importance of this research is to determine the effect of integrating the REACT strategy, which is a practice of the context-based learning method, with STEM education on students' scientific literacy and STEM motivation. The research was conducted with 82 seventh-grade students. A quasi-experimental design with a pre-test and post-test control group was used. The study group of the research consists of three seventh-grade classrooms selected by simple random sampling method. Scientific literacy scale and STEM motivation scale were used as data collection tools in the research. Before the implementation, these scales were administered to all three groups as a pre-test. Then, context-based REACT strategy-supported STEM activities were administered to the experimental-I group, context-based REACT strategy-supported activities to the experimental-II group, and science practicing teaching program to the control group. After practicing, the scales were applied to the groups as a post-test. ANCOVA test was used in the analysis of the data. According to the data obtained from the research, it has been found that the experimental-I group, in which context-based STEM activities were implemented, showed a higher level of positive impact on scientific literacy and STEM motivation compared to the control groups, which received context-based learning activities in experiment-II and science practice curriculum.

Keywords: STEM, context-based learning, REACT strategy, scientific literacy, STEM motivation.

ÖZ: Bu çalışmanın amacı, bağlam temelli öğrenme yönteminin bir uygulaması olan REACT stratejisinin STEM eğitimi ile entegrasyonunun, öğrencilerin bilimsel okuryazarlık ve STEM motivasyon üzerine etkisini tespit etmektir. Araştırma 2021-2022 eğitim-öğretim yılında yedinci sınıfta öğrenim gören 82 öğrenci ile yürütülmüştür. Araştırmada ön test son test kontrol gruplu yarı deneysel desen kullanılmıştır. Araştırmanın çalışma grubunu basit seçkisiz örneklem yöntemiyle seçilen ve yedinci sınıfta öğrenim gören üç sınıf oluşturmaktadır. Araştırmada veri toplama aracı olarak bilimsel okuryazarlık ölçeği ve STEM motivasyon ölçeği kullanılmıştır. Uygulama öncesi bu ölçekler ön test olarak üç gruba da uygulanmıştır. Ardından deney-I grubuna bağlam temelli REACT strateji destekli STEM etkinlikleri, deney-II grubuna bağlam temelli REACT strateji destekli etkinlikler ve kontrol grubuna bilim uygulamaları öğretim programı uygulanmıştır. Uygulamanın tamamlanmasıyla ölçekler gruplara son test olarak uygulanmıştır. Verilerin analizinde ANCOVA testi kullanılmıştır. Araştırmadan elde edilen verilere göre, bilimsel okuryazarlık ve STEM motivasyon yönünden bağlam temelli STEM etkinlikleri uygulanan deney-I grubunun olumlu etkilenme düzeyinin, bağlam temelli öğrenme etkinlikleri uygulanan deney-II ve bilim uygulamaları öğretim programı uygulanan kontrol gruplarına göre daha fazla olduğu tespit edilmiştir.

Anahtar kelimeler: STEM, bağlam temelli öğrenme, REACT stratejisi, bilimsel okuryazarlık, STEM güdülenme**.**

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The rapid changes in science and technology in the 21st-century world have directly or indirectly impacted individuals and society (Friedman, 2007). This situation has made it necessary for individuals in the 21st century to be equipped to meet the era's demands (Clark, 2010; Iwuanyanwu, 2019). Especially when this change is evaluated in terms of education, it has brought different approaches to learning and teaching, and reforms have been made in education.

In order to reflect the changes in the education system in Turkey to the science curriculum, updates were made in 2005, 2013, and 2018 (Özcan & Koştur, 2019). In this context, context-based learning was included in the science curriculum in 2005, and a transition was made from the traditionalist learning paradigm to constructivist learning (Topuz et al., 2013) Context-based learning is essentially a learning model in which individual differences are taken into account. Its aim is to establish a link between daily life and science and to explain the situations that students encounter or may encounter with the science content (Ültay & Çalık, 2011). Thus, a step was taken towards integrating science into life, and science literacy was included in the science program for the first time in this direction. In 2013, inquiry-based learning was included in the science curriculum. Finally, in 2018, STEM education, in which 21st-century skills and science, technology, engineering, and mathematics disciplines (under the title of engineering and design skills) are recruited, was included in science curriculum teaching (Ministry of National Education [MoNE], 2018). STEM mentioned here is an interdisciplinary collaborative learning model consisting of the initials of the words "Science, Technology, Engineering, Mathematics" (Dugger, 2010; Li, 2014; Sanders, 2009; Vasque et al., 2013).

STEM Education

One of the reasons STEM education has gained importance in Turkey is that desired results are not achieved due to being below the average score of the Organisation for Economic Co-operation and Development (OECD) countries in international exams such as PISA and TIMSS. These exams serve as indicators of the significance countries place on STEM education (Kadijevich, 2019). In addition, economic concerns highlighted the need for STEM education to be included in the science curriculum (Akgündüz et al., 2015). Because STEM education is necessary for a country's economic competitiveness and social well-being, it is accepted as the basis of national development and productivity (Lacey & Wright, 2009; Marginson et al., 2013; Thomas, 2014). One of the goals of STEM education is to train individuals with advanced 21st-century skills and to bring them into society (Olivarez, 2012). This is one of the reasons why STEM is included in the science curriculum in Turkey.

STEM education entered the science curriculum in Turkey in 2018, but various problems were encountered in its implementation. These are the problems that science teachers are afraid of in STEM practice; teacher competencies are not at an appropriate level, material problems, and problems arising from the nature of cooperative teaching (Özbilen, 2018). In addition, there is literature in which teachers do not have enough knowledge about STEM (Yıldırım, 2017). Therefore, there is a need for more explanatory STEM activities for teachers.

There are many teaching models that can be used with STEM, but it is not known which one will work best (Dugger, 2010). As a matter of fact, when examining studies conducted both abroad (Geng et al., 2019) and in Turkey (Hacıoğlu et al., 2016), it becomes evident that STEM education is not at a sufficient level and is implemented with different methods and techniques. For this purpose, context-based learning, which was included in the science curriculum in Turkey in 2005 (Topuz et al., 2013), may be an alternative approach that can be used for STEM integration. Context-based learning is a model that aims to achieve lasting learning by establishing connections between subjects and daily life, aligning with the goal of STEM education to generate solutions for real-life problems encountered by students (Moore et al., 2014). Constructivist learning theory is the basis of context-based learning (Glynn & Koballa, 2005; Stinner, 2006). In constructivist learning theory, there is a learning environment in which the students construct the knowledge themselves and are at the center of the learning process (Brooks & Brooks, 1993; Rezaei & Katz, 2002).

Context-Based Education

The starting point of the context-based learning approach is that students have difficulties understanding science subjects (Osborne & Collins, 2001) and low interest in science lessons (OECD, 2006). In curriculums (such as PLON, ChemCon) prepared with the context-based learning approach in mind, the content is designed to increase student interest (Parchmanna et al., 2006) and enable students to actively participate in the lesson in line with their interests (Glynn & Winter, 2004).

When the studies on the context-based learning approach in the literature are examined, it is seen that different teaching methods, such as 5E, the four-stage model, and REACT, are applied (Gilbert et al.,2011; Patro, 2008). Among these models, it is seen that the REACT strategy is increasingly taking place in academic studies (Yiğit, 2015). With the REACT strategy, students will be able to relate the knowledge they have learned to real-life situations, actively engage in the learning environment and move away from the rote learning approach (Ültay & Çalık, 2011). The REACT strategy is formed by combining the initials of the words “Relating,” “Experiencing,” “Applying,” “Cooperating,” and “Transferring” (Crawford, 2001; Hull, 1999).

In the relating stage, a link is established between the prior knowledge or life experiences of individuals and the knowledge (subject). In the experiencing phase, there is learning by doing, experiencing, and developing a project and/or in a laboratory environment. Applying is the stage where useful concepts are introduced and learned. In the cooperating phase, there is communication with other students. In the transfer phase, the previously learned information is transferred to a situation encountered for the first time (Crawford, 2001; Hull, 1999).

Scientific literacy

Scientific literacy, the scope of science (Lee, 1997), what counts as science, the ability to think scientifically (DeBoer, 2000), the ability to use scientific knowledge, the nature of science (Hanrahan, 1999), and knowledge about the risks and benefits of science (Shamos, 1995) can be expressed as understanding. Another definition is made by Lederman and Niess (1998). According to this definition, individuals with scientific literacy possess the following characteristics: they can effectively comprehend and apply scientific theories, concepts, laws, and processes; use scientific methods to solve personal and social issues; differentiate scientific events from personal opinions; use science and technology for the benefit of humanity; and have an understanding of the nature of science.

Motivation

Motivation refers to the drive or willingness to take action and engage in activities. Someone who takes action based on a goal is considered motivated (Ryan & Deci, 2000). In educational terms, motivation is the effect on the activation, maintenance, and control of the learning action (Chen, 2001). In other words, it is defined as all of the motives that cause intentional or unintentional behavior in the individual, and that can be controlled by the individual (Arık, 1996). A student with insufficient motivation is not ready to learn (Akbaba, 2006).

Importance of Study

Upon examining the literature, it can be observed that there are numerous studies on the context-based learning approach and STEM education in both Turkey and abroad. These studies included teachers (Akdeniz & Paniç, 2012), pre-service teachers (Özay Köse & Çam Tosun, 2010), secondary school (Sadi, 2013) and middle school (Karslı & Kara Patan, 2016) students, and the misconceptions in these studies (Karslı & Saka, 2017), motivation (Alivernini & Lucidi, 2011) and academic achievement (Güneş Koç, 2013) are considered as dependent variables.

The studies on STEM education have explored aspects, including teachers (Pilkinton, 2018), prospective teachers (Moon, 2018), secondary school students (Çevik, 2018; Olivarez, 2012), and primary school students (Tolliver, 2016). These studies have investigated topics such as interest (Pekbay, 2017), motivation (Yıldırım, 2016), attitude (Tseng et al., 2013), academic achievement (Olitsky, 2012), and scientific process skills (Gökbayrak & Karışan, 2017). In this direction, the present study aims to contribute to the literature by investigating the effects of context-based STEM activities on students' scientific literacy and STEM motivation. The research problem statement is: "Does the implementation of context-based STEM activities have an impact on the scientific literacy and motivation towards STEM among 7th-grade middle school students?" In this regard, the sub-problems of the study are expressed below. Is there a significant difference in terms of scientific literacy and STEM motivation among the corrected post-test mean scores, based on the pre-test mean scores, of Experiment-I, where context-based STEM activities were implemented, Experiment-II, where context-based activities were implemented, and the control groups where the current curriculum was implemented?

Method

In this research, a quasi-experimental design with a pre-test and post-test control group, which is one of the quantitative research methods, was used. In quasi-experimental designs, an unbiased assignment cannot be made in the formation of groups. Previously created groups are matched over certain variables. After the matching phase, the groups are randomly assigned to the processing groups (Büyüköztürk, 2013).

Research Sampling

The study group consists of three randomly selected classes in a secondary school affiliated with the MoNE. Among these classes, the science practicing course curriculum was applied to the control group, context-based STEM activities to the experimental-I group, and context-based activities to the experiment-II group. The study was carried out with a total of 82 students, 25 in the control group, 29 in the experimental-I group, and 28 in the experimental-II group. Before the research, scientific literacy and STEM motivation scales were applied as a pre-test, and the obtained data were analyzed with ANCOVA. As a result of the analysis, it was seen that there was no significant difference between the groups in terms of scientific literacy. In terms of STEM motivation, it was determined that there was a significant difference between the experimental-II and control groups in favor of the experimental-II group.

Data Collection Tools

The scientific literacy scale and STEM motivation scale were used as data collection tools.

Scientific Literacy Scale

The scientific literacy scale was developed by Fives et al. (2014) and adapted into Turkish and Turkish culture by Şahin and Ateş (2018). In order to adapt it to Turkish culture, the scale was applied to 823 students studying in the seventh-grade, the data obtained were analyzed with confirmatory factor analysis, and as a result of the findings, it was determined that the standard goodness of fit criteria were at an accepted level. The KR-20 internal consistency coefficient of the scale was found to be .66. The highest score that can be obtained from the scale is 18. The reason for choosing this scale is that it is easy to use for students and practitioners, the items are understandable, and a validity and reliability study has been conducted for Turkey.

STEM Motivation Scale

The STEM motivation scale, originally called “Development and practicing of a scale to measure students’ STEM continuing motivation,” developed by Luo et al. (2019), was used to reveal students’ motivation levels for STEM. The scale was developed to measure the STEM motivations of 7th and 8th-grade students (Şimşek & Hamzaoğlu, 2022). The scale consists of 25 items and is in a 4-point Likert type as never (1), rarely (2), often (3), and always (4). Two of the items in the scale are negative items. The scale consists of four sub-dimensions. These; science, technology, engineering, and mathematics dimensions. In order to determine the adaptation of the scale to Turkish culture, it was applied to 359 students studying in the 7th and 8th grades, and the data obtained were calculated by confirmatory factor analysis and EAP/PV reliability value used in item response theory. As a result of confirmatory factor analysis, it was determined that the scale was suitable for Turkish culture, and the standard goodness of fit criteria were at an acceptable level. EAP/PV values were calculated as .734 for science, .708 for technology, .803 for engineering, and .796 for mathematics and were found to be at an appropriate level (Luo et al., 2019).

Research Process

Information was given about the content prepared for the control group, the experimental-I group, and the experimental-II group, respectively, and the practices conducted during the study. The scientific literacy and STEM motivation scales were administered to the students in the control group as a pre-test after selecting the 7/G class through simple random sampling. Then, the science practice course was taught in line with the current annual program of the MoNE (2018). The methods and techniques applied during the course were in the form of lectures, project-based learning, and discussion. The “Science Applications” courses, in which all the activities of this study were carried out, were taught in the “Science Laboratory” class at the school. Five tables were created by arranging the science laboratory class in accordance with cooperative learning. The students were divided into five groups heterogeneous within themselves but homogeneous among the groups. Each group was given a name. Considering the Covid-19 pandemic, the temperature of the students was measured, the maximum attention was paid to masks, distance, and cleaning rules, and the activities were carried out under these conditions.

During the implementation process of the research, pre-tests were conducted for the control group, and information was provided about the science practice course. Then, the science teaching program titled "Journey to Space, Constellations, Genetic Code and the Fusion of Science and Art through Dance" were sequentially implemented. Finally, the post-tests were conducted, completing the thirteen-week process. Some of the images of the control group are shown in the appendix.

Context-based REACT strategy-supported STEM activities were applied to the Experiment-I group. The activities were carried out by the researcher for 10 weeks (20 class hours), 2 hours a week, with 7/A class students selected by simple random method. After conducting pre-tests for the experiment-I group, the activities titled "designing my ship, launching my rocket, designing my cable car, constructing my roof, my floating vehicle, producing clean water" were implemented sequentially. The thirteen-week implementation was completed with the administration of post-tests. Some pictures of the experiment-I group are shown in the Appendix. An example lesson plan is shown below.

1. Relating: The teacher started the lesson with the students at their desks. After the greeting, the following questions were asked to the students.

- Have you ever been in a ship or boat-type vehicle? Please explain.
- Have you traveled by plane before? If you did or observed it in various ways, how did it look? What are its most prominent features? Please explain.
- What is the difference between a ship and a raft?

After the answers to the questions are received, the news content called school ordeal is distributed.

School Ordeal

Millions of children in the world go to school under very difficult conditions for various reasons.

One of these difficult conditions is experienced in Sootea, a small village in India. Students risk their lives every day because there is no school in their area, and the closest school to them is on the other side of the river. Because there is no access by bridge or boat on the river.

With their school bags on their backs, they line up first, then try to cross the river by getting on pots almost their size.

One of the children's teachers, J Das, said, "The students are crossing the river using aluminum pots as there are no bridges in the area." summarizes the situation.

Answer the following questions based on the news above.

a. What are the characteristics of the vehicle and vehicle the students use to cross the river?

………………………………………………………………………………………………
………………………………………………………………………………………………

b. What is the difference between the vehicle used by the students and a boat?
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Then, the students are asked to read the news content inside themselves first. After the internal reading is completed, a student is read aloud. After the reading is completed, the students are asked the questions under the news content in order to make the students think about the event and to relate the water resistance and air resistance, and the students are asked to write the answers to the questions. Upon the completion of this activity, the content of the news about the plane crash is distributed to the students. Students are asked to read the relevant news, and the existence of air resistance is made to feel through the working principle of the parachute. With the news, students are made aware of the existence of water and air resistance.

2. Experiencing: This is the stage where the STEM activity is implemented. Here, students are asked to design a ship based on the events in the school ordeal story. If you were to make a vehicle that could move on water, what would its characteristics be, and how would it be seen? Please show by drawing. An equal amount of material is then given to all groups. The materials are in the form of 1 hot glue stick and gun, 2 pipettes, 20X50 cm aluminum foil, cling film, a blow dryer or fan, stopwatch, cardboard, liquid adhesive, dynamometer, 2 garbage skewers, 2 tongue sticks. Provided that the objects of the same mass are carried, the ship must cover the desired distance in the shortest possible time. Here, students are expected to design a ship with the least water resistance and the most air resistance. It will be taken into account that the weather is windy and the wind blows from north to south at a constant speed.

3. Applying: Groups are asked to introduce the products they have made in the "experiment phase." Speakers selected from the groups introduce the ships they designed. By drawing the following table on the class board, the characteristics of the ideal ship are determined by the class, and the existence and importance of water and air resistance are emphasized.

4. Cooperating: In this stage, students are given a diagnostic branched tree to work collaboratively within and between groups by applying the knowledge and concepts they have learned through STEM activities in the "experiencing" stage. In this context, students are asked to solve the questions in the worksheets that involve air and water resistance gains.

5. Transferring: In order to transfer the knowledge acquired about air resistance to different situations that students may encounter in daily life, a worksheet is distributed to them. They are asked to solve the questions individually. Several of the solutions are read aloud, and the lesson is completed.

In order to determine the effect of context-based REACT strategy activities on students in the practicing for the Experiment-II group, the 7/E branch, which was taught in the same school as the Experiment-I group, was randomly selected as the Experiment-II group. In the science practicing course, lessons were carried out with teaching supported by the context-based REACT strategy, which is one of the context-based learning methods. The practice was implemented by the researcher for 10 weeks (20 lesson hours), 2 lesson hours per week. The planning for the implementation is shown in Table 1.

Table 1
Activities and Duration of the Experiment-II Group

Practicing time	Activities for the Experiment-II group	Time
8.09.2021	Pre-tests and giving information about the science practice course	80’
15.09.2021	I’m learning about water and air resistance	80’
22.09.2021	bow and arrow activity	80’
29.09.2021	bow and arrow activity	80’
6.10.2021	Energy and its transformations	80’
13.10.2021	Energy and its transformations	80’
20.10.2021	I’m designing a dynamometer	80’
27.10.2021	Intensity	80’
3.11.2021	Intensity	80’
10.11.2021	Can it be seen that sound is an energy?	80’
17.11.2021	1st-semester break	-
24.11.2021	Let’s separate the mixtures	80’
1.12.2021	Conducting final tests	40’

When Table 1 is examined, it is seen that the pre-test and post-tests were done in two weeks, and the practice lasted for 10 weeks. Some pictures of the experiment-II group are shown in the Appendix. An example lesson plan is presented below.

1. Relating: The following questions are asked to students to make them realize that gravitational potential energy can also be converted into kinetic energy by taking advantage of the flexibility potential energy they have learned in the previous lesson:

   -How can a bicycle go downhill without pedaling? Explain.

   -What is the effect that makes a pot on the balcony fall to the ground when it is released into the air?

   The students’ responses are evaluated, and the lesson continues. Then, the news titled “The Black Sea and Transportation” is distributed to the students, and they are encouraged to do intrinsic reading. Then, a student is asked to read the text, and the questions below the text are directed to the students. Thus, students are encouraged to think about the working principle of the cable car.

2. Experiencing: The students go to the schoolyard together. Here, two objects with the same weight are thrown onto the ground, and their sinking depths are compared. Then, two objects with different weights are thrown onto the ground again, and their sinking depths in the ground are measured. Afterwards, the results are discussed, and a test related to energy conversion is distributed to the students.

3. Applying: In this section, students are given cable car materials that have been previously prepared, and they are given the opportunity to investigate the transformation of potential energy into kinetic energy practically. Students are

expected to make inferences by observing the cable carload-carrying platform dropped from various heights.

4. Cooperating: A working sheet is given to student groups who understand energy conversion. They are asked to solve the questions by communicating within and between their own groups.
5. Transferring: In this section, energy conversion devices that have been previously designed are given to student groups to encourage observation and experimentation. They are made to understand the relationship between weight and the movement of the car in these tools. They are encouraged to make enough trials, then asked to write 5 examples related to energy conversion, and a test is distributed to end the lesson.

Data Analysis

It was decided that ANCOVA analysis would be appropriate since there was a significant difference between the groups as a result of the pre-test. Whether the data met the ANCOVA assumptions was examined. The assumptions of ANCOVA are that the variances of the scores of the dependent variables are homogeneous and the scores are normally distributed, the regression slopes within the groups are equal, and there is a linear relationship between the dependent variable and the covariate.

Levene test results were examined for the equality of one-way variances of the groups. In the data obtained, there is no significant difference in scientific literacy (F_{2-76}=.834;.p>.05) and STEM motivation (F_{2-76}=1.33; .p>.05) scales. The data obtained show that the variances regarding the test scores are homogeneous.

Shapiro-Wilk test values were examined to determine whether the groups showed a normal distribution, and the results were found to be .05<p. These data show that the dependent variable scores are normally distributed (Tabachnick & Fidell, 2001).

When the data on the homogeneity of the regression slopes within the groups were examined, it was found that the post-test scores of the scientific literacy (F_{2-76}=1.84; p>.05) and STEM motivation (F_{2-76}=.347; p>.05) scales were examined. It was determined that the group pre-test joint effect was not significant. The obtained findings show that the slopes of the regression lines belonging to the dependent variables are equal (homogeneous).

Finally, the assumption of ANCOVA test is that there is a linear relationship between the dependent variable and the covariate. Pearson Correlation test was used to reveal this relationship. It was determined that there was a significant difference between the pre-test and post-test mean scores of all groups for scientific literacy and STEM motivation variables (p< .001). The data obtained show that the scales meet the ANCOVA assumptions in the analysis.

In the analysis of the data, the effect size was checked. To calculate the effect size, the eta-square coefficient (η^2) is found. If η^2=.01-.06 is interpreted as “small,” up to η^2=.06-.14 as “medium,” η^2=.14 and above as large effect size (Büyüköztürk, 2014).

Findings

It will be examined whether there is a significant difference between the scientific literacy post-test mean scores of the experiment-I, in which context-based REACT strategy-supported STEM activities are applied, experiment-II in which context-based REACT strategy activities are applied, and the control group in which the current curriculum of the science practicing course is applied. In order to analyze the ANCOVA test, firstly, the pre-test score averages were determined as covariant, and the corrected average of the post-test scores was calculated. The results are shown in Table 2.

Table 2
Post-Test Mean Scores Adjusted According to the Scientific Literacy Pre-Test Mean Scores of the Groups

Group	N	$\bar{x}$	SD
Experimental-I	29	11.34	11.36
Experimental-II	28	8.71	8.69
Control	25	6.56	6.56

When Table 2 is examined, the corrected mean score of the students in the experimental-I group from the scientific literacy scale is 11.36, the students in the experimental-II group are 8.69, and the students in the control group are 6.56. ANCOVA test was used to determine whether there was a significant difference between the scores of the experimental and control groups. The results are shown in Table 3.

Table 3
ANCOVA Results for Post-Test Means Adjusted for Scientific Literacy Pre-Test Mean Scores

Source of Variance	Sum of Squares	df	Mean Squares	F	*p*	η^2
Pre-test	0.56	1	.56	.77	.770	.001
Group	311.068	2	155.534	22.06	.000	.361
Error	546.869	78	7.05			
Total	860.988	81				

When Table 3 is examined, there is a significant difference between the post-test mean scores of the groups ($F_{1\text{-}78}$=22.06; p<.05) according to the scientific literacy scale corrected pre-test mean scores. The partial eta square value, which is the calculated effect size value for the significant difference, was found to be .361. Bonferroni test was applied to determine between which groups the significant difference between the groups was. The results are shown in Table 4.

Table 4
Bonferroni Test Results Regarding the Scientific Literacy Scale Mean Scores of the Groups

Groups	Average difference between groups	Standard error	*p*
Experiment-I and experiment-II	2.67	.711	.001*
Experiment-I and control	4.8	.725	.000*
Experiment-II and control	2.13	.734	.014*

*p<.05

Table 4 shows that there is a significant difference between the experimental-I group, in which context-based REACT strategy-supported STEM activities were applied, and the experimental-II group, in which context-based REACT strategy activities were applied, and the control group, in which the current curriculum was applied. In addition, that there is a significant difference between the experimental-II group, in which context-based REACT strategy activities were applied, and the control group, in which the current curriculum was applied. According to these results, the context-based REACT strategy supported STEM activities applied to the experimental-I group, context-based REACT strategy activities applied to the experimental-II group, and the current curriculum applied to the control group; context-based REACT strategy activities applied to the experimental group II are more effective in improving scientific literacy than the current curriculum applied to the control group.

It will be examined whether there is a significant difference between the STEM motivation scale post-test scores of the experimental group in which context-based REACT strategy supported STEM activities were applied, experiment-II in which context-based REACT strategy activities were applied, and the control group in which the current curriculum of the science practicing course was applied. ANCOVA test will be applied to analyze the data obtained from the STEM motivation scale applied to Experiment-I, Experiment-II, and control groups. For this purpose, pre-test mean scores were determined as covariant, and the corrected mean of post-test mean scores were calculated. The results are shown in Table 5.

Table 5

Post-Test Mean Scores Adjusted According to Groups' STEM Motivation Pre-Test Mean Scores

Group	N	$\bar{x}$	SD
Experimental-I	29	81.82	81.90
Experimental-II	28	72.00	72.12
Control	25	65.28	65.04

Table 5 show that the corrected mean score of the students in the experimental-I group from the STEM motivation scale is 81.90, 72.12 in the experimental-II group, and 65.04 in the control group. ANCOVA test was used to determine whether there was a significant difference between the scores of the experimental and control groups. The results are shown in Table 6.

Table 6

ANCOVA Results for Post-test Mean Scores Adjusted for STEM Motivation Scale Pre-Test Mean Scores

Source of Variance	Sum of Squares	df	Mean Squares	F	*p*	η^2
Pre-test	19.74	1	19.74	.172	.679	.002
Group	3688.63	2	1844.32	16.08	.000	.292
Error	8945.24	78	114.68			
Total	12724.51	81				

Table 6 shows that there is a significant difference between the post-test mean scores of the groups (F_{1-78} =16.08; *p*= <.05) according to the STEM motivation scale, adjusted pre-test mean scores. Partial eta square value, which is the calculated effect size value for significant difference, was found to be .292 for STEM motivation.

Bonferroni test was applied to determine between which groups the significant difference between the groups was. The results are shown in Table 7.

Table 7
Bonferroni Test Results Regarding the STEM Motivation Scale Mean Scores of the Groups

Groups	Average difference between groups	Standard Error	*p*
Experiment-I and experiment-II	9.78	2.83	.010*
Experiment-I and control	16.86	3.02	.000*
Experiment-II and control	7.08	3.06	.024*

*p<.05

When Table 7 is examined, it is seen that there is a significant difference in favor of the experimental-I group between the experimental-I group, in which context-based REACT strategy supported STEM activities were applied, and the experimental-II group, in which context-based REACT strategy activities were applied, and the control group, in which the current curriculum was applied. In addition, it was determined that there was a significant difference between the experimental-II group and the control group in favor of the experimental-II group. According to these results, it is seen that the context-based REACT strategy-supported STEM activities applied to the experimental-I group are more effective on the STEM motivations of the students than the context-based REACT strategy activities and the current curriculum.

Discussion

When the findings obtained from the scientific literacy scale are examined between the experimental-I group and the experimental-II and control groups, there is a significant difference between the experimental-II group and the control group (Table-4). It has been concluded that context-based REACT strategy-supported STEM activities are more effective in terms of scientific literacy than context-based REACT strategy activities and the current curriculum. Here, the STEM activities applied to the students are more effective than both methods on the science literacy of the students. It can be said that students' efforts to produce products by planning in line with a scientific method within the scope of a specific purpose during STEM activities affect their scientific literacy positively. As a matter of fact, students made an effort to solve personal, social, and scientific problems by using their scientific process skills during STEM activities.

Conclusion

REACT strategy and STEM education have been discussed separately since a resource about the context-based REACT strategy STEM education could not be reached in the literature. In this direction, when the studies on the REACT strategy are examined, studies showing parallelism with the current study are found (Avargil et al., 2012; Krajcik et al.,2008; Phillips & Norris, 2009). For example, in the study conducted by Keskin and Çam (2019), the effect of the REACT strategy on the academic success and scientific literacy of sixth-grade students were examined. The findings show that the REACT strategy had a positive effect on students' science literacy. These results coincide with the goal of raising scientifically literate individuals, which is one of the objectives of the REACT strategy (Leoul et al., 2006; Millar & Osborne, 1998).

The fact that Turkey's average science literacy score is below the PISA results (OECD, 2013) reveals the importance of STEM education. Because students' discovery of real-life problems in STEM education is a factor that positively affects scientific literacy. The scientific literacy levels of students who use scientific process skills and are willing to solve social problems, research and question information will be expected to increase (MEB, 2013). This situation can be justified by the fact that the mean of the experimental group I, in which the STEM application was made, was higher than the other groups.

As a result, context-based activities were applied in both groups, but STEM supported context-based learning method was more effective on students' scientific literacy. This result shows the importance of STEM education and is seen as the most important result of this study.

In line with these results, context-based REACT strategy-supported STEM activities are more effective than both context-based REACT strategy activities and the current curriculum in terms of STEM motivation.

Motivation is the individual's willingness to take action towards a specific goal. An individual who is motivated in the face of a situation does his actions willingly and is happy because of these actions (Ryan & Deci, 2000). STEM motivation is the desire of students to take action towards STEM fields and to continue this action. In light of the data on STEM motivations, it is believed that STEM activities have an important role in making a significant difference between the experimental group I and the other groups in which context-based REACT strategy-supported STEM activities were applied. Because the students did the STEM activities that they had not done before during the lesson effectively and developed materials to solve daily problems.

There are studies showing that the context-based REACT strategy, which is a type of context-based learning approach, creates a statistically significant difference in students' motivation levels (Bennett & Lubben, 2006; Campbell & Lubben, 2000; Finkelstein, 2005; Parchmann et al., 2006). Implementing the context-based REACT strategy with activities that will attract students' attention according to the current curriculum may be a factor that increases the students' motivation levels. In the research conducted by Yıldırım and Gültekin (2017), it was determined that the context-based learning method increased the motivation of the students. In order for students' motivation towards STEM disciplines to be at the desired level, STEM activities need to be implemented in the educational process.

Context-based REACT strategy was more effective on students' motivation levels than the current program. It has been determined that STEM activities supported by the context-based REACT strategy are more effective than both the context-based REACT strategy and the current program. This result shows that STEM education effectively increases students' motivation levels in context-based REACT strategy-supported STEM activities. Because STEM education adopts an interdisciplinary approach, students produce a product as a result of the activity (Bybee, 2010), and enable students to focus on producing solutions for the problem by associating the subjects with daily life problems are the factors that increase the students' motivation.

Implications

It was observed that context-based REACT-supported STEM activities increased the averages of scientific literacy and STEM motivation in 7th-grade students. These activities can be tested at other grade levels to see if they provide similar benefits. Context-based REACT strategy-supported STEM activities can be done in different courses, and their effects can be investigated. Due to the Covid-19 global epidemic, the implementation period of this study has been limited. After this threat is gone, the effects can be investigated again by keeping the practice time longer.

Statement of Responsibility

All authors contributed to the study conception and design. First author performed material preparation, data collection and analysis. Second author wrote the first draft of the manuscript and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Conflicts of Interest

No potential conflict of interest with respect to the research, authorship, and/or publication of this article was reported by the authors. This research received no specific grant from any funding agency in the public, commercial or not-for profit sectors.

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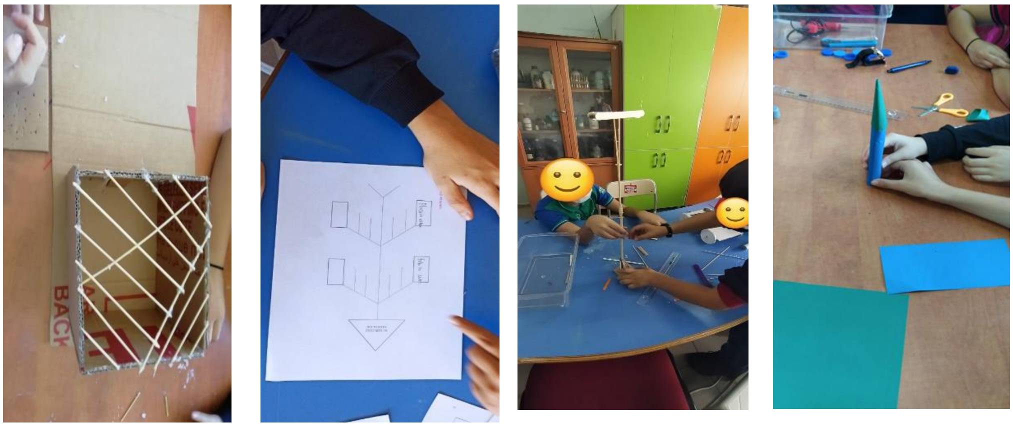
Appendix 1. Sample Photos

Pictures

Sample Photos of the Activities in the Experimental-I Group



Sample Photos of the Activities in the Experimental-II Group

Sample Photos of the Activities in the Control Group