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The effect of teaching of the 7th grade 'the cell and divisions' unit through REACT strategy on learning[1]

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Abstract. The aim of this study is to examine the effect of teaching of the 7th grade 'The Cell and Divisions' unit through REACT strategy on learning. A quasi-experimental method was employed in the study. The sample of the study consists of a total of 60 students in the 7th grade of a randomly determined secondary school located in the center of Trabzon Vakfıkebir during the academic year 2018-2019. The data were collected through 'Cell and Divisions Achievement Test' developed by researchers. The data were analyzed through descriptive statistics (mean values, standard deviation), dependent and independent-samples t-tests and gain score formula developed by Hake (1998). The findings showed that there were statistically differences between the students' pretest, posttest and retention test scores in favor of experimental group. Finally, the suggestions for future studies were made.

Keywords: REACT strategy, cell and divisions, learning

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INTRODUCTION

Today, advances in science and technology affect the education system, and in parallel with this, a renewal process is experienced in the field of education as in every field. Along with this process, the Ministry of National Education (MEB) focuses on increasing the quality of education (Gümüş and Buluç, 2007). One of the important steps taken by MEB in this regard was the transition to constructivist approach in the science curriculum since 2005-2006 academic year. Constructivist learning approach envisions students to integrate existing prior knowledge with new information they encounter rather than memorize information, interpret it and apply it to their real life (Aydın, Diken, Yel and Yılmaz, 2011; Özbilen, 2015).

Unlike the learning environments that adopt the traditional education approach and take the teacher to the center, the constructivist approach that activates the student in the process, places the learning responsibility first on the student, assimilates the information, integrates it with the prior knowledge, also closes an important gap in biology teaching (Cibik, Diken and Darcin, 2008; Salman, 2006). As a matter of fact, the results of many studies reveal that it is quite difficult to understand the abstract issues in science courses in general and biology courses in particular, and to establish an accurate structure among the new information acquired by traditional methods (Kablan, 2004). The structuring of the information is important, especially since biology issues are closely related and to ensure the integrity of the subject. In this sense, adopting the constructivist approach is of great importance in biology education.

On the other hand, constructivist approach is effective in increasing success by providing meaningful and permanent learning in science teaching. However, it may be too ambitious to say that it is an absolute method to solve all the problems in this matter. In the literature, the reason for this approach to be insufficient is that the subjects are intense, new information cannot be connected with daily life or the student has difficulty in transferring this information to daily life and most importantly, the student cannot find a convincing answer about why he/she learned this information (Ültay and Çalık, 2011). Context-Based Learning approach, which is based on the constructivist approach but also tries to meet its stated deficiencies, is proposed for eliminating

[1] This study was produced from the first author's master thesis

all these and similar problems by solving them and for a more qualified education objective.

Context-based learning can be defined as the use of various events that students are familiar with from their daily lives in the learning-teaching process (Glynn and Koballa, 2005). The main purpose of context-based learning is to enable individuals to use the new information they encounter or acquire in their real life. In this way, it will be possible for the students to see the relationship between the contexts they have created in their minds and the new information they have learned, and also to find solutions to the new problems they will encounter by transferring what they have learned. The context established during this process is effectively used throughout the whole process. This feature is the most important point that distinguishes the context-based approach from constructivism (Bulte, Westbroek, de Jong and Pilot, 2006). Context-based learning approach aims to make students understand that the objectives they gain/will gain are a necessity. In order to achieve this goal, it tries to use an event taken from daily life. Thus, the student finds the answer to the question "Why am I learning this information?" (Ramsden, 1997).

Context-Based Learning approach, which is also defined as “Life Based Learning (YTÖ)” (Sözbilir, Sadi, Kut, and Yıldırım (2007) in our country, is used effectively in the education system of many countries (Gül, 2016). The origin of the approach was originally developed as a context-based chemistry curriculum called 'Salters Chemistry' (Salters) in the UK, then in Germany (ChiK), America (ChemCom and CiC), the Netherlands (ChiP) and Israel ' (IC) has been developed and implemented under different names (Kutu, 2007). On the other hand, REACT is one of the most used learning strategies of YTÖ in learning environments and this strategy has been used frequently in science education lately (Demircioğlu, Vural and Demircioğlu, 2012; Eshetu and Shimeles, 2019; Karslı-Baydere and Aydın, 2019; Tatlı and Bilir, 2019).

REACT strategy takes its name from the initials of the English words in each step and consists of stages of relating, experiencing, applying, cooperating and transferring. However, these stages whose general framework is outlined below (Figure 1) in the study of Demircioğlu, Vural and Demircioğlu (2012), can be used cyclically. REACT strategy is a learning model that starts with associating the contexts based on daily life with the subjects, continues with the students' experience and practice the knowledge in cooperating and ends with transferring what they have learned (Yıldırım and Gültekin, 2017).

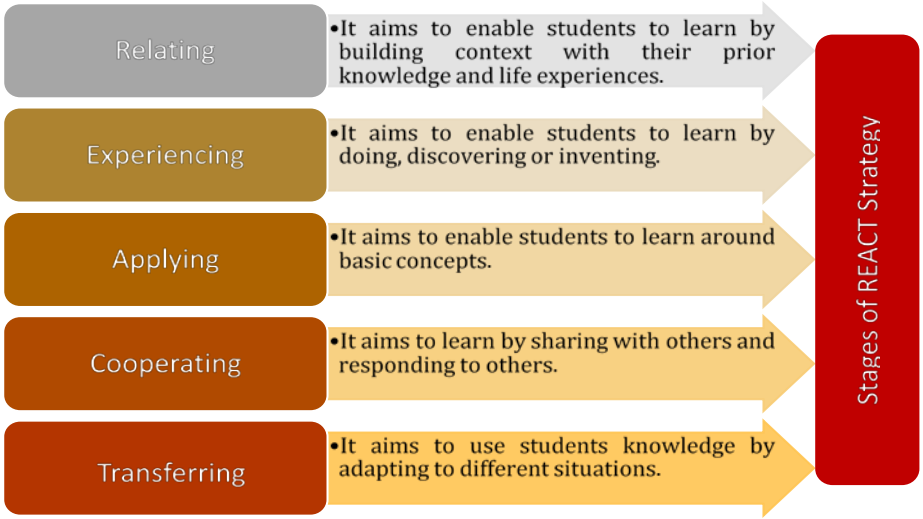

FIGURE 1. *Stages of* REACT *strategy*

The REACT strategy is a teaching model that enables the connection of newly learned concepts with the previous ones, and also contributes to the realization of meaningful learning by linking the topics with each other and with daily life. The subjects that have the most connection with daily life in the science courses are undoubtedly in the field of biology, and the

biological events that come across them in daily life can facilitate the teaching of abstract concepts in biology subjects to students (Acar and Yaman, 2011). On the other hand, when the literature is examined, the subjects that students have difficulty in understanding and have learning difficulties are in biology field (Gül, Özay-Köse and Konu, 2014; Özay and Öztaş, 2003). In addition, the studies draw attention to the insufficient level of linking students between biology subjects and daily biological events (Gül, Gürbüzoğlu-Yalmancı and Yalmancı, 2017). Studies on REACT Strategy are very limited in both biology and other science education fields (Demircioğlu, Vural and Demircioğlu, 2012, Günter, 2018; Karsli and Yigit, 2017; Kirman-Bilgin, Demircioğlu-Yürükel and Yiğit, 2017; Ültay, Durukan and Ültay, 2015). Smilerly, it is seen that very few studies carried out for the teaching of biology-based subjects with the REACT strategy at all levels of education in our country, and also are carried out these studies by certain researchers in general. When the studies are examined, the subject of photosynthesis was carried out by Gül (2016) at the secondary education level to the eleventh-grade students with activities based on the REACT strategy. As a result of the research, it was determined that the method used did not have a significant impact on students' attitudes, motivation and perceptions of inquiry learning skills, but it contributed greatly to the permanence of learning. On the other hand, in a study conducted by Gül, Gürbüzoğlu-Yalmancı and Yalmancı (2017), the biology lesson in which the excretory system subject was taught was conducted with activities based on REACT strategy. The results reached at the end of the research revealed that the activities based on REACT strategy increased the success levels of the students. On the other hand, the method has shown that it does not affect students' perceptive learning skills perceptions and motivations for learning biology. On the other hand, the findings showed that the method does not affect students' perceptions of inquiry learning skills and motivations for learning biology.

Studies to examine the effect of REACT strategy on the teaching of biology subjects are done at a low level, even at primary level. One of these studies was carried out by Yıldırım and Gültekin (2017) with fourth grade students. According to findings of study in which was discussed unit 'Let's solve our body's puzzle', the activities based on REACT strategy significantly increased the students' achievement and retention levels and their motivation to learn science. However, it was seen that the method did not have a significant effect on the students' scientific attitudes. In the study, observations and interviews were also conducted and as a result of the analyzes, various themes have been reached as the application process, the benefits of the REACT strategy, contributions to the science and technology lesson, and the problems encountered in its implementation, suggestions for the method.

In addition, at the primary education level, a study was conducted by Karslı and Saka (2017) to examine the effect of the REACT strategy on fifth grade students' conceptual understanding of subject 'Getting to Know Foods' and the elimination of alternative concepts. While the activities were carried out in the experimental group with activities based on the REACT strategy, the control group was carried out based on the 5E model. When the findings obtained at the end of the study are analyzed, it was determined that the method was more effective than the control group in eliminating the conceptual understandings and alternative concepts of the experimental group students.

In a study carried out with seventh grade students, the effect of teaching conducted in accordance with the REACT strategy supported with explanation on the subject of "Eye" on the students conceptual understanding and permanence of conceptual understanding was examined. Researchers found that the explanation-supported REACT strategy had positive effects on students' conceptual understanding about eye and its permanence in these conceptual understandings (Karslı-Baydere and Aydın (2019). Another study with seventh grade students was conducted by Erdoğan-Karaş and Gül (2019). In the study, cell and division unit was taught with activities based on REACT strategy. According to the findings reached at the end of the education, no significant difference was observed between the pre-test/post-test scores of the experimental and control groups in terms of both attitudes towards science and motivation levels for learning science.

When the above studies are evaluated in general, it is noteworthy that the REACT strategy has a positive effect on the teaching of biology-based subjects, but the studies on this subject are

quite limited. On the other hand, a good understanding of cell and cell divisions, one of the most fundamental subjects of biology, is the basis for understanding and learning further issues (such as protein synthesis, plant and animal tissues) (Kete, Horasan, and Namdar, 2012). In addition, in order for students to learn clearly the concepts such as "living" and "vitality" that constitute the essence of biology, this subject must be revived correctly in the mind (Koç and Sönmez, 2018). Therefore, it is of great importance to teach the concept of the cell correctly in order to teach students biology issues (Yörek, 2007). However, the researches show that this subject is considered as a concept that is difficult to understand by students of different grade levels (Ayvacı, Bebek, Atik, Keleş and Özdemir, 2016; Cavas and Kesercioglu, 2010; Cle´ment, 2007). Therefore, it is necessary to carry out more studies for the determination of the effectiveness of the REACT strategy in the teaching of such an important subject starting from the first steps of the teaching process. Therefore, the fact that this subject is important, the lack of sufficient studies on this subject and the study of the effectiveness of the REACT strategy in the teaching of biology-based subjects led to the need for this study. It is thought that a study based on this need will contribute positively to the literature, and will compensate the existing deficiency in terms of revealing the effect of activities based on the REACT strategy in teaching the subject of cell and division.

The Aim of the Research

The aim of this research is to examine the effect of REACT strategy based on the Context-Based Learning approach on 7th grade students' learning the "Cell and Divisions" unit.

The Problem of the Research

Does the REACT strategy based on the Context-Based Learning approach have an impact on 7th grade students' learning the "Cell and Division" unit and the permanence of the learning?

Sub-problems

1. Is there a significant difference between the experimental group students' the pre-test and post-test scores obtained from Cell and Divisions Achievement Test (CDAT)?
2. Is there a significant difference between the control group students' the pre-test and post-test scores obtained from Cell and Divisions Achievement Test (CDAT)?
3. Is there a significant difference between the groups in terms of pre-test and post-test scores obtained from Cell and Division Achievement Test (CDAT) of experiment and control group students?
4. Is there a significant difference between the groups in terms of permanence scores obtained from Cell and Division Achievement Test (CDAT) of experiment and control group students?

METHODS

In this research was used a quasi-experimental method which is one of the experimental patterns of quantitative research approach. This research design is frequently preferred especially in researches in the field of education because of the advantages it provides when it is not possible to keep all variables under control (Aydede ve Matyar, 2009; McMillian ve Schumacher, 2010). Therefore, quasi-experimental method was preferred in this research since the experimental and control groups were selected from pre-formed classes (Büyüköztürk, Çakmak, Aygün, Karadeniz, Demirel, 2017). In order to see the effect of the application, all measurement tools were applied to both groups as pre-test and post-test. At the same time, the achievement test was applied as a permanence test six weeks after the post-test applications.

Sample Group

The sample of the study consists of a total of 60 students in the 7th grade of a randomly determined secondary school located in the center of Trabzon Vakfıkebir during the academic year 2018-2019. One of the classes studied was randomly selected as the experimental group (16

females, 13 males) and the other as the control group (16 females, 15 males).

Data Collection Tools

Cell and divisions achievement test (CDAT)

In this study, since this unit belongs to the renewed curriculum and will be applied for the first time in the 2018-2019 academic year, there is no achievement test whose reliability and validity are determined in the field literature. For this reason, an achievement test that includes all topics of the unit was prepared by the researchers.

Achievement test has been prepared by considering the MEB 7th grade science course curriculum and textbook. After the literature review, an item pool containing multiple-choice questions was created and these questions were presented to the opinion of two faculty members and a teacher who were experts in their fields to examine in terms of language, scope and content. The draft form of the test, which was reduced to 50 questions following the feedbacks and corrections, was applied as a pilot study to a total of 160 eighth grade students studying in a secondary school in the city center of Trabzon. In the pilot application of the test, considering the readiness/age level of the sample group, the test was divided into two main sections based on the idea that solving 50 problems at the same time might affect reliability negatively, and these sections were applied to the students separately. While the first part of the test included 22 questions on the subject of 'Cells and Organelles'; the second part consists of 28 questions including the subject of 'Cell Divisions'. While determining the sample group, it was paid attention that the number of questions in the test was at least five times and it was tried to increase the reliability by allowing the volunteer students to solve the test. Then, item difficulty index and item discrimination indexes were calculated to analyze the obtained data. In the interpretation of the indices obtained after item analysis, the criteria specified by Çalık and Ayas (2003) were taken into consideration. Accordingly, the values that remained 0.29 and below were evaluated as very difficult, those with 0.30-0.49 were evaluated as medium and those with 0.50 and above were evaluated easy/very easy for the item difficulty index. For the item discrimination index, values of 0.29 or less should not be used or should be rearranged when necessary; it is stated that the items with a value between 0.20-0.30 should be used or changed in the mandatory situations. It is recommended to include the items with a value of 0.30 and above in the test.

Following the evaluations made by considering the above-mentioned criteria in the item analysis, the questions (questions 3, 10, 14 and 15) whose discrimination was below 0.30 for the first part of the test were excluded from the test. However, considering the other part of the test and keeping the number of questions within a certain limit, it was decided to exclude the questions whose discrimination was below 0.40 (questions 6, 8, 12, 18 and 21). However, although the discrimination of the 12th and 15th questions were close to the 0.30 limit, it was deemed appropriate to be left in the test due to the objectives involved. As a result, the 12th and 15th questions of 15 questions, which were decided to be kept in the test, and other questions that were “very easy” in terms of item difficulty index were revised and included in the test.

In the item analysis made for the second part of the test, nine questions (questions 1, 2, 3, 4, 5, 8, 18, 22, and 28) whose discrimination was below 0.30 were excluded from the test. On the other hand, questions 7, 24 and 27, whose discrimination values are close to the limit of 0.30, were removed from the test. A question in the test (question 9) was excluded from the test because the item difficulty was in the “very difficult” category. Accordingly, other questions remaining in the test (except questions 6, 11, 20 and 26) were revised as they were considered as "very easy" in terms of item difficulty. An example question for both parts of the test is given in Figure 2.

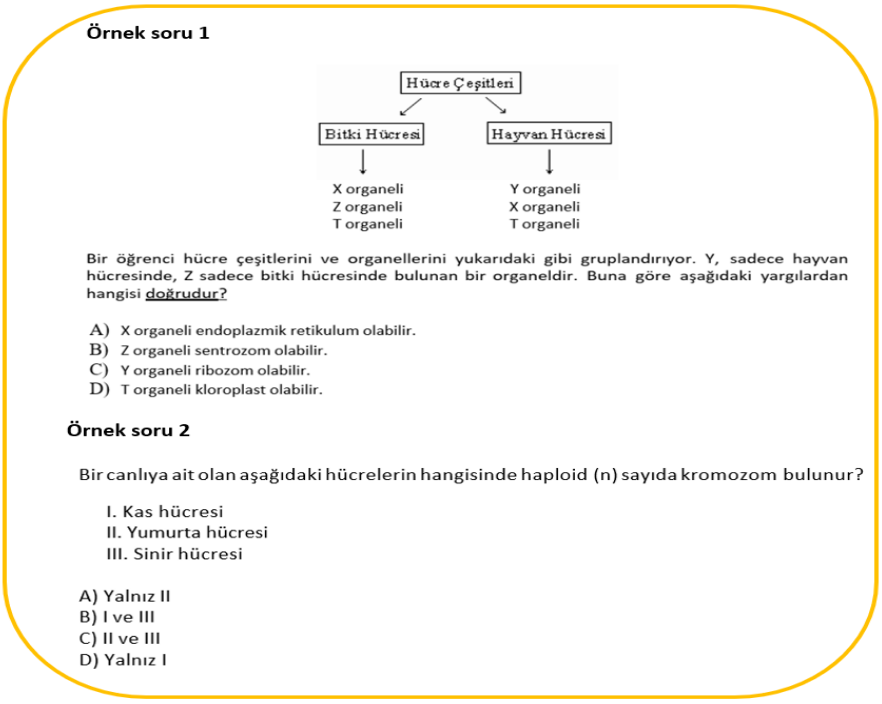

FIGURE 2. Sample questions of CDAT

As a result, a final "Cell and Division Achievement Test (CDAT)" with a total of 30 questions, including all objectives and finalized with expert opinions, was developed after the item analysis. The test was applied to a group of 148 students in a secondary school different from the actual applications for reliability analysis and the KR-20 reliability coefficient was calculated as 0.87. As such, the test can be said to be reliable. The distribution of the questions in the final test according to the objectives stated in the MEB (2018) 7th grade science course curriculum is given in Table 1.

Table 1. *The distribution of the questions in CDAT according to the objectives*

Objectives	**Questions in CDAT***
F.7.2.1.1. Compares animal and plant cells in terms of their basic parts and functions.	S1, S2, S4, S5, S6, S7, S8, S9, S11, S12, S13, S14
F.7.2.1.2. Discusses the ideas about the structure of the cell from past to present by associating with technological developments.	S3, S10
F.7.2.1.3. Explains the relationship between cell-tissue-organ-system-organism.	S15
F.7.2.2.1. Explains the importance of mitosis for living things.	S19, S28
F.7.2.2.2. Explains that mitosis consists of different phases that follow each other.	S16, S17, S18, S25, S27, S29, S26
F.7.2.3.1. Explains the importance of meiosis for living things.	S20, S23, S30
F.7.2.3.2. Shows on the model how meiosis occurs in reproductive cells.	S21, S22, S25, S26
F.7.2.3.3. Compares the differences between meiosis and mitosis.	S24, S26, S30

* Question numbers were rearranged according to the final form of the test.

When Table 1 is examined, there are twelve questions in the first objective, two in the second objective, one in the third objective, two in the fourth objective, seven in the fifth objective, three in the sixth objective, four in the seventh objective, and three in the eight objective, and

some questions (questions 25, 26 and 30) was observed to be for more than one objective.

Teaching Material

In the study, 3 worksheets were developed for the "Cell and Divisions" unit. While the worksheets are being developed, both internet, newspaper etc. resources were utilized and materials were prepared by getting the expert opinions by the researchers themselves. In each worksheet prepared, open-ended questions including key concepts and objectives related to the subject were asked. In order to attract the students' attention to the scenarios in the worksheet, appropriate pictures were used. The worksheets were examined and found appropriate by a science teacher and a faculty member who is an expert in biology education in terms of its compliance with REACT strategy and student level.

Application Process

In the study, permissions were obtained from both the university ethics committee and the MEB prior to the implementation, and then the school where the application will be carried out was determined. During the application process, applications in the experimental and control groups were carried out in 6 weeks, including 1 week pretest, 4 weeks applications (4 * 4 = 16 course hours), 1 week posttest. In addition, students were informed about the use of microscope and applications during the weeks of pre-tests, and interviews were held with the students in the week of post-tests. Permanence test was performed 6 weeks after the application. Accordingly, the study lasted 12 weeks in total. The courses in the experimental and control groups were taught by the first researcher who was also the teacher of the course. Activities in the experimental and control groups are separately presented below.

Applications in experimental group

Courses in the experimental group were taught with activities prepared in accordance with the REACT strategy. The unit where the study was conducted basically covers three subjects. The subject distribution of the objectives was also taken into account and 3 different materials were prepared, one for each subject. Each material consists of five phases of the REACT strategy in accordance with its own subject. A pretest was carried out one week before the courses started to be processed with REACT strategy. Before the application of the first material, information was given to the experimental group about the course process. In addition, because experience stage in the material is required the skill of the microscope usage, the students was informed by working outside the course on finding and drawing images under the microscope before the application. An example activity for teaching "Cell and Organelles" subject is presented below briefly:

Relating: At this stage, students were asked to read the text "A Detective Adventure" and answer the given questions individually. The reading part is about a movie that Arda and his father watched, the detective trying to solve the secret of a murder and his adventures of finding the murderer based on the evidence collected by his team. With the reading part, it was aimed to both students are attracted and to establish a connection between the cell and invisible particles that allow identification in forensic cases. After reading the reading part, students were asked to find key concepts related to the subject. By providing the students to compare their answers, a discussion environment was created, and the preliminary information and concepts of the students were revealed by examining the reasons of the answers.

Experiencing: At this stage, based on the context in the reading part, students were asked to observe the blood and intraparietal epithelial cell in the prepared preparations given to them under a microscope and draw. Before the activities, students were informed about finding images and drawing under the microscope and then divided into groups. The groups were reminded that they would work together in situations that require group work throughout the activity. The students who needed help during the activity were guided by the teacher. After completing the microscope observation and drawings, students were asked to answer the questions in the interpretation section and share their answers with the class. With this activity, students are aimed to reach the knowledge that the basic structure unit of the living thing is the cell and that

the basic parts of the cell are the cell membrane, cytoplasm and nucleus. In the experiencing stage, students were provided to learn by doing and living with the context established in the relating stage. At the last part of the experiencing stage, students were watched an animation video about the subject and asked to review their answers.

Applying: At this stage, worksheets with five questions were distributed to the students. The worksheet consists of questions involving the basic parts and functions of the cell, DNA, gene and chromosome relationships. The students were asked to answer the questions individually based on the observations in the experiencing stage and the animation they watched. The answers were shared with the class. Later, it was provided to try to learn the subject by linking the subject with daily life and by giving different examples from daily life in groups. In this stage, it is aimed to the acquisition of basic concepts and reinforces what has been learned.

Cooperating: At this stage, "Discovery and Historical Development of the Cell" was given as a research assignment to the previously determined student groups before the activities. Students were asked to report their research in the form of a poster and present it in the classroom. The purpose of student presentations is to create an environment for using concepts related to the subject through examples related to daily life instead of subject expression (Ültay and Çalık, 2016). After the presentations, the students were asked to answer the questions in the worksheets distributed to the groups by discussing with their group friends and share them with the class. The worksheet consists of questions involving the historical discovery of the cell as well as the discovery and functions of the cell organelles. At this stage, it is aimed to enable students to learn in collaboration by sharing ideas and to deepen the subject.

Transferring: At this stage, students were expected to transfer their knowledge to a situation they had not encountered before by taking a reference to a situation they encountered. Students who were familiar with the animal cell in the experiencing stage were asked to examine the plant cell with the study groups and compare it with the animal cell. For this, students were asked to draw the onion skin cell by examining it under a microscope. After the drawing, the questions on the worksheet were answered individually. In this step, students are aimed to learn the basic parts of the plant cell and the parts that are different from the animal cell based on the animal cell.

Post-test application was carried out in the following week of the transferrin stage. Permanence test was applied six weeks after the posttest.

Applications in control group

In activities carried out in the control group, it was followed that the Secondary School and Imam Hatip Secondary School 7th Grade Science Book, which has been accepted as the main textbook since the 2018-2019 academic year with the decision of the Board of Education and Discipline dated 25.06.2018 and numbered 12254648. Considering that the textbooks adopt a constructivist approach, it can be said that the course is taught with a constructivist approach. The activities given in the book are not excluded, and the subjects are simultaneously covered with the experimental group. Pretest, posttest and retention tests were also performed simultaneously with the experimental group. The course was started with the preparatory work given at the beginning of the textbook and a discussion environment was created. These studies, which consisted of several questions, were used both to attract the students' attention to the subject and also provided the background information about the subject. Then, based on the objectives and the content of the subject in the textbook, the concepts and information about the subject were conveyed to the students by the teacher.

It was aimed to reinforce the subject by ensuring that the "You have the turn" activities in the textbook are carried out by the student (Demirkazan, Kalik and Özal, 2018, p: 53). Regarding the subject of cells and organelles, onion skin and intraoperative epithelial cell were observed under the microscope within the scope of the "You have the turn" activities in the book. At the same time, a table was created in which the characteristics of the plant and animal cells were compared, and also an activity involving analogy, in which cell organelles are compared to the parts of a factory, has been carried out. In addition, students were provided to prepare a cell model using the materials they wanted to use. Group work was carried out in "Let's examine cells"

and "Let's make a cell model" activities. The groups were created by the teacher.

Additionally, the student groups have prepared a model showing the stages of mitosis by using ropes and paper clips within the scope of the "You have the turn" activities in the textbook. A debate was held at the end of the subject. In this debate, while a group argued that mitosis division is more important for living things, the opposite group argued that meiosis division is more important for living things. Finally, the puzzle and evaluation questions at the end of the unit were solved with the students. In all activities, students were guided, students were encouraged to ask the parts they did not understand, and they were given the opportunity to make explanations. At the end of each subject, the subject was summarized by the teacher and the previous subject was repeated before starting the new subject.

Data Analysis

In the study, the data obtained after applying CDAT as a pre-test, post-test and permanence test to the students in the experimental and control groups were analyzed using the SPSS 20.0 statistical package program. Arithmetic means, standard deviation, dependent and independent sample t test were used to compare students' scores. The error margin was accepted as 0.05 in the analysis. On the other hand, the formula for gain score developed by Hake (1998) was used in order to determine the gains for achievement scores. The formula proposed by Hake (1998) is as follows:

$$g = (\%posttest - \%pretest) / (100 - \%pretest)$$

g values in the above formula;

if $g<0$; no gain

if $0<g<0.3$; low gain

if $0.3\leq g<0.7$; medium gain

if $0.7\leq g<1.0$; it defined as high gain.

RESULTS

The findings obtained after the analysis are presented below in the scope of research questions. Accordingly, an answer was sought for the sub-problem of 'Is there a significant difference between the experimental group students' the pre-test and post-test scores obtained from Cell and Divisions Achievement Test (CDAT)?'. The findings are shown in Table 2.

Table 2. *Comparison of pre-test and post-test CDAT scores of experimental group students*

	$\overline{X}$	sd	t	p	g
Pre-test	9.45	3.84	-12.81	0.000	0.56
Post-test	20.86	5.28			

Maximum score: 30

As seen in Table 2, dependent sample t test was conducted to compare the CDAT scores of the experimental group students before and after the application for the first sub-problem. The findings obtained as a result of the analysis revealed that there was a statistically significant difference in the students' scores in favor of the post-test ($t_{(28)}= -12.81$, $p< .05$). This finding was clearly seen in arithmetic means. As a matter of fact, it was determined that the post-test scores of the experimental group students increased by 56% when the gain scores were examined.

The findings for the second sub-problem of the study, 'Is there a significant difference between the control group students' the pre-test and post-test scores obtained from Cell and Divisions Achievement Test (CDAT)?' are shown in Table 3.

Table 3. *Comparison of pre-test and post-test CDAT scores of control group students*

	$\overline{X}$	sd	t	p	g
Pre-test	8.97	3.49	-6.69	0.000	0.25
Post-test	14.26	4.50			

Maximum score: 30

As seen in Table 3, dependent sample t test was conducted to compare the CDAT scores of the control group students before and after the application for the second sub-problem. The findings obtained as a result of the analysis revealed that there was a statistically significant difference in the students' scores in favor of the post-test ($t_{(30)}$= -6.69, p< .05). This finding was clearly seen in arithmetic means. As a matter of fact, it was determined that the post-test scores of the control group students increased by 25% when the gain scores were examined.

The findings for the third sub-problem of the study, 'Is there a significant difference between the groups in terms of pre-test and post-test scores obtained from Cell and Division Achievement Test (CDAT) of experiment and control group students?' are shown in Table 4.

Table 4. *Comparison of pre-test and post-test CDAT scores of experimental and control group students*

Groups	Pre-test $\overline{X}$	sd	Post-test $\overline{X}$	sd	$g_{(post\text{-}test)}$
Experimental group	9.45	3.84	20.86	5.28	0.42
Control group	8.97	3.49	14.26	4.50	

Maximum score: 30

In the study, whether the students in both groups are equivalent in terms of their achievements was firstly examined for the third sub-problem. Accordingly, as a result of the independent sample t test for CDAT pre-test scores, it was determined there was no statistically significant difference between the groups ($t_{(58)}$= -4.44, p> .05). Therefore, independent sample t test was performed to compare the post-test scores of the students. As a result of the analyzes, it was determined that there was a statistically significant difference between the groups in favor of the experimental group ($t_{(58)}$= 5.23, p <.05). When the arithmetic means are analyzed, it is clearly seen that the post-test scores of the experimental group are much higher than the control group. On the other hand, in order to examine the change between the posttest scores of the two groups, it was found that the posttest scores of the experimental group students increased 42% more than the control group when the gain scores obtained using the posttests were examined.

Finally, the findings for the fourth sub-problem of the study, 'Is there a significant difference between the groups in terms of permanence scores obtained from Cell and Division Achievement Test (CDAT) of experiment and control group students?' are shown in Table 5.

Table 5. *Comparison of CDAT permanence scores of experimental and control group students*

Groups	$\overline{X}$	sd	t	p	g
Experimental group	17.83	5.93	4.00	0.000	0,32
Control group	12.06	5.22			

Maximum score: 30

As seen in Table 5, it was determined that there was a statistically significant difference ($t_{(58)}$= 4.00, p <.05) in the permanence test scores of the experimental group and control group students in favor of the experimental group. This finding is clearly seen in both arithmetic means and gain scores. As a matter of fact, it was found that the permanence scores of the experimental group were 32% higher than the control group when the gain scores are examined.

DISCUSSION and CONCLUSIONS

As it is known, the vision of the Science Course Curriculum was defined as "to educate all students as science literate individuals" (MEB, 2013). The context-based approach also aims to

be able to use the knowledge of students in their daily lives and thus raise science literate individuals (Karslı and Saka, 2017). However, the literature is emphasized that students often have difficulty in learning subjects related to science courses (Balbağ, Leblebicier, Karaer, Sarıkahya and Erkan, 2016), and also because science textbooks contain both incomplete/incorrect information (Gündüz, Yılmaz and Çimen, 2016; Yılmaz, Gündüz, Diken and Çimen, 2017) and fail to relate the concepts to daily life, it is insufficient in increasing and maintaining the students' interest and curiosity (Küçüközer, Bostan, Edge, Seçer and Yavuz, 2008). At this point, it can be said that there is a need the preparation of teaching materials that support the relationship with real life and the creation of learning environments in which activities are carried out with these materials in science teaching. Therefore, this study is important in terms of revealing the effect of activities based on REACT strategy on the achievements of 7th grade students in the 'Cell and Divisions' unit.

The findings obtained within the scope of the first sub-problem of the study show that teaching based on REACT strategy is effective in increasing students' achievements. Similar findings were found in studies conducted in the literature (Gutwill-Wise, 2001; Özay-Köse and Çam-Tosun, 2011; Ültay, Durukan, and Ültay, 2015). For example; a study by Gül (2016) was revealed that teaching practices based on REACT strategy caused a significant increase in students' achievement in photosynthesis. Similarly, another study by Gül, Gürbüzoğlu-Yalmancı and Yalmancı (2017) revealed that the REACT strategy caused a statistically significant increase in the students' achievements in the excretory system unit. On the other hand, it is understood that there is a moderate increase in post-test scores when the g score values of the students in the experimental group are examined. This finding may suggest that teaching based on the REACT strategy significantly increases student achievement, but is insufficient to meet the expectations at a very high rate. This may be related to the adaptation process of this method, which students encounter for the first time. Likewise, similar findings reached in a study by Gül and Konu (2018) have been associated with the first-time students who encountered the method had problems in the adaptation process. Of course, in order to discuss the fact that there is a similar possibility in this study, it would be more appropriate to have face-to-face interviews with students.

In the study, the findings obtained within the scope of the second sub-problem indicate that constructivist learning environments are effective in students' learning. Indeed, these findings are supported by similar studies in the literature (Özay-Köse, Gül and Konu, 2014). For example, Ayaz and Şekerci (2015) conducted a meta-analysis study to determine the effect of the constructivist approach on students' academic achievement and attitudes. As a result of the meta-analysis, which made by a wide literature review relating to the studies in Turkey, it was determined that the constructivist approach has a positive effect as strong on students' academic achievement and as moderate on their attitudes compared to traditional teaching methods. Consequently, the fact that constructivism is based on today's curriculum as an educational method, in which both teachers and students take responsibility for learning, are motivated and recognize the values of teaching and learning, can be considered as a reflection of these positive effects of constructivism. On the other hand, the fact that there is a slight increase in the achievement scores of the students in the control group implies that more efforts should be made to increase the achievement.

According to the findings obtained within the scope of the third sub-problem of the study, it can be said that the preliminary information of the groups in the cell and division unit is close to each other. On the other hand, as a result of the post-test score comparison after the applications, a statistically significant difference was found in favor of the experimental group. Similarly, when the students' post-test scores are examined, it is determined that there is a moderate increase in the experimental group compared to the control group. Therefore, these findings can be considered as an indicator of the positive effect of using activities based on REACT strategy in context-based learning environments on student achievement. In many studies conducted in the literature, the findings of this study are supported and also literature reveals that teaching based on REACT strategy has a very positive effect on learning and increases achievement (Demircioğlu, Vural and Demircioğlu, 2012; Demircioğlu, Kurnaz and Erol, 2017; Gül, 2016; Gül, Gürbüzoğlu-Yalmancı and Yalmancı, 2017; Karsli and Yigit, 2017). Of course, this

noticeable increase in the experimental group, as stated by Özay-Köse and Çam-Tosun (2011), can be explained by ensuring the active participation of students in the course with appropriate activities in context-based learning environments, the creation of discussion environments, the use of visual materials and constantly attracting students' attention, and thus enabling the course to be conducted more fluently and effectively.

When the findings obtained within the scope of the fourth sub-problem of the study were examined, a decrease in the scores of both groups was observed. Of course, this decrease observed in students' permanence scores is an expected situation. Because the permanence test is applied 6 weeks after the post-tests, it is natural to see a slight decrease during this interval. However, the fact that this decrease observed in the students' permanence scores is negligibly low can be considered as a very pleasing finding in terms of the effectiveness of the said activities. Parallel findings to this study were similarly interpreted with the results of different studies in the literature (Gül, 2016). On the other hand, after comparing the permanence scores of the experimental and control group students, it was determined that there was a significant difference in favor of the experimental group and the permanence scores of the experimental group were higher than the control group. These findings show that activities based on the REACT strategy are more effective in maintaining the permanence of learning in students and are similar to the findings of different studies in the literature (Ültay and Çalık, 2011, 2016; Kirman-Bilgin and Yiğit, 2017). As stated by Kutu and Sözbilir (2011), this positive effect of context-based learning practices on permanence can be explained that as the fact that this method draws students' attention to the subject with real-life contexts, enables students to realize the relationship between the subject and their own life, ensures that the acquired knowledge is permanently in the mind of the student through various activities such as experiments in small groups.

When the above findings are evaluated in general, it is determined that the students who learn the 'Cell and Division' unit in the learning environments designed according to the REACT strategy of the context-based learning model are more successful than their peers studying in the learning environments (constructivist approach) designed according to the current curriculum. In addition, it was revealed that learning was more permanent in experimental group students. This result can be explained by the fact that the REACT strategy is more effective for students to make sense of the 'Cell and Divisions' unit. Gilbert (2006) emphasizes the importance of transferring the information presented in learning environments to real life and associating science lessons with real life situations in realizing more effective learning. Therefore, in this study, students may have realized learning more effectively in the learning environments based on the REACT strategy because knowledge was created based on the association of science subjects learned with real life contexts (Karslı and Saka, 2017). On the other hand, the continuous active participation of the students in the experimental group to the activities compared to the students in the control group has been ensured improvement in their achievement and also the long-term permanence of the knowledge in learning environments where was used the REACT strategy. As a matter of fact, some studies in the literature indicated similar findings that the active participation of the student in the context-based learning environments is effective in increasing the achievement (Gül and Konu, 2018; Karslı and Yiğit, 2015; Karslı and Saka, 2017; Yıldırım and Gültekin, 2017).

As a result, the findings of the study indicated that context-based learning (with REACT strategy) is more effective than the approaches (constructivist approach) predicted in the current curriculum. At this point, these issues should not be ignored and context-based learning approach should be included in the process while preparing or reorganizing the curriculum.

As stated above, it is obvious that both methods have a positive effect on student achievement, although context-based learning seems to be slightly more effective than constructivist approach in increasing success. However, it is understood from the gain scores that this effect is not very high at the desired level for both methods. Ültay and Calik (2016) examining the effect of REACT strategy of context-based learning and 5E model of constructivist approach, and also reaching similar findings in this study suggested that both learning model should be revised in the context of Turkey. However, the same researchers suggested that a longitudinal

study should be carried out on how to review and/or expand methods. Therefore, the recommendations of Ültay and Çalık (2016) are supported in line with the findings of this study.

In the study, it was determined that the activities based on the REACT strategy caused a statistically significant increase in the achievement of the students in the experimental group. However, gain score indicated that this increase was not very high. As stated before, the activities took some time because of the adaptation process, as it is the kind of students encountered for the first time. Therefore, students may be familiar with the process by giving a little more time to applications in future studies or by conducting a pilot study before actual applications. In addition, it is considered important to support the findings with qualitative data by conducting interviews with students in order to make clearer evaluations regarding this process.

This study was investigated the effect of REACT strategy on achievement and permanence of learning. In similar future studies, it may be suggested to examine the effect of this method on different variables (attitude, motivation, conceptual understanding, etc.). On the other hand, the sample of the study is limited to 60 students attending the seventh grade of a school in the city center of Trabzon. Therefore, generalizability of the findings can be increased by implementing new studies in more schools and larger sample groups.

In the study, the seventh grade 'Cell and Division' unit was taught with activities based on the REACT strategy. In future studies, the effectiveness of the method can be investigated in different grade levels or different subjects and units of the science course.

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