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Exploring the Impact of Digital REACT Applications on Science Education*

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Abstract

This study examines the effects of teaching the "Reproduction, Growth, and Development in Living Organisms" unit from the 7th-grade science curriculum using digital REACT applications on students' academic performance, attitudes towards science and digital technology, motivation for learning science, and knowledge retention. Conducted in a secondary school in Mersin's Akdeniz district during the 2022-2023 academic year, this quasi-experimental research involved 66 seventh-grade students. The students were divided into three groups: one control group and two experimental groups. The first experimental group participated in digital REACT activities, while the second group used the REACT strategy without digital tools. The control group followed the standard curriculum. Data collection instruments included the "Academic Achievement Test," the "Science Course Attitude Scale," the "Attitude Scale Toward Digital Technology," and the "Motivation Scale for Learning Science." The findings of the research show that digital REACT activities increased the academic achievement of the students and strengthened the retention of the information learned. However, no significant changes were observed in their attitudes towards science or digital technology and their motivation for learning science. Based on these results, recommendations were made for future research and for consideration by the Ministry of National Education.

Key Words: Digital REACT applications, educational technology, middle school, science education

Dijital REACT Uygulamalarının Fen Eğitimi Üzerindeki Etkisinin Araştırılması

Öz

Bu araştırma, 7. sınıf fen bilimleri müfredatında yer alan "Canlılarda Üreme, Büyüme ve Gelişme" ünitesinin dijital REACT uygulamalarıyla öğretilmesinin öğrencilerin akademik başarıları, fen bilimlerine ve dijital teknolojiye yönelik tutumları, fen öğrenmeye yönelik motivasyonları ve bilgilerin kalıcılığı üzerindeki etkilerini incelemektedir. 2022-2023 eğitim-öğretim yılında Mersin'in Akdeniz ilçesinde bir ortaokulda gerçekleştirilen bu yarı deneysel çalışma, 66 yedinci sınıf öğrencisini kapsamıştır. Öğrenciler, bir kontrol grubu ve iki deney grubu olarak üçe ayrılmıştır. İlk deney grubu dijital REACT etkinliklerine katılırken, ikinci grup REACT stratejisini dijital araçlar kullanmadan uygulamış, kontrol grubu ise standart müfredatı takip etmiştir. Veri toplama araçları arasında "Akademik Başarı Testi," "Fen Dersi Tutum Ölçeği," "Dijital Teknoloji Tutum Ölçeği" ve "Fen Öğrenme Motivasyon Ölçeği" yer almaktadır. Araştırma bulguları, dijital REACT etkinliklerinin öğrencilerin akademik başarısını ve bilgilerin kalıcılığını artırdığını göstermektedir. Ancak, fen bilimleri veya dijital teknolojiye yönelik tutum ve motivasyonda belirgin bir değişiklik gözlenmemiştir. Bu sonuçlara dayanarak, gelecekteki araştırmalar ve Milli Eğitim Bakanlığı için öneriler sunulmuştur.

Anahtar Kelimeler: Dijital REACT uygulamaları, eğitim teknolojisi, ortaokul, fen eğitimi.

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Introduction

Rapid advancements in science have initiated significant changes in political, economic, cultural, and technological fields, beginning with the human factor. These developments have permeated various aspects of society, influencing how we interact, communicate, and function daily. In a globalizing world, these innovations have not only impacted the different systems of countries but have also triggered profound transformations in the field of education (Erdoğan, 2005; Çelik, 2012; Kıvılcım, 2013; Çelebi, 2016). The education sector, in particular, has had to adapt swiftly to keep up with these changes' new demands and expectations. Adapting to these changes has become an essential need, especially for the components of the education system, namely, teachers and students. The urgency of rapidly implementing these changes in democratic, independent, and developed countries like Turkey is increasing daily (Boydak, 2010).

The curriculum, updated in 2004, aims to educate individuals not only to acquire information but also to interpret this information effectively, to produce solutions to problems, and to recognize and develop their learning styles. This holistic approach to education is designed to create lifelong learners equipped with critical thinking and problem-solving skills. With the steps taken in this direction, contemporary education programs are based on a constructivist approach to education, which seeks to provide students with effective learning and comprehension skills (Ministry of National Education, 2005). The constructivist approach encourages students to actively construct knowledge rather than passively receive it, fostering a deeper and more meaningful learning process through their experiences and reflections. In this context, countries like Turkey must quickly embrace this transformation in education and update their educational policies to cultivate individuals who are well-prepared for the demands of the future. The innovations in education aim to ensure that individuals are not only successful in the complexities of today's world but are also equipped to thrive in the dynamic and ever-evolving landscape of tomorrow.

With the curriculum revised in 2004, the education system aimed to adapt to a rapidly changing world. This update sought to equip students with skills not only to memorize information but also to interpret this information within its context, to produce effective solutions to problems, and to develop their learning styles (Ministry of National Education, 2005). By focusing on these skills, the education system aims to prepare students for the complexities of modern life. Contemporary education programs strive to construct knowledge based on students' real-life experiences and emphasize a perspective known as "life-based learning" in Turkey (Çam & Özay Köse, 2008; Ayvacı, 2010).

The life-based learning model, which is regarded as a component of the constructivist approach in science education, has been pioneering the field since 2004. This model incorporates the REACT strategy, which is designed to teach students topics through five steps: relating, experiencing, applying, collaborating, and transferring (Coştu, 2009). These stages are crafted to deepen understanding and retention by actively engaging students in the learning process. The REACT strategy not only facilitates the comprehension of scientific concepts but also encourages collaborative learning and real-world application, thus making education a more dynamic and interactive experience.

With this strategy, students learn how to apply knowledge in real-life scenarios rather than merely acquiring theoretical information. During the relating phase, students connect the educational content with problems they encounter in daily life, making learning more relevant. The experiencing phase provides opportunities for students to engage hands-on with the material, which makes the learning process more meaningful. In the applying phase, students practice how to use their knowledge in practical situations. The collaborating phase promotes social learning through group

activities and team projects. Finally, in the transferring phase, students learn to adapt and apply their knowledge to various contexts and scenarios, enhancing their ability to use what they have learned in different settings.

The fact that digital technology has become an integral part of our daily lives has necessitated the effective use of this technology in education (Mashadi & Kargozari, 2011; Karakoyun, 2014). The integration of technology in education, which has particularly positive effects on younger age groups, holds the potential to offer students more engaging and effective learning experiences (Junco, 2015). Digital tools can cater to diverse learning styles and provide access to a wealth of resources that enhance the educational experience. In this context, many studies support that classroom activities carried to digital platforms yield more effective and efficient results in teaching (Mashadi & Kargozari, 2011; Daşdemir et al., 2012; Arıcı, 2013; Ceylan & Bozkurt, 2017; Dağdalan & Taş, 2017; Ülker, Acar & Bülbül, 2017; Ulum & Yalman, 2018; Dinçer, 2019; Gürleroğlu, 2019; Türksoy, 2019; Yılmaz, 2019; Bağ, 2020; Laçin, 2021; Meço, 2021; Pınar & Dönel Akgül, 2021; Pınar & Dönel Akgül, 2024). These studies highlight the enhanced engagement and learning outcomes when educational activities are digitized. With the help of digital technologies, students are provided with special learning experiences, enabling them to experience authentic and effective learning. The rich content of digital technology makes science teaching more understandable and concrete, making its use in classroom environments inevitable. Digital resources can simplify complex scientific concepts and provide interactive, hands-on learning opportunities.

However, despite the advantages provided by digital technologies, it is observed that there is a lack of research on digital applications in which the REACT strategy is integrated into educational platforms. This gap in the research indicates a need for further exploration to fully leverage the potential of digital tools in enhancing the REACT strategy's effectiveness in science education. The REACT strategy, encompassing Relating, Experiencing, Applying, Cooperating, and Transferring, encourages students to develop critical thinking skills, solve problems, and make connections between their learning and real-life situations. When combined with digital technologies, this strategy could deepen these skills even further, providing students with more immersive and meaningful educational experiences. Therefore, exploring how digital tools can support and enhance the REACT strategy is crucial for advancing modern educational practices and making learning more relevant and impactful for students.

This study seeks to investigate the impact of using digital REACT strategies to teach the "Reproduction, Growth, and Development in Living Organisms" (ReGaDiLO) unit on students' academic achievement, attitudes towards science and digital technology, motivation for learning science, and retention of knowledge. In line with this objective, the study will address the following questions:

1. Is there a statistically significant difference in academic achievement for the ReGaDiLO unit between the pre-test, post-test, and retention test scores of the study groups?
2. Do the post-test scores of the study groups show a statistically significant difference in their attitudes towards science courses?
3. Are there statistically significant differences in the study groups' post-test scores regarding their attitudes toward digital technology?
4. Is there a statistically significant difference in the study groups' post-test scores in terms of their motivation to learn science?

Method

Research Design

Quantitative research aims to examine, interpret, and predict cause-effect relationships using numerical data (Demir, 2021). In this type of research, experimental designs are classified as full, quasi-, and weak experimental (Creswell & Tashakkori, 2007). In the course of this research, three distinct groups were randomly assembled, and a quasi-experimental design incorporating pre-test and post-test with a control group was employed. This approach, characterized by the random assignment of paired groups, is recognized as a quasi-experimental design. Quasi-experimental methods are preferred in educational research when random assignment of students is not possible (Demircioğlu, 2003).

Study Group

The scope of this study includes students attending the 7th grade at a village secondary school in the Akdeniz district of Mersin province during the 2022-2023 school year. The sample for the research was selected using convenience sampling, encompassing all 7th-grade students taught by the teacher, who is also the researcher, at a public school. This sampling technique involves selecting groups that are readily accessible and willing to participate voluntarily in the study (Erkuş, 2009). Three different classes, totaling 66 students, were chosen for the study; one class was assigned as the Control Group (CG), while the other two were designated as Experimental Group-1 (EG-1) and Experimental Group-2 (EG-2). These control and experimental groups were randomly chosen by the school administration. The breakdown of participating students by group and gender is shown in Table 1.

Table 1. The Distribution of Students Participating in The Study, Categorized by Groups and Gender, in Terms of Frequency and Percentage

Groups	Gender	Experience	%
EG-1	Male	5	7.58
	Female	16	24.24
EG-2	Female	12	18.18
	Male	11	16.67
CG	Female	12	18.18
	Male	10	15.15

Upon analysis of Tablo 1, it is seen that there are a total of 21 students (31.82%) in EG-1. Of these, 5 were male (7.58%) and 16 were female (24.24%). There was a total of 23 students (34.85%) in EG-2. Of these students, 12 were male (18.18%) and 11 were female (16.67%). It is seen that there are a total of 22 students (33.33%) in CG. Of these students, 12 were male (18.18%) and 10 were female (15.15%). In total, 43.94% of the 66 students included in the study were male and 56.06% were female.

Data Collection Tools and Application Process

During the data collection phase of the study, the Academic Achievement Test (AAT), Science Course Attitude Scale (SCAS), Digital Technology Attitude Scale (DTAS), and Motivation Scale for Learning Science (MSLS) were administered both as a pre-test at the beginning and as a post-test upon the completion of the application. Furthermore, to assess the retention of the learned material, the AAT was administered again four weeks after the experimental phase concluded. To ensure that the methods, materials, and measurement tools used in the study groups adhered to ethical guidelines, and to conduct the research, approval was obtained from the Erzincan Binali Yıldırım University Human Research Ethics Committee on March 31, 2021, under protocol number 04/26. Additionally,

permissions were secured from the Mersin Provincial Directorate of National Education, facilitated by the Erzincan Binali Yıldırım University Institute of Science and Technology, to carry out the study in the selected school.

Development of AAT related to the unit of ReGaDiLO

To evaluate students' performance in the ReGaDiLO topics, the researchers devised an achievement test. This assessment aligns with the goals outlined in the 7th Grade Science Curriculum and consists of a pool of 40 multiple-choice questions, each with distractors, created by the researchers.

This test includes the objectives in the 7th-grade science curriculum and a 40-question multiple-choice question pool with misleading options was prepared by examining the textbooks published by the MoNE and central exams.

To establish the content validity of the test, an in-depth review was conducted by two faculty members, three science teachers who are experts in science education, and four Turkish teachers. Following their review, the questions were revised and new ones were added. In the second week of November during the 2021-2022 academic year, the test was administered to 213 8th-grade students across three different public schools in Mersin. The data collected were entered into SPSS 22.0 software, where correct answers were scored as "1" and all other responses were scored as "0". The questions left blank by 10 consecutive students were not taken into consideration to avoid negatively affecting the calculations. Therefore, the data of 203 students were used for the analysis. Table 2 shows which acquisitions the questions in the AAT are aimed at and at which level they are located according to Bloom's taxonomy.

Table 2. Specification Table Prepared for The AAT

Outcomes	Recall	Understanding	Application	Analysis	Evaluation	Synthesis
F.7.6.1.1. Human reproductive structures and organs are explained using a diagram to illustrate their functions.	1, 2	3, 4, 5, 7				
F.7.6.1.2. The relationships among sperm, egg, zygote, embryo, fetus, and baby are described.	8	6, 9, 12				
F.7.6.1.3. Discusses necessary precautions for the healthy development of the embryo, supported by research findings.			10, 11		13, 14, 15	
F.7.6.2.1. Compares the different reproduction methods in plants and animals.	17, 19, 20	16, 18, 21				
F.7.6.2.2. Explains the growth and development processes in plants and animals using illustrative examples.	22, 23, 28, 29	24, 25, 26, 27, 30, 31, 32			33	
F.7.6.2.3. Describes the main factors that influence the growth	34, 38,	39, 40		35, 36, 37		

and development of both plants and animals.

After ranking the total scores of the students, upper and lower groups, each comprising 27% of the students, were formed, and the item difficulty indices and item discrimination indices of these groups were calculated.

Table 3. Item Difficulty and İtem Discrimination İndices of The Questions in The Test

Question Number	*Pjx*	*Rjx*	Question Number	*Pjx*	*Rjx*
1	0.41	0.51	21	0.17	0.09*
2	0.57	0.28	22	0.40	0.33
3	0.53	0.46	23	0.39	0.09*
4	0.53	0.59	24	0.35	0.27
5	0.54	0.44	25	0.30	0.41
6	0.33	0.37	26	0.24	0.17*
7	0.32	0.07*	27	0.33	0.31
8	0.52	0.52	28	0.54	0.44
9	0.39	0.50	29	0.36	0.41
10	0.54	0.22	30	0.38	0.56
11	0.59	0.44	31	0.36	0.48
12	0.47	0.63	32	0.22	0.04*
13	0.73	0.50	33	0.47	0.37
14	0.55	0.59	34	0.33	0.35
15	0.25	0.20	35	0.33	0.26
16	0.30	0.46	36	0.33	0.39
17	0.23	0.05*	37	0.30	0.24
18	0.29	0.20	38	0.20	0.04*
19	0.49	0.48	39	0.22	-0.07*
20	0.49	0.20	40	0.34	0.10*

*Questions removed from the test

According to Başol (2015), the item difficulty index takes a value between 0 and 1. Indices between 0 and 0.15 indicate that the item should be removed from the test. Indices between 0.16 and 0.39 represent difficult items and can be made easier according to the need. Indices between 0.40 and 0.60 are considered to be moderately difficult and ideal items. Indices between 0.61 and 0.84 represent easy items and can be made harder when necessary. Indices between 0.85 and 1.00 represent very easy items and should be removed from the test. If the item discrimination index is less than 0.20, the questions should be removed, if it is between 0.20 and 0.29, it can be improved by correction, if it is between 0.30 and 0.39, it is interpreted as good, and if it is 0.40 and above, it is interpreted as very good. Accordingly, the difficulty and discrimination indices of the test items were analyzed according to the criteria determined by Başol (2015). According to the evaluation results, the difficulty index of the 15th question was 0.25; the difficulty index of the 17th question was 0.23; the difficulty index of the 18th question was 0.29; the difficulty index of the 21st question was 0.17; the difficulty index of the 26th question was 0.24; the difficulty index of the 32nd question was 0.22; the difficulty index of the 38th question was 0.20 and the difficulty index of the 39th question was 0.22. Questions with item difficulty indices below 0.29 are considered difficult, so these eight questions were removed from the test.

In addition, the discrimination index of question 7 was 0.07; the discrimination index of question 17 was 0.05; the discrimination indices of questions 21 and 23 were 0.09; the discrimination

index of question 26 was 0.17; the discrimination indices of questions 32 and 38 were 0.04; the discrimination index of question 39 was -0.07 and the discrimination index of question 40 was 0.10. The discrimination indices of these questions were below 0.20, so these questions were also removed from the test.

Following the analysis, 12 questions were eliminated from the assessment, resulting in a final version comprising 28 questions. The KR 20 reliability analysis assesses the extent to which the test effectively measures the intended characteristic. Typically ranging between "0" and "1", this value indicates the test's reliability. The reliability coefficient of the assessment was determined to be 0.768, signifying its reliability.

The SCAS, developed by Şaşmaz-Ören (2005), was designed to assess students' perceptions of their science course. Originating from the "Attitude towards Science in School Assessment," a 5-point Likert-type scale adapted from German and integrated into Şaşmaz-Ören's doctoral research, this instrument consists of 22 items. These items include 13 positively worded and 9 negatively worded statements. Responses are rated on a scale from "Strongly Disagree" to "Strongly Agree," corresponding to scores of 1 to 5, respectively. Reverse scoring is applied to negative statements. The scale demonstrates high reliability, with Şaşmaz-Ören reporting a coefficient α of 0.92, indicative of strong validity and consistency. In the current study, the pre-test reliability coefficient α was computed at 0.82, and for the post-test, it was determined to be 0.84.

The MSLS, developed by Dede and Yaman (2015), comprises 23 items measured on a 5-point Likert scale, including two negatively worded items. This scale assesses students' motivation across five distinct dimensions: research motivation, performance motivation, communication motivation, cooperative work motivation, and participation motivation, collectively explaining 47.16% of the total variance. The overall internal consistency reliability, as measured by Cronbach's Alpha, is reported at 0.80. In this study, the reliability coefficient (α) for the pre-test was 0.81, slightly decreasing to 0.79 for the post-test.

The DTAS, developed by Cabı (2015), comprises 39 items measured on a 5-point Likert scale, with five items phrased negatively. Organized into eight dimensions, the DTAS evaluates students' attitudes toward digital technology, encompassing competence, social networks, technology utilization at work, interest in technology, technology assurance, negative perceptions, recreational use, and conscientious use. The scale demonstrates strong internal consistency reliability, with an overall Cronbach's Alpha coefficient of 0.90, ranging from 0.61 to 0.86 across individual factors. For this study, the pre-test reliability coefficient α was found to be 0.78, increasing to 0.83 for the post-test administration.

Implementation Process

The study outlines the execution of the digital REACT and REACT strategy-based applications, which cover the unit of ReGaDiLO for 7th-grade students. Before commencing the actual research implementation, the problems identified during the pilot implementation phase were addressed and necessary adjustments were made to mitigate these issues. Subsequently, the implementation process itself was thoroughly discussed.

Pilot Implementation

Before fully implementing the research, a pilot study was conducted to evaluate the efficacy and practicality of the digital REACT strategy and to anticipate any potential challenges in its instructional application. This preliminary investigation involved 7th-grade students from a rural secondary school in the Akdeniz district of Mersin province. A total of 75 students across three

separate classes participated, with one class designated as the control group and the remaining two as experimental groups, chosen through random allocation.

Before commencing the pilot implementation, detailed lesson plans for the REACT strategy were developed and classroom activities were executed. Additionally, a dedicated website for the digital REACT strategy was created, and relevant activities were completed. The digital REACT activities were administered to students in Experimental Group 1 (EG-1), while traditional REACT activities were assigned to students in Experimental Group 2 (EG-2), spanning a total of 18 lesson hours. Challenges encountered during the pilot phase were meticulously recorded, and remedial actions were promptly undertaken. Subsequently, the instructional materials underwent rigorous review by two educational experts in the field before their finalization.

Throughout the pilot study, initial observations indicated that students faced challenges in adapting to digital materials, particularly those from low-income backgrounds grappling with internet accessibility issues. Consequently, it was decided to incorporate digital materials in the preceding unit to provide students with increased exposure. Support mechanisms were established for students experiencing connectivity issues, and necessary adjustments were made to resolve any encountered problems during digital activities. Classroom arrangements were optimized for these activities, and students were guided to create accounts on the websites. Furthermore, a dedicated diary feature was integrated into the website to help students monitor their progress. Seating arrangements conducive to collaborative activities were planned, and an informative session was held with students and parents before initiating the activities. Guidelines for website usage were introduced, and animations in the association step were refined. Students were encouraged to access information by revisiting the transferring steps, and worksheets were developed to enhance active participation during lessons. Following the pilot phase, all identified shortcomings, adjustments, and pending tasks were thoroughly addressed in preparation for the full-scale implementation.

Actual Implementation

The research was designed in the 2021-2022 academic year, encompassing pre-application preparations such as the development of measurement tools, creation of teaching materials, pilot application, and selection of control and experimental groups. Following the evaluation of the pilot application results, adjustments were made to the teaching process, and the actual implementation took place during the second semester of the 2022-2023 academic year.

The control and experimental groups involved in the research were chosen randomly and comprised students with comparable academic achievement levels. From the pool of 7th-grade students, to whom the researcher taught science lessons, three classes were selected: one control group and two experimental groups. The academic achievements of these groups were closely matched, as evidenced by the comparison of science course grades from the previous semester. A detailed depiction of the research process is provided in Table 4.

Table 4. The Actual İmplementation Process of The Research

Groups	**Pre-Implementation**	**Implementations**	**Post-Implementation**	**Retention**
EG-1	• AAT • SCAS • DTAS • MSLS	Digital REACT strategy	• AAT • SCAS • DTAS • MSLS	• AAT
EG-2	• AAT • SCAS • DTAS • MSLS	REACT strategy	• AAT • SCAS • DTAS • MSLS	• AAT

CG	• AAT • SCAS • DTAS • MSLS	Science course curriculum activities	• AAT • SCAS • DTAS • MSLS	• AAT	

The study was implemented with a total of 66 students, comprising 21 students from EG-1 (who received the digital REACT strategy), 23 students from EG-2 (who received the REACT strategy), and 22 students from the control group (who followed the activities outlined in the textbook aligned with the current curriculum). Throughout the study, the topics in the "Cell and Divisions" unit were taught by the objectives in the curriculum through five-week (18 lesson hours) practices with the participation of the first author both as a researcher and as a teacher. The dependent variables were the data of AAT, SCAS, DTAS, and MSLS in all groups. All groups underwent pre-test and post-test administrations of these scales and assessments. Additionally, AAT was readministered four weeks after the experimental applications to assess information retention.

Data Analyses

To analyze the quantitative data collected in this study, both the TAP and SPSS 22.0 software packages were employed. A threshold of $p < 0.05$ was set for determining statistical significance during data analysis and interpretation. The quantitative data were evaluated using either parametric or nonparametric methods, depending on the distribution. The Shapiro-Wilk test was applied to check for normality, alongside examining the skewness and kurtosis values. Since the sample size was under 50 participants, the p-value from the Shapiro-Wilk test was primarily used to assess normality. The results of this normality assessment for the data collected from the research group are summarized in Table 5.

Table 5. Normal Distribution Analysis Results of The Scores Obtained from The Data Collection Tools

Test/					Shapiro-Wilk test		
Scale	Groups	Implementations	Skewness	Kurtosis	Statistics	*Sd*	*p*
AAT	EG-1	Pre-test	0.944	0.585	0.933	21	0.162
		Post-test	0.049	-1.660	0.874	21	0.012*
		Retention test	0.185	-1.270	0.931	21	0.146
	EG-2	Pre-test	0.178	-0.891	0.951	23	0.313
		Post-test	0.945	0.464	0.915	23	0.051
		Retention test	0.116	0.286	0.974	23	0.790
	CG	Pre-test	0.182	-1.282	0.921	22	0.079
		Post-test	0.210	-0.813	0.975	22	0.815
		Retention test	0.883	0.499	0.939	22	0.184
SCAS	EG-1	Pre-test	0.293	-0.297	0.975	21	0.848
		Post-test	0.302	-0.231	0.954	21	0.409
	EG-2	Pre-test	-0.261	1.457	0.971	23	0.718
		Post-test	-0.849	1.425	0.943	23	0.208
	CG	Pre-test	-0.374	-0.614	0.961	22	0.488
		Post-test	-0.130	-1.471	0.911	22	0.053
DTAS	EG-1	Pre-test	0.991	-0.083	0.877	21	0.014*
		Post-test	0.252	-1.087	0.940	21	0.234
	EG-2	Pre-test	-0.488	-0.731	0.939	23	0.170
		Post-test	-0.123	-0.596	0.961	23	0.486
	CG	Pre-test	-0.880	0.338	0.923	22	0.094
		Post-test	-0.290	-0.661	0.970	22	0.730

MSLS	EG-1	Pre-test	0.211	-0.965	0.948	21	0.328
		Post-test	0.044	-0.804	0.963	21	0.608
	EG-2	Pre-test	-0.902	0.571	0.926	23	0.095
		Post-test	-0.481	-0.811	0.936	23	0.145
	CG	Pre-test	0.102	-0.928	0.951	22	0.337
		Post-test	0.314	-0.828	0.946	22	0.264

*$p<$ 0.05

Upon examining Table 5, the skewness and kurtosis values for the scores derived from the data collection tools are within the acceptable range of -2 to +2. However, the Shapiro-Wilk test revealed that the p-values for the post-test scores in the AAT and the pre-test scores in the DTAS for the EG-1 group are below 0.05, indicating that these scores do not follow a normal distribution. As a result, to analyze the pre-test scores across the study groups, a one-way ANOVA was employed. For comparing the AAT post-test mean scores, both the parametric t-test and the non-parametric Mann-Whitney U test were applied. To assess the mean scores of EG-1 students in the AAT across the pre-test, post-test, and retention test, the non-parametric Friedman test was used, and the Wilcoxon signed-rank test was performed to determine the significance of the differences between these measurements. Additionally, a one-way ANOVA was utilized to compare the pre-test, post-test, and retention test mean scores for EG-2 and CG students in the AAT, followed by the Bonferroni test to examine the significance of differences between the groups. For the SCAS and MSLS, the pre-test and post-test scores were analyzed using a one-way ANOVA. While the Kruskal-Wallis H test, a non-parametric method, was applied to evaluate the DTAS pre-test scores, a one-way ANOVA was used to compare the DTAS post-test scores among the study groups. Furthermore, Cohen's measure of effect size (eta squared, η^2) was utilized to assess the impact of the applied methods on the group scores. According to this measure, η^2 values of 0.01, 0.06, and 0.14 correspond to small, medium, and large effects, respectively. For non-parametric tests, the effect size is interpreted using the r coefficient, with values of 0.10, 0.30, and 0.50 indicating small, medium, and large effects, respectively.

Validity and Reliability in the Study

The research's validity hinges on the precision with which the measurement tool assesses the intended characteristics independently of other factors, thereby indicating its validity (Büyüköztürk et al., 2018). To enhance the validity of the study, several measures were implemented. Firstly, each phase of the study was meticulously elucidated, and the researcher ensured objectivity in both describing and interpreting the data. Moreover, the research data were gathered from the field through prolonged interaction and collected at various intervals using four distinct data collection instruments, thereby enhancing data diversity. Expert opinions were sought during the development of the data collection tools, and the research data, analysis process, and findings were shared with experts.

The reliability of the research is expected to give similar results when a test is applied to the same person more than once (Alpar, 2016). Reliability provides external reliability by obtaining research results again in similar environments and conditions, and internal reliability by other researchers reaching similar results based on the same data. In this context, to increase the reliability of the study, the characteristics of the students were explained and the researcher accurately transferred the study data without comment.

Findings

The aim was to examine the impact of implementing the digital REACT model in teaching the ReGaDiLO unit to 7th-grade students and to present the resulting data. Below are the findings about each research question addressed in the study.

1. Findings Related to the First Research Question

The first research question investigated whether there existed a statistically significant difference among the study groups' pre-test, post-test, and retention test scores in terms of academic achievement in the ReGaDiLO unit. To achieve this, the mean scores of the students' academic achievement tests were calculated, and the scores from the pre-test, post-test, and retention tests were analyzed. The arithmetic means and standard deviations of the relevant data are depicted in Table 6.

Table 6. Descriptive Statistics of The Pre-Test, Post-Test, and Retention Test Scores of The Study Groups

	Pre-test		Post-test		Retention Test	
Groups	$\bar{X}$	*Ss*	$\bar{X}$	*Ss*	$\bar{X}$	*Ss*
EG1	11,38	5,11	18,10	5,58	17,29	5,58
EG2	11,91	3,73	17,04	3,95	15,74	4,68
CG	11,05	4,08	13,09	5,91	11,18	5,02
Total	11,45	4,27	16,06	5,55	14,71	5,65

Note: The lowest score is 0 and the highest score is 28.

According to the data in Table 6, the mean achievement pre-test scores of the students in EG-1, where the digital REACT strategy was applied, EG-2, where the REACT strategy was applied, and CG, where the course was taught with the current curriculum, were quite close to each other (EG-1: X=11,38, EG-2: X=11,91, CG: X=11,05). While there was an improvement in the post-test scores across all groups, it's notable that a decline was observed in the retention test scores. Specifically, the average post-test score of EG-1 students was observed to be the highest (X=18.10), whereas that of CG students was the lowest (X=13.09). There was a significant increase in the post-test and retention test mean scores of the experimental groups compared to the control group.

In order to determine if there was a statistically significant difference in the AAT pre-test mean scores among the different study groups prior to the intervention, it was essential to first verify the homogeneity of the data variances. This verification was performed using Levene's test, which was applied to the pre-test mean scores of the AAT across the study groups. The results of this test are detailed in Table 7.

Table 7. Levene's Test Results for The Mean Scores of The AAT Pre-Test Scores of The Study Groups

Levene's statistic	Sd1	Sd2	p
0.878	2	63	0.421

As per the data displayed in Table 7, the p-value (p=0.421) derived from Levene's statistic exceeded 0.05, indicating homogeneous variances. Consequently, the outcomes of the one-way ANOVA conducted to compare the mean scores of the AAT pre-test among the study groups are illustrated in Table 7.

Table 8. One-Way ANOVA Results for The AAT Pre-Test Scores of The Study Groups

Groups	SS	*Sd*	MS	*F*	*p*
Between Groups	8.631	2	4.315	0.231	0.795
Within Groups	1177.733	63	18.694		
Total	1186.364	65			

Note: SS: Sum of Squares, MS: Mean Squares

Upon examining Table 8, it was observed that there existed no statistically significant difference in the mean academic achievement pre-test scores among the study groups (F (2, 63) = 0.231, p>0.05). These findings suggest that the groups exhibited similar levels of academic achievement before the study.

To assess potential differences in the mean scores of the EG-1 students across the AAT pre-test, post-test, and retention test, the Friedman test was employed, considering the non-normal distribution of AAT post-test scores. The outcomes are delineated in Table 9.

Table 9. Friedman Test Results for EG-1 Students' AAT Pre-Test, Post-Test, and Retention Test Scores

Variables	*N*	*X̄rank*	*Sd*	X^2	*p*	meaningful difference
Pre-test		1.07				1-2
Post-test	21	2.71	2	30.889	0.000*	1-3
Retention test		2.21				

*p <0.05; 1: Pre-test, 2: Post-test, 3: Retention test

As depicted in Table 9, a noteworthy difference emerged among the pre-test, post-test, and retention test scores for evaluating the academic achievement of EG-1 students (X2(2) = 30.889, p<0.05). Upon examination of the rank averages, it became apparent that post-test scores were the highest, followed by retention test scores. Wilcoxon tests were conducted to ascertain significant differences. The analysis outcomes disclosed notable differences between the pre-test and post-test, as well as between the pre-test and retention test (p<0.05). These observed disparities underscore a significant change in the AAT scores, with the effect size being substantial for both the pre-test versus post-test (r=0.88) and the pre-test versus retention test (r=0.84). The significant improvement seen in the post-test scores of the EG-1 group, when compared to their pre-test scores, highlights the effectiveness of integrating the digital REACT strategy in teaching the ReGaDiLO unit. Moreover, the lack of a significant difference between the post-test and retention test results suggests that students were able to sustain the knowledge they gained over a longer period.

One-way ANOVA for repeated measures was utilized to ascertain whether there existed a notable difference between EG-2 and CG students' AAT pre-test, post-test, and retention test scores, considering the normal distribution of the data. The findings are delineated in Table 10.

Table 10. One-Way ANOVA Results for Repeated Measures Regarding EG-2 and CG Students' AAT Pre-Test, Post-Test, and Retention Test Scores

Groups	Source of Variance	SS	Sd	MS	F	p	*η2*	meaningful difference
EG-2	Between Subjects	804.957	22	36.589				1-2
	Measurement	327.072	2	163.536	22.05	0.000*	0.50	1-3
	Error	326.261	44	7.415				
	Total	1458.290	68					
CG	Between Subjects	1344.258	21	64.012				1-2
	Measurement	57.545	2	28.773	4.513	0.017*	0.18	2-3
	Error	267.788	42	6.376				
	Total	1669.591	65					

*p<0.05; 1: Pre-test, 2: Post-test, 3: Retention test

Based on the analysis results presented in Table 10, a significant difference was observed among the pre-test, post-test, and retention test scores of EG-2 students (F (2, 44) = 22.05; p < 0.05; η^2 = 0.50). To identify which tests showed significant differences, the Bonferroni test was conducted. According to this test, there were statistically significant differences between the pre-test and post-test average

scores ($\bar{X}$ pre-test = 11.91; $\bar{X}$ post-test = 17.04) and between the pre-test and retention test average scores ($\bar{X}$ pre-test = 11.91; $\bar{X}$ retention = 15.74) of EG-2 students.

When comparing the pre-test and post-test scores, a significant improvement in favor of the post-test was noted. This indicates that teaching the ReGaDiLO unit using the REACT strategy effectively increased student achievement. The effect size, which measures the strength of this difference, was calculated as "$\eta^2 = 0.50$", suggesting that the experimental application had a substantial impact on improving student performance. However, no significant difference was found between the post-test and retention test scores. This result indicates that the students retained their knowledge over time and that the impact of the experimental application was sustained in the long term.

Similarly, a notable difference was observed in the CG students' AAT pre-test, post-test, and retention test scores ($F(2, 42) = 4.513$; $p < 0.05$; $\eta^2 = 0.18$). The Bonferroni test results revealed that the average scores of CG students in the AAT pre-test and post-test differed significantly. This finding suggests that the students in the CG group showed a considerable improvement in their achievement levels, which can be attributed to their ability to grasp specific concepts by the end of the learning process. Additionally, there was a statistically significant difference between the post-test and retention test scores of the CG students, indicating that the standard curriculum had little impact on the students' ability to retain knowledge over time.

2. Findings Related to the Second Research Question

Regarding the second research question, the study aimed to determine if there was a statistically significant difference in the post-test scores among the groups concerning their attitudes toward science classes. Before the interventions began, it was crucial to check whether the data variances were homogeneous to assess if there was a significant difference in the pre-test average scores among the groups. To address this, Table 11 presents the results of Levene's test for the pre-test average scores of the study groups.

Table 11. Levene's Test Results of The Pre-Test Mean Scores of The Study groups

Levene's Statistic	**Sd1**	**Sd2**	**p**
1,156	2	63	0.321

Since the p-value of Levene's statistic (p=0.321) in Table 11 is greater than 0.05, it is concluded that the variances are homogeneous. In this case, it was decided to apply a one-way ANOVA test for unrelated samples. The one-way ANOVA results of the pre-test mean scores of the study groups are presented in Table 12.

Table 12. One-Way ANOVA Results Related to The Pre-Test Scores of the Study Groups

Groups	**SS**	***Sd***	**MS**	***F***	***p***
Between Groups	946.648	2	473.324	2.875	0.064
Within Groups	10370.943	63	164.618		
Total	11317.591	65			

Based on the analysis results shown in Table 12, there is no statistically significant variance among the pre-test average scores of the different study groups ($F(2, 63) = 2.875$, $p > 0.05$). These findings show that the attitudes of the groups towards science courses were similar to each other before the research.

To evaluate how the various methods applied to the study groups influenced students' attitudes toward science classes, the arithmetic means and standard deviations of their pre-test and post-test scores were calculated. Table 13 provides the descriptive statistics for these scores, illustrating the students' performance before and after the intervention.

Table 13. Descriptive Statistics of The Pre-Test and Post-Test Scores of The Study Groups

	Pre-test		Post-test	
Groups	$\bar{X}$	*Ss*	$\bar{X}$	*Ss*
EG1	88.67	10.33	89.52	9.99
EG2	91.78	13.78	88.91	11.67
CG	82.73	13.91	85.32	13.26
Total	87.77	13.20	87.91	11.71

Note: The score range spans from a minimum of 22 to a maximum of 110.

Table 13 reveals that the initial pre-test mean scores among the students in the study groups were quite comparable. Following the implementation process, the EG-1 group showed the highest attitude score ($\bar{X}$=89.52), whereas the CG group recorded the lowest score ($\bar{X}$=85.32). It was also noted that the attitude scores for both EG-1 and CG students improved, while there was a decline in the scores for EG-2 students.

To evaluate whether there was a statistically significant difference in the post-test scores across the study groups, Levene's test was first applied to examine the homogeneity of the variances. The results indicated no significant difference ($F=1.795$; $p > 0.05$). Subsequently, the one-way ANOVA analysis results for the mean post-test scores of the groups are detailed in Table 14.

Table 14. One-Way ANOVA Results Related to The Post-Test Scores of The Study Groups

Groups	**SS**	***Sd***	**MS**	***F***	***p***
Between Groups	225.618	2	112.809	0.819	0.446
Within Groups	8681.837	63	137.807		
Total	8907.455	65			

Based on the analysis results shown in Table 14, there is no statistically significant difference between the mean SCAS post-test scores among the study groups ($F(2, 63) = 0.819$, $p > 0.05$). This suggests that the different teaching models do not significantly improve students' attitudes toward the science course.

3. Findings Related to the Third Research Question

Regarding the findings for the third research question, to determine if there is a statistically significant difference in the mean DTAS post-test scores among the study groups, we first examined whether their pre-test scores for attitudes toward digital technology were comparable. Given that the pre-test scores of the EG-1 group did not follow a normal distribution, the Kruskal-Wallis H test, a non-parametric test, was used. The results of this test are presented in Table 15.

Table 15. Kruskal-Wallis Test Results Regarding The Pre-Test Scores of The Study Groups for DTAS.

Variables	**Groups**	***N***	***X̄rank***	***Sd***	X^2	***p***
	EG1	21	30.69	2	0.737	0.692
Pre-test	EG2	23	35.59			
	CG	22	34.00			

In Table 15, it is observed that the study groups had similar attitudes toward digital technology initially ($X^2(2) = 0.737$, $p>0.05$). This indicates that the study groups exhibited a similar attitude towards digital technology.

To examine the impact of different methods on students' attitudes toward digital technology, the mean and standard deviation values of students' DTAS scores were determined in the research. Descriptive statistics for students' DTAS pre-test and post-test scores are presented in Table 16.

Table 16. Descriptive Statistics for The Pre-Test and Post-Test Scores of The Study Groups for DTAS.

	Pre-test		Post-test	
Groups	$\bar{X}$	*Ss*	$\bar{X}$	*Ss*
EG1	141.00	18.37	150.33	21.35
EG2	143.13	20.87	143.22	26.04
CG	141.32	20.57	140.77	21.83
Total	141.85	19.72	144.67	23.24

Note: The score range spans from a minimum of 39 to a maximum of 195.

Reviewing Table 16 reveals that the pre-test mean scores for digital technology attitudes (DTAS) among the study groups were fairly consistent. After completing the implementation phase, the EG-1 group achieved the highest digital attitude score ($\bar{X}$=150.33), showing a notable increase compared to their pre-test scores. Conversely, the CG group had the lowest digital attitude score ($\bar{X}$=140.77), which reflected a decrease from their pre-test scores.

To ascertain if there was a statistically significant difference in the DTAS post-test scores among the study groups, the homogeneity of variances was first evaluated using Levene's test. The results indicated no significant differences ($F=0.246$; $p>0.05$). The one-way ANOVA analysis for the post-test DTAS score averages of the study groups is detailed in Table 17.

Table 17. One-Way ANOVA Results for The Study Groups' DTAS Post-Test Scores.

Groups	**SS**	***Sd***	**MS**	***F***	***p***
Between Groups	1056.223	2	528.112	0.977	0.382
Within Groups	34046.443	63	540.420		
Total	35102.667	65			

The analysis results presented in Table 17 show that there is no statistically significant difference between the study groups' mean scores on the DTAS post-test ($F(2,63) = 0.977$, $p>0.05$). This suggests that different teaching strategies had an insignificant impact on altering students' attitudes toward digital technology.

4. Findings Related to the Fourth Research Question

Regarding the final research question, the study also aimed to determine if there was a statistically significant difference in the MSLS post-test scores among the study groups. To address this, the first step was to verify the homogeneity of variances for the MSLS pre-test scores to ensure any observed differences in mean scores were statistically meaningful. Levene's test was employed to examine the pre-test scores for this purpose, and the outcomes are shown in Table 18.

Table 18. Levene Test Results for The Study Groups' MSLS Pre-Test Mean Scores.

Levene's Statistic	**Sd1**	**Sd2**	**p**
0.010	2	63	0.990

Based on the Levene test results for the MSLS pre-test scores among the study groups, it was confirmed that the variances were homogeneous ($p=0.99$). Given this homogeneity, the one-way ANOVA test was used to compare the MSLS pre-test mean scores of the study groups, as shown in Table 19.

Table 19. One-Way ANOVA Results for the Study Groups' MSLS Pre-Test Scores.

Groups	**SS**	***Sd***	**MS**	***F***	***p***
Between Groups	613.840	2	306.920	2.407	0.098
Within Groups	8033.918	63	127.523		
Total	11317.591	65			

The analysis in Table 19 (F(2, 63) = 2.407, p>0.05) revealed no statistically significant difference in the pre-test mean scores among the groups. This suggests that, before the study began, the groups had similar levels of motivation toward learning science.

To evaluate how different instructional methods impacted the students' motivation toward science learning, the arithmetic means and standard deviations of their MSLS pre-test and post-test scores were calculated. These descriptive statistics for the MSLS scores are summarised in Table 20.

Table 20. Descriptive Statistics for The Study Groups' MSLS Pre-Test and Post-Test Scores.

	Pre-test		**Post-test**	
Groups	$\bar{X}$	*Ss*	$\bar{X}$	*Ss*
EG1	89.43	11.33	93.29	11.50
EG2	95.04	11.11	94.74	10.42
CG	88.09	11.45	89.05	12.47
Total	90.94	11.53	92.38	11.56

Note: The score range spans from a minimum of 23 to a maximum of 115.

The descriptive statistics presented in Table 20 reveal that the average scores of the study group students on the MSLS pre-test are quite similar. Upon inspecting the post-test scores, no notable difference is observed. Although the post-test mean scores for motivation are highest among EG-2 students ($\bar{X}$=94.74), CG students' scores remain the lowest ($\bar{X}$=89.05). There is an increase in motivation score averages for EG-1 and CG students, whereas EG-2 students show a decrease in their scores.

Lastly, to ascertain whether there exists a significant difference in the study groups' MSLS post-test scores, the Levene test was initially conducted to assess the homogeneity of variances. The results obtained (F=0.103; p>0.05) indicate no significant variance. The one-way ANOVA results for the study groups' MSLS post-test score averages can be found in Table 21.

Table 21. One-Way ANOVA Results for The Study Groups' MSLS Post-Test Scores.

Groups	**SS**	*Sd*	**MS**	*F*	*p*
Between Groups	389.855	2	194.928	1.479	0.236
Within Groups	8301.675	63	131.773		
Total	8691.530	65			

Upon reviewing Table 21, it is evident that based on the one-way ANOVA results concerning the study groups' MSLS post-test score averages (F (2,63) = 1.479, p>0.05), there exists no statistically significant distinction among the groups. These outcomes suggest that diverse instructional approaches do not effectively enhance students' motivation toward science learning.

Discussion, Results and Recommendations

This study highlights the importance of integrating the REACT strategy into life-oriented learning processes to enhance students' ability to connect new concepts with existing knowledge and engage in meaningful learning by relating them to everyday experiences. It underscores the effectiveness of employing this strategy in teaching biology by linking theoretical concepts to real-life contexts. Furthermore, within the ReGaDiLO unit, the study investigates the impact of the digital REACT strategy on various aspects of 7th-grade students' academic performance, knowledge retention, attitudes toward science, attitudes toward digital technology, and motivation for science learning. The findings obtained from this study were discussed within the framework of the research questions and compared with the results of previous studies in the literature. This comprehensive

discussion provides a deeper understanding of how the REACT strategy can be effectively applied in education and its potential impacts.

1. Discussion and Results Regarding the First Research Question

The discussion and results pertaining to the first research question revealed that by the conclusion of the teaching period, experimental groups exhibited significantly higher academic achievement compared to the control group. This suggests that interventions implemented in the experimental groups positively influenced student success. Moreover, integrating the REACT strategy with digital resources was found to enhance students' retention of knowledge. According to Demirel et al. (2002), multisensory learning—where students engage visually, auditorily, verbally, and tactically—facilitates better recall and reduces forgetting. The use of digital resources in education effectively concretizes abstract concepts, events, and objects (Lin et al., 2015). Thus, digital REACT applications may enhance knowledge retention by aiding mental visualization of information.

Similarly, literature findings indicate that teaching methods employing the REACT strategy on digital platforms enhance student success. For instance, Kumaş (2015) demonstrated that integrating innovative technology into instructional materials using the REACT strategy supports conceptual change, overcomes learning obstacles, improves application skills, and fosters success. Türksoy (2019) reported a significant improvement in student achievement levels when augmented reality and online advanced concept teaching materials were integrated with the REACT strategy, favouring the experimental groups. Similarly, Saka (2011) found that combining the REACT strategy with computer-assisted instruction positively impacted student success.

Additionally, studies suggest that using the REACT strategy alone enhances long-term learning. Ültay and Çalık (2011) indicated that employing the REACT strategy increases the permanence of learning and improves success rates. Gül (2016) demonstrated that thoroughly processing subjects with the REACT strategy enhances knowledge permanence in students. These findings support the efficacy of the REACT strategy in the learning process.

2. Discussion and Results Regarding the Second Research Question

Analysis of pre-test and post-test scores on the SCAS indicated an increase in science attitude scores among EG-1 and control group students, whereas EG-2 students experienced a slight decrease. These findings suggest that different instructional models did not significantly alter students' attitudes toward science. Literature notes that enduring changes in attitudes and behaviours often require extensive instructional periods (Karamustafaoğlu, 2003; İnceoğlu, 2010; Tavşancıl, 2006; Kılıç, 2015; Yıldırım & Gültekin, 2017).

Other studies examining the impact of the REACT strategy on science attitudes have produced conflicting results. Gül (2016) found that using the REACT strategy to teach photosynthesis did not significantly enhance students' attitudes toward the subject. Similarly, Karaş and Gül (2019) found no substantial impact of the REACT strategy on student attitudes or motivation when teaching units on cells and divisions.

However, contrasting studies indicate that the REACT strategy can positively affect attitudes. For example, Dağıstanlı and Yıldırım (2020) observed that teaching environmental topics with the REACT strategy significantly improved attitudes toward environmental issues in daily life.

3. Discussion and Results Regarding the Third Research Question

Analyzing pre-test and post-test scores on the DTAS revealed an increase in post-test scores among EG-1 students where the digital REACT strategy was applied. However, this increase was not statistically significant compared to other groups, suggesting that attitudes may change over time and some attitudes may be more resistant to change, despite new information or influences (Freedman et al., 1998; Sakallı, 2001; Demirtaş Madran, 2012).

The literature lacks studies investigating the impact of digitally integrated REACT strategies on students' attitudes toward technology, despite EG-1 students being identified as digital natives with a strong affinity for digital technology. Consequently, a review of research on technology-supported science education revealed findings consistent with those of this study. For instance, Gürleroğlu (2019) found that utilizing Web 2.0 tools in teaching force and energy increased academic achievement and motivation but did not significantly alter attitudes or digital literacy levels. Similarly, Yılmaz (2019) noted that games incorporating QR codes positively influenced attitudes toward science and technology in teaching the solar system.

In contrast to these findings, studies suggest that technology-supported science education can enhance attitudes toward digital technology. For example, Tavukçu (2008) reported that computer-assisted instruction improved students' attitudes toward computers. Similarly, Gül and Yeşilyurt (2011) found a positive increase in attitudes toward computers in groups receiving computer-assisted instruction.

4. Discussion and Results Regarding the Fourth Research Question

Results from analyzing pre-test and post-test scores on the MSLS indicated increased motivation levels among EG-1 and CG students, with a slight decrease observed among EG-2 students. However, no significant change in motivation was observed before and after the application. Initial motivation levels were notably high among students.

Reviewing relevant literature revealed numerous studies investigating motivation in science education through the REACT strategy. Gül (2016) found that using the REACT strategy for teaching photosynthesis did not significantly affect motivation. Similarly, Gül et al. (2017) observed no significant difference in motivation.

Karaş and Gül (2019) studied the impact of the REACT strategy on attitudes toward science and motivation for learning science in the unit on cells and divisions. Keleş (2019) assessed the effects of the REACT strategy on academic performance and learning experiences in topics such as pure substances and mixtures, finding no significant impact on motivation levels.

Conversely, other research suggests that the REACT strategy enhances motivation. Yıldırım (2015) found positive effects on various variables except scientific attitudes in activities using the REACT strategy for the "Let's Solve the Riddle of Our Body" unit. Similarly, Demircioğlu et al. (2019) reported increased motivation when teaching processed foods with the REACT strategy. Kaya (2020) observed positive motivational effects in teaching the digestive system with the REACT strategy.

In conclusion, comparing post-test scores on the MSLS between EG-1 with digitally integrated REACT and CG with the standard curriculum revealed no significant difference. Correspondingly, literature reviews support these findings. Laçin (2021) examined the effects of e-learning on teaching force and energy through the Classdojo application, finding no significant impact on science motivation.

Based on the research results, recommendations have been presented for researchers and the MoNE under two separate categories.

Recommendations for Researchers:

1. Given the current scarcity of research, it is advisable to pursue further studies centered on the REACT strategy. This approach will provide deeper insights into the strategy's diverse effects on learning processes and the factors influencing its efficacy.
2. The study's findings indicate no significant changes in students' attitudes and motivations following the application. Therefore, it is recommended to extend these interventions to study groups over longer periods, as this may enhance their effectiveness in fostering attitudes and motivations.
3. Positive outcomes were observed when implementing the REACT strategy via digital platforms, particularly in terms of student achievement and long-term learning. Based on these findings, developing similar methodologies for various topics within the field of science is recommended.
4. This study investigated the impact of the REACT strategy on students' affective characteristics, such as attitudes and motivations. Future research should explore additional traits such as interest, perception, and self-efficacy to comprehensively assess the method's influence.
5. One limitation of this study is its brief focus on the ReGaDiLO unit. Future research should delve into activities conducted over extended periods to thoroughly examine their effects on learning processes and attitudes.
6. Recommendations for future research and insights into study limitations are crucial for guiding researchers in similar investigations. These aspects should be carefully considered to enhance the robustness and applicability of future studies. In this context, it is recommended to examine not only the unit ReGaDiLO but also different units and lessons.
7. This study was conducted in three different classes in a state school. Similar studies conducted in more groups and schools can contribute to making the research more meaningful.
8. The research focused on how the REACT strategy can be integrated into a digital environment. In future studies, a more advanced learning experience can be created by combining the steps of the REACT strategy with new digital platforms such as metaverse technologies.

Recommendations for the MoNE:

1. It is recommended to provide the necessary tools and learning environments for the implementation of the REACT strategy enriched with digital activities. This way, teachers can use this strategy more effectively and efficiently.
2. For teachers to better understand the potential of the REACT strategy and use it effectively, in-service training sessions can be organized. These training sessions can cover topics such as how to implement the strategy, material selection, and methods to increase student interest.
3. Considering the recent regulations in schools where students are not allowed to bring their phones and tablets to school, it may be considered to establish a technology science classroom equipped with fixed computers for future similar studies.

Ethics Committee Approval

Ethics committee approval was obtained from the Erzincan Binali Yıldırım University Human Research Ethics Committee on March 31, 2021, with the decision number 04/26.

Author Contributions

Concept – MAP&GDA; Design - MAP&GDA; Supervision - MAP&GDA; Resources - MAP&GDA; Materials - MAP; Data Collection and/or Processing - MAP; Analysis and/or Interpretation - MAP&GDA; Literature Search - MAP&GDA; Writing Manuscript - MAP; Critical Review - MAP&GDA

Conflict of Interest Statement

There is no conflict of interest among the authors in this study.

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Türkçe Özet

Giriş

Bilim dünyasındaki hızlı gelişmeler, çeşitli alanlarda köklü değişimlere yol açarken, eğitim sistemlerini de derinden etkilemiştir (Erdoğan, 2005; Çelik, 2012; Kıvılcım, 2013; Çelebi, 2016). 2004 yılında Türkiye'de güncellenen müfredat, bireylerin sadece bilgi edinmesini değil, bilgiyi yorumlama, sorun çözme ve öğrenme tarzlarını geliştirme becerilerini kazanmalarını hedeflemiştir (Milli Eğitim Bakanlığı, 2005). Yapılandırmacı eğitim yaklaşımını benimseyen bu müfredat, fen eğitiminde "yaşam temelli öğrenme" modelini öne çıkarmış (Çam ve Özay Köse, 2008; Ayvacı, 2010) ve REACT stratejisiyle öğrenmeyi daha etkin hale getirmeyi amaçlamıştır.

Fen eğitiminde yapılandırmacı yaklaşımın temel bir unsuru olarak görülen yaşam temelli öğrenme modeli, 2004 yılından itibaren fen öğretiminde önemli bir rol üstlenmiştir. Bu model, öğrencilerin konuları **İlişkilendirme, Tecrübe Etme, Uygulama, İş birliği** ve **Transfer Etme** aşamalarından oluşan beş adımlı bir süreçle öğrenmelerini hedefleyen REACT stratejisini içermektedir (Coştu, 2009).

Dijital teknolojilerin günlük yaşamın vazgeçilmez bir parçası haline gelmesi, bu araçların eğitimde kullanımını zorunlu kılmıştır (Mashadi ve Kargozari, 2011; Karakoyun, 2014). Teknolojinin eğitime entegre edilmesi, öğrencilere daha etkili, ilgi çekici ve otantik öğrenme deneyimleri sunma fırsatı yaratmıştır. Ancak, dijital platformlarda REACT stratejisinin uygulanması üzerine yapılan araştırmaların sınırlı olduğu belirtilmiştir. Bu çalışmada, dijital REACT uygulamalarının ortaokul 7. sınıf öğrencilerinin akademik başarıları, fen dersine ve dijital teknolojiye yönelik tutumları, motivasyonları ve bilgi kalıcılığı üzerindeki etkileri incelenmiştir.

Yöntem

Araştırma, 2022-2023 eğitim-öğretim yılında, Mersin Akdeniz ilçesindeki bir köy ortaokulunda, 7. sınıf öğrencilerinden oluşan üç çalışma grubuyla gerçekleştirilmiştir. Rastgele atanan sınıflar, kontrol grubu (22 öğrenci) ve iki deney grubu (21 ve 23 öğrenci) olarak belirlenmiştir. Araştırmada ön test-son test kontrol gruplu yarı deneysel desen kullanılmıştır. Veri toplama araçları olarak Akademik Başarı Testi (ABT), Fen Bilimleri Dersi Tutum Ölçeği (FBDTÖ), Dijital Teknolojiye Yönelik Tutum Ölçeği (DTYTÖ) ve Fen Öğrenmeye Yönelik Motivasyon Ölçeği (FÖYMÖ) uygulanmıştır. ABT, uygulamadan dört hafta sonra tekrar edilerek kalıcılık ölçülmüştür.

ABT, araştırmacılar tarafından geliştirilmiş, MEB müfredatına uygun ve uzman incelemelerinden geçirilmiştir. Test, 40 soruluk bir havuzdan 28 soruya indirgenmiş, Cronbach Alfa güvenirlik katsayısı 0,768 olarak hesaplanmıştır. FBDTÖ, Şaşmaz-Ören (2005) tarafından geliştirilmiş ve güvenirlik katsayısı 0,92 olarak belirlenmiştir. FÖYMÖ ise Dede ve Yaman (2015) tarafından tasarlanmış, beş faktörden oluşan bu ölçeğin güvenirlik katsayısı 0,80'dir. DTYTÖ, Cabı (2015) tarafından geliştirilmiş, sekiz faktörlü bir yapıdadır ve güvenirlik katsayısı 0,90 olarak hesaplanmıştır.

Veri toplama araçlarından elde edilen puanların çarpıklık ve basıklık değerleri, kabul edilebilir aralık olan -2 ile +2 arasında bulunmuştur. Ancak, Shapiro-Wilk testi sonuçlarına göre, EG-1 grubunun AAT son test puanları ve DTAS ön test puanları için p-değerleri 0,05'in altında olup bu puanların normal dağılım göstermediği belirlenmiştir.

Araştırma gruplarının ön test puanlarını analiz etmek için tek yönlü ANOVA kullanılmıştır. AAT son test ortalama puanlarının karşılaştırılmasında hem parametrik t-testi hem de non-parametrik Mann-Whitney U testi uygulanmıştır. EG-1 öğrencilerinin AAT ön test, son test ve kalıcılık testi ortalama puanlarını değerlendirmek için non-parametrik Friedman testi kullanılmış, ölçümler arasındaki farkların anlamlılığı Wilcoxon işaretli sıralar testi ile belirlenmiştir.

EG-2 ve KG öğrencilerinin AAT ön test, son test ve kalıcılık testi ortalama puanları tek yönlü ANOVA ile karşılaştırılmış, gruplar arasındaki farkların anlamlılığı Bonferroni testi ile incelenmiştir. SCAS ve MSLS için ön test ve son test puanları tek yönlü ANOVA ile analiz edilmiştir. DTAS ön test puanlarının değerlendirilmesinde non-parametrik Kruskal-Wallis H testi, son test puanlarının karşılaştırılmasında ise tek yönlü ANOVA kullanılmıştır.

Grup puanları üzerindeki yöntemlerin etkisini değerlendirmek için Cohen'in etki büyüklüğü ölçütü (eta kare, η^2) kullanılmıştır. Buna göre, η^2 değerleri 0,01 küçük, 0,06 orta ve 0,14 büyük etkiyi ifade etmektedir. Non-parametrik testler için etki büyüklüğü, r katsayısı ile değerlendirilmiş; 0,10 küçük, 0,30 orta ve 0,50 büyük etki olarak yorumlanmıştır.

Tartışma, Sonuç ve Öneriler

Ders süreci sonunda deney grupları, kontrol grubuna göre daha yüksek akademik başarı göstermiş ve dijital kaynakların kullanımı bilgi kalıcılığını artırmıştır. Literatürde de REACT stratejisinin öğrencilerin başarılarını ve kavramalarını olumlu etkilediği belirtilmektedir (Kumaş, 2015; Saka, 2011; Türksoy, 2019). Fen bilimlerine yönelik tutumlar üzerine yapılan analizde ise gruplar arasında anlamlı bir fark bulunmamış, bu durum literatürde tutumların uzun süreli eğitim süreçleriyle değiştiği yönündeki bulgularla örtüşmüştür (Karamustafaoğlu, 2003; İnceoğlu, 2010; Tavşancıl, 2006; Kılıç, 2015; Yıldırım ve Gültekin, 2017). Dijital REACT stratejisinin teknolojiye yönelik tutum üzerindeki etkisi istatistiksel olarak anlamlı bulunmamakla birlikte, literatürde teknoloji destekli eğitimin tutumları olumlu etkileyebileceğine dair bulgular da mevcuttur. Motivasyon seviyelerinde deney ve kontrol gruplarında artış gözlenmiş, ancak uygulama öncesi ve sonrası anlamlı bir değişiklik saptanmamıştır. Literatür, REACT stratejisinin motivasyon üzerinde farklı etkileri olabileceğini göstermektedir (Demircioğlu vd., 2019; Kaya, 2020).

Araştırmacılara yönelik öneriler arasında, REACT stratejisi üzerine daha fazla araştırma yapılması, uygulamaların daha uzun süreli olması, dijital platformlarla entegrasyon için yeni yöntemler geliştirilmesi, öğrenci ilgisi ve öz yeterlilik gibi diğer özelliklerin de araştırılması, ayrıca daha fazla okul ve öğrenci grubu üzerinde çalışmalar yapılması bulunmaktadır. Milli Eğitim Bakanlığı'na yönelik öneriler ise dijital etkinliklerle zenginleştirilmiş REACT stratejisi için uygun araçlar ve öğrenme ortamlarının sağlanması, öğretmenler için hizmet içi eğitimler düzenlenmesi ve teknoloji ile donatılmış fen bilimleri sınıflarının oluşturulması şeklindedir.