ORIGINAL ARTICLE

Comparison of the Effects of Emergency Distance and Face-to-Face Education Applications on Students' Analytical Thinking Skills in Science Course: Example of Energy Transformations and Environmental Science Unit

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ABSTRACT

The aim of this study was to compare the analytical thinking skills of the 8th grade students who received emergency distance and face-to-face education in a science course and to get student ideas concerning emergency distance education. An unequal control group model from the quasi-experimental models was used in the study. The study group consisted of 39 students. Fifteen students who received energy transformations and environmental science unit as emergency distance education constituted the first group and 24 students who received face-to-face education constituted the second group. The data were collected with ATAT, TATDL, and SOF. In conclusion, it was determined that the cognitive success of the students who received face-to-face education based on analytical thinking improved more. The ability to adapt analytical thinking to daily life developed equally in both groups. While the students who received emergency distance education did not express a negative opinion about the activities carried out in the teaching process, they stated negative opinions about the realization of this process online, such as internet shortage, lack of communication tools, noise, occasional power cuts, inefficiency compared to face-to-face education, difficulty in understanding the lesson, difficulty in speaking in front of the screen, inability of the teacher to be effective in distance education, and inability to experiment together. However, there were also students who expressed a positive opinion that the course was productive, interesting, calm, more comfortable than face-to-face education, and safer to protect from the disease. As a result, it is thought that emergency distance education cannot replace face-to-face education; however, it is an effective education process that can be applied to prevent students from being completely disconnected from school and education during periods when lessons cannot be continued due to extraordinary circumstances such as pandemic.

KEY WORDS: Context-based learning approach; environmental studies; emergency distance education; higher-order thinking skills; science education; secondary school students

INTRODUCTION

The COVID-19 pandemic, which broke out in 2019 and affected the whole world, continues to threaten the lives of many people from every country. This pandemic negatively affects social life, economy, education, as well as human health (Şeker *et al*., 2020). One of the biggest measures to be taken to control the epidemic has been to put distance between people. This has brought situations such as curfew restrictions, working from home, and the interruption of face-to-face education.

According to the United Nations Educational Scientific and Cultural Organization [UNESCO] (2020a; 2020b) data, interruptions in face-to-face education during the pandemic have affected more than 1.5 billion students at various levels from primary school to university worldwide. Online education applications have been introduced due to the interruption of face-to-face education. These practices are named differently in the literature. For example, web-based distance education is defined as the education that takes place through distance education applications and research centers of some higher education institutions (Keskin and Özer Kaya, 2020) and online education is defined as the education that is carried out connected to the server through various software on the internet (Chen et al., 2020). Online education is a well-thought-out, consistent, and pre-planned process and involves appropriate methodology and design of subjects and educational programs (Bakhov et al., 2021). Distance education applications such as web-based education and online education are an option, that is, it is education based on theoretical and practical knowledge for the planned field (Bozkurt et al., 2020). Emergency distance education has been a necessity as an effort to provide education in times of crisis (Bakhov et al., 2021; Bozkurt et al., 2020). In this study, the term emergency distance education was used due to the sudden transformation of education into an online form without planning under pandemic conditions.

Emergency Distance Education and Education during COVID-19 Pandemic in Turkey

The issue of education in emergencies, which came to the fore in the 1990s in connection with a series of conflicts such as food shortages, diseases, natural disasters, and lack of housing for the population, is on the rise worldwide (Sinclar, 2002). Although emergency distance education has been used in various crisis situations such as migrations, wars, natural disasters, and pandemics since those days, research on education in emergency situations is still scarce (Keskin et al., 2020) and we are still not ready for effective implementation of emergency distance education during the COVID-19 pandemic.

Emergency distance education can be defined as the education process that is carried out separately from the school environment instead of formal education in times of crisis (Bakhov et al., 2021; Bozkurt et al., 2020; Sinclair, 2002). The main purpose of emergency distance learning is to provide temporary access to learning and learning support, which is easy to set up and make available during an emergency or crisis (Bakhov et al., 2021).

During the COVID-19 pandemic, educational institutions and educators had to respond quickly to the unexpected and compulsory transition from face-to-face education to emergency distance education (Carrillo and Flores, 2020). As a result of the first COVID-19 cases announced in Turkey, it was decided to close schools on March 12, 2020. Schools were suspended for a week as of March 16. On March 23, distance education started. The Education Information Network (EBA), which serves as a digital education platform by the Turkish Ministry of National Education (MEB), transformed into a distance education system that could be used by all students and teachers. Three new television channels were established in cooperation with the Turkish Radio and Television Corporation (TRT) within 2 weeks following the closure of the schools and "live lessons" were filmed (Özer, 2020). To eliminate the deficiencies in the emergency distance education process, face-to-face compensatory lessons were carried out in August 2020. However, with the increase in the number of cases, face-to-face education has been frequently interrupted. During the periods when face-to-face education was not possible, the lessons continued in the form of emergency distance education.

In cases such as epidemics and natural disasters, where face-to-face education cannot be continued, the option of distance education is very important in terms of ensuring continuity in education and training. However, the fact that this transition was very sudden and fast prevented sufficient planning. This situation may not only prevent education from achieving its goals but also lead to inequalities of opportunity in education. For this reason, there is a need for studies to be carried out to determine the effectiveness of emergency distance education during the pandemic period. These studies may contribute to revealing any deficiencies in emergency distance education and, therefore, help to eliminate these deficiencies. It is thought that distance education, which has been compulsory in all education levels in Turkey since March 2020, will take place more widely in our education system even after the end of the COVID-19 outbreak (Eroğlu and Kalayci, 2020a) and may even form the basis of education (Telli Yamamoto and Altun, 2020).

Analytical Thinking

According to Turkish Ministry of Education (MEB, 2018), the main purpose of the Turkish science curriculum is to educate individuals to become science and technology literate. In this direction, it is aimed to provide students with various skills such as scientific process skills, life skills, and engineering and design skills in addition to gaining knowledge in science class. Life skills are defined as basic skills related to accessing and using scientific knowledge in the Turkish science curriculum. These skills in the curriculum can be listed as decision making, analytical thinking, creative thinking, entrepreneurship, teamwork, and communication skills (MEB, 2018). It is understood that thinking skills are given importance in the curriculum when these skills are examined (Kanyilmaz and Özata Yücel, 2020). To effectively and deeply learn, to solve problems, and to adapt to the increasingly complex life and work environments, students need to develop thinking skills (Sternberg, 2002; Heong et al., 2011; Saekhow and Cheewaviriyanon, 2021). Analytical thinking, which is one of these skills, means dividing the whole into self-constituting elements based on logic, principles, function, situational conditions, and grouping different elements based on relationships and putting them of importance (Montaku et al., 2012). According to Irwanto (2017), analytical thinking, which is one of the higher-level thinking skills, is students' ability in describing a concept into part of the more comprehensive concept and explaining the correlation between parts.

The analytical thinking process enables us to reach a better decision by pushing us to have alternative options and then focus more on the best of those alternatives (Nuroso et al., 2018). An individual with advanced analytical thinking skills can define a problem encountered, develop suggestions for the solution to the problem, evaluate the reliability of the bases of ideas by questioning, and make the right decisions by operating reasoning processes correctly (Akkuş Çakır and Senemoğlu, 2016; Robbins, 2011; Tsalapatas, 2015). With the help of analytical thinking skill, students can develop knowledge and experience to interpret their lives and make a difference in the global society in this way (Wahyuni and Analita, 2017). Therefore, it is important to develop analytical thinking skills in schools. This goal has become even more important during the COVID-19 pandemic and is still important to prevent the spread of this disease thanks to people who follow scientific developments, value scientific knowledge, and take decisions and act in the light of this information. In the literature, it has been observed that there are studies on the development of critical thinking (Dill, 2003; Huff, 2000; Hussin et al., 2019; Msila, 2014) of students who receive emergency distance education and face-to-face education. However, there was

no study on the development of students' analytical thinking skills. Therefore, it is thought that this study, which includes analytical thinking skills, will contribute to the literature.

FEACA Teaching Model

The FEACA teaching model is one of the context-based learning approaches that enable students to develop their analytical thinking skills. This model was developed by Panprueksa (2012) and has five stages: Focusing, Exploring, Analyzing, Conceptual Developing, and Applying (FEACA). In the "Focusing" stage, real-life situations are taken as a starting point and the subject to be covered is associated with real-life contexts. In the "Exploring" stage, students have the opportunity to investigate real situations that they discovered in the previous step and formed in their minds through activities and experiments in small groups. In the "Analyzing" stage, students construct information in their minds and create connection by making observations, answering questions, making summaries, and establishing relationships between observation and information, on their own and with the help of their teacher when necessary. In "Conceptual Developing," with the guidance of the teacher, students form the correct conceptual understanding about the subject. At this stage, students discuss the results from the previous phase and redevelop and shape their conceptual understanding with the help of the teacher. Finally, in "Applying," each student group applies the new scientific concepts they have learned to new contexts and real-life experiences and shares these applications with the whole class.

Energy Transformations and Environmental Science Unit

Energy transformations and environmental science unit is included in the eighth grade Turkish science curriculum within the scope of "Living things and Life" subject area (MEB, 2018). This unit consists of four topics: Food chain and energy flow; energy transformations; substance cycles and environmental problems; sustainable development; and 12 learning outcome in total.

Energy transformations and environmental science unit is at an abstract level (Güneş et al., 2012; Zeytinli Ünal, 2018), complex by nature (Ahi and Alisinanoğlu, 2016; Doğança and Saysel, 2013; Hmelo-Silver et al., 2007; Özata Yücel and Özkan, 2018; Özdemir, 2007; Plate, 2010), and a unit that includes concepts that require association (Eberbach et al., 2012; Hmelo et al., 2000; Özata Yücel and Özkan, 2018; Özdemir, 2007; Seçgin et al., 2010). It requires higher thinking skills such as analytical thinking to be understood in-depth and holistically. In this respect, it is a coherent issue for the purpose of this study. It is also a unit that includes some concepts that are difficult to learn (Zeytinli Ünal, 2018), where students have various misconceptions (Adeniyi, 1985; Özkan et al., 2004; Seçgin et al., 2010; Tekkaya and Balcı, 2003; Ünal, 2011) and a lack of knowledge (Aksan and Çelikler, 2013; Köklükaya and Güven Yıldırım, 2016; Mahanoğlu, 2019; Ünal, 2011). For all these reasons, this unit in the curriculum was chosen for the purpose of the research.

Aim of the Study

The aim of the study was to compare the analytical thinking skills of the 8th grade students who receive emergency distance and face-to-face education during the energy transformations and environmental science unit in the science course. In addition, obtaining student opinions about emergency distance education were also within the scope of this study.

METHODS

Research Pattern

In the study, the convergent parallel mixed method design was used. In this model, quantitative and qualitative data are collected at the same time, analyzed separately, and eventually interpreted together (Creswell and Plano Clark, 2020). In the quantitative dimension of our study, an unequal control group design was used from the quasi-experimental models, and in the qualitative dimension, descriptive analysis was used. Students were informed that it was not compulsory to participate in the study; they would only participate if they wanted to, and the students who brought the informed consent form signed by their families were included in the study.

Study Group and Data Collection Tools

A total of 39 eighth grade students (aged 13–14), 24 students in the first group where face-to-face education was carried out and 15 students in the second group where emergency distance education is carried out, constitute the study group.

Two tests were developed by the researcher to determine the effects of instructional design, which was prepared in accordance with the FEACA teaching model on students' analytical thinking skills. These were Energy Transformations and Environmental Science, Analytical Thinking Achievement Test (ATAT), and Test for Adapting Analytical Thinking to Daily Life (TATDL). In addition, the opinions of the students who received emergency distance education about this process were taken with the Student Opinion Form (SOF).

Energy Transformations and Environmental Science Analytical Thinking Achievement Test (ATAT)

In the development of the ATAT, first, the unit learning outcomes were examined. Later, high school entrance examinations conducted throughout the country, sample questions prepared by the MEB General Directorate of Measurement and Evaluation and Examination Services for the high school entrance examination, questions in international exams (e.g., TIMSS and Pisa), and various question banks were examined, respectively, and a pool of questions consisting of 3–4 questions for each learning outcome was created. A draft ATAT was prepared by the researcher using this question pool. Then, this draft ATAT was presented for the opinions of two experts and two science teachers in the field of science education. Some questions were revised in the light of the opinions received, and one question was removed from the ATAT on the grounds that it did not provide content validity. After necessary arrangements were made in line with these

Table 1: A sample question from the test for adapting analytical thinking to daily life

Question 8: Fires, which have been going on for nearly 6 months in Australia, have been contained for the 1st time by heavy rainfall and the accompanying flooding. So far, 33 people have died in the fires, and 11 million hectares of land have been burned. About 1.25 billion animals died (Source: Anadolu Agency, February 14, 2020)

8A. What could be the causes of the fires in Australia? Explain	8B. What solutions can be provided to prevent fires from occurring again in Australia? Explain
Correct answer	
Students gives answers where the right cause and effect relationships are established	Student provides the right solutions to the cause of the problem
Example: With global climate change, temperatures have increased and forest fires occurred	Example: The use of renewable energy sources should be encouraged by reducing the use of fossil fuels
	The use of public transportation or bicycles should be preferred instead of cars
	More trees should be planted
	I'll start a protest to protect nature
	People's awareness should be raised and announcements should be made, brochures should be posted
Partial correct answer	
Student writes down the causes of the fires but does not explain them	Student says that they should reduce the factors that cause global climate change, but does not explain what to do
Example: Global warming, People, Climate change, Droughts, Desertification, Lack of water, Melting of glaciers in the poles, Part of the description is correct and other part is incorrect	Example: We need to reduce the causes of global warming
Example: If the energy of the sun comes in more due to global warming, sparks may have formed through reflections from garbage and glass bottles thrown into nature, and then a large fire may have occurred	
Incorrect answer	
Student writes down the wrong causes of the fire	Student indicates solutions that are not related to the cause of the problem
Example: Glass bottles may be thrown on the ground, fire may not be extinguished and cigarettes may be thrown on the ground without being extinguished and forests may be dirty	Example: Uncontrolled fires should not made
	I think there is nothing a lot of people can do, but people can pay more attention to some things, like put in a filter, and it's a little weird, but they can reduce the use of deodorant because it pierces the deodorants layer
Unanswered	

expert opinions, the test consisting of 20 open-ended questions was finalized. An example question is presented in Figure 1.

Test for Adapting Analytical Thinking to Daily Life (TATDL)

The TATDL was prepared by considering the criteria in the analytical thinking classroom observation form developed by Kanyılmaz and Özata Yücel (2020). These criteria are defining/explaining the concept/situation/problem; showing the concepts/situations/issues with graphics, models, or diagrams; comparing/classifying the analysis units of the concept/situation/problem; comparing/classifying the concepts/situations; choosing the solution to the problem; explaining the solution steps of the problem; explaining the concept/situation/problem into analysis units; explaining the characteristics of the concept/situation/problem's analysis units; problem-solving; explaining the relationship between concepts/situations/issues; and explaining the characteristics of the concept/situation/problem's analysis units. The draft TATDL was revised by taking into account the opinions of two experts and a science teacher in the field of science education. In this way, the test of adapting analytical thinking consisted of 13 open-ended questions. An example question is presented in Table 1.

Student Opinion Form (SOF)

The SOF was prepared to collect the opinions of the students who receive emergency distance education about the teaching process and emergency distance education. The students were asked what were the contributions of the education process that improved their knowledge and skills, what were the subjects or concepts they had difficulty with, and what were their favorite and least favorite activities?

Preparation and Implementation Process of Lesson Plans

The study aimed to determine the effects of instructional design, which was prepared in accordance with the FEACA teaching model before the COVID-19 pandemic, on students' analytical thinking skills. Face-to-face education was interrupted due to the epidemic just before the start of the application. For this reason, the application was adapted to emergency distance education and carried out in this way in June 2020. In August 2020, face-to-face compensatory education started in schools and the same unit was applied face-to-face as initially planned with another group. This process has provided an opportunity for researchers to compare face-to-face and distance education.

Eight course plans were applied to both groups for 6 weeks (24 class hours) using the FEACA model developed by Panprueksa (2012) (Table 2). The reason why this model was preferred is that it aims to improve analytical thinking (Panprueksa, 2012). As stated, the FEACA learning model has five stages. In the focus stage, a scenario or news that includes real-life contexts that will attract students' attention was presented. Then, a class discussion was held about the scenario or news. During the discussion, the students were

asked to compare their own answers with their friends' answers and to refute or accept them by showing reasons. At this stage, the answers of the students were not evaluated as correct or incorrect. During the exploration stage, students were asked to do an activity about the learning outcomes or to answer the questions about the scenario or news given during the focus phase. During the analysis stage, students were enabled to establish a relationship between what they observed and what they thought. In the concept development stage, after students learned the subject, the scenario or news given in the focus phase was returned. Students were asked to express their thoughts about the scenario or news as their initial thoughts and final thoughts. The answers given by the students were evaluated. During the application stage, students were enabled to apply what they learned to new situations.

The change in students' analytical thinking skills was determined by applying ATAT and TATDL as pre-test and post-test. The opinions of the students about emergency distance education were taken from the students who covered the subject with emergency distance education through SOF after the application (Table 2).

Data Analysis

The analysis of ATAT and TATDL was made with the prepared answer keys; the obtained data were scored and transferred to the SPSS 15.0 program. Shapiro–Wilk test, arithmetic mean mode and median values, skewness and kurtosis results, and the number of students in the face-to-face and emergency distance education groups were taken into consideration and Mann–Whitney U-test, which is one of the non-parametric tests, was used for the analysis of the data. The data obtained from the SOF were analyzed descriptively.

It was determined that there was a statistically significant difference between the ATAT pre-test scores of the face-to-face and emergency distance education groups (U=75.000, significance level $(\rho) = 0.002 < 0.05$) (Table 3). Since the ATAT pre-test scores of the groups were not equal, the difference scores (post-test-pre-test) were used in the comparison of the groups.

It was determined that the TATDL pre-test results of the face-to-face and emergency distance education groups were equal according to the Mann–Whitney U-test result (U = 136.000, $\rho = 0.202 > 0.05$) (Table 4). Therefore, it was decided to compare the post-test scores of the groups.

Findings

The ATAT pre-test mean of the students in the face-to-face education group was 8.63 and the post-test mean was 23.38. The mean pre-test and post-test scores of the students in the emergency distance education group were 15.13 and 17.8, respectively. Although there is an increase in the analytical thinking based success of both groups, it is understood that the increase in the scores of the face-to-face education group was carried out which is much higher (Figure 2).

It was determined that the rate of increase in analytical thinking based success of the students in the face-to-face and emergency distance education group was statistically significant and this difference was in favor of the face-to-face education group (U = 8.500, $\rho = 0.000 < 0.01$) (Table 5).

It was observed that there was no statistically significant difference in the post-test scores of the face-to-face and emergency distance education groups for adapting analytical thinking to daily life (U = 131.000, $\rho = 0.156 > 0.05$) (Table 6).

The last step of the study was to evaluate the opinions of the students in the emergency distance education group about the teaching process and emergency distance education. Ten students in this group stated that the educational process improved their environmental awareness and sensitivity, and six students stated that their knowledge level increased. In summary, there were no students who expressed negative

Table 2: Experimental process and data collection tools used in the research

Groups	Pretest	Process	Allocated time	Posttest
Face-to-face education group	ATAT TATDL	FEACA teaching model based on context-based learning approach	6 weeks (24 class h)	ATAT TATDL
Emergency distance education group	ATAT TATDL	FEACA teaching model based on context-based learning approach	6 weeks (24 class h)	ATAT TATDL SOF

ATAT: Analytical Thinking Achievement Test, TATDL: Test for Adapting Analytical Thinking to Daily Life, FEACA: Focusing, Exploring, Analyzing, Conceptual Developing, and Applying, SOF: Student Opinion Form

Table 3: Mann–Whitney *U*-test results of Analytical Thinking Achievement Test pre-test scores according to experimental groups

Groups	n	Rank average	Ranks total	U	Significant (ρ)
Face-to-face education group	24	15.63	375.00	75.000	0.002
Emergency distance education group	15	27.00	405.00		
Total	39				

Table 4: Mann–Whitney *U*-test results of Test for Adapting Analytical Thinking to Daily Life pretest scores according to experimental groups

Groups	n	Rank average	Ranks total	U	ρ
Face-to-face education group	24	18.17	436.00	136.000	0.202
Emergency distance education group	15	22.93	344.00		
Total	39				

QUESTION 4: The figure below shows a partial food web in a forest
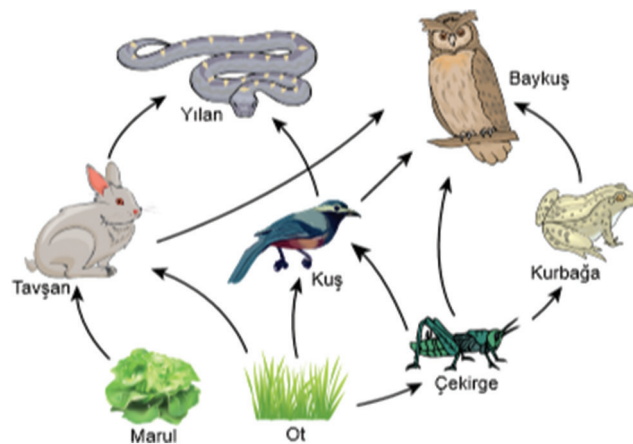
If birds become extinct in this food web, how will other creatures be affected? Please explain with reasons.

Correct Answer

It can be explained that there will be a decrease in the food variety of the creatures that use birds as food, but the amount of food will not decrease due to the increase in the amount of grass, grasshoppers, and rabbits. Example: If birds become extinct, owls and snakes will have less food. If birds become extinct, the amount of grass and lettuce will increase.

Owls and snakes do not decrease in number because they also have food varieties such as rabbits, frogs, and grasshoppers. If birds become extinct, the amount of grass and lettuce will increase.

Partial Correct Answer

It can be explained that there will be a decrease in the type of food of the creatures that use birds as food, but their number will not decrease or the number of creatures that feed the birds will increase.

Example: If birds become extinct, the owls and snakes will have less food.

If birds become extinct, the amount of grass and lettuce will increase.

Incorrect Answer

Indicates that living things will not be affected.

Indicates that it will be adversely affected, does not explain.

It can be explained that there will be a decrease in the number of the creatures that use the birds as food, and the number of creatures that are food of the birds will decrease or become extinct.

Example: The living things will not be affected by this situation.

If birds become extinct, the number of owls and snakes will decrease.

If birds become extinct, the amount of grass and lettuce decreases.

Incorrect answers (deleted, scribbled, illegible, or irrelevant)

Unanswered

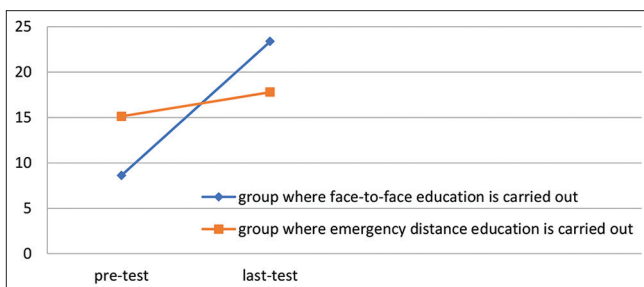**Figure 1:** A sample questio from analytical thinking achievement test

Figure 2: Increase in ATAT scores for emergency distance and face-to-face education groups before and after the application

Table 5: Mann–Whitney *U*-test results of Analytical Thinking Achievement Test difference scores according to experimental groups					
Groups	*n*	Rank average	Ranks total	*U*	*ρ*
Face-to-face education group	24	27.15	651.50	8.500	0.000
Emergency distance education group	15	8.57	128.50		
Total	39				

opinions about the teaching process. All the students expressed that the lessons taught in energy transformations and environmental science unit contributed positively to their knowledge and development of their skills. In addition, all the students (f = 15) stated that energy transformations and environmental science unit were not the subjects they had difficulty in. Sample student opinions are given below:

Table 6: Mann–Whitney *U*-test results of Test for Adapting Analytical Thinking to Daily Life post-test scores according to experimental groups

Groups	n	Rank average	Ranks total	U	ρ
Face-to-face education group	24	22.04	529.00	131.000	0.156
Emergency distance education group	15	16.73	251.00		
Total	39				

Example 12: I realized that we need to learn more about the environment and protect it.

EX5: I started paying more attention to the environment. I started saving more energy in many things. I started to warn people in a better way when they make mistakes about these things.

EX3: I did not have difficulty in any matter.

When asked about their favorite activity in the emergency distance education group during the education process, the student' answers were as follows: Creating a loop (f = 4), interpreting stories (f = 3), preparing a poster (f = 2), recycling game (f = 1), preparing an experiment at home (f = 1), and creating a food chain (f = 1). Students stated the following as their least favorite activities; poster preparation (f = 2), researching the answers to the questions (f = 2), experimenting on its own (f = 1), and lecturing (f = 1). Nine students stated that they did not have the least favorite activity during the education process (Table 7).

Sample student opinions are given below:

Ex15: It was so much fun to interpret the stories.

Ex7: There was not any activity I did not like.

Ex4: Experimenting at home because experimenting alone is boring.

It was observed that the students had some negative opinions about the realization of the lessons with distance education. While all the students (f=15) expressed negative opinions about the realization of the course process online, 11 students also mentioned some positive sides. Negative opinions expressed by students are as follows: Internet shortage (f=6), lack of communication tools (f=1), noise (f=2), occasional power cuts (f=3), inefficiency compared to face-to-face education (f=10), difficulty in understanding the lesson (f=9) and boring (f=1), difficulty in speaking in front of the screen (f=1), inability of the teacher to be effective in distance education (f=1), inability to experiment together (f=1), and reluctance because it is not compulsory (f=1). Positive opinions are that the course is efficient (f=10), interesting (f=3), calm (f=2), necessary to prevent the spread of the disease (f=1), and more comfortable than face-to-face education (f=1) (Table 8).

Sample student opinions are given below:

Ex6: I was tired on the way from school, but I was learning more efficiently during the day because I was not tired in online classes.

Table 7: The opinions of the students about the activities carried out during the education process

Favorite activity (s) during the education process	f	Least popular activity/activities during the education process	f
Creating a loop	4	Preparing posters	2
Interpreting stories	3	Searching the answers to the questions	2
Preparing posters	2	Experimenting on its own	1
All	3	Subject expression	1
Recycling game	1	None	9
Preparing experiments at home	1		
Creating a food chain	1		

Table 8: Students' opinions about emergency distance education

Opinion	Statement	f*
Positive	Efficient	10
	Calm	2
	Intriguing	3
	Comfortable	1
	Necessary to prevent the spread of the disease	1
Negative	Internet problems	6
	Lack of means of communication	1
	Noise	2
	Interruption of electricity	3
	Makes learning difficult	9
	Inefficient	10
	Boring	1
	Not being able to experiment together	1
	Difficulty in speaking in front of the screen	1
Other	Reluctance because it is not mandatory	1
	Inability of the teacher to be effective in distance education	1

*Students responses could be evaluated in more than 1 theme

Ex.13: There was no advantage for me. I would not change education at school for any education. I think the lessons we learn at school are more efficient.

Ex9: The connection can be lost, sometimes, everyone says something, but we can raise our hands more easily at school, and we can understand each other more easily. I think face-to-face lessons are more efficient.

DISCUSSION, CONCLUSIONS, AND SUGGESTIONS

It was determined that the cognitive achievement of the students who received face-to-face education based on context-based learning approach and analytical thinking in energy transformations and environmental science unit was better than the student group who studied this unit through emergency distance education. When the literature was examined, there was no study on the development of secondary school students' analytical thinking skills in distance education. However, Heliawati et al. (2021) in their research aiming to evaluate

the effects of online learning on the development of XI class students' thinking skills in the context of the material solubility and solubility product, found that online learning helped students increase their analytical thinking skills from average category (44%) to very good category (74%). According to Heliawati et al. (2021), even though it has been considered effective, the online learning process still needs to be improved to further enhance student involvement in a fun learning process amid the pressures of the learning process from home. In addition, while some of the studies examining the effect of face-to-face education on academic learning outcomes have reported that distance education is more effective (Balaman, 2018; Campbell et al., 2008; Gürsul, 2008; Kör et al., 2013), other studies suggest that face-to-face and distance education are equally effective (Driscoll et al., 2012; Falck et al., 1997). In our study, the fact that the education was either face-to-face or online has affected the cognitive success of the students based on analytical thinking.

The results of the study showed that both the face-to-face education group and the emergency distance education group students' development in their ability to adapt analytical thinking to daily life were similar. In the study conducted by Sadi Yılmaz (2013), it was determined that students' level of transferring their chemistry knowledge to events in daily life was higher in the experimental group in which the lesson was taught according to life-based learning practices. Yalçin (2020) obtained similar results in his study. In his study, Hoşgören (2018) determined that the use of life-based concept cartoons increased students' level of association with daily life. When these results are taken into consideration, it is concluded that the context-based learning approach is effective in increasing the students' ability to adapt what they learn to daily life regardless of whether they are delivered face-to-face or through emergency distance education.

While the students in the emergency distance education group did not express a negative opinion about the teaching method, activities, and comprehension of the subjects in the teaching process, they expressed various negative opinions about online lessons rather than face-to-face lessons. The most important of these is the lack of communication tools and the internet and occasional power cuts. It has been observed that such problems caused by infrastructure deficiencies in distance education are also mentioned in different studies in the literature (Akgün et al., 2013). The students in the distance education group stated that the teaching process was noisy, more boring, more difficult to understand, and less efficient. The students complained that they could not do experiments in the distance education process and stated that the teacher was not as effective as face-to-face education in this process. Critics of the teaching process and the effectiveness of the courses and the teacher in this process are similar to the literature. In various studies in the literature, criticisms have been made about the fact that the distance education process is tiring and challenging, requires constant concentration, is boring and slow (Falck et al., 1997), that the inability to conduct experiments causes deficiencies (Pınar and Dönel Akgün, 2020), that students cannot get enough feedback, that the desired efficiency cannot be obtained from the lessons (Genç and Gümrükçüoğlu, 2020), and that they forget the subjects they have learned quickly (Keskin and Özer Kaya, 2020). The last criticism made by distance education group students was the difficulty they had in speaking in front of the screen. When the literature was examined, it was seen that distance education prevented socialization (Eroğlu and Kalayci, 2020b; Genç and Gümrükçüoğlu, 2020), and problems related to socialization and students' inability to express themselves adequately (Keskin and Özer Kaya, 2020) were reported. Both the results of the research and other studies in the literature have revealed that there are students who find distance education as efficient (Keskin and Özer Kaya, 2020; Pınar and Dönel Akgün, 2020) and related attractive (Harasim, 2000) as well as students who state that the lessons are inefficient. However, similar to the study of Erkut (2020), the students in the distance education group stated that they eliminated the fear of getting the disease they experienced. When all these are evaluated, in this study comparing the context-based learning approach in face-to-face education and emergency distance education, it was concluded that face-to-face education is more effective. In this context, it is thought that emergency distance education cannot replace face-to-face education; however, it is an effective education process that can be applied to prevent students from being completely disconnected from school and education during periods when lessons cannot be continued due to extraordinary circumstances such as pandemic.

Ensuring the effectiveness of the distance education process but eliminating infrastructure deficiencies is possible by creating support systems for students who cannot access technological opportunities. In this way, distance education can be prevented from creating inequality of opportunity. In addition, teachers' preparing alternative plans for how to adapt the lesson plans when the distance education process needs to be operated in the anual course preparation process will ensure that they are more prepared for the distance education process and increase efficiency. In the preparation of alternative plans, the necessity of teaching technologies such as Web 2 tools can reduce the problems of distance education such as not being able to do experiments and activities. For these plans to be prepared without difficulty and effectively, and for teaching technologies to be included in these plans effectively, informing teachers about online education processes in their pre-service and in-service professional development can also contribute.

ETHICAL STATEMENT

All rules to be followed within the scope of "Higher Education Institutions Scientific Research and Publication Ethics Directive" were taken into consideration in the planning, implementation, data collection, data analysis, and writing of this research. Furthermore, this research was conducted with the permission of Kocaeli University Institute of Science and

Technology Ethics Committee, dated February 5, 2020, and numbered 10017888-100.

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