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Navigating Emergency Remote Teaching: A Phenomenological Study of Biology Teachers' Experiences During the COVID-19 Pandemic

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Abstract: With the global COVID-19 pandemic, a profound transformation occurred in education systems, and distance learning practices quickly became an integral part of the daily lives of educators and students. During this process, teachers' experiences and perceptions regarding distance education have become one of the focal points of educational research. The challenges teachers faced in rapidly changing technological and pedagogical environments, their perceptions, subjective experiences, and the meanings they derived constitute an area that requires in-depth qualitative approaches beyond numerical data. In this context, a phenomenological research design was developed to analyze the personal narratives of 58 biology teachers to understand the essence of their experiences with distance education. Based on the data obtained, it was found that biology teachers mostly used tools such as computers, tablets, mobile phones, Zoom, and EBA during the process. The most significant challenges encountered were internet access issues, lack of technological resources, reduced classroom interaction, and students' lack of motivation. Teachers mostly prefer question-and-answer and presentation methods, supporting their lessons with visual materials and videos. While negative effects of distance education on students were noted, such as a decline in academic achievement, lack of socialization, and technology addiction—positive aspects such as ease of technology use and new learning opportunities were also emphasized. For teachers, the process contributed to improving technology literacy and enhancing their ability to present lesson content using digital tools. Overall, although distance education was not found to be as effective as face-to-face education, it offered time and cost advantages for some teachers; however, low participation and deficiencies in experimental practices limited its efficiency.

Keywords: Biology Education, Covid-19, Distance Education, Biology Teacher, Biology Lesson, Phenomenological Research, Perception of Distance Education, Technology Dependence, Efficiency of Distance Education, Challenges Encountered in Distance Education

Highlights

What is already known about this topic:

- During the COVID-19 pandemic, teachers faced challenges such as poor internet access, limited technological resources, reduced classroom interaction, and low student motivation.
- Online teaching in biology lessons was hindered by the inability to conduct experiments and practical activities, along with gaps in digital pedagogy and assessment methods.

What this paper contributes:

- Provides a phenomenological analysis of biology teachers' experiences during distance education, focusing on their perceptions, challenges, and coping strategies.
- Highlights both limitations and benefits of distance education, including improvements in teachers' technology literacy and adaptation of instructional methods.

Implications for theory, practice and/or policy:

- Findings can inform professional development programs aimed at strengthening teachers' digital competencies and pedagogical approaches for online and blended learning.
- Offers guidance for integrating interactive tools, improving infrastructure, and designing policies to support effective teaching and student engagement in future distance education contexts.

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Introduction

Rapid advances in information and communication technologies are driving changes in the field of education and paving the way for new models of teaching and learning. One of the most important dimensions of this outlook is distance education, which eliminates spatial and temporal constraints and facilitates learning. Distance education is an educational model that aims to acquire knowledge and skills independently of time constraints, and whose teaching methods are largely conducted through technology (Moore & Kearsley, 2012). Considered an alternative or complement to traditional face-to-face education, this model has become increasingly widespread, particularly with the advancements in communication and information technologies.

Distance education is the product of a long historical process whose roots date back to the 18th century. The first distance education practices began in 1728 with an advertisement in the Boston Gazette announcing that shorthand lessons would be taught by letter (Holmberg, 2005). In the 19th century, correspondence education, conducted via mail in Europe and America, became the most common form of distance education. During this period, universities and private tutoring centers sent educational materials to students via correspondence (Moore & Kearsley, 2012).

With the advancement of technology in the 20th century, distance education reached wider audiences through radio and television broadcasts. Starting in the 1920s, some universities began offering lessons over the radio, and in the 1960s, television-based educational programs gained significant traction (Perraton, 2000). The Open University, founded in England in 1969, combined television broadcasts and printed materials to bring distance education to a systematic and institutional level in higher education. With the widespread use of computer technologies in the 1980s and the advent of the internet in the 1990s, distance education entered a new phase. During this period, learning management systems (LMS), online lessons, and virtual classrooms were developed, and the concept of e-learning entered the education literature (Moore, Dickson-Deane, & Galyen, 2011). In the 2000s, internet-based distance education rapidly spread worldwide, and in the 2010s, Massive Open Online Courses (MOOCs) provided millions of students with free online lessons (Yuan & Powell, 2013). This historical development has enabled distance education, initially seen as an alternative to traditional education, to become a globally accepted educational model integrated with digital technologies. It has become increasingly widespread, particularly since the mid-20th century, and with the development of digital technologies, online learning environments have become an integral part of educational systems through various applications such as e-learning and blended learning (Moore, Dickson-Deane, & Galyen, 2011).

In Turkey, distance education practices began to emerge in the second half of the 20th century, paralleling the rest of the world. The first attempts were made with correspondence lessons in the 1970s, and then the Open Education Faculty at Anadolu University gained an institutional structure in 1982 (Alkan, 1987). The Open Education Faculty became a pioneer of distance education in Turkey, reaching millions of students through television and radio broadcasts. With the widespread use of internet technologies in the 1990s, distance education practices began to shift to online environments, and distance education centers were established within higher education institutions (Bozkurt, 2019). During this period, foreign language, computer, and professional development lessons began to be offered online. The Ministry of National Education became more actively involved in this process in the early 2000s and began providing digital learning materials to primary and secondary school students through online platforms such as EBA (Education Information Network) (MoNE, 2012).

Distance learning practices, experienced at varying levels across the world and in Turkey, were largely viewed as a voluntary and supportive form of learning until 2020. However, with the pandemic, distance learning quickly became a replacement for face-to-face education and became central to education policies.

Literature

The COVID-19 pandemic profoundly impacted education systems worldwide in early 2020, necessitating the implementation of distance learning on an unprecedented scale. School closures during the pandemic required teachers to quickly learn online tools and adapt their lessons to the digital environment (König, Jäger-Biela & Glutsch, 2020; Yıldız & Göçen; 2022). This sudden transition is described in the literature as "emergency remote teaching" and is considered a distinct phenomenon from planned online teaching. Emergency Remote Teaching (ERT) refers to the temporary shift of instructional activities to an alternative mode of remote delivery due to crisis conditions in contexts where education is normally conducted face-to-face or in a blended format (Hodges et al., 2020).

According to UNESCO (2020) data, during the peak of the pandemic, approximately 1.6 billion students in more than 190 countries were deprived of face-to-face education and were forced to continue their learning online. During this period, many countries quickly deployed their existing digital education infrastructures, attempting to reach students through online lessons, television and radio broadcasts, mobile learning applications, and various learning management systems (LMS) (Bao, 2020).

While the pandemic has highlighted the importance of distance education on a global scale, it has also highlighted issues such as digital inequality, access issues, and pedagogical inadequacies. Learning losses have been particularly pronounced in countries with inadequate internet infrastructure or where students struggle to access digital devices (Dhawan, 2020). However, some research has also shown that this period presents significant opportunities for teachers to develop their digital pedagogical skills, diversify learning materials, and accelerate the adoption of educational technologies (Zhao, 2020).

With the COVID-19 pandemic, distance education has become a mandatory and comprehensive practice in Turkey. Following the closure of all schools in Turkey for in-person instruction on March 16, 2020, distance education practices were quickly adopted. Following the closure of schools in Turkey in 2020, distance education services were offered to millions of students and teachers through EBA TV, EBA Live Course, and various online platforms. As of 2020, approximately 18 million students in Turkey had accessed the EBA platform (Yıldız, 2020). During this process, the Ministry of National Education (MoNE) restructured the Education Information Network (EBA), previously launched in 2012, as a central digital learning platform, providing students with lesson content, interactive materials, and live lessons (MoNE, 2020). Additionally, EBA TV, which began broadcasting lessons at primary, secondary, and high school levels via television channels, provided an alternative learning opportunity for students experiencing internet access difficulties (Yıldız, 2020). However, while distance education during this period offered an alternative learning opportunity, it also brought with it challenges such as digital inequality, internet access difficulties, and teachers' technological competencies (Can, 2020). Students living in rural areas, in particular, were unable to adequately benefit from distance education due to a lack of technological infrastructure. Furthermore, the distance education process also helped teachers develop their digital pedagogical skills, gain experience designing online materials, and experiment with new teaching methods (Bakioğlu & Çevik, 2020).

Teachers' experiences during this process offer a significant opportunity to identify the strengths and weaknesses of distance education. Teachers are not only the ones who convey lesson content; they are also the actors who guide students' learning motivation, use digital tools for pedagogical purposes, and design the learning environment. In this context, teachers' perspectives on distance education directly impact on the quality and sustainability of distance education (Hodges, Moore, Lockee, Trust & Bond, 2020). Indeed, the literature has shown that teachers' positive attitudes towards distance education increase student engagement, while negative attitudes lead to various obstacles in the learning process (Trust & Whalen, 2020). Biology, in particular, is one of the subjects where these challenges are most acute due to its structure, which is supported by the examination of living specimens, laboratory experiments, and observations. Because laboratory and hands-on activities play

a critical role in students' understanding of abstract biological concepts, transferring these activities to the online environment has required a special effort from biology teachers.

Current Study

There are several reasons why biology and its teachers are the focus of this study. One of these is that biology, by its very nature, relies on experiments, observations, and laboratory activities. Understanding abstract biological concepts is generally supported by concrete learning experiences and hands-on activities (Çimer, 2012). Therefore, transferring laboratory practices to the online environment in distance education presents significant challenges in terms of ensuring student engagement and increasing learning retention. Another reason is that biology instruction is not limited to the transfer of conceptual knowledge but also aims to equip students with higher-level skills such as scientific thinking, research, and environmental awareness (Tekkaya, Çapa, & Yılmaz, 2000). Teacher guidance and student-teacher interaction play a critical role in developing these skills, so examining the experiences of biology teachers in distance education is of particular importance.

The literature emphasizes that teachers' technology use skills have improved, their awareness of digital material design has increased, and they have gained new experiences in diversifying their learning resources (Küçük & Şahin, 2021). Furthermore, some studies indicate that students' ability to work at their own pace in digital learning environments supports learning and that teachers could develop different teaching strategies in this process (Trust & Whalen, 2020). Therefore, examining biology teachers' perspectives on distance education is important both for understanding the current situation and for guiding future educational models. Identifying the problems teachers encounter during this process and the solutions they develop will contribute to identifying the pedagogical needs specific to biology lessons and supporting teachers' professional development. At the same time, such research will also guide blended learning practices, which have become increasingly important in the post-pandemic period. The purpose of this study is to reveal biology teachers' perspectives on distance education and, considering these findings, to discuss the implications of distance education for biology teaching. The primary objective in shaping the research questions in this study is to reveal the essence of the phenomenon experienced by the participants and the meaning they attribute to it. The research questions developed within this scope centered on the fundamental phenomena, problems, and perspectives biology teachers encountered during the distance education process.

The main research questions can be listed as follows:

- What do biology teachers think about the effectiveness of distance education?
- What are the main challenges they face during distance education?
- How have their perspectives on the teaching methods they use been shaped during this process?
- How have their relationships with students and technology changed during distance education?
- What are the impacts of this experience on the teaching profession and educational practices?

Methodology

Research Model/Design

The phenomenological approach is a qualitative research method in educational sciences that focuses on examining individuals' subjective lives, the essence of experiences, and the structures of meaning. One of the key determinants of this method's selection is that the research topic requires the examination of a directly experienced phenomenon and to which participants ascribe meaning. The distance education process has required teachers to restructure their roles in educational practices, their pedagogical approaches, and their use of technology. This shift has led teachers to consciously construct unique meanings and perspectives based on their own experiences.

The aim of research conducted with this approach is to identify the "essence" of the participant's experience-that is, the fundamental meaning that shares a common denominator. The phenomenological design, which explains events, processes, or phenomena in the context of individuals' personal experiences rather than objective data, provides a much deeper understanding of the challenges, opportunities, and strategies teachers face in distance education. The literature demonstrates that the phenomenological approach is particularly effective in understanding new phenomena in education and contributing to policy development (Haque & Ahmad, 2025).

The distance learning experiences of a specific group, such as biology teachers, can be understood not only through general superficial actions and reactions but also through the internal meaning behind the experience. Therefore, a phenomenological design was chosen in this study, aiming to access the essence of the teachers' experiences through their own language, rather than relying on numerical generalizations.

Data Collecting Tools

One of the most crucial stages of phenomenological research is developing appropriate data collection strategies to enable participants to reflect on their lived experiences in depth. For this purpose, semi-structured interviews were adopted as the primary data collection tool in this study (Yıldırım & Şimşek, 2016).

The interview process was conducted in the following steps:

1. Preparing the semi-structured interview form: Open-ended, thought-provoking questions were developed to address the research questions.

2. Obtaining expert opinions: Expert opinions were obtained to determine whether the questions reflected the content and to establish the validity and reliability of the study.

3. Scheduling online interviews at convenient times: Interviews were conducted via Zoom or Google Meet, depending on the participants' wishes.

4. Recording of interviews: Digital voice recorders were used with the participants' permission.

5. Obtaining written opinion forms: Data was collected via an online form.

In-depth interviews are the most frequently used method in the phenomenological approach because they allow participants to narrate their own processes of making sense of their experiences (Glesne, 2012). Qualitative research literature demonstrates that distance education experiences are inherently diverse and that, beyond a specific question-and-answer sequence, the essence of a participant's lived experience can only be revealed through free expression.

During data collection, the average interview duration ranged from 30-60 minutes, with participants encouraged to share their experiences and perceptions in as much detail as possible. Open-ended questions were designed to elicit a variety of responses, such as "What challenges did you encounter?" and "What development impacted you most professionally?"

Sampling or Study Group

The aim of phenomenological research is to collect detailed data from participants with as rich and diverse experiences as possible. In this context, the research population consists of biology teachers

who have experienced distance learning during the pandemic. The study used " criterion maximum variation sampling," a purposive sampling method, and reached 58 biology teachers by considering variables such as different school types, age, years of service, and gender. The main criterion addressed in the study was being a biology teacher and teaching biology courses during the 2020–2021 academic year. It was emphasized that at least five teachers from each of Türkiye's seven geographic regions should participate (Table 1).

Table 1. Demographic information of Teachers

Groups	Variables	Frequency	Percentage (%)
Gender	Female	34	59
	Male	24	41
Age	20-30	16	28
	31-40	25	43
	41-50	15	26
	51-60	2	3
Seniority	0-5 years	17	29
	6-10 years	15	26
	11-15 years	11	19
	16-20 years	8	14
	21-25 years	6	10
	26 years and above	1	2
School level	Anatolian High School	27	46
	Private School/College	5	9
	Science High School	3	5
	Multi-Program High Schools	15	26
	Vocational and Technical High School	8	14

Incorporating diversity into the selection of participants allows phenomenological research to explore the common essence of experiences while simultaneously analyzing individual perspectives from diverse backgrounds. The literature indicates that sample size in qualitative research is determined by the depth of the data, and that a group of 50-60 participants is sufficient to replicate data and access themes (Hennick, Kaiser & Marshall, 2022). The fact that the participants work in different institutions and possess diverse experiences deepens the diversity of meaning in the research. This also supports the production of rich and holistic data required by the phenomenological method.

Data Analysis

The analysis process was systematically conducted until overarching themes emerged and the essence of the experience was described. To achieve an in-depth understanding of the content dimension, teachers' opinions were evaluated using content analysis (Bardin, 2015; Yıldırım & Şimşek, 2016). The analysis process was carried out in the following stages:

1. Data Organization: Interview recordings were saved without alteration and prepared for analysis. The texts were examined individually to determine the teachers' experiences.

2. Coding: Statements directly reflecting the teacher’s lived experiences were identified. Codes were created inductively based on data.

3. Creation of Themes: The codes were grouped based on their similarities, and themes were formed accordingly.

4. Arrangement and Description of Themes: The experiences of teachers during the distance education process were described using direct quotations.

5. Reaching the Essence: The essential nature of the distance learning experience was determined by integrating sensory and structural descriptions.).

Validity and Reliability

Data obtained from the teachers was quickly transferred to Excel, and the raw data was categorized. To increase reliability in the analysis, the researchers conducted separate coding, ensuring consistency among the resulting themes. Miles and Huberman's (1994) formula was used to determine internal and external consistency. A concordance of 86.75% was observed between coders. This value indicates an acceptable level of agreement between coders (Miles & Huberman, 1994; Miles, Huberman, & Saldana, 2014). Direct quotes from the participants were also included. This supported the analyzed data with direct statements from the participants and detailed descriptions of the environment and conditions, contributing to the reliability of the study.

Research Procedures

Before the study began, written approval was obtained from the relevant university's ethics committee; all participants were fully informed of the research's purpose, scope, confidentiality policies, and voluntary nature. Participants were assured that they could withdraw from the interview at any time and that their recorded data would be used solely for research purposes.

In addition, the participants' identities were coded as T1 (Teacher1), T2, and T58 and presented within the study. Ethical rights were strictly protected during and after the interviews.

Findings

The findings are presented using direct quotes from teachers' narratives. The findings are structured into themes and codes, and sample explanations from participants are extensively included under each theme. The themes and codes are tabulated and interpreted by comparing them with similar studies in literature.

Figure 1. Themes related to distance education

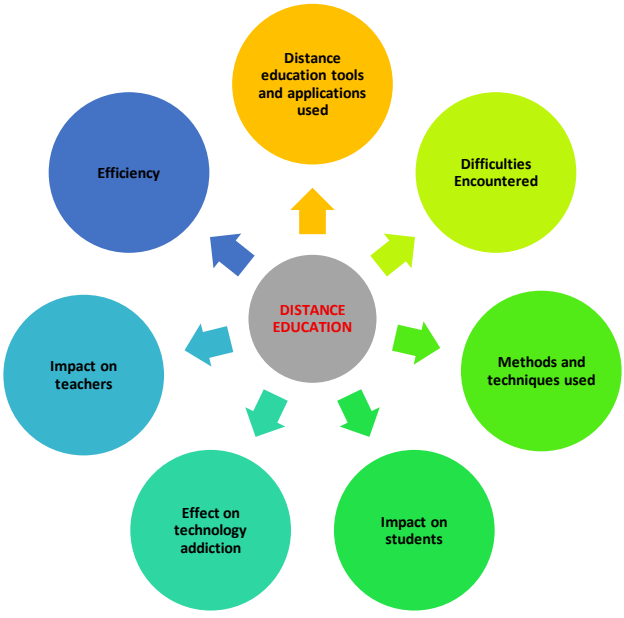

Figure 1 shows the themes that emerged from biology teachers' views on distance education. The codes for these themes are presented in Tables 2, 3, 4, 5, 6, 7, and 8.

Table 2. Findings regarding the distance education tools and applications used

Theme	Codes	Frequency
Distance education tools and applications used	Computer/Laptop/Tablet	31
	Zoom meeting	24
	Mobile phone	19
	EBA	15
	Video and PowerPoints	13
	Google meeting	8
	MoNE OGM Material	8
	Skype	7
	Smartboard applications	5
	Pdf lesson notes	5
	Animations	4
	Experimental tools	4
	Digital resources from special publications	4
	Phet simulations	4
	Headset with microphone	3
	Images/Visuals	3
	Web2.0 tools	3
	Z books	3
	Ed puzzle	2
	Google classroom	2
	KAHOOT	2
	QUİZİZZ	2
	Canva	1
	Chemlab	1
	EDMODO	1
	e-mail	1
	K12	1
	Models	1
	PERCULUS	1
	Radio and TV broadcasts	1
	Discussion sessions	1
	Workshops via WhatsApp	1
	ZİPGRADE	1

Under the theme of used educational tools and applications, the most frequently encountered codes are "computer/laptop/tablet," "Zoom meeting," "mobile phone," and "EBA." Technological products used in distance education appear to be the concepts most emphasized by teachers.

> T2: “The resources I created were photocopies of textbooks, activity books from the Ministry of National Education (MEB), and digital supplementary resources from private publishers, and distributed to students. These are lesson content resources. The web tools we use to deliver these to students remotely are EBA, ZOOM meeting, ZIPGRADE test reading program, QUIZIZZ application, KAHOOT application, etc.”

> T10: "I think experimental materials can be used as tools in biology classes during distance learning. Conducting experiments on a topic after a topic is introduced will make it more concrete and help students better grasp the topic. Furthermore, using three-dimensional images to create realistic images related to the topic to be covered in class will increase students' interest in the lesson."

> T13: “We are trying to conduct our lessons using EBA and ZOOM. In addition, we are using the books and supplementary resources provided by the government while teaching.”

> T15: "The first thing that comes to mind is EBA. Students in elementary, middle, and high schools affiliated with the Ministry of National Education use the distance learning platform EBA, the educational information network, developed by the Ministry of National Education. Students can use EBA by entering their student passwords over the internet using computers and mobile phones. Passwords are sent to the mobile phones of those who don't have a password or can't access it. There's also ZOOM. Zoom offers remote voice and visual conferencing services using cloud computing and its specialized software. Zoom enables video conferencing, online meetings, chat,

and mobile collaboration. To access ZOOM, students must first download the program from the website. They can register and log in using their email addresses and passwords."

T43: “During the lesson, I use computers, books, tablets, phones (mobile phones), and PDF lesson notes I prepared myself. I also use online tests and test books with online book access. When necessary, I use lesson animations I find online. Some of the animation topics I use most frequently are mitosis and meiosis, and the events that occur during DNA replication.”

T50: “Throughout this process, I have been primarily and most effectively using the EBA system. I use the lesson videos and questions available on the EBA system. I also try to conduct my lessons by projecting our own prepared lesson notes onto the screen.”

Most teachers used EBA for accessing and sharing lesson content. Zoom, on the other hand, stood out as a tool for conducting live lessons. In this case, we can say that tools like Zoom increased teacher-student interaction. According to T6 and T13, distance education initially started with Zoom-centric use and gradually transformed into an EBA-centered structure.

Table 3. Findings regarding the difficulties encountered

Theme	Codes	Frequency
Difficulties encountered	Internet access difficulties	31
	Disparity among students due to lack of resources	16
	Students not attending classes	15
	Decreased interaction in classes	14
	Lack of focus and motivation among students	12
	Students' failure to fully learn certain topics	11
	Lack of communication with students	10
	Insufficient class time	5
	Inability to conduct experiments such as experiments	4
	Students cheating	4
	Difficulty in providing detailed information about topics	3
	Students not completing homework	3
	Students' technological literacy deficiencies	3
	Inability to manage classroom management	2
	Students not repeating lessons	1
	Homework is difficult to control	1
	Students' decreased confidence in mainstream education	1
	Students experiencing eye and health problems	1

Accessing the internet has been found to be the most common challenge faced by teachers during distance learning. This situation particularly negatively impacts students living in rural areas and those without internet access. Another challenge our teachers have noticed during this process is the inequality faced by students who lack the technological tools necessary to participate in distance learning classes.

T2: "Especially since biology is a subject that involves hands-on activities, the inability to conduct these activities in person is one of the major problems encountered. Therefore, I think that some topics are not fully understood by the students and remain unclear."

T8: "The lesson doesn't provide complete learning. Internet connections can be problematic."

T16: "I can't ask many questions due to time constraints. There's no eye contact, no feedback. (We can't ask if I understand.) Not every student has a computer. We listen to our phones, and they say our battery is dying, the screen is small, and we can't see, and it gives us headaches. One of my students (10th grade) said her eyes were swollen and sent a picture. It was from staring at the screen too much and listening to the lesson."

T26: "Students are generally reluctant. We struggle to provide feedback. Furthermore, because there's no direct communication, even the shortest-answer question takes time. Class time is also insufficient."

> T33: “Of course, there is an inequality of opportunity. Not all of our students have sufficient resources. Therefore, participation can be problematic. Furthermore, especially in winter, the electricity can be cut off and internet connections can be interrupted by the slightest breeze. There is insufficient infrastructure for these issues, and this makes things difficult for both educators and students. These are two major problems. Besides these, minor, momentary problems can also occur.”

> T58: "The inadequate internet infrastructure, some students lacking devices for distance learning, or students having difficulty accessing the internet. Furthermore, in live lessons, students' audio and video are usually muted. This prevents me from determining whether students understand the material."

Teachers' statements emphasize that biology lessons, by their very nature, are based on hands-on activities, and these activities cannot be adequately carried out in the distance learning environment. Biology is a discipline based on concrete experiences such as experiments, observations, laboratory work, and the use of materials. The inability to conduct such practices makes it difficult for students to construct abstract concepts and leads to superficial learning.

Teachers' statements such as "no eye contact," "we are not receiving feedback," and "students' audio and video are off" point to a lack of interaction in distance learning. Limited interaction makes it difficult for the teacher to observe the student's cognitive and affective state; this prevents the individualization of the teaching process. Furthermore, the students' apparent reluctance indicates a decrease in motivation and participation levels in the lesson.

Table 4. Findings regarding the methods and techniques used

Theme	Codes	Frequency
Methods and techniques used	Question-and-answer technique	22
	Presentation	18
	Use of visuals	12
	Video	10
	Use of Web 2.0 tools	10
	Argumentation	9
	PowerPoint/Presentation	7
	Experiment technique	6
	Self-directed learning/Individual study	6
	Problem-solving method	6
	Research assignment	5
	Digital learning materials	5
	Active learning	5
	Brainstorming technique	4
	Collaborative	4
	Project-based learning	4
	Information sheets	3
	Demonstration	3
	Discovery/discovery teaching	3
	Case study	3
	Creative drama	3
	3D models	2
	Smart notebook applications	2
	Animation	2
	Analogy technique/Analogy	2
	Fun games with lesson content	2
	Preparing short films/documentaries	2
	5E model	1
	Experience acquisition	1
	Blended (hybrid) learning	1
	Storytelling	1
	Concept map	1
	Giving rewards	1
	Problem solving	1
	Role playing	1

Virtual reality materials	1
Flipped classroom model	1
Learning by doing	1
Competition	1

Biology teachers appear to have used the question-and-answer technique and presentation-based instruction most frequently during distance learning. They also stated that they utilize visuals and videos in their lessons.

> T6: "Contrary to popular belief, many different methods and techniques can actually be used in distance education. In my own lessons, I start with "Telling." I easily utilize audiovisual materials during teaching. Then, depending on the content of the topic, discussion, case study, problem solving method, individual work, collaborative, and even show-and-give methods can be used. In terms of techniques, techniques such as Brainstorming Technique, Demonstration Technique, Drama and Role-Playing Technique, Question-Answer Technique, and Simulation Technique are used."

> T14: "In distance learning, the teacher's face must be visible during instruction. Questions should be asked at appropriate points as the topic progresses, and these questions should be answered collaboratively. There should be pictures and videos. This prevents boring lessons."

> T19: "Blended (Hybrid) Learning and the Flipped Classroom Model are methods that support academic success and motivation in this process. These methods facilitate student-centered, active learning. Students can watch content repeatedly and ask the teacher questions about what they don't understand. Digital learning materials are interactive, self-paced, and include ample formative feedback and assessment. Students work through the content individually and can review, fast-forward, or skip sections based on assessment scores, feedback, and their own assessment of their progress."

> T24: "In distance learning biology lessons, visual presentations, clue-based explanations, entertaining animations, student-active Q&A sessions, engaging games within the lesson content, creating a discussion environment around the lesson topic, and engaging students in research and curiosity about the next week's topic all support academic success and motivation."

> T31: "I think the 5E model is a good method for distance learning, especially for students using materials for the visualization and exploration stages. I place great emphasis on question-and-answer techniques, especially when it comes to assessing what they've learned at every stage."

> T41: "In my opinion, the most effective method for distance learning in biology is the question-and-answer technique because this information is embedded in students' minds and allows them to comprehend it better later. Visual techniques help students retain the subject matter, and group work techniques allow students to connect with each other, even remotely. These support students' academic success and motivation."

An examination of biology teachers' statements regarding the methods and techniques they used in distance education reveals that the teaching process was not reduced to a one-dimensional narrative; rather, it was enriched with multiple teaching strategies. Teachers' preferences aimed both to achieve the learning outcomes required by the curriculum and to compensate for the limitations inherent in distance education.

Table 5. Findings on the impact on students

Codes	Codes	Frequency
Impact on students	Academic achievement has decreased.	21
	Inability to use technology comfortably	11
	Getting used to comfort and disengaging from class	10
	Decreased socialization	7
	Development of a negative attitude towards classes	5
	Ineffective	5
	Technology addiction	3
	Health problems due to inactivity and radiation exposure	2
	Loss of motivation	2
	Social media addiction	2
	Learning new things with new techniques	2
	Raising individuals who rely on rote learning	1

Biology teachers stated that distance learning has both positive and negative effects on students. The most common negative effects were observed in students' "Academic achievement has decreased" and "Getting used to comfort and disengaging from class. "However, they also noted benefits such as" Ability to use technology comfortabl " and "learning new things with new techniques."

> T6: "Distance learning can have negative effects on students, such as falling behind in human relations and not being able to socialize. Could it lead to the development of negative attitudes towards the lesson itself? I can never say no to the question, especially the competence of the lesson leader is crucial in this regard."

> T10: "I think it has a negative impact. This increases students' internet addiction. At the same time, students isolate themselves from the digital environment, and this negatively impacts both their eye health and their support and movement systems because they're constantly sitting in front of a screen. In other words, students appear to be studying under the guise of distance learning, but they spend their time engaged in many extracurricular activities under the guise of studying. This leads to students experiencing poor academic performance. In other words, using distance learning in many subjects, especially biology, will actually reduce children's academic success."

> T35: “Distance education offers students a blended form of education with technology. In this technological age, I already thought we would transition to this system within a few years, even if this pandemic hadn't happened. We know that every lesson will be conducted this way in the future, and the need for teachers will be minimized. This is because technology is less stable, and access to information is becoming easier. Students growing up with this technology help them be prepared for the future.”

> T45: “Distance education offers students a blended form of education with technology. In this technological age, I already thought we would transition to this system within a few years, even if this pandemic hadn't happened. We know that every lesson will be conducted this way in the future, and the need for teachers will be minimized. This is because technology is less stable, and access to information is becoming easier. Students growing up with this technology help them be prepared for the future.”

In-person learning environments provide a space where students develop their social skills through peer interaction, group work, and direct communication with the teacher. The limited interaction in distance learning can negatively impact students' social development.

Table 6. Findings regarding the effect of technology addiction

Theme	Sub-themes	Codes	Frequency
Effect of technology addiction	Effect	Spending long hours in front of a screen	18
		Becoming a habit	7
		Getting bored with class and spending time online	7
		Failure to control	2
		Causes health problems	2
		Excessive exposure to technological devices	2
		Purchase of new technological devices	2
		Decreased circle of friends	1
		Abstaining from social activities	1
	Doesn't affect	Family supervision	6
		Staying in front of a screen like in the past	6
		Useful use in education	5
		Short class hours	1
		Also allocating time for reading books	1
		Becoming bored with technology	1

Biology teachers stated that students spending extended periods of time in front of screens, which has become a habit, is triggering technology addiction. They also believe that students, bored during class, play games in the background and spend time on social media. Some biology teachers, however, stated that this process won't affect technology addiction because technology use is under parental supervision.

> T1: "I don't think it triggers it. I mean, even without distance learning, children these days spend the same amount of time in front of screens, and they don't stay away from these devices anyway. Let me give an example from my own children. They're doing distance learning, but they spend as much time in front of the screen as they normally do, but not as much time in front of the screen as before. Or, when children have other preoccupations, I think they don't focus on them as much."

> T7: "Yes, it triggers it. We're surrounded by technological devices for most of the day, and after a while, both students and teachers are negatively affected."

> T10: "Yes. This generalization can be made for all subjects. Because students have many classes, they're in front of their desks or phones all day. Constantly studying bores, them after a while, and they direct their attention to other topics online. For example, they might watch videos they find entertaining or discover other games that interest them and begin to spend their time this way. After a while, students might spend their time playing games instead of listening to lessons, turning this habit into a routine. This causes students to become addicted to technology and minimizes their academic success."

> T12: "I specifically ask students how many hours they spend in front of the computer and what changes they've seen in their bodies. Their answers usually include headaches, some weight problems, and other similar issues. Despite these issues, what I hear from my students is that they can't live without their computers or phones anymore; they can't move without them, and they can't even put their phones down even when there's no class or reason to look at them. This seriously worries me because, while it's not very noticeable, we're making them addicted to this lifestyle. They also say they're installing more programs and games on their phones and that even though they realize they're becoming increasingly antisocial; they can't stop themselves from doing so."

> T23: "Of lesson it will trigger this. Students who spend hours in front of a screen listening to lessons become accustomed to this and make it a lifestyle. They reduce their physical activity.

> T44: "Of lesson it will trigger this. Students who attend lessons digitally become bored after a while and start playing games. Naturally, we can't intervene."

> T45: "I think it will trigger technology addiction. As children are separated from the school environment, their friendships will diminish. Therefore, children will become friends with tablets, computers, and phones."

T51: "Isolating students from other social activities they enjoy, forcing them to study, and forcing them to spend hours in front of a screen can create a predisposition for technology addiction for unsuspecting individuals."

T55: "This can be examined in two ways. Let's say the child already spends a lot of time on their phone, computer, etc., in their normal lives, I don't think this will trigger this. Because the time they previously spent using technology would be spent watching lesson videos during class hours. Otherwise, let's consider a child who doesn't spend much time with technology. Outside of class, the child will be curious about their phone and want to explore it. In such a case, it will trigger it."

When teachers' opinions are evaluated holistically, it is understood that the impact of distance education on technology addiction is not directly and solely determinant; however, it may pose a risk through factors such as prolonged screen exposure, physical inactivity, and social isolation.

Table 7. Findings on the impact on teachers

Theme	Codes	Frequency
Impact on teachers	Attracting students' attention	24
	Reinforcing lessons with questions	13
	Preparing for lessons	12
	Proficient use of web tools	11
	Proficient use of lesson content	10
	Proficient use of programs to present lesson content	7
	Filling in gaps in teacher technology literacy	3

Under the theme of the impact of distance education on biology teachers, codes such as "attracting students' attention," "reinforcing lessons with questions," "preparing for lessons," and " Proficient use of web tools" were observed to be prominent (Table 7).

T2: "Teachers needed to master lesson content, master the programs that could present lesson content, master the web tools that could connect with students, and master the web tools that could provide feedback from students during distance education. Students needed to use web tools that enable social communication appropriately and in a timely manner."

T10: "Teachers can reinforce many biology topics, especially with experiments. In other words, teachers should conduct experiments immediately following the topic in biology classes. This will help students better grasp the concepts. Furthermore, teachers should ask students to conduct experiments during this time to achieve the intended learning outcome. This way, students can experiment and actively participate in the lesson during distance learning, helping them better understand the subject. Students studying online for biology lessons during distance learning will also increase their academic success. For example, watching a simulation that introduces the names of the sense organs, and their functions will positively impact students' visual intelligence and help them better grasp the subject. This will facilitate student learning."

T41: "Our duty is to ensure students' focus and attention by showing them animations during class and to provide weekly homework to reinforce the material. Students shouldn't put off today's work until tomorrow; they should study daily, following their lessons. This will be an advantage for them. They won't struggle with exams either. They need to read presentations and take notes. If biology isn't taken, it will be forgotten and they will need to review."

During the distance education process, it is evident that teachers are required not only to possess content knowledge but also to be competent in technological knowledge and the integration of technology into pedagogy. This situation increases teachers' workload and compels them to develop multidimensional digital expertise. This need becomes even more pronounced in subjects such as biology, which require experimentation and visualization. Consequently, the teacher's role shifts from that of a traditional lecturer to that of a designer, content creator, and digital moderator.

Table 8. Findings on Efficiency

Theme	Sub-theme	Codes	Frequency
Efficiency	Positive	While not as effective as face-to-face instruction, it is effective.	15
		It allows teachers to improve themselves.	7
		It is fun and inexpensive.	4
		It reduces transportation and time loss.	1
	Negative	It is not very effective.	7
		It is low in participation.	6
		It lacks hands-on learning and experiments.	6
		It is difficult for students to adapt to the lesson.	4
		It causes interruptions in the lesson due to internet and power outages.	3
		It causes students to be unmotivated and have low motivation.	3
		It shows little interest in some difficult topics.	1

Some biology teachers found the distance learning process to be effective, though not as effective as in-person instruction. Others expressed negative opinions, such as low efficiency, low participation, and a lack of experimental work.

> T4: “Although there are some problems faced by students and teachers... However, distance education has proven to be quite effective, in addition to being fun, and has saved students some costs.”

> T6: “I believe distance education offers an opportunity for biology teachers. First of all, it addresses a significant gap in teachers' need to improve their technological literacy. Furthermore, biology classes require visual materials in the classroom. We have the opportunity to completely address this gap in distance education.”

> T10: "I don't think it's effective enough. Internet interruptions during class cause students to lose focus. This leaves important points related to that topic incompletely etched in their minds. Furthermore, a lack of a classroom atmosphere leads to low student motivation. For example, constantly sitting at a desk listening to a lesson can be psychologically tiring and can eventually lead students to turn their attention to other tasks. Finally, frequent power outages cause students to be unable to attend class."

> T24: "Frankly, there aren't many positive opinions about the effectiveness of distance learning in biology classes. I say 'opinions' because I hear my colleagues have almost the same opinions. Let me explain why I have a negative opinion: students don't take it as seriously as they do with face-to-face instruction. Some students don't even turn on their cameras during class on online applications, or don't want to. Sometimes I don't even get any feedback from students I ask questions about during class. I think these things wouldn't have happened if the lesson had been productive and positive. I don't think the seriousness, sincerity, and effectiveness of face-to-face instruction are quite possible in distance learning."

> T28: “While online education may not be as effective as face-to-face education in a classroom, lessons can be conducted in the most efficient way with the dedication of students and teachers. Enriching the lesson content, especially visually, can attract students' attention and yield results comparable to face-to-face education.”

The absence of a classroom atmosphere reduced social interaction, and students not turning on their cameras suggest that the social dimension of distance education has weakened. The emphasis on the lack of "seriousness" and "intimacy" of face-to-face education reveals that learning is not only a cognitive process but also a social and affective one.

Discussions and Conclusion

The sudden shift in education systems brought on by the COVID-19 pandemic has significantly impacted teachers' adaptation to distance learning. This shift, defined as Emergency Remote Teaching (ERT), involved remote teaching solutions that could be quickly established and used until the crisis passed, in

order to ensure the continuation of teaching activities. Biology teachers have experienced the limitations of distance learning, particularly in lessons requiring face-to-face interaction, such as laboratory exercises (Karakaya et al., 2020). While some teachers have adapted their lessons to the online environment by using technology effectively, others have faced challenges due to infrastructure deficiencies and digital proficiency issues (Collins, 2025). This has led teachers to reconsider their pedagogical approaches.

In light of the findings, it appears that teachers mostly turned to using computers/phones/tablets, Zoom, EBA, videos, and PowerPoint during this process; in the Turkish context, the proliferation of EBA live lessons, the use of TRT-EBA lesson videos, and the rapid use of synchronous tools such as Zoom have led to this result (Karakaya et. al., 2020; World Bank, 2023). However, studies based on teacher opinions have found that EBA is beneficial but also raises concerns, such as limited interaction (Doğan & Koçak, 2020; Gezen & Efendioğlu, 2021). This finding aligns with ERT's characteristic approach of generating quick and temporary solutions through existing technological infrastructure. It appears that teachers are gravitating towards accessible and practical tools rather than developing pedagogically designed digital learning environments. This clearly highlights the aspect of ERT that differentiates it from planned online learning.

Teachers' dependence on technology has increased during the distance education process, and this has produced both positive and negative outcomes. The most common problems encountered by biology teachers include inadequate internet infrastructure, low student participation, and inequality in access to technological tools. Similarly, a study by Karakaya et al. (2020) indicated that biology teachers experienced technical infrastructure deficiencies and digital proficiency issues during the distance education process. While some teachers increased student interaction by using digital tools effectively, others encountered problems such as distraction and loss of motivation due to excessive screen time (Bates & Bozkurt, 2025; Bozkurt et al., 2020; Seema & Varik-Maasik, 2023). Students' active participation in the learning process can be directly related to the teacher's level of digital pedagogical knowledge (TPACK) (Hsu et al., 2023). Cheating and reliability issues in assessment and evaluation, insufficient class time, lack of feedback, and lack of interaction in synchronous lessons are among the other significant challenges. This situation can be considered a natural consequence of implementing ERT in crisis conditions without adequate infrastructural preparation.

Among the methods used by biology teachers in distance education are question-and-answer techniques, visual materials, videos, interactive content, and Web 2.0 tools. This finding supports Aslan and Güner's (2022) phenomenological study with science teachers; teachers appear to prefer similar methods to increase interaction in online learning environments. However, for these methods to be effective, teachers must possess both content knowledge and technological knowledge (Nilsson, 2024). Teachers' experiences demonstrate that distance education is not only a technical process but also a pedagogical transformation. Furthermore, while Web 2.0 tools and gamification (Kahoot, Quizizz) used by teachers provide rapid feedback and engagement in remote lessons, they alone do not guarantee deep learning; a combination of multiple tools for educational purposes has been shown to be more effective (Özdemir, 2024; Tandiono, 2024). This supports the idea that ERT prioritizes applicability rather than comprehensive instructional design processes.

Teachers have stated that distance learning has both positive and negative effects on students. Negative effects include decreased academic achievement, loss of motivation, and technology addiction, while positive effects include improved technology use skills and opportunities to learn with digital materials. This situation was similarly reported in Özbuğutu's (2021) study; while preservice teachers experienced technical difficulties in distance learning, they stated that digital tools contributed to the learning process. Online learning has been found to lower grades, particularly for at-risk students, and is associated with attention/focus problems (Kofoed, Gebhart, Gilmore, & Moschitto, 2021). The decline in academic achievement reflects the qualitative difference between pedagogically designed online learning and ERT.

While students' comfortable use of technology is an advantage, increased screen time is associated with health and psychosocial risks; review articles and longitudinal studies have revealed a small but significant association between screen time and depressive symptoms, attention deficits, and sleep problems (Nagata et al., 2024; Priftis & Panagiotakos, 2023). Research confirming the association between prolonged screen time and negative physical and psychosocial outcomes suggests that extracurricular screen consumption should be limited and school-based preventive measures should be implemented (Baltacı, 2021; Priftis & Panagiotakos, 2023; Zablotsky et al., 2025).

Teachers appear to have increased their digital competencies in terms of professional development during distance learning. This finding is consistent with a study by Bumagat et al. (2023). Teachers used different teaching strategies in distance learning but experienced significant limitations in laboratory practices. Similarly, Mohale and Photo (2024) noted that science teachers working in rural areas struggled to adapt to distance learning due to a lack of technological infrastructure.

Teachers did not find distance education as effective as face-to-face instruction, and the lack of experimental practices, particularly in biology classes, was cited as a significant limitation. This finding is consistent with other phenomenological studies in national and international literature (Altawalbeh & Al-Ajlouni, 2022; Davidson, Xiao, & Davidson, 2024; Tangülü & Öz, 2024). This situation reveals that ERT functions as a temporary and crisis-oriented solution; it does not aim for pedagogical excellence. The lack of experimentation or practice is a significant limitation in biology classes; therefore, various simulations, virtual laboratories, and argumentation-focused assignments are thought to be helpful in increasing efficiency (Adams, 2010; Ishimwe & Rutegwa, 2024).

This study sheds light on the digital transformation process in education by revealing biology teachers' perspectives and experiences regarding distance education. The challenges teachers face in distance education are related to factors such as technological infrastructure deficiencies, digital proficiency levels, and student interaction. Furthermore, the distance education process has enabled teachers to develop their technology use skills and restructure their pedagogical approaches.

In conclusion, the lived experiences of teachers during the distance education process point to a transformative professional condition shaped by technological constraints, pedagogical restructuring, and evolving instructional roles. The essence of this experience reflects a period in which teachers were required to reconstruct their teaching practices within digitally mediated environments under conditions of uncertainty. These findings highlight the need to strengthen technological infrastructure, enhance teachers' digital pedagogical competencies, and develop more interactive instructional content. In applied disciplines such as biology, the integration of virtual laboratory simulations appears particularly significant in reducing learning loss and sustaining experiential learning opportunities.

However, these findings should be interpreted within the boundaries of the study's methodological and contextual limitations. First, the data is based on teachers' self-reports; therefore, the results reflect participants' subjective perceptions rather than directly observed practices. Second, the study was conducted within a specific institutional and socio-educational context, which means that the findings are context-bound. Third, the research was carried out during a particular phase of the COVID-19 pandemic, a period characterized by emergency remote teaching conditions. Consequently, the experiences reported may represent a transitional and crisis-driven adaptation process rather than stabilized long-term distance education practices.

For these reasons, the findings should not be generalized in a statistical sense. Instead, their value lies in analytical and contextual transferability. Through detailed description of participants, context, and analytical procedures, the study aims to enable readers to evaluate the extent to which the findings may be transferable to similar educational settings. Future research conducted in different contexts and post-

pandemic conditions may further refine and expand the understanding of teachers' evolving digital pedagogical experiences.

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Serpil Kalaycı: Conceptualization, Methodology, Visualization, Writing –original draft, Writing –review & editing; Özlem Yunus: Writing –original draft, Data curation. All authors have read and agreed to the published version of the manuscript.

Data Accessibility Statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics and Consent

In this study, the necessary ethics committee permissions were obtained, and consent forms were obtained from the participants to ensure ethical standards. The identities of the participants were protected; pseudonyms were used.

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