



Mobile learning supported science teaching application: Electric charges and electric energy

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Abstract

The aim of this study is to examine the effect of mobile learning supported science teaching on eighth grade students' Science, Technology, Engineering and Mathematics fields and Information Technologies Self-Efficacy and to determine students' views on this process. For this purpose, a quasi-experimental design with pre-test post-test control group was used in the study. The study group consisted of a total of 45 students, 25 in the experimental group where the mobile learning supported 5E learning model was applied and 20 in the control group where the 5E learning model was applied. The applications in the experimental and control groups took place in a total of four weeks. Science, Technology, Engineering and Mathematics Career Interest Survey, Information and Communication Technologies Self-Efficacy Perception Scale and semi-structured interview form were used as data collection tools in the study. As a result of the analysis of the data obtained; it was determined that mobile-assisted science teaching had a positive effect on eighth grade students' STEM interests and self-efficacy levels. In addition, students stated that mobile-assisted science teaching increased the retention of knowledge, facilitated understanding of the lesson, and was instructive and fun. Depending on the results obtained from the research, it was suggested that mobile assisted science teaching should be used in different units of the Science course in order to see the effect of mobile assisted science teaching on different variables more clearly.

Keywords Science teaching · Mobile learning · Self-efficacy · STEM

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1 Introduction

Obtaining information as quickly and practically as possible is very important in today's world. In this context, communication technology systems that make access to information sources more practical and convenient should be used at a higher level. In our age, almost every age group uses technological tools such as tablets, laptops, and cell phones (Dalkıran, 2019; Kuo et al., 2023). The ability to use these technological tools independently of time and space thanks to wireless internet has accelerated the spread of these technologies. It has become inevitable to use mobile technologies, which have such a wide usage area in daily life, in education. In this direction, the integration of educational environments into mobile learning tools has started rapidly and a modern transformation has found its place in the education policies of states. According to Schofield et al. (2011), mobile learning reduces the cognitive load of students by reducing the amount of information given to students. Mobile learning is a convenient, flexible, and useful method for on-site learning. Lin (2013) stated that mobile learning is faster and offers more effective learning tools.

With the widespread use of mobile devices in learning environments, many studies have been conducted on this subject (Çallı, 2019; Gumbheer et al., 2022; Karahan & Canbazoglu Bilici, 2017; Kumar et al., 2022; Sivri & Gorgülü-Arı, 2020; Uçak, 2019). The common features of these studies are to provide conceptual learning of science education in learning environments. Therefore, mobile learning environments can be expressed as a suitable method for effective and fast learning at all grade levels and in many courses.

It is inevitable that STEM education, which is one of the cornerstones of today's learning programs, will also be affected by this evolutionary process of mobile learning in educational environments. As with mobile learning integration, STEM has gained an important place in modern societies (Xie et al., 2015). STEM education is of critical importance for countries to achieve the technological advances and sustainable economic development they need. It is stated by researchers that the countries where STEM education emerged and developed lead the economic, technological, and scientific world (Goldin & Katz, 2009). In this context, it can be stated that STEM education and mobile learning processes should be examined together in order to gain skills such as problem solving, critical thinking, cooperation, and effective communication that twenty-first century individuals should have (Akgündüz, 2016; Bybee, 2010; Karamustafaoğlu et al., 2023).

Although STEM education has an important place in raising the education levels of countries, it faces various challenges. Factors such as the lack of science laboratories or materials, students' low motivation towards the course, and lack of parental involvement hinder the quality of STEM education and lead to low performance outcomes (Makgato, 2007; Modisaotsile, 2012; Schulze & Bosman, 2018; Visser et al., 2015). It is stated by various researchers that mobile learning can offer various opportunities to overcome these challenges faced by STEM education (Criollo-C et al. 2018; Herring et al., 2016; Kong, 2018; Pinker, 1997; Yeop et al., 2019). Mobile learning offers teachers many different pedagogies such as educational

games, quizzes, and group work that can be used to meet students' different learning preferences (Yeop et al., 2019). Mobile learning makes materials for assessment and evaluation processes accessible to students anytime and anywhere (Criollo-C et al., 2018). Mobile learning enables the use of visualized science experiments that can improve students' understanding of science concepts and provide complete explanations of scientific concepts (Pinker, 1997). STEM education contributes to individuals' problem solving and technology use in their daily lives (Chiang et al., 2022; Günbatar & Bakırcı, 2019; Zhang et al., 2023). The effective use of mobile learning in the learning and teaching process; lifelong learning, learning without realizing it, independent learning, when necessary (Kuo, et al., 2023), learning independently from place and time (Georgieva et al., 2011), students learning difficult lessons easily and having a positive attitude towards lessons thanks to interactive mobile applications are among these advantages.

Mobile learning, which had a relatively limited area before the COVID-19 pandemic, became the center of education with the pandemic process, and then integrated into education and training environments in a structure intertwined with face-to-face education. STEM education in mobile learning environments can be carried out within the framework of various pedagogies. One of the methods that can be preferred in this process is the 5E learning model (Akpınar & Bayrakçeken, 2023). The 5E model (Bybee et al., 2006), which covers the process of making sense of individuals' prior knowledge and experiences and new situations they encounter, has an application area within the scope of STEM education. Considering the advantages offered by mobile learning, structuring STEM education to be carried out in these learning environments within the framework of the 5E model will contribute to the quality of education. Because the steps in the 5E model include elements that put the student at the center, require interactive and instant evaluations, and create equality of opportunity in learning (Ayas et al., 1997; Campbell, 2006; Smerdon et al., 1999). It can be stated that mobile learning is one of the environments that can provide these elements that will be necessary in the STEM education process. In this direction, it is obvious that the effect of mobile learning on students' STEM and information technologies self-efficacy perception variables should be examined. In this respect, it is believed that this study will make an important contribution to the literature.

It is seen that studies on mobile learning/technology are mostly conducted with high school and university students. However, it can be said that studies conducted with secondary school students are limited. On the other hand, mobile learning-supported instruction has focused more on academic achievement, attitude, and motivation (Gür & Bulut-Özek, 2021). There are no studies on the effect of mobile learning supported science teaching on eighth grade students' STEM fields and information technology self-efficacy.

As a result of the above, the aim of this study is to examine the effect of mobile learning supported science teaching on eighth grade students' STEM interests and Information Communication Technologies Self-Efficacy Perceptions and to determine students' views on this process. In order to realize this purpose, answers to the following sub-problems were sought.

1. Does the mobile learning supported 5E learning model have an effect on eighth grade students' interest in Science, Technology, Engineering and Mathematics (STEM)?
2. Does the mobile learning supported 5E learning model have an effect on eighth grade students' Information and Communication Technologies Self-Efficacy Perceptions?
3. What are the opinions of eighth grade students about the mobile learning supported 5E learning model?

2 Method

2.1 Research design

In this study, a quasi-experimental design with unequal pre-test and post-test control groups was used to examine the effect of mobile learning supported science teaching on eighth grade students in the "Electric Charges and Electric Energy" unit. Variables such as selecting control and experimental groups by measurements instead of randomly, not allowing random sampling and grouping by school administrations, allowing comparison of experimental and control groups, and grouping students were effective (Çepni, 2011). In addition, factors such as the fact that the study groups were as similar as possible and one of the important advantages of studies with this approach was that errors or effects that could threaten internal validity could be controlled more (Cook et al., 2002). The lessons were conducted by a researcher in the experimental and control groups. The fact that the researcher was working as a teacher in the school where the research was conducted contributed to the control of internal validity. In the experimental group, the lessons were taught using the mobile learning supported 5E learning model and in the control group, the lessons were taught using the 5E learning model. Since there was no intervention in the control group and there was a special intervention in the experimental group, a quasi-experimental design was used in this study.

2.2 Participants

This study was conducted with 45 eighth grade students (25 in the experimental group and 20 in the control group) studying in a secondary school in the centre of Erciş district of Van province in the 2021–2022 academic year. The experimental and control groups were randomly selected. There are six eighth grade classes in the school where the study was conducted. Since these classes were heterogeneously distributed, the experimental and control groups were selected by drawing lots. As a result of this lottery, 8/B was set as the experimental group and 8/D as the control group. The study group was determined according to the convenience sampling method. It can be said that factors such as the fact that the researcher was working in the school where the application was made and the speed and

practicality of the research were effective in the use of this sampling method (Yıldırım & Şimşek, 2006).

In the study, eight students selected in the experimental group were interviewed. The interviewed students were determined according to the pre-test scores of the STEM-CIS measurement tool. In this measurement tool, the scores of the students were divided into three categories: low, medium, and high. In these categories, the study was conducted with a total of eight students, three at low level, two at medium level, and three at high level. The research ensured ethics and confidentiality by using coded identifiers (e.g., S1, S2, S3, ..., and S8) instead of the names of the participating students in interviews. The students' personal information was kept strictly confidential, and every measure to protect their privacy was taken. The name of the school where the study was conducted, and the student's names and surnames were omitted. No data was included that could potentially disclose the identities of the participating students. Demographic information of the students in the experimental and control groups is given in Table 1.

2.3 Implementation process

The implementation took place in a total of four weeks. In the experimental group, the lessons were taught according to the mobile learning supported 5E learning model, while in the control group, the lessons were taught according to the 5E learning model. The lessons in the experimental and control groups were conducted by the researcher. Videos, interactive animations, experimental activities, and instructive documentaries from Morpa Kampüs and Education Information Network (EBA) applications were used in the lessons. Below, one week of the applications in the experimental and control groups are explained in detail.

The selection of the "Electric Charges and Electric Energy" unit for the study was influenced by several factors. Firstly, it was observed that the students often faced challenges in understanding the content of this unit, which contains abstract concepts and leads to misconceptions (Chin-Siong et al., 2023; Taslidere & Yıldırım, 2023). Additionally, mobile learning in educational settings offers several advantages (Hamidi & Chavoshi, 2018). Mobile learning-supported instruction simplifies and enhances the learning experiences, particularly in abstract and technically demanding subjects where students frequently encounter difficulties (Köse et al., 2013). Another study found that mobile learning promotes individualized learning by enabling students to progress at their own pace, making abstract concepts more tangible and facilitating learning (Cheon et al., 2012).

Table 1 Demographic characteristics of the students in the experimental and control groups

Groups	Boys		Girls		Total	
	N	%	N	%	N	%
Experiment	11	50	14	25	25	55,6
Control	11	50	9	20	20	44,4

2.3.1 Experimental group

In the experimental group, students were informed by the teacher about mobile learning before starting the application. Information was given about the use of the tablet, smartphone and interactive board used in this study. The problems encountered by the students during the application were solved by the teacher. Since they were used to using tablets, computers and cell phones, there were no problems in using mobile devices.

Before the application, two scales, Science, Technology, Engineering and Mathematics Career Interest Survey (STEM-CIS) and the Information and Communication Technologies Self-Efficacy Perception Scale (ICTSPS), were applied to the experimental group as a pre-test. At the end of the application, the same scales were applied to the same group again as a post-test. In order for the students to learn the subjects that they had problems in learning more easily/effectively and to support technology discipline, various activities were applied by using <http://www.morpa.kampus.com> and <http://www.eba.gov.tr> websites appropriate to the topics. Figure 1 shows a section of screenshots of the activities that utilized these websites.

In the screenshot on the left of Fig. 1, it is seen that the evaluate stage of the lesson about electricity is included. In this mobile learning-supported environment, the information learned by the students is evaluated with question–answer activities. In the screenshot on the right of Fig. 1, there is an electrification experiment based on the contact of glass and ebonite rods with silk and wool for the explore stage. Details about the execution of this lesson process are given below.

Engage: The teacher entered the classroom with his/her mobile device and activity sheets, attracted students' attention to the lesson, and ensured students' motivation and participation. By asking various questions, a problem was identified, or students were confronted with an interesting event. At the end of the introduction, students were informed about what to do in the lesson.

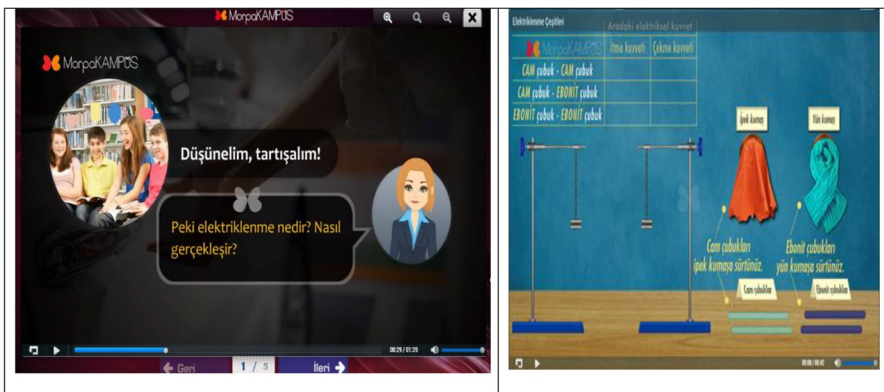


Fig. 1 Sections of mobile application interface

Explore: The teacher asked students about their mobile devices (tablet, computer, phone) and divided them into groups by brainstorming. She asked them to open Morpa Kampüs on their mobile devices. She asked them to research and discuss the problem situation in the activity and to transfer the information discovered with their groupmates to the activity sheet. Students were given the following problem situation.

In the Morpa Kampüs video material, "In the winter months, we can hear crunching sounds when we take off our wool sweaters and comb our hair, and we can even see sparks with these crunches in a dark environment. When we touch any metal object, we may experience a situation similar to electric shock. These are caused by electrification. So, what is electrification? How does it happen?" In the activity, the students who examined the problem situation were asked to answer, "What kind of comments can be made to the problem situation in order to comprehend the causes of these and similar events you encounter in daily life?" by discussing with their groupmates. The aim here is to compare students with a problem situation from daily life, to gather their attention, to raise their motivation to the desired level and to enable them to produce solutions to the problem situation.

Explain: The teacher asked questions about the topic of electrification based on the knowledge acquired by the students and received feedback. While explaining the subject, the teacher used the interactive board in the classroom and educational programs such as EBA and Morpa Kampüs, which are MoNE applications.

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Elaborate: The teacher had the students solve various activities and studies related to the topic available on Morpa Kampüs together with their groupmates on their mobile devices.

Evaluate: Students who completed the activities and studies were asked to solve the questions in the "Printable activities" and "Subject screening tests" sections on Morpa Kampüs. It was evaluated whether the students were able to apply what they learned to new situations. After the solutions of the questions were completed, an evaluation was made within the group.

2.3.2 Control group

In the control group, the lessons were conducted according to the 5E learning model. Science textbook, printed books for the course and other learning materials were used as resources. Before the study, STEM-CIS and the ICTSPS were applied to the control group as a pre-test. At the end of the application, the scales used in the pretest were repeated as post-test.

Engage: The teacher started the lesson by giving two examples from daily life about "Electricity". Then she asked the students to give examples related to the

subject. In this way, it was tried to learn the students' prior knowledge, readiness levels and prior knowledge levels about the subject.

Explore: The teacher showed the pictures of tools such as wool fabric, silk fabric, glass rod, ebonite rod to the students and asked them to indicate what they were. The aim was to enable students to discover information through the invention strategy.

Explain: After finishing the explore phase, the teacher started to teach students about electrification. While teaching the students about electrification, the teacher used the lecture method, discussion and question and answer methods to structure the basic concepts.

Elaborate: The teacher asked the students to apply the "Let's Electrify Objects" activity on page 199 of the textbook. In this way, the teacher provided the students with the opportunity to apply what they had learned in the lesson in daily life.

Evaluate: The teacher asked the following questions to the students in order to measure what they learned about electrification.

1. What is the effect of two ebonite rods electrified by rubbing against wool fabric?
2. What is the effect of two glass rods electrified by rubbing against silk fabric?
3. What is the effect of an ebonite rod electrified by rubbing against wool fabric and a glass rod electrified by rubbing against silk fabric?

After the solutions of the questions were completed, an evaluation was made within the group. In the following weeks, the lessons were conducted in the same way as in the first week.

2.4 Data collection tools

Three different data collection tools were used in the study. These are: "Science, Technology, Engineering and Mathematics Career Interest Scale (STEM-CIS)", "Information Technologies Self-Efficacy Perception Scale (ITPS)" and "Semi-structured Interview Form". The data collection tools used in the study are explained in detail below.

2.4.1 Science, Technology, Engineering and Mathematics Career Interest Survey (STEM-CIS)

The scale created by Kier et al. (2014) and adapted into Turkish by Pekbay (2017) was used to measure students' interest in science, technology, engineering, and mathematics. The STEM-CIS consists of 36 questions in a 5-point Likert scale and four sub-dimensions. These dimensions are science (9 items), mathematics (9 items), technology (9 items) and engineering (9 items). The statements in the survey were scored

on a 5-point scale with 1 point for "Strongly Disagree", 2 points for "Disagree", 3 points for "Undecided", 4 points for "Agree" and 5 points for "Strongly Agree".

According to the analysis conducted by Pekbay (2017), the Cronbach's Alpha reliability coefficient of the scale was obtained as ($\alpha=0.94$), and the Cronbach's Alpha coefficient for each dimension was calculated as ($\alpha=0.85$) for the science dimension, ($\alpha=0.86$) for the technology dimension, ($\alpha=0.90$) for the engineering dimensions, and ($\alpha=0.87$) for the mathematics dimension.

Within the scope of the study, the STEM-CIS was administered to 200 eighth grade students in Erciş district of Van province before it was used. As a result of the analyses conducted after this application, Cronbach's Alpha values of the sub-dimensions of STEM-CIS were calculated. It was calculated as ($\alpha=0.81$) for science ($\alpha=0.81$), technology ($\alpha=0.85$), engineering ($\alpha=0.87$) and mathematics ($\alpha=0.82$). The Cronbach's Alpha reliability coefficient for all dimensions of the STEM-CIS scale used in the study was calculated as 0.83.

2.4.2 Information and Communication Technologies Self-Efficacy Perception Scale (ICTSPS)

In the study, "Information and Communication Technologies Self-Efficacy Perception Scale (ICTSPS)" was used to determine students' self-efficacy in information technologies. The ICTSPS developed by Göçer and Türkoğlu (2018) is a 30-item, five-point Likert-type scale. There are five options in the scale: "it does not suit me at all" (1), "it suits me very little" (2), "it suits me" (3), "it suits me quite well" (4) and "it suits me completely" (5). Göçer and Türkoğlu (2018) calculated the Cronbach Alpha reliability coefficient of the scale as 0.90. In the analyses conducted on 150 people in Erciş district of Van province before using the ICTSPS within the scope of the study, the Cronbach Alpha reliability coefficient was obtained as 0.86.

2.4.3 Semi-structured interview form

The interview form for eighth grade students about mobile supported science teaching was developed by the researcher and prepared as six questions. The interview form used in the study was subjected to validity and reliability studies. Three faculty members who are experts in science education were consulted to ensure that the questions in the interview form were clear enough for the participants to comprehend, not complex and not to cause different understandings. Necessary corrections, additions and deletions were made in line with these expert opinions. In order to increase the reliability of the semi-structured interview form, eight students from one eighth grade class were selected. To ensure the validity of the study, techniques such as participant confirmation, detailed introduction of the participants and avoiding the researcher's prejudices were used. The questions in the semi-structured interview form used in the study are presented in [Appendix](#).

2.5 Data analysis

Within the scope of the study, the data obtained from the STEM-CIS, which was applied to determine the effect of mobile-assisted science teaching on eighth grade students' STEM domains, were analysed with independent sample t-test. The data obtained from the ICTSPS, which was applied to determine the effect of mobile-supported science teaching on students' information technology self-efficacy perceptions, were also analysed with an independent sample t-test.

Qualitative data were analyzed using the content analysis method, which thoroughly examines the collected data. This method allows for discovering themes and dimensions that may not have been apparent initially. The primary goal of content analysis is to identify concepts that can help to explain the collected data and the relationships among these concepts (Merriam & Grenier, 2019). Students who participated in the interviews were coded as S1, S2, S3, ... and S8 to maintain confidentiality. The researchers transcribed the interview transcripts. Themes, categories, and codes were then developed based on common features in the transcribed data. The researchers collaborated to compare and determine the levels, categories, and codes they had created. To calculate this agreement rate, the reliability formula proposed by Miles and Huberman (1994) was utilized (Reliability: Consensus / [Consensus + Disagreement]). In this study, the coefficient of agreement reliability between the coders was determined to be 0.86. This value demonstrates the reliability of the coding process in qualitative studies (Miles & Huberman, 1994). The resulting themes, categories, and codes from the analysis are presented in tables.

2.6 Ethics committee decision

Data collection tools and teaching materials to be used for the study titled "Mobile Learning Supported Science Teaching Application: Electric Charges and Electric Energy", as reviewed by the Van Yüzüncü Yıl University Social and Humanities Publication Ethics Committee (dated 07/07/2022 and numbered 2022/15–08), have been examined. It was determined that applying these tools to the relevant individuals is by the principles and regulations of the Social and Human Ethics, and no harm is foreseen.

Permission for the research was obtained from the Van Yüzüncü Yıl University Social and Humanities Publication Ethics Committee. Subsequently, an application was made to the school where the research was conducted, and the school administration informed both students and parents about the study. Students participating in the investigation did so voluntarily, and an official letter was sent to the parents of these students, granting the necessary permissions. It is ensured that the data collected within the scope of the study will be treated as confidential and will not be shared with others. Students and parents were informed that the data obtained for the study will be used solely for scientific research purposes.

3 Findings

3.1 Findings related to the first sub-problem of the research

The first sub-problem of the study is "Does mobile-supported science teaching have an effect on eighth grade students' STEM domains?". In order to answer this sub-problem, STEM-CIS was applied to experimental and control groups. By examining the results of STEM-CIS on the experimental and control groups, the effect of mobile-supported science teaching on students' STEM disciplines is presented below. The findings regarding the pre-test and post-test scores of the experimental and control groups on the science sub-dimension of STEM-CIS are given in Table 2.

Before the application, there was no significant difference between the scores of the experimental and control groups regarding their interest in the science sub-dimension of the STEM scale [$t_{\text{pretest}}=0.291$, $p_{\text{pretest}}>0.05$]. After the application, it was determined that there was a significant difference between the post-test scores of the experimental and control groups, and this difference was in favour of the experimental group [$t_{\text{posttest}}=0.61$, $p_{\text{posttest}}<0.05$].

The comparisons of the pre-test and post-test scores of the experimental and control groups in the math sub-dimension of STEM are given in Table 3.

There was no significant difference between the pre-test scores of the experimental and control groups on the mathematics sub-dimension of the STEM-CIS scale [$t_{\text{pretest}}=0.392$; $p_{\text{pretest}}>0.05$]. After the application, there was a significant difference between the post-test scores of the mathematics sub-dimension of the experimental and control groups in favour of the experimental group [$t_{\text{posttest}}=3.963$, $p_{\text{posttest}}<0.05$].

The comparisons of the pre-test and post-test scores of the experimental and control groups on the technology sub-dimension of STEM-CIS are given in Table 4.

Table 2 Independent sample t-test results for the pre- and post-test scores of the interest levels of the experimental and control groups for the science subdimension

Test	Group	N	X	Ss	t	p
Science Pre-Test	Experiment	25	3.92	0.50	0.291	0.593
	Control	20	3.62	0.49		
Science Post Test	Experiment	25	4.41	0.62	0.61	0.031
	Control	20	3.84	1.08		

Table 3 Independent sample t-test results for the pre- and post-test scores of the interest levels of the experimental and control groups for the mathematics subdimension

Test	Group	N	X	Ss	t	p
Mathematics Pre-Test	Experiment	25	3.68	0.67	0.392	0.534
	Control	20	3.56	0.64		
Mathematics Post-test	Experiment	25	4.53	0.54	3.963	0.002*
	Control	18	3.74	1.02		

Table 4 Independent sample t-test results for the pre- and post-test scores of the interest levels of the experimental and control groups for the technology subdimension

Test	Group	N	X	Ss	t	p
Technology Pre-Test	Experiment	25	3.62	0.80	3.077	0.087
	Control	20	3.99	0.56		
Technology Post-Test	Experiment	25	4.18	0.82	0.865	0.048*
	Control	19	4.15	0.97		

It is seen that there is no significant difference between the pretests of the technology sub-dimension of the STEM-CIS scale of the experimental and control groups [$t_{\text{pretest}} = 3.077$, $p_{\text{pretest}} > 0.05$]. It is seen that education supported by mobile application caused a significant difference on students' interest in technology compared to education not supported by this application [$t_{\text{posttest}} = 0.865$, $p_{\text{posttest}} < 0.05$].

The comparisons of the pre-test and post-test scores of the experimental and control groups for the engineering sub-dimension of STEM-CIS are given in Table 5.

There was no significant difference between the pre-test scores of the engineering sub-dimension of the STEM-CIS scale of the experimental and control groups [$t_{\text{pretest}} = 1.613$; $p_{\text{pretest}} > 0.05$]. On the other hand, a statistically significant difference was found between the post-test scores of the engineering sub-dimension of the experimental and control groups after the implementation. This significant difference was in favour of the experimental group [$t_{\text{posttest}} = 0.166$; $p_{\text{posttest}} < 0.05$].

3.2 Findings related to the second sub-problem of the research

The second sub-problem of the study is "Do the practices in the experimental and control groups have an effect on the eighth-grade students' Information Technologies Self-Efficacy Perception?". In order to answer this sub-problem, ICTSPS was applied. By analysing the results of the ICTSPS on the groups, it was tried to determine the effect of mobile-supported science teaching on eighth grade students' ICT self-efficacy perception.

Independent t-test comparisons of the pre-test and post-test scores of the experimental and control groups are given in Table 6.

It was determined that there was no significant difference between the pre-test scores of the experimental and control groups in terms of Information and

Table 5 Independent sample t-test results for the pre- and post-test scores of the interest levels of the experimental and control groups for the engineering subdimension

Test	Group	N	X	Ss	t	p
Engineering Pre-test	Experiment	25	3.37	0.97	1.613	0.21
	Control	19	3.71	0.70		
Engineering Post-Test	Experiment	25	3.97	0.64	0.166	0.039
	Control	20	3.86	0.90		

Table 6 Independent samples t-test results regarding the significance between the pre-test and post-test scores of the experimental and control groups

Test	Group	N	X	Ss	t	p
Pre-Test	Experiment	25	2.88	0.71	9.640	0.063
	Control	20	2.60	0.75		
Post-Test	Experiment	25	3.54	0.78	8.660	0.005*
	Control	20	2.45	1.02		

Communication Technologies Self-Efficacy Perception (ICTSPS) [$t_{\text{pretest}} = 9.640$, $p_{\text{pretest}} > 0.05$]. There was a significant difference between the post-test scores of the experimental and control groups in favour of the experimental group [$t_{\text{posttest}} = 8.660$, $p_{\text{posttest}} < 0.05$].

Dependent sample t-test results regarding the significance between the pre- and post-test of the experimental and control groups are given in Table 7.

When the pre-test and post-test scores of the experimental group were analysed with the dependent samples t-test, a statistically significant difference was found between the pre-test and post-test scores in favour of the post-test scores in terms of ICTSPS [$t = -0.312$, $p < 0.05$]. As a result of the dependent t-test conducted for the pre-test and post-test scores of the control group, it was determined that there was no statistically significant difference between the pre-test and post-test scores in favour of the post-test scores in terms of ICTSPS [$t = -0.312$, $p > 0.05$].

3.3 Findings related to the third sub-problem of the research

A semi-structured interview form was used to reveal the experimental group students' opinions about mobile learning supported science teaching. The third sub-problem of the study is "What are the opinions of eighth grade students about the mobile learning supported 5E learning model?". Eighth grade students' opinions about mobile learning are given in Table 8.

When Table 8 is examined, it is seen that students' opinions are grouped under the theme of "mobile learning". Students expressed their opinions with the codes of increasing the permanence of information ($f = 8$), students' easy access to information ($f = 7$), facilitating the learning of the course ($f = 6$), accessing information independent of time and space ($f = 6$), facilitating teacher-student communication ($f = 5$), increasing students' motivation towards the course and giving students a sense of responsibility ($f = 4$). Sample sections of the eighth-grade students' views on mobile learning are given below.

Table 7 Dependent Samples t-Test Results Regarding the Significance Between the Pre- and Post-Test of the Experimental and Control Groups

Group	Tests	N	X	Ss	t	P
Experiment	Pre-test	25	2.60	0.75	-0.312	0.022
	Post-test	25	2.45	1.02		
Control	Pre-test	20	2.40	0.75	-0.312	0.758
	Post-test	20	2.45	1.02		

Table 8 Eighth grade students' mobile learning supported science teaching findings

Theme	Codes	S1	S2	S3	S4	S5	S6	S7	S8	f
Mobile Learning	Increasing the retention of information	+	+	+	+	+	+	+	+	8
	Easy access to information for students	-	+	+	+	+	+	+	+	7
	Facilitating the learning of the course	+	-	+	+	+	+	+	-	6
	Access to information independent of time and space	+	+	-	+	+	-	+	+	6
	Facilitating teacher-student communication	+	+	+	-	+	+	-	+	5
	Increasing students' motivation towards the lesson	+	-	-	+	+	+	+	-	5
	Giving students a sense of responsibility	-	+	+	-	+	-	+	-	4

* + sign indicates that the relevant student has made a statement about the code; —sign indicates that the relevant student has not

"I think that it facilitated the understanding of the lesson and made the new information I learned more permanent in my mind. Therefore, my motivation towards the lesson increased. It increased and facilitated my communication with the teacher" (S₁).

"I think it made it easier to access information, and I believe that the permanence of the information I can easily access has increased. My communication with the teacher has become easier. I think my sense of responsibility increased thanks to this different teaching style" (S₂)

"Thanks to the applied model, the information I learned became more permanent, it became easier for me to understand the lesson thanks to easy access to information. Being able to access information regardless of time and place was useful for me to study the subjects related to the course whenever I want. As a result of all these, my motivation towards the course increased. Being able to access the lesson whenever and wherever I want helped me to increase my sense of responsibility" (S₃).

Eighth grade students' views on the problems they encountered in mobile learning supported science teaching are given in Table 9.

It is seen that the problems encountered by students in mobile learning supported science teaching are mostly focused on mobile devices. Therefore, the problems encountered by the students were grouped under the title of "limitations of mobile learning". Students explained these problems with the codes of mobile devices being expensive ($f=8$), reading being difficult due to the small screen size ($f=8$), short charging time of mobile devices ($f=7$) and slow internet speed. In addition, students expressed their opinions as power outages ($f=4$) and the complexity of using mobile devices ($f=3$). The views of eighth grade students on this issue are given below.

"The applications in this course use tablets, cell phones and computers. It is not possible for everyone to buy these devices because they are expensive. Also, these devices are good to use in the lesson, but I can say that it is difficult to read because the screen is small" (S₁).

"I had connection problems during the application. Either I could not connect at all, or I experienced disconnections after I connected. Other than that, the sound and image were very good, it was easy to use" (S₃).

Eighth grade students' opinions about the course videos used in mobile supported science teaching are given in Table 10.

The answers given by the students participating in the study to the third question were grouped under the title "Benefits of Application Videos". The students expressed their opinions as; increasing the retention of information thanks to visuals ($f=8$), being always accessible ($f=8$), being suitable for individual learning ($f=7$), being repeatable ($f=6$) and making it easier to focus on the lesson ($f=6$). In addition, students expressed their opinions that it makes it easier to listen to the subject ($f=5$), increases motivation towards the lesson ($f=4$) and appeals to multiple sensory organs ($f=4$). Student opinions on this subject are given below.

Table 9 Findings related to problems encountered in mobile learning supported science teaching

Theme	Codes	S1	S2	S3	S4	S5	S6	S7	S8	f
Limitations of Mobile Learning	Expensive mobile devices	+	+	+	+	+	+	+	+	8
	Difficult to read due to small screen size	+	+	+	+	+	+	+	+	8
	Short charging time of mobile devices	-	+	+	+	+	+	+	+	7
	Internet problems	+	-	-	+	+	+	+	+	6
	Slow internet speed	-	-	+	+	+	+	+	-	5
	Audio and visual disturbances	+	+	+	+	-	+	+	-	5
	Power outages	-	+	+	-	+	-	-	+	4
	Mixed use of mobile devices	-	-	-	+	-	-	+	+	3
	Audio and video problems in videos	-	-	-	+	-	+	+	+	3

* + sign indicates that the relevant student has made a statement about the code; —sign indicates that the relevant student has not

Table 10 Findings regarding the course videos used in mobile assisted science teaching

Theme	Codes	S1	S2	S3	S4	S5	S6	S7	S8	f
Benefits of Lecture Videos	Increasing the permanence of information thanks to visuals	+	+	+	+	+	+	+	+	8
	Always accessible	+	+	-	+	+	+	+	+	8
	Suitable for individual learning	+	+	+	+	+	+	+	-	7
	Reproducibility	-	+	+	-	+	+	+	+	6
	Facilitates focusing on the lesson	+	+	+	+	+	+	-	-	6
	Makes it easier to listen to the subject	+	-	+	+	-	+	-	+	5
	Increasing motivation towards the lesson	+	-	+	-	-	+	+	-	4
	Appeals to more than one sense organ	-	-	+	+	-	+	+	-	4

* + phasis>sign indicates that the relevant student has made a statement about the code;—sign indicates that the relevant student has not

"I think that the information I have learned is more permanent thanks to the visuals in the videos in the application. The fact that the experiments that we cannot do in the classroom environment are included in the videos makes it easier to learn both by practicing and seeing and makes it easier to listen to the subject. The fact that the lessons become more fun thanks to the videos increases my motivation towards the lesson" (S₃).

"Because I learn by seeing the videos, the information I learn is more permanent. Watching the experiments that we cannot do in the classroom causes me to understand the lesson more easily. It is difficult to listen to the videos because the videos are too colourful, the image in the videos freezes, distorts and the sound is too loud" (S₆)

Student opinions on whether the lessons should be taught with mobile learning supported science teaching or face-to-face in the classroom are given in Table 11.

When Table 11 was analysed, it was seen that eighth-grade students expressed different opinions about the teaching of the lessons. Five students (S₁, S₄, S₅, S₆, and S₈) expressed their opinions about teaching the lessons with mobile learning support. It is seen that the students put forward their opinions in favour of mobile learning supported for reasons such as feedback, instant evaluation, efficient use of time, flexibility and convenience, ease of access to information and subject repetition. Student opinions on this subject are given below.

"I prefer mobile learning supported lessons because learning is easier and more flexible thanks to the applications in visuals and videos, it provides longer interest in the lesson with entertaining content and increases motivation" (S₁)

"Thanks to the richness of the content, I learn more easily and more permanently. My repetitions are more efficient with solved questions and tests. Therefore, I find it more accurate to teach the lessons with mobile learning support." (S₄)

Three students (S₂, S₃ and S₇) among the eight students interviewed expressed their opinions about the current teaching method. It is seen that the students supported these opinions with the codes of having peer communication, being economical, socialization of children, not being addicted to technology and taking responsibility. Some of the data obtained from the interviews with the students are given below.

"I always prefer a teacher who can ask me what I don't understand. In face-to-face education, I can get answers quickly or I can ask the teacher again and again until I understand what I misunderstand. For these reasons, I think face-to-face teaching is better" (S₂)

"The app content is very entertaining and instructive. Thanks to the experiments, what I learn stays in my mind longer. However, face-to-face teaching has the advantage of being able to ask immediately when you do not understand something. For this reason, I prefer a combination of both methods" (S₇).

Table 11 Would you prefer mobile learning supported or face-to-face classroom instruction? Findings related to the question

Theme	Category	Codes	S1	S2	S3	S4	S5	S6	S7	S8
Lesson Procedure	Mobile Learning	Feedback	+	-	-	+	+	+	-	+
		Instant evaluation	+	-	-	+	+	+	-	+
		Efficient use of time	+	-	-	+	+	+	-	+
		Flexibility and convenience	+	-	-	+	+	+	-	+
		Ease of access to information	+	-	-	+	+	+	-	+
		Repetition of the subject	+	-	-	+	+	+	-	+
		Having peer communication	-	+	+	-	-	-	+	-
Current Teaching Approach		Economical	-	+	+	-	-	-	+	-
		Socialization of children	-	+	+	-	-	-	+	-
		Lack of technology addiction	-	+	+	-	-	-	+	-
		Taking responsibility	-	+	+	-	-	-	+	-
		Seeing value	-	+	+	-	-	-	+	-
		Equal opportunity in education	-	+	+	-	-	-	+	-

* + sign indicates that the relevant student has made a statement about the code; —sign indicates that the relevant student has not

The opinions of the students about the process they enjoyed the most from the mobile learning supported science teaching application are given in Table 12.

When Table 12 is examined, it is seen that the points that eighth grade students liked the most in mobile supported science teaching applications are gathered under the theme of "Popular Aspects of Mobile Learning". The students made explanations with the codes of teaching the lessons through mobile devices ($f=8$), teaching the lessons with my favourite technological tools ($f=8$), teaching the lessons game-oriented ($f=7$) and enabling me to use technological tools ($f=6$). In addition, students expressed their opinions as providing active participation in the lesson ($f=5$), conducting experiments in a virtual environment ($f=5$), having visual content ($f=4$) and easy access to information ($f=4$). Some sample opinions of the students on this subject are given below.

"I like that the lessons are taught with tablets, computers and cell phones. In addition, since we cannot do experiments in the classroom, being able to watch the experiments done with videos allows us to understand the subjects easily. Visually rich content increases retention and makes learning easier. Another thing I liked was accessing information easily through the application" (S_1).
"Since I took an active role in the learning phase, my enthusiasm for the lesson increased. In addition, I was very happy that the lessons were taught as if we were playing a game. Seeing the experiments that we could not do or see helped us to retain more of what we learned. I think visual content should be better and more" (S_3).

4 Discussion and conclusion

4.1 Discussion and conclusion regarding the first sub-problem of the research

As a result of the applications, it was determined that the significant difference between the pre-test and post-test scores of the experimental group's STEM sub-dimensions was in favour of the post-test. This result can be stated that mobile learning supported science teaching applied in the experimental group was effective on eighth grade students' interest in STEM. When the results related to the sub-dimensions of the STEM interest scale are examined, it is seen that a significant difference was found in favour of the experimental group students in all sub-dimensions. In other words, students' interest in science, technology, engineering, and mathematics increased at a higher level within the framework of the lessons carried out in the mobile learning environment. It can be stated that the fact that the mobile learning process offers a student-centred approach and creates more holistic learning experiences contributes to this result (Herring, Koehler, and Mishra, 2016). In courses conducted in mobile learning environments, more senses of students are addressed; experiments that cannot be conducted in the classroom environment or that may be dangerous to conduct can be presented to learners through animations and simulations. This situation is thought to contribute to increasing students' interest levels in both the course and STEM. Similar results can be found in other studies. In the

Table 12 Findings regarding the positive aspects of mobile learning supported science teaching application

Theme	Codes	S1	S2	S3	S4	S5	S6	S7	S8	f
Favorite Aspects of Mobile Learning	Teaching courses through mobile devices	+	+	+	+	+	+	+	+	8
	Teaching the lessons with my favorite technological tools	+	+	+	+	+	+	+	+	8
	Game-oriented lessons	+	+	+	-	+	+	+	+	7
	Providing the ability to use technological tools and equipment	+	+	+	+	+	+	-	-	6
	Active participation in the course	+	-	+	-	+	-	+	+	5
	Conducting experiments in virtual environment	+	+	-	-	-	+	+	+	5
	Having visual content	-	-	+	+	-	+	-	+	4
	Easy access to information	+	+	+	-	-	-	-	+	4
	Repeatable	-	-	-	+	+	+	-	-	3

* + sign indicates that the relevant student has made a statement about the code; —sign indicates that the relevant student has not

studies conducted by Berberoğlu (2020) and Yılmaz (2013), mobile learning environments were utilized and as a result, it was determined that students' interest and achievement towards the lessons changed positively. In this study, it can be stated that the result that mobile-supported science teaching is effective on eighth grade students' STEM interests is similar to the results of mobile learning/technologies studies that sample middle school students in the literature. On the other hand, there are also studies showing that the mobile learning process is more fun for students, keeps their motivation high and increases their motivation for the lessons (Büyükkalkan, 2020; Sönmez, 2018; Tanır, 2018). When high motivation and fun elements come together, it can be stated as a natural result of the study to expect students' interest in STEM to increase.

4.2 Discussion and conclusion for the second sub-problem of the research

As a result of the applications, it was determined that there was a statistically significant difference between the pre-test and post-test scores of the experimental group and this difference was in favour of the post-test. Thus, it was seen that the mobile learning supported science teaching in the experimental group had a positive effect on eighth grade students' ICTSPS. In other words, it can be stated that as a result of the lessons carried out in the mobile learning environment, students' judgments about being able to do tasks related to information technologies, solving the problems they encounter with these technologies, and having various skills related to them have developed positively. Bandura (1997) states that past experiences, indirect observation, verbal persuasion, and affective experiences are seen as sources of self-efficacy. In the current study process, it can be thought that students' long-term experience with mobile technology tools and their dialogues with each other, their teachers or their parents in problem situations related to mobile technologies contributed to the improvement of their ICTA scores.

It was determined that there was a significant difference between the post-test scores of the experimental and control group students in favour of the experimental group. This result can be interpreted as that the mobile learning supported science teaching applied in the experimental group was effective on the eighth-grade students' ICTSPS. In mobile learning, mobile devices are used in learning environments. These devices are used by students in most of their daily lives. Thus, it is thought that it is effective for students to think of the learning in the lessons as game-based and to spend more time with their mobile devices. In addition, within the scope of the "Electric Charges and Electric Energy" unit, it can be said that watching the videos on the subject in Morpa Campus and Education Information Network (EBA) via mobile devices and technology-oriented activities related to the subject are effective on eighth grade students' ICTSPS. Interviews conducted in the experimental group at the end of the application supported the quantitative data. The students expressed that they were happy that the lessons were taught through mobile devices during the application.

A statistically significant difference was found between the pre-test and post-test scores of the control group students. This difference was in favour of the post-test.

This result shows that the application in the control group was effective on the eighth-grade students' ICTSPS. This is thought to be due to the videos shown in the control group within the scope of the "Electric Charges and Energy" unit in the deepening phase of the 5E learning model. In addition, it can be said that the fact that the majority of the students had tablets and that parents used their cell phones for lessons and games was effective. In addition to these, it is thought that teaching the lessons with interactive whiteboard in the control group was also effective on students' information technology self-efficacy. In a study, it was determined that the computer-aided 5E learning model increased the academic achievement and retention of knowledge of eighth grade students (Akdeniz, Öztürk, & Bakırcı, 2017).

In the literature, it has been observed that the reflections of studies on mobile learning or mobile technologies on learning environments are quite positive. For example, in one study, mobile learning applications increased the course motivation and academic achievement of primary school students (Yıldırım, 2012). In another study, fifth grade students were taught the science course by gamifying it with mobile applications. As a result of the study, it was determined that mobile learning increased students' achievement and motivation (Su & Cheng, 2015). A similar study was conducted with third year university students. As a result of the study, it was seen that mobile supported instruction had positive reflections on the academic achievement and attitudes of university students (Alioon & Delialioğlu, 2019). In the literature, studies on mobile learning have positive effects on variables such as academic achievement, attitude, and motivation. In the current study, it was concluded that mobile learning has a positive effect on eighth grade students' information technology self-efficacy. From this point of view, it can be said that the results of the current study overlap with the results of the studies conducted in the literature.

4.3 Discussion and conclusion for the third sub-problem of the research

The opinions of eighth grade students about mobile-assisted science teaching were examined with the first question of the interview. The students who participated in the study stated that mobile-assisted science teaching increased the retention of information, facilitated access to information and facilitated learning of the lesson. In addition, students stated that this application increased motivation towards the lesson, contributed to teacher-student communication, and access to information independent of time and space. It is thought that the fact that the lessons are taught through tablets, cell phones and computers is effective in the formation of these thoughts about mobile supported science teaching. In addition, it is believed that students' positive attitudes towards technology products and their willingness to use mobile devices in daily life are also effective. In a study conducted on this subject, it was determined that the use of mobile devices in the lesson facilitates the understanding of the lesson, helps to listen more carefully, and increases the interest in the lesson (Sönmez, 2018). In another study, it can be said that mobile learning positively affects learning, facilitates students' learning and its use in learning environments is very useful (Gür & Bulut-Özek, 2021). In addition, it is thought that videos will help students learn the subjects they have difficulty in easily and develop

positive attitudes towards the course (Bulun et al., 2004). In this study, it can be said that the opinions of eighth grade students about mobile learning are similar to the results of studies conducted with students and teachers at different levels of education.

The second question of the interview aimed to reveal the problems encountered by eighth grade students during mobile learning supported science teaching practices. The students who participated in the study stated that the problems encountered by students in mobile learning supported science teaching were mostly caused by mobile devices. The students stated that they had difficulty in reading the texts related to the subject due to the small screen size of tablets and cell phones during teaching. In addition to this, they expressed problems such as the fast charging of the mobile devices used during the application, slow internet speed and power outages. When the underlying causes of these problems encountered by the students are analysed, it is believed that they are due to the insufficient internet infrastructure of the school where the study was conducted, power outages due to the rural location of the school where the application was conducted, and the physical characteristics of the mobile devices. In a study, it was emphasized that although mobile learning has limitations, this application has a positive effect on students. It was pointed out that the mobile devices used in mobile learning have limitations such as the small size of the screens, the fear of the devices not working, and the fact that their batteries run out in a short time (Gikas & Grant, 2013). In this study, it was seen that the problems encountered by the students in the application of mobile learning supported science teaching emerged in previous studies. Therefore, the results of this study were found to be very similar to the results of the study in the literature.

The opinions of eighth grade students about the course videos used within the scope of mobile supported science teaching were revealed with the third question of the interview. The students stated that the video content is rich, easy to use, increases learning motivation and contributes to the learning of the subject because it includes documentaries. The students stated that the videos were effective in teaching the subjects because they allowed experiments that were dangerous for the students and did not involve tools and equipment. In addition, the fact that the videos were effective in repeating the subject and that there were questions that reinforced learning on the subject were positively evaluated by the students. It was determined that the videos on the science course in the Education Informatics Network (EBA) appeal to more than one sensory organ, which helps students learn the subjects in an entertaining way, reinforce the subjects and increase students' motivation (Bakırcı & Kılıç, 2021). In another study conducted in this field, middle school students claimed that the EBA website was effective in reinforcing and reviewing subjects. In addition to these benefits, they stated that the lectures, educational games, and videos on the EBA website are interesting (Tüysüz & Çümen, 2016). In this study, it was seen that the result obtained from the eighth-grade middle school students about the benefits of EBA videos had common features with previous studies.

In the fourth question, in which students were asked whether they preferred the mobile supported learning model or the face-to-face model, most of the students stated that they preferred the mobile learning supported method. Students stated that they would prefer mobile learning because of the advantages of mobile learning

such as facilitating learning through visuals and videos, increasing interest in the lesson through entertaining content and increasing student motivation. It is thought that the effective use of mobile learning devices in learning, especially in the distance education process, is effective in students' expressing their opinions in this way. Yılmaz (2013) states that the features of mobile tools have also increased due to the multifactorial nature of the tools that can be used in mobile learning. The variety of content such as videos, animations, materials, experimental activities that can be used in mobile learning makes learning more permanent. He stated that some educational games will positively affect the student's course success and motivation and that these games can be used as effective teaching materials. In similar studies conducted in our country, it is seen that mobile learning influences student success (Berberoğlu, 2020; Bilgin, 2019).

The fifth question of the interview examined the points that students enjoyed the most from the mobile learning supported science teaching application. The eighth students who participated in the study stated that they enjoyed this application because the lessons were taught through mobile devices, these devices played an important role in students' daily lives, and the lessons gave the impression that the lessons were game-oriented. Thanks to this application, students can conduct dangerous experiments and access information independently of space and time. Therefore, thanks to this application, students stated that it contributed to learning science subjects by having fun. In the school where the study was conducted, students do not perform many science experiments due to the lack of sufficient materials in the science laboratory. Thus, it is thought that the fact that many experiments were done in a virtual environment thanks to mobile learning contributed to the students' satisfaction with this application. It can be said that the students actively participated in learning thanks to mobile learning, and that the experiments conducted in the virtual environment were effective in learning the subject, and that the students enjoyed the applications in the experimental group. In a study on mobile learning, it was found that tablet computers helped students understand the subjects better and that the lessons using tablets attracted students' attention more (Eren, 2015). In the current study, it can be said that one of the points that the students enjoyed the most from this application was that the students expressed that they were doing lessons with their favourite mobile devices, which is similar to the results of Eren's (2015) study. In a study conducted on this subject, it was determined that the use of mobile application technology in the learning environment contributed to middle school students' ability to access information quickly, increase their interest in the lesson and increase students' motivation (Sümer, 2020).

5 Recommendations

- This study was conducted in a quasi-experimental design with a total of 45 students, 25 in the experimental group and 20 in the control group. This can be stated as the limitation of this study. In order to make a more accurate and general judgment on how the students' interest in STEM and the level of STEM-ori-

ented STEM skills change, the application can be carried out on a larger sample at different grade levels and in different research designs.

- It was determined that the students participating in the research experienced technical problems in the mobile learning process. This can be expressed as a factor that directly affects the quality of mobile learning. In future studies, it is recommended to carry out controls at the point of students' access to technology and to carry out studies after the deficiencies (material, technological equipment, internet, etc.) to be identified are eliminated.
- In this study, the data obtained from eighth grade students were analysed as the source of findings. In future studies, teachers' perspectives on mobile learning and STEM subjects can be examined and how they affect the results related to students' changes in these elements can be investigated.
- In the mobile application used for the research, there are themes belonging to textbook units related to national education textbooks. In a similar study, different textbooks and themes of different units can also be addressed.
- The mobile application used in the research is the mobile version of the EBA system, which is accessible to every student affiliated to national education. In similar studies, the content to be developed by the researcher or the use of different existing mobile platforms can increase the effectiveness of the research.
- Since the mobile learning process can be carried out from anywhere outside the school, it is recommended that various studies be conducted to examine the effects of student parents on the process, the opportunities they provide to their children, and their perspectives on mobile learning.

Appendix: Semi-structured interview form

1. What are your thoughts on mobile learning supported science teaching applied in science course? Explain
2. What do you think are the problems you encounter during mobile learning supported science teaching applications?
3. What are your thoughts about the course videos used in mobile supported science teaching? Explain
4. Do you prefer mobile learning supported courses or face-to-face in the classroom? Please explain.
5. What do you think you enjoyed the most from the mobile learning supported science teaching application? Explain.

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

Declarations

Conflict of interest The authors do not have any possible conflicts of interest.

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