Journal of Computer and Education Research
J. Comp. Educ. Res., 14
dergipark.org.tr/jcer
ISSN: 2148-2896
Continuous Publishing Model

Research Article | Open Access

A Technology-Supported Learning Environment Aimed at Developing Digital Mathematical Reasoning Skills and Mathematical Achievement: Participants' Views

Abdullah ÖZÇELİK [1,*] Aziz İLHAN [2] Recep ASLANER [3]

[1] Ministry of National Education, Elazığ, Türkiye abdullahozcelik232323@gmail.com

[2, 3] İnönü University, Malatya, Türkiye aziz.ilhan@inonu.edu.tr ; recep.aslaner@inonu.edu.tr

[*] Corresponding Author: abdullahozcelik232323@gmail.com

Article Info

Received: 14 January 2026
Accepted: 22 May 2026
Published: 08 July 2026

10.18009/jcer.1863661

Keywords: Mathematics education, focus group discussion, digital reasoning, technology-supported education

Publication Language: English

This article was published under the continuous publishing model.

Abstract

Many higher-level skills, such as reasoning, have become intertwined with digital conditions and have become prerequisites for success. Therefore, the study determined student opinions on the impact of an innovative technology-supported educational application aimed at developing digital mathematical reasoning skills and mathematical achievement. Designed as a qualitative action research study, data on student opinions obtained through focus group discussions at the end of the application process. Eight students (four girls and four boys) selected from among the year 7 students participating in the application and interviewed. The data obtained through audio and video recordings evaluated using content analysis and interpreted by separating them into themes, codes, and categories. The results showed that, in addition to the students' satisfaction with the application, it also had an impact on their reasoning skills, technological skills, mathematical perspectives, areas for improvement in the application, and mathematical practices. The responses indicate that the application is highly effective in teaching and that the intensive use of digital technology in mathematics education positively affects mathematical achievement and digital reasoning skills.

To cite this article: Özçelik, A., İlhan, A. & Aslaner, R. (2026). A technology-supported learning environment aimed at developing digital mathematical reasoning skills and mathematical achievement: Participants' views. *J. Comp. Educ Res.*, 14, e2614050 https://doi.org/10.18009/jcer.1863661

Introduction

Technology can be defined as the process of controlling the environment and altering nature through the use of tools to meet human desires and needs (Selwyn, 2021). Digital technology, on the other hand, is essentially a technology system focused on processing digital information (Li et al., 2024). Although digital technology has emerged recently, it has begun to have an impact in almost every area of life today, and it seen that individuals of all ages benefit from technology in many areas of their daily lives (Drijvers & Sinclair, 2024). Developments in technology, which is the means of producing information or accessing and sharing it (Dağhan et al., 2015), have accelerated the transformation of contemporary society and directly affected many areas of activity, including education (Popa, 2025). In particular, the need to integrate technology into the education process has emerged, but without innovation in the learning and teaching process, changing the tools used, such as replacing blackboards with smartboards, may be insufficient to encourage learning (Elen & Depaepe, 2025). Therefore, it can be said that the need for updates in technological capabilities or teaching programmers has come to the fore. Turkey is one of the countries that has made changes in this context. In Turkey, the Turkey Century Education Model (TCEM) teaching programme, updated for the 2024–2025 academic year, emphasizes the development of skills in recognizing mathematical tools and technology and identifying and using the tools and technology necessary to solve a mathematical situation or problem (MoNE, 2024).

It is evident that technology enriches the learning environment in mathematics education, with particular emphasis placed on the importance of technology use (MoNE, 2024; NCTM, 2000). Research has also yielded significant findings indicating that technology-supported mathematics education and the use of digital tools positively impact the learning experience (Bray & Tangney, 2017; Kutluca & Akran, 2025). The use of technology in mathematics lessons helps students develop their problem-solving skills in a dynamic and interactive environment by enabling them to visualize abstract concepts (Cirneanu & Moldoveanu, 2024). The use of technology also facilitates the development of higher-order thinking skills such as analysis and synthesis, making the learning process more effective (Appavoo, 2020; Kutluca et al., 2010). With this in mind, studies on the integration of technology into mathematics lessons have increased, and it has been stated that new technologies used for educational purposes contribute to teaching (Drossel et al., 2017). Therefore, it can be said that technology-supported applications offer significant opportunities in understanding mathematics lessons and increasing students' conceptual understanding and motivation.

Digital Mathematical Reasoning

In today's world, where the digital realm is rapidly shaping society, the education system has also transformed, and as a result, expectations of qualified individuals have changed (Usta & Kaleci, 2021). Today, education aims to equip students with the necessary skills to succeed in a rapidly changing world, rather than simply memorizing facts (Cirneanu & Moldoveanu, 2024). One of these is mathematical reasoning, which is the ability to

 https://doi.org/10.18009/jcer.1863661

produce and analyses arguments to justify mathematical claims (Niss & Højgaard, 2019). With digitalization, digital technologies have become widespread in mathematics education. Operations that have been considered fundamental skills in mathematics until now, such as graphing, solving algebraic equations, and constructing geometric structures, have now been transferred to advanced digital technologies (Drijvers & Sinclair, 2024). The combination of digital tools with appropriate pedagogy increases the potential for solving existing problems in mathematics. For example, thanks to the dynamic and interactive tools used, students can explore and concretize mathematical objects and build a mathematical understanding (Hoyles, 2016). Although there is no definition in the literature, within the framework of this research, digital reasoning defined as the process of critically analyzing information presented in a digital environment to question its accuracy and reliability, and establishing logical relationships by filtering the information obtained through interaction with digital tools.

Technology-Supported Learning

Technology refers to any tool or device that makes human life easier (Sürer, 2020). Technology-supported learning refers to a method in which technology enriches the traditional face-to-face classroom environment by using electronic technologies such as the internet, video, mobile devices, and computers. In technology-enhanced learning, different hardware and software tools used to identify and monitor how students are progressing and to facilitate student-student and student teacher communication (Koller et al., 2006). Many types of technology can be used within this framework to support and enhance learning, such as interactive whiteboards, computer-assisted learning systems, simulation tools, online learning content, and educational games (Goodyear & Retails, 2010). Interactive materials make learning faster and more enjoyable, while the use of presentation visuals and animations has been found to improve students' ability to comprehend and retain information (Morrison & Vogel, 1998; Vogel & Klassen, 2001). In mathematics education research, it can also be said that the use of digital resources positively affects student achievement (Byun & Joung, 2018; Chan & Leung, 2014). Therefore, technology used to motivate students who have difficulty understanding mathematics and to ensure that they learn the rich content of mathematics (Offer & Bos, 2009). Technology-enhanced learning involves learning situations where the teaching experience created with the support of a physical device such as a computer or the internet (Mayer, 2010).

 https://doi.org/10.18009/jcer.1863661

Theoretical Framework

Various technologies used today to improve education (Schweighofer & Ebner, 2015). These approaches, which utilize technology to support the learning and teaching process, referred to as technology-enhanced learning (Schweighofer & Ebner, 2015). Digital technologies have been seen to create significant opportunities for learning to be carried out in various ways. The role of digital technologies in enhancing learning and teaching has also attracted the attention of mathematics educators (Geiger et al., 2012). The use of digital tools in mathematics lessons motivates students by making them active, creates interactive learning opportunities, and enables teachers to make better use of their teaching strategies (Selimi et al., 2020). For example, interactive software such as Scratch, which facilitates thinking by offering students creative problem-solving opportunities (Calder & Taylor, 2010), and computer software used to develop students' mathematical thinking habits and generate mathematical ideas (Cuoco et al., 1996) can be cited as examples. It can also be said that tools used interactively positively affect the teaching process and increase students' knowledge (Selimi et al., 2020). Taylor (1980) proposed three basic roles for computers. When computers used in an instructional role, students presented with applications (such as GeoGebra) prepared in advance in a software environment, and they answer questions by observing, with the computer providing appropriate feedback. The student progresses based on this feedback. In the tool role, computers used to perform operations such as problem solving and using a calculator, while in the teaching role, the student expected to create a design requested of them on the software (Kabaca, 2016).

Purpose and Significance of the Research

This research conducted to determine student opinions regarding the process of technology-supported mathematics teaching. A focus group discussion held to determine student opinions about the application, and the data obtained analyzed. By focusing on the experiences of students who participated directly in the teaching process, this research aims to determine how technology integration reflected in the application, and it hoped that the data obtained would serve as a guide. The data obtained from the discussion will play an important role in understanding the opportunities and challenges encountered in the technology-supported teaching process. A review of the literature reveals that there are many studies showing that technology-supported mathematics teaching has a positive effect on students' attitudes, achievement and motivation. Research has shown that quantitative-experimental studies predominate, and that the applications conducted focus on one of the following digital tools: interactive whiteboards, computers, mobile technology, the EBA platform, educational videos or digital games (Çavuş & Yorgancı, 2020; Kutluca & Tum, 2018; Poçan et al., 2021; Sezer & Şenbakar, 2023). Furthermore, it has been suggested that for computer-assisted mathematics teaching to be effective, the mathematics lesson should be teacher-led and supported by a variety of materials (Hangül & Üzel, 2010). In this study, however, student views regarding an action research application conducted under teacher supervision using multiple digital tools sought, and the results analyzed. This research provides detailed qualitative findings on the difficulties students encountered during the process, supportive or hindering factors, and their personal experiences and perceptions. Understanding students' thoughts on participant experiences in terms of the impact of technology on the teaching process will guide both the understanding of the effectiveness of the application and similar plans to be made in the future. The main research problem is to determine, based on students' views, how a technology-supported action research study affects students. Consequently, this study aims to identify students' views on an innovative technology-supported educational intervention designed to develop digital mathematical reasoning skills and mathematical achievement. In line with this general objective, the study sought to address the following sub-problems:

1. What are the students' views on the classroom environment created during the application?
2. How did the application affect the development of students' technological skills, their practical skills in mathematics, their view of mathematics, and their ability to relate it to daily life?
3. What are the students' views on which subjects other than mathematics the application could be applied to?
4. What are the students' views on the areas in which the application needs to be improved?

Method

Research Design

The data presented in this study obtained from a focus group interview conducted at the end of an extensive action research process. In action research, teachers and other

https://doi.org/10.18009/jcer.1863661

researchers typically conduct research related to their own institutions (Cohen et al. 2021). Technological developments also influence teachers' perspectives on education, their lesson planning, and the ways they interact with students. In this sense, action research is a powerful approach that can be used to review, update, and improve teachers' own lesson plans (Clark et al., 2020). Therefore, the action research design preferred in the main application, which based on a qualitative research approach. Action research, which is the process of improving education (Mertler, 2024), is research conducted by teachers to improve their environment, teaching methods, and student learning in response to problems arising in the school or classroom setting (Creswell, 2017). Action research is an educational research approach that enables educators to examine and develop their practices and engage in critical reflection (Clark et al., 2020). In other words, action research aims not only to understand but also to change (Mertens, 2019). Focus group interviews also used to understand student views on this process. The data presented in this study also obtained from focus group discussions. A focus group interview is a type of research conducted with participants who share common characteristics regarding a topic to determine what people think about a subject, idea, product, or service and to gather information (Krueger, 2014). For qualitative researchers, focus group interviews structured group discussions planned to encourage participants to talk about specific topics. The aim is to encourage participants to approach the topic from different angles or to discuss a topic that they would not be able to discuss individually (Bogdan & Biklen, 2022). Focus group interviews are discussions held with 6-10 people with similar experiences on a specific topic (Patton, 2018). They typically conducted with 4-12 people who share common characteristics, facilitated by a moderator, and aim to collect data by creating an interactive environment where participants feel comfortable expressing their genuine thoughts (Gülcan, 2021). Focus group discussions should be as short as possible (ideal duration 30-60 minutes) (Berg & Lune, 2015).

Participants

The participants in the study selected from among 45 pupils enrolled in year 7 during the spring term of the 2024-2025 academic year who had continuously participated in the action research process, based on their average examination scores during the implementation phase. Eight students, four girls and four boys, selected using criterion-based sampling, one of the purposive sampling methods. In criterion-based sampling, the researcher determines a criterion, and then situations that meet that criterion must be identified (Mertens, 2019). The main criterion for student selection in the study was the students' participation in the application. The aim was to reveal the views of students who actively participated in the action process in depth. The students selected for the focus group interview selected on a voluntary basis.

Data Collection Tools

A focus group interview form used to collect data for the research. Semi-structured interview questions consisting of 9 open-ended questions prepared to determine student opinions regarding the application. Care taken to ensure that the questions formulated in such a way as to allow students to clearly express their thoughts on the implementation process, without any leading questions. The opinions of 3 academics specializing in mathematics education and a teacher (Dr) who applied focus group interviews in their doctoral thesis sought to determine whether the items were clear, adequate, and suitable for the research. It deemed appropriate to remove Question 8 from the initial draft, as its meaning was similar to that of other questions. Changes have also been made to some questions in line with expert opinions. For example, the draft question "The lessons I attended have …….. affected the development of my technological skills. Because…" amended to "The lessons I attended have …………….. affected my technological skills. Because…" following expert advice, as the original phrasing deemed to be leading. Taking into account the possibility that the lessons may not have affected the student's skills, the student now asked to fill in the blank. Following these opinions, the necessary adjustments made, and the final interview questions took their final form with 8 open-ended questions.

The Role of the Researcher

The primary researcher is also the subject teacher who has been teaching mathematics in the class where the study conducted since the beginning of the 2024-2025 academic year. Prior to the focus group discussions, the environment where the discussions would take place arranged, and the seating arrangement prepared by the researcher. Ventilation, temperature, and lighting adjustments made by the researchers themselves. Furthermore, measures taken to prevent noise and distractions (such as doors opening) during the interviews. Throughout the interview, the researcher facilitated and organized the process, guiding the students to obtain in-depth information. The researcher encouraged the students to speak freely, without imposing their own views, and promoted in-depth responses within a framework of impartiality.

Data Collection Process

The study conducted during the spring term of the 2024-2025 academic year. It investigated students' digital mathematical reasoning skills and mathematical achievement in relation to polygons, circles and discs, and how these could be developed through technology-supported education. Prior to the research, the digital curriculum to use throughout the process (Polypad, Matshpad, GeoGebra, etc.) introduced to the students. In line with the lesson plans prepared in advance and finalized with expert opinions, the digital curriculum used during the 5-week application lessons, and at the end of each lesson, the researcher and students kept a daily log for evaluation. In addition, weekly assessment tests prepared by the researcher via Education Informatics Network (EIN) administered after each week's topic completed, and the action plan updated based on the results obtained. A one-hour computer class held each week so that students could personally experience similar digital activities to those carried out in class. Due to the large class size and insufficient number of computers, the class divided into two groups, and each group had one computer lesson per week. The action plan updated by evaluating the weekly assessment tests, analyzing the EIN test results, computer lesson screen recordings, and student and teacher diaries. The action plan updated, and in the last three weeks of the implementation, one weekly lesson hour conducted via the Zoom platform. Clinical interviews and focus group discussions conducted to learn the students' views on the process. The results obtained from the analysis of the focus group data presented in this study.

Prior to the focus group discussion, all necessary approvals obtained, including ethical committee approval, research permission, and consent from parents and students (regarding audio and video recording). The discussion questions prepared, expert opinions sought, and the final version finalized and implemented. A pilot study lasting 11 minutes and 16 seconds conducted with three different students who did not participate in the focus group interview (two days prior), and video and audio recordings made to identify any shortcomings in the questions, environment, etc. Before the interview, the necessary explanations provided to make the students feel comfortable (e.g., that it was not for grading purposes, the purpose of the research, that there would be no evaluation in terms of right or wrong, etc.), and the ambient sound, temperature, and lighting adjusted appropriately. After the students answered each question, the interviewers moved on to the next questions. Even if it was not their turn to speak, students who wished to add to their friends' thoughts or express their opinion again after everyone else had spoken given the floor again. The focus group discussion lasted 47 minutes and 33 seconds. During the discussion, the discussion data recorded on camera and audio and filed to transfer to Word later.

Figure 1. Interview setting

Data Analysis

Content analysis used to analyses the interview data. Content analysis involves coding according to specific rules to identify the presence of certain words or concepts within a text or a set of texts (Büyüköztürk et al., 2013). The audio and video recordings made during the interviews subsequently examined in detail and transcribed verbatim. For the analysis of the data, each student's response divided into meaningful units, coded, and examined in detail. The data obtained subjected to content analysis by different researchers separately; the resulting categorical structure tabulated with frequencies indicated and compared. To determine the internal consistency of the research, Miles and Huberman's (1994) reliability coefficient based on the percentage of inter-coder agreement used

 https://doi.org/10.18009/jcer.1863661

(Reliability coefficient=Agreement/(Agreement+Disagreement) x 100). An inter-coder agreement of at least 80% is sufficient. (Miles & Huberman, 1994). In this study, the calculation showed a consensus of 94.52%, indicating that coding reliability achieved.

Reliability and Ethics

After the interview questions prepared, expert opinions sought to finalize them. Two days before the focus group interview, a pilot study conducted with three different students. Based on the results obtained, any issues identified regarding the environment, questions, and recording process rectified. The students participating in the interview selected on a voluntary basis, and all necessary permissions (parental consent, student consent, Ethics Committee, research permission) obtained for audio and video recordings. During the interview, an environment created where students could express their opinions openly without being guided. The researchers took notes on important points and, when necessary, sought confirmation from the students to prevent misunderstandings. Recordings made during the interviews to prevent data loss. The data obtained from the interviews analyzed using content analysis, and to ensure reliability, the data coded independently by the researchers. Codes with differing interpretations discussed and adjusted to align with a common understanding. To support the data obtained from the analysis, the responses provided as direct quotations, and for ethical reasons, the students' names coded as K1, K2, etc.

Findings

When preparing the interview questions, care taken to ensure that the questions formulated to address the specified sub-problems. Within this framework, questions 1 and 2 prepared to address Sub-problem 1, whilst questions 3, 4, 5 and 7 prepared to address Sub-problem 2. Furthermore, Question 8 assessed as relating to Sub-problem 3, whilst Question 6 assessed as relating to Sub-problem 4. As the interview questions and sub-problems do not correspond in a sequential order, the data obtained has been presented in a sequence corresponding to the interview questions.

Findings related to the first question of the focus group discussion

The themes, categories, and codes created by examining the responses given by the students participating in the discussion to the question, 'I liked the classroom environment that created during the lessons because...' presented in Table 1. The aim of this question was to determine the situations that the students liked and their reasons for liking them in relation to the implementation process.

Table 1. Students' reasons for liking the implementation process

Theme	Category	Code	Participants								
			K1	K2	K3	K4	K5	K6	K7	K8	f
Satisfaction	Positive Attitude	Active Participation	X	X	X	X	X	X	X	X	8
		Enjoyable Classroom Environment	X					X		X	3
	Positive Digital Attitude	Interaction with Digital Tools	X		X	X		X			4
		Technology Use	X	X	X	X	X	X	X	X	8
		Camera Use								X	1
	Learning Applications	Learning by Doing	X		X			X	X	X	5
		Visualization	X		X	X		X	X	X	6
		Effective Classroom Management			X	X			X		3
		Permanence					X	X	X	X	4

Table 1 shows that three separate categories have been formed under the theme of satisfaction. When examining the reasons for satisfaction, it seen that in the positive attitude category, students most frequently expressed their satisfaction with the active participation code, while in the positive digital attitude category, the most frequently mentioned reasons were technology use and learning applications, and in the visualization code. The categories of positive attitude, positive digital attitude, and learning applications formed under the theme of 'satisfaction'. In the positive attitude category, active participation (f=8, K1: 'Sir, the lessons were very enjoyable, the class participated a lot in the activities. Also, sir, some of our friends who normally don't participate in the lessons have now started to participate.'), enjoyable lesson environment (f=3, K8: 'Using technology was both fun and we learned well, it was productive.'), In the positive digital attitude category, interaction with digital tools (f=4, K3: 'The math's curriculum we used and the extra lessons done on Zoom were also very useful in terms of reinforcing the subject matter.'), technology use (f=8, K3: "I couldn't do some of the questions on polygons at all, I didn't understand them. When you showed me using the smart board curriculum, I understood and now I can solve them very well. 'and

 https://doi.org/10.18009/jcer.1863661

camera usage (f=1, K8: '... another thing that increased participation in the lesson was the camera recording. Everyone participated in the lesson better."

Findings related to the second question of the focus group discussion

The themes, codes and categories related to the responses given by the students participating in the discussion to the question 'I did not like the classroom environment that created during the lessons because...' presented in Table 2. The aim of this question was to determine the situations that the students did not like and their reasons for not liking them in relation to the implementation process.

Table 2. Reasons why students did not like the implementation process

Theme	Category	Code	Participants								
			K1	K2	K3	K4	K5	K6	K7	K8	f
Complaints	Classroom Climate	Division of the Lesson	X	X	X				X		4
		Crowded Environment				X	X		X		3
		Class Noise	X		X	X	X		X		5
		Participation Noise				X	X	X			3
		Presence of Camera								X	1
		İzinsiz Cevap				X	X	X		X	4
	Negative Digital Attitude	Online Noise							X		1
		Different Web Visits	X								1

Table 2 shows that two separate categories formed under the theme of complaints. When examining the reasons for complaints, it observed that students most frequently expressed complaints related to classroom noise in the classroom climate category, while in the negative digital attitude category; they mentioned issues related to online classes and computer classes. Under the complaint theme, the categories of classroom climate and negative digital attitudes have been formed. In the classroom climate category, the disruption of the lesson (f=4, K2: 'Sir, what I didn't like was that the students on duty interrupted the lesson too much in the middle of it. It decreased later on. Other than that, there was no other issue.' Crowded environment (f=3, K5: "There were people making noise

 https://doi.org/10.18009/jcer.1863661

without asking permission or raising their hands to go to the blackboard. Our class is already noisy.'), Classroom noise (f=5, K3: '...I was sitting at the back, and when those in front of me talked, even a little, it distracted me.'), Participation noise (f=3, K4: '...When raising their hands, everyone wants to go to the board themselves. They say "me, me". For example, one of our friends, I won't mention their name, raises their hand, says "me, me", and at the same time wants to give the answer to the question and solve it on the smart board.' Presence of the camera (f=1, K8: 'Because the camera was on, I sometimes looked at the cameras and tried to be quieter, which distracted me a little." and unauthorized answers (f=4, K6: 'I agree with Meryem because we all want to go up to the board, but 1-2 people would immediately say the answer, which discouraged us.' In the negative digital attitude category, online noise (f=1, K7:: "Sir, I generally liked it, but in the lessons you did on Zoom, the class crowded and everyone participated, so some people talked while others were speaking. When that happened, we missed some parts.' Different web visits (f=1, K1: 'In computer class, after completing the required activity, some friends tried to visit other websites."

Findings related to the third question of the focus group discussion

The themes, codes, and categories related to the responses given by the students participating in the interview to the question 'the lessons taught improved my ability to relate the subject matter to daily life... because...' presented in Table 3. This question aimed to determine how the implementation process affected the students' ability to relate the subject matter to daily life and their reasons for this effect.

Table 3. Student opinions and reasons regarding the impact of the implementation process on their ability to relate concepts to real life

Theme	Category	Code	Participants								
			K1	K2	K3	K4	K5	K6	K7	K8	f
Association	Positive	Different Perspective	X	X	X		X	X	X		6
		Mathematical Awareness	X	X	X		X	X	X		6
		Visualization skills							X		1
		Mathematical Perspective						X			1
	Neutral	Perception of Being Good				X				X	2

https://doi.org/10.18009/jcer.1863661

Upon examining Table 3, it observed that two separate categories formed under the theme of association. When examining the reasons for association, it seen that in the positive category, students focused most on codes related to gaining different perspectives and developing mathematical awareness; while in the neutral association category, it seen that they thought, 'I was already good, so it did not affect my association skills.' Positive and neutral categories have emerged under the theme of association. In the positive category, different perspectives (f=6, K3: 'It had a great effect on me too, sir. I now look at the tiles in this place differently.' Mathematical awareness (f=6, K1: "I think it had a good effect, sir. Because now I look at geometric shapes differently. I pay particular attention to their edges and corners. I also examine car wheels, for example, relating them to circles and comparing their diameters. I used to just see them as wheels.", K5: "…for example, I never looked at the decorations in the mosque mathematically. Now I pay attention.", Visualization skills (f=1, K7: It had a positive effect on me, sir. Now I pay attention to the shapes of roadside signs. How many corners they have, what they called.' Mathematical perspective (f=1, K6: '... Especially the active activities were more impressive." codes have been formed. In the neutral category, the perception of being good (f=2, K4: 'For example, I really liked the circle and sphere activities, but since I already love math in daily life, I was looking at them mathematically. So it didn't affect me; my perspective was already as you described it' code formed.

Findings related to the fourth question of the focus group discussion

The themes, codes, and categories related to the responses given by the students participating in the interview to the question 'the lessons taught have improved my technological skills ………… because…' presented in Table 4. The fourth question of the interview aimed to determine how the implementation process affected the development of students' technological skills and the reasons for this effect.

Table 4. Student opinions and reasons regarding the impact of the implementation process on the development of their technological skills

Theme	Category	Code	Participants								
			K1	K2	K3	K4	K5	K6	K7	K8	f
Technological Skill	Digital Experience	Technological Knowledge Increase	X	X	X	X	X	X	X	X	8
		Device Interaction	X	X	X	X	X	X	X	X	8
		Digital Feedback			X	X					2
		Visualization Skills					X	X			2

 https://doi.org/10.18009/jcer.1863661

		Fun-Learning Opportunity						X	X		2
	Technological Passivity	Technological apathy	X								1

Table 4 shows that two separate categories have been formed under the theme of 'Technological Skills'. When examining the students' reasons regarding the development of technological skills, it seen that 5 codes created in the 'Digital Experience' category and that the students most frequently mentioned the codes 'Increase in Technological Knowledge' and 'Device Interaction', while 1 student explained the lack of development of technological skills as their own lack of interest in technology. Below are some student views on this question in their original form: Under the theme of technological skills, the categories of digital experience and technological passivity emerged. In the digital experience category, technological knowledge increase (f=8, K3: 'At first, we couldn't use the new curriculum we learned, but after you taught us, we used them ourselves and improved.' Device interaction (f=8, K8: "I learned new curriculum, which helped me improve. I had never heard of this curriculum before. I also learned how to use them."), digital feedback (f=8, K3: "Using EBA was also good; our skills improved while solving questions there, and we saw our mistakes."), visualization skills (f=2, K5: "We learned to use curriculum such as GeoGebra, Matspad, and Polypad very well. I think using technology in mathematics is a great thing for visualization.' Fun learning opportunity (f=2, K5: 'We used technology in a way that allowed us to learn and have fun at the same time, just as we normally use it for fun. This changed my perspective on technology." In the technological passivity category (f=1, K1: 'Sir, it didn't really affect my technological skills. Because I don't use technology much at home either. I only use it when I'm given homework. I started using the computer here. Even though I have a computer at home, I don't use it much. The curriculum used were very nice.')

Findings related to the fifth question of the focus group discussion

The themes, codes, and categories related to the responses given by the students participating in the interview to the question, 'the lessons taught changed my perspective on mathematics... because...' presented in Table 5. This question aimed to determine how the

 https://doi.org/10.18009/jcer.1863661

implementation process affected the students' perspective on mathematics and their reasons for this effect.

Table 5. Student views and reasons regarding the impact of the implementation process on their mathematical perspective

Theme	Category	Code	Participants								
			1	**2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**f**
Mathematical Perspective	Emotional Management	Overcoming Fear	X						X		2
		Increased Motivation				X	X		X	X	4
	Learning Process	Ease of Learning	X		X		X		X	X	5
		Fun Learning			X	X	X			X	4
		Visualization	X	X	X	X	X			X	6
	Cognitive	Different Perspective		X	X	X	X		X	X	6
		Increase in Success	X		X	X	X		X	X	6
		Lasting learning	X		X		X				3

Table 5 shows that three separate categories formed under the theme of 'Mathematical Perspective'. When examining the reasons students gave for the change in their mathematical perspective, it observed that in the 'Emotional Management' category, students stated that their mathematical perspective changed most due to 'Increased Motivation'. In the 'Learning Process' category, the visualization code stands out, while in the 'Cognitive Category,' the codes 'Different Perspective' and 'Increase in Success' are prominent. Some student opinions regarding this question provided in their original form: Under the theme of mathematical perspective, the categories of emotional management, learning process, and cognitive emerged. In the emotional management category, overcoming fear (f=2, K1: "My perspective on mathematics has changed very positively. For example, I had a fear of circles and spheres since primary school. I couldn't do the circumference and area at all; I didn't even know the formula. Thanks to the curriculum, I understood it easily when it visualized. I no longer struggle with the formula and I don't forget it either.'), Increased motivation (f=4, K4: 'When you did this application and used technology and computers to teach lessons via EBA and Zoom, it motivated me again."), In the learning process category, Ease of learning (f=5, K3: 'Thanks to the curriculum we used, I realized that math isn't just about formulas and that it can actually be made fun and easy.' Fun learning (f=4, K8: "Considering the lessons done on Zoom, what we did on the computer, and what we did together on the smart board in class, using technology really made the lesson fun. I didn't get bored and I enjoyed it.' Visualization (f=6, K1: 'I couldn't do perimeter and area at all, I didn't even know the formula. Thanks to the curriculum, it became easy to understand when visualized, I no longer struggle with the formula and I don't forget it either." codes formed. In the cognitive category, there is a different perspective (f=6, K2: '...But I can say that I saw that mathematics is more effective when it presented with proofs and shapes, rather than just operations and formulas.'), and an increase in success (f=6, K4: "...When you did this application and used technology and computers to teach lessons via EBA and Zoom, it motivated me again. My math scores in the exams I took also increased significantly.'), Lasting learning (f=3, K5: 'Math normally considered a difficult subject by everyone, but we saw that it can be made more enjoyable, easier, and more lasting through different activities and the use of technology." The codes obtained.

Findings related to Question 6 of the focus group discussion

The themes, codes, and categories related to the responses given by the students participating in the discussion to the question, 'While lessons are being conducted... it would be more effective if... For example...' presented in Table 6. This question aimed to identify the areas that need improvement in the implementation process and to determine the shortcomings.

Table 6. Student opinions and justifications regarding areas for improvement in the implementation process

Theme	Category	Code	Participants								
			K1	K2	K3	K4	K5	K6	K7	K8	f
Developable area	Learning Environment	Group learning					X				1
		Class size		X	X		X	X			4
		Number of computer lessons							X	X	2
		Opportunity to participate		X	X			X			3
		Actions taken are sufficient	X		X						2
	Technological Requirement	Online participation	X			X					2

 https://doi.org/10.18009/jcer.1863661

	Network issue		X	1
Behavioral Management	In-class permission	X	X	2
	Distracting behavior		X	1

Table 6 shows that three separate categories have been created under the theme of 'Areas for Improvement'. When examining the reasons given by students for their shortcomings in relation to the application under this theme, it seen that the code most frequently mentioned by students in the 'Learning Environment' category was the 'Class Attendance' code. In the 'Technological Demand' and 'Behavior Management' categories, the codes 'Online Right to Speak' and 'Permission during Lessons' came to the fore. Some student opinions regarding this question provided in their original form: Under the theme of areas for improvement, the categories of learning environment, technological requests, and behavior management formed. In the learning environment category, group learning (f=1, K5: 'Sir, I think it would be better if we formed groups and worked on the lesson during class, but of course there should be fewer students.' Class size (f=4, K6: "It would be good if each student could get up 5-6 times during a lesson. However, our class crowded. I don't know how this could be done; you know better how this problem could be solved." Number of computer lessons (f=2, K7: 'Sir, we had one computer lesson per week. Perhaps if possible, I think it would be more useful to increase these computer lessons.'), Opportunity to participate (f=3, K2: "Sir, because there were so many students in the class, we couldn't get up to the blackboard very often during the lessons. It would be better if everyone could get up a few times in each lesson.' What done was sufficient (f=2, K1: 'Sir, I don't think there was anything more we could have done for the lessons we did at school. Because we already did everything we could. It was good that the computer lessons recorded so that we couldn't go to other websites.") In the technological requests category, there were comments such as: Online speaking rights (f=2, K4: 'It would have been better if everyone spoke one by one on Zoom.'), Network problem (f=1, K4: "On Zoom, when the sound delayed for some due to internet issues, people would talk to themselves. It would be better if microphones turned off and only the person who given the floor could speak.' In the behavior management category, the codes obtained were in-class permission (f=2, K4: '...When raising their hands, they shout

 https://doi.org/10.18009/jcer.1863661

"me, me". It would be better if this didn't happen.' and distracting behavior (f=1, K4: 'Some of our friends do things that distract us in class.").

Findings related to Question 7 of the focus group interview

The themes, codes, and categories related to the responses given by the students participating in the interview to the question 'The lessons taught improved my practical skills in mathematics... Because...' presented in Table 7. This question aimed to determine how the implementation process affected students' practical skills in mathematics lessons and their reasons for this effect.

Table 7. Student opinions and reasons regarding the effect of the implementation process on their practical skills

Theme	Category	Code	Participants								
			K1	K2	K3	K4	K5	K6	K7	K8	f
Mathematical Practicality	Cognitive Benefit	Mental Visualization				X	X		X		3
		Visualization Skill	X	X		X	X				4
		Reasoning Skill							X		1
		Problem Solving		X	X			X			3
		Meaningful Learning	X	X		X	X				4
	Technological Benefit	Digital Interaction	X	X		X	X				4
		Digital Diversity						X			1
		Digital Tools	X	X	X	X	X	X		X	7

Upon examining Table 7, it observed that two separate categories have been formed under the theme of 'Mathematical Practicality' and that no negative category related to hindering mathematical practicality has been formed. When examining the reasons that increase students' mathematical practicality, it seen that the codes 'Visualization Skill' and 'Meaningful Learning' mostly mentioned in the 'Cognitive Benefit' category, while the code 'Digital Tool' stands out in the 'Technological Benefit' category. Some student opinions regarding this question provided in their original form: Under the theme of mathematical practicality, the categories of cognitive benefit and technological benefit have emerged. In the cognitive benefit category, mental visualization (f=3, K4: 'I can visualize the shapes in my mind. Rather than going through the formulas, we learned by grasping the logic behind the

 https://doi.org/10.18009/jcer.1863661

shapes.' Visualization skills (f=4, K1: "I think it greatly improved my practical skills. I couldn't remember some formulas, such as finding the sum of the interior angles. But when I cut out the triangles in the programme and showed them, I remembered them.' Reasoning skills (f=1, K7: 'My reasoning skills have improved. I can visualize shapes in my mind.' Problem solving (f=3, K6: 'Sir, I think it became very memorable for us when we did the activities ourselves using both EBA and the smart board and the computer. Solving lots of questions reinforced it. My speed also increased.' Meaningful learning (f=4, K2: 'For example, when finding the sum of the interior angles, instead of using the formula directly, we divided it into triangles and found the formula." codes formed. In the technological benefit category, Digital interaction (f=4, K5: "Instead of just giving us the formula, you explained it by moving shapes around and cutting them out, and we had the opportunity to apply it ourselves, so I didn't forget what I learned and my speed increased because I could remember it quickly. The shapes came to life in our minds.'), Digital diversity (f=1, K4: 'Teacher, I think it became very memorable in our minds because we did the activities ourselves using both EBA and the smart board and the computer. Solving lots of questions reinforced it. My speed also increased.' Digital tool (f=7, K4: '...When solving EBA tests, it was very easy to solve the questions by opening the curriculum and making the drawings." Codes have been generated.

Findings related to Question 8 of the focus group interview

The themes, codes, and categories related to the responses given by the students participating in the interview to the question, 'The digital activities and applications carried out used in subjects other than mathematics... For example...', presented in Table 8. The aim of this question in the discussion was to determine the applicability of the activities and work carried out during the implementation process in other subjects and the students' reasons for this.

Table 8. Student views on the applicability of the implementation process in different subjects

Theme	Category	Code	Participants								
			K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**f**
Lessons	Main lesson	Turkish	X								1
		Science	X		X			X	X		4
	Elective	Technology Design	X	X	X	X		X		X	6
		Physical				X					1

		Education			
		Visual Arts		X	1
	All	All courses	X		1

Upon examining Table 8, it observed that three separate categories formed under the theme of ‘Lessons’. When examining the codes related to other subjects where the application and digital tools used in this process could apply, opinions expressed regarding five subjects, while its applicability in technology design lessons stands out in student opinions. Some student opinions regarding this question given in their original form: Under the subject theme, the main subject, intermediate subject, and all categories formed. In the main subject category, Turkish (f=1, K1: “Punctuation marks don't stick in our minds in Turkish. Using technology to explain this could be more effective.‘), Science (f=4, K7: ’I think it should be used in science lessons. For example, an animation or visual aid about the focal point of a lens could help explain this difficult topic to students better.‘), Technology Design in the elective category (f=6, K3: ’I also think it should be used in technology design lessons. Models can be shown visually. We can watch videos.‘ Physical education (f=1, K4: ’Games to be played in physical education can be designed in a computer environment, shown, and then the games can be played." Visual arts (f=1, K8: ‘...In visual arts, other people's paintings can be shown to us via computer to guide and inspire us...’ Sir, I disagree with my other friends. Because I think technology should be used in all lessons. I think it would be effective in all of them. Using technology, the retention of information can be ensured in all lessons."

Discussion and Conclusion

The aim was to determine students' satisfaction with the application process. Upon examining the results, it can say that the objective achieved. The codes ‘Active Participation’ and ‘Use of Technology’ reflected the satisfaction of the entire class. Furthermore, the high number of satisfaction ratings for opportunities such as ‘Interaction with digital tools,’ ‘Visualization,’ and ‘Learning by doing’ can be interpreted as indicating the effectiveness of technology-supported education. In related studies in the literature, studies using technology (smart boards, computers) (Akgün & Yücekaya, 2015; Hangül & Üzel, 2010; İlhan & Aslaner, 2020; Köysüren & Üzel, 2018; Tatar et al., 2015) show that students express similar satisfaction with the learning environment. The findings of Draude and Brace (2007), which indicate that the use of technology positively affects student learning and increases student interest and satisfaction, support the results of this study.

It observed that students disliked eight codes related to the application. Six of these codes found to be in the 'Classroom Climate' category, while the other two were in the 'Negative Digital Attitude' category. It observed that students disturbed by the large number of students in class, the class monitor interrupting the lesson for announcements, and the noise generated by students during the lesson and their desire to participate. In the negative digital attitude category, complaints made about some students attempting to access other websites after activities in computer class had ended and about the noise generated during online lessons. The results of this study are consistent with similar findings (Dündar, 2024; Gülburnu, 2013), which indicate that students disturbed by noise and talking without permission in technology-supported learning environments. Although situations such as noise during class and disruption of the lesson disturbed the entire class, the reason why some students did not complain about this during the interview can be attributed to the reduction in complaints as a result of the measures taken in line with the spirit of the action research process. It can also be stated that conducting the application with fewer students may be beneficial. Regarding the presence of the camera, it noted that while one student expressed satisfaction in the first question, the same student indicated discomfort with the camera's presence (distraction) in the second question. This situation demonstrates that technology can become both a supporting and hindering factor in learning; however, the fact that other students not affected by this situation can be explained by students' individual learning differences or motivation-anxiety levels. At the end of the research conducted by Salman and Akay (2022), it determined that 52% of students did not find distance education useful, while 9% expressed negative opinions about the low level of participation in the course. In this study, while it observed that students fully participated in all online lessons, the fact that no opinion expressed regarding the ineffectiveness of online lessons can interpret as suggesting that partial online lessons conducted in parallel with school lessons may be more effective than fully online lessons.

During the implementation process, it observed that there was no situation that negatively affected students' ability to relate mathematics to daily life, while the codes 'Gaining a different perspective' and 'Mathematical awareness' stood out as having a positive effect. Students stated that as a result of engaging in active activities on smartboards

 https://doi.org/10.18009/jcer.1863661

and computers, both in class and individually, they were able to better understand and recognize the properties of shapes, which changed their perspective on mathematical objects in daily life (e.g., signs, floor tiles). Parallel to this research, Köysüren and Üzel (2018) concluded that technology-supported mathematics teaching enables students to perceive themselves as competent in creating a fun learning environment and recognizing mathematical relationships in daily life. However, two students stated that the application had no effect on their association skills. The students explained that this was because they already considered themselves to be good at mathematics.

It has been determined that they stated that the implementation process had a positive impact on their technological skills. In particular, 'increased technological knowledge' and 'interaction with technological devices during lessons' stood out. Although no students expressed negative views, one student explained that their technological skills had not improved due to their lack of interest in technology. It also observed that students had a positive view of the feedback on questions solved on digital platforms such as EBA. The feedback received by both teachers and students contributed to both the development of the application process and the development of the students. This situation is also consistent with the results of other studies in the literature on the impact of technological applications (Poçan & Yaşaroğlu, 2021).

It has been determined that the application positively affects all students' mathematical perspective. In particular, the fact that it mostly expressed that overcoming fear of mathematics, increased motivation, making learning enjoyable and lasting, visualization, and increased success demonstrate that digital applications have a multifaceted positive effect on mathematics learning. This is consistent with other studies in the literature. Studies in the literature (Akgün & Koru, 2015; Boz & Özerbaş, 2020; Eraytaç & Tarım, 2014; Öztop, 2022) conclude that mathematics lessons using technology increase students' motivation, make learning enjoyable and lasting, and that technology-supported teaching increases academic achievement (Batdi et al., 2018), which supports the results of this study.

Students asked to express their thoughts on areas they perceived as lacking, as opposed to complaints about the implementation process. When examining their thoughts on areas they thought could be improved in the implementation, the most frequently mentioned code was the small class size. It also stated that the implementation would be

 https://doi.org/10.18009/jcer.1863661

more efficient if there were fewer connection problems in online lessons and fewer instances of talking without permission. These issues encountered in online classes seen to be similar to the results obtained in the literature (Gürdil, 2022; Şengül & İzci, 2023). Furthermore, while two students stated that, they did not see any shortcomings in the application; two students expressed the view that increasing the number of computer activity classes, which held once a week would increase efficiency.

The implementation process has been observed to increase students' mathematical proficiency without any negative effects. In particular, it has been stated that the use of digital tools, digital interaction enabled by technology, and improved visualization skills have positively impacted their mathematical proficiency. The fact that the increase in mathematical reasoning skills only mentioned by one student contradicts the results of the digital mathematical reasoning skills test obtained during the action research process. This is because the analysis of the test data showed a high level of increase in digital mathematical reasoning skills. The fact that the students did not express their opinions positively or negatively may be due to their lack of understanding of the concept.

It has been noted that similar digital applications could be implemented for five different subjects. The technology and design course particularly mentioned in this regard. This situation parallels the findings in the literature (Zengin et al., 2024) concerning technology integration in technology design courses. Furthermore, one student indicated that digital applications could be used in physical education classes. It can be said that the fact that the student's father is a physical education teacher and therefore has knowledge about this subject was influential in their mentioning this subject in particular. One student, however, expressed the view that digital studies can be applied in every subject without distinction.

Limitations and Recommendations

When the interview data examined, it can be clearly stated that, in general, the vast majority of students found the lessons and activities conducted using the smart board, the digital curriculum used (GeoGebra, Polypad, Matspat, Toytheatre, etc.), the simulations, the EBA platform, the computer lessons, and the online lessons to be efficient and useful, and they comfortably expressed the areas they found lacking in practice. Considering the results obtained from the focus group interview data, the following recommendations can be made:

• Teachers should not only actively use technology in their lessons but also strive to ensure digital diversity by using multiple tools or curriculum when necessary.

• Online lessons, parallel to school lessons, rather than completely online education, can be effective in increasing mathematics achievement through topic repetition or question solving.

• This research conducted with 8 students. More in-depth information can be obtained by gathering the opinions of more students.

Author Contribution Statement

Abdullah ÖZÇELİK: *Conceptualization, data analyses*

Aziz İLHAN: *Literature review, methodology*

Recep ASLANER: *Conceptualization*

Author Name SURNAME: *Data analyses, conceptualization.*

Acknowledgement

The article has been generated from the PhD thesis of the first author, who supervised by the third author.

Ethical Committee Permission Information

Name of the board that carries out ethical assessment: İnönü University Social and Humanities Scientific Research and Publication Ethics Board

The date and number of the ethical assessment decision: 20.03.2025-2

References

Akgün, M., & Koru, G. (2015). Teachers perceptıons and students attıtudes towards usage of smart board (Ankara city sample). *Qualitative Studies, 10*(3), 1-12. https://doi.org/10.12739/NWSA.2015.10.3.E0023

Appavoo, P. (2020). The impact of a technology-based approach for the learning of mathematics at secondary school level. *Journal of e-Learning and Knowledge Society, 16*(4), 76-85. https://doi.org/10.20368/1971-8829/1135210

Batdi, V., Aslan, A., & Zhu, C. (2018). The effect of technology supported teaching on students' academic achievement: a combined meta-analytic and thematic study. *International Journal of Learning Technology*, *13*(1), 44-60. https://doi.org/10.1504/IJLT.2018.091632

Berg, B. L., & Lune, H. (2015). *Qualitative research methods in the social sciences (Translated from the 8th Edition).* Translated and Edited by H. Aydın. Education Publishing House.

Boz, İ., & Özerbaş, M. A. (2020). Opinions of primary school teachers about the use of technology in mathematics lesson. *Science, Education, Art and Technology Journal (SEAT Journal), 4*(2), 56-66.

Bogdan, R. C., & Biklen, S. K. (2022). *Qualitative research: An introduction to theory and methods (S. Balcı, & B. Ahi, Trans.).* Pegem Academy.

Bray, A., & Tangney, B. (2017). Technology usage in mathematics education research–A systematic review of recent trends. *Computers & Education, 114*(1), 255-273. https://doi.org/10.1016/j.compedu.2017.07.004

Byun, J., & Joung, E. (2018). Digital game-based learning for K–12 mathematics education: A meta-analysis. *School Science and Mathematics, 118*(3-4), 113-126.

Calder, N., & Taylor, M. (2010). Scratching below the surface: Mathematics through an alternative digital lens? *Mathematics Education Research Group of Australasia*.

Cirneanu, A. L., & Moldoveanu, C. E. (2024). Use of digital technology in integrated mathematics education. *Applied System Innovation*, *7*(4), 66-84.

Chan, K. K., & Leung, S. W. (2014). Dynamic geometry software improves mathematical achievement: Systematic review and meta-analysis. *Journal of Educational Computing Research, 51*(3), 311-325. https://doi.org/10.2190/EC.51.3.c

Clark, J. S., Porath, S., Thiele, J., & Jobe, M. (2020). *Action research*. New Prairie Press.

Cohen, L., Manion, L., & Morrison, K. (2021). *Research methods in education*. (E. Dinç, K. Kıroğlu, Trans.). Pegem Academy.

Creswell, J. W. (2017). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Edam Publishing.

Çavuş, H., & Keskin Yorgancı, F. (2020). Middle school mathematics teachers's levels of utilization the education informatics network (EBA) project and their opinions about the project. *Van Yüzüncü Yıl University Journal of Education Faculty, 17*(1), 1272-1303. https://doi.org/10.33711/yyuefd.831077

Cuoco, A. A., & Goldenberg, E. P. (1996). A role for technology in mathematics education. *Journal of Education, 178*(2), 15-32. https://doi.org/10.1177/002205749617800202

Dağhan, G., Nuhoğlu Kibar, P., Akkoyunlu, B., & Atanur Baskan, G. (2015). Approaches and views of teachers and administrators related to the usage of interactive whiteboards and tablet PC. *Turkish Journal of Computer and Mathematics Education, 6*(3), 399-417.

Draude, B., & Brace, S. (2007). *Assessing the ımpact of technology on teaching and learning: Student perspectives.* Conference: Distance Learning and the Internet (DLI) Conference, Chulalongkorn University, Thailand.

Drijvers, P., & Sinclair, N. (2024). The role of digital technologies in mathematics education: Purposes and perspectives. *ZDM–Mathematics Education, 56*(2), 239-248. https://doi.org/10.1007/s11858-023-01535-x

Drossel, K., Eickelmann, B., & Gerick, J. (2017). Predictors of teachers' use of ICT in school–the relevance of school characteristics, teachers' attitudes and teacher collaboration. *Education and Information Technologies, 22*(2), 551-573.

Elen, J., & Depaepe, F. (2025). Education and technology: Elements of a relevant, comprehensive, and cumulative research agenda. *Educational Technology Research and Development*, *73*(1), 1-14. https://doi.org/10.1007/s11423-024-10420-7

Eraytaç, Ö. F., & Tarım, K. (2024). The effect of technology-assisted teaching on students' academic achievement in 6th grade mathematics class. *Journal of Theory and Practice in Education, 20*(2), 184-205. https://doi.org/10.17244/eku.1482878

Geiger, V., Forgasz, H., Tan, H., Calder, N., & Hill, J. (2012). Technology in mathematics education. In *Research in Mathematics Education in Australasia 2008–2011* (pp. 111-141). Rotterdam: SensePublishers.

Gülcan, C. (2021). A qualitative data collection tool: A study on the application and validity of focus group technique. *Mersin University Journal of Social Sciences Institute, 4*(2), 94-109.

Gülburnu, M. (2013). *Using cabri 3D in geometry teaching on 8th grade effect on academic success and assesment of students opinions* [Master's Thesis]. Adıyaman University, Institute of Science.

Gürdil, B.K. (2022). *Determining the problems faced by classroom teachers in distance education durıng the epidemic (Covid-19) Process.* [Master's Thesis]. Maltepe University Graduate Education Institute.

Goodyear, P., & Retalis, S. (2010). Learning, technology and design. *In Technology-Enhanced learning* (pp. 1-27). Brill. https://doi.org/10.1163/9789460910623_002

Hoyles, C. (2016). *Engaging with mathematics in the digital age*. Cuadernos de Investigación y Formación En Educación Matemática, 225-236. Retrieved from http://www.centroedumatematica.com/Cuadernos/CuadernosCompletos/Cuaderno15.pdf. At 03.05.2026.

İlhan, A., & Aslaner, R. (2020). The effect of using dynamic geometry software on pre-service mathematics teachers achievements and opinions about the teaching. *Turkish Journal of Educational Studies*, 7(2), 99-129. https://doi.org/10.33907/turkjes.713606

Kabaca, T. (2016). *Theoretical approaches to the use of tecnology in mathematics education*. Theories in mathematics education.

Koller, V., Harvey, S., & Magnotta, M. (2006). *Technology-based learning strategies*. Social Policy Research Associates Inc.

Krueger, R. A. (2014). *Focus groups: A practical guide for applied research*. Sage publications.

Kutluca, T., Arslan, S. & Ozpinar, I., (2010). Developing a scale to measure information and communication technology utilization levels. *Journal of Turkish Science Education, 7*(4), 37-45.

Kutluca, T. & Akran, K. (2025). Realistic mathematics education and integration of digital tools: A model development study for secondary school mathematics education. *International e-Journal of Educational Studies, 9* (20), 169-185. https://doi.org/10.31458/iejes.1604874

Kutluca, T., & Tum, A. (2018). The difficulties encountered while using smart boards in mathematics teaching. *Balıkesir University The Journal of Social Sciences Institute*, *21*(40), 183-208. https://doi.org/10.31795/baunsobed.492520

Li, H., Li, Q., Xu, Z., & Ye, X. (2024). Digital technologies. *Journal of Digital Economy, 3*(1), 240-248. https://doi.org/10.1016/j.jdec.2025.02.001

Mayer, R. E. (2010). *Learning with technology*. The nature of learning: Using research to inspire practice, 179-198.

Ministry of National Education [MoNE]. (2024). *Primary education institutions (Elementary schools and middle schools) mathematics course curriculum*. MoNE Publications, Ankara.

Mertler, C. A. (2024). *Action research: Improving schools and empowering educators*. Sage Publications.

Mertens, D. M. (2019). *Researche and evaluation in education and psychology*. Anı Publication.

Miles, M, B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded Sourcebook*. Sage.

Morrison, J., & Vogel, D. (1998). The impacts of presentation visuals on persuasion. *Information & Management*, *33*(3), 125-135. https://doi.org/10.1016/S0378-7206(97)00041-4

National Council of Teachers of Mathematics [NCTM] (2000). *Principles and standards for school mathematics.* Council of Teachers of Mathematics.

Niss, M., & Højgaard, T. (2019). Mathematical competencies revisited. *Educational Studies in Mathematics*, *102*(1), 9-28. https://doi.org/10.1007/s10649-019-09903-9

Offer, J., & Bos, B. (2009). The design and application of technology-based courses in the mathematics classroom. *Computers & Education*, *53*(4), 1133-1137. https://doi.org/10.1016/j.compedu.2009.05.020

Öztop, F. (2022). Effect of mobile technology use in mathematics teaching on academic achievement: A meta-analysis study. *MAUN Journal of Education*, *2*(1), 66-81.

Patton, M. Q. (2018). *Qualitative researche and evaluation methods*, (Translation from the 3rd edition), translated and edited by Mesut Bütün and Selçuk Beşir Demir, Pegem A.

Popa, D. (2025). Education in the digital age–The benefits and challenges of technology in the learning process. *EIRP Proceedings, 20*(1), 393-401.

Poçan, S., Altay, B., & Yaşaroğlu, C. (2021). Parents' opinions on the use of mobile technology in teaching mathematics. *Inonu University Faculty of Education Journal, 22*(1), 500-532. https://doi.org/10.17679/inuefd.815348

Salman, M. & Akay, C. (2022). Examining the distance education perceptions of secondary school students: A mixed method study. *Trakya Journal of Education, 12*(2), 979-997 https://doi.org/10.24315/tred.949053

Schweighofer, P., & Ebner, M. (2015). Aspects to be considered when implementing technology-enhanced learning approaches: A literature review. *Future Internet*, *7*(1), 26-49. https://doi.org/10.3390/fi7010026

Selimi, A., Saracevic, M., & Useini, A. (2020). Impact of using digital tools in high school mathematics: A case study in North Macedonia. *Universal Journal of Educational Research*, *8*(8), 3615-3624.

Selwyn, N. (2021). *Education and technology: Key issues and debates*. Bloomsbury Publishing.

Sezer, S. Y., & Şenbakar, K. (2023). Assessment of mobile phone usage and loneliness levels of faculty of sports sciences students. *International e-Journal of Educational Studies, 7*(15), 730-737. https://doi.org/10.31458/iejes.1344541

Sürer, A. G. (2020). The age of digitalization in education. *Cappadocia Education Journal*, *1*(1), 28-34.

Şengül, N., & İzci, E. Class teachers' views on lessons conducted via distance learning. *Ulakbilge*, *83*(April 2023), 319–328. https://doi.org/10.7816/ulakbilge-11-83-02

Tatar, E., Kağızmanlı, T., & Zengin, Y. (2015). The Effect of a Dynamic Mathematics Software on Preservice Teachers' Opinions Regarding Interactive Whiteboards. *Mersin University Faculty of Education Journal, 11*(2), 1-13. https://doi.org/10.17860/efd.98053

Uzel, D., & Hangül, T. (2010). The effect of the computer assisted instruction (CAI) on student attitude in mathematics teaching of primary school 8th class and views of students towards CAI. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, *4*(2), 154-176.

Vogel, D., & Klassen, J. (2001). Technology-supported learning: status, issues and trends. *Journal of Computer Assisted Learning*, *17*(1), 104-114.

Zengin, S., Akel, E., Çolak, A., Çolak, N., Ay, Z. Ö., & Metin, E. (2024). Teachers' views on the use of technology in education. *International Journal of Social and Humanities Sciences Research (JSHSR), 11*(103), 165-173. https://doi.org/10.5281/zenodo.10616592