MIDDLE SCHOOL MATHEMATICS TEACHERS' VIEWS AND EXPERIENCES REGARDING TECHNOLOGY INTEGRATION

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submitted by **ANIL AYSELİ DURAN** in partial fulfillment of the requirements for the degree of **Master of Science** i**n Mathematics Education in Mathematics and Science Education, Middle East Technical University** by,

Prof. Dr. Halil Kalıpçılar
Dean, Graduate School of **Natural and Applied Sciences** _____

Prof. Dr. Erdinç Çakıroğlu
Head of the Department, **Mathematics and Science Education** _____

Prof. Dr. Erdinç Çakıroğlu
Supervisor, **Mathematics and Science Education, METU** _____

Examining Committee Members:

Prof. Dr. Didem Akyüz
Mathematics and Science Education, METU _____

Prof. Dr. Erdinç Çakıroğlu
Mathematics and Science Education, METU _____

Assist. Prof. Dr. Gönül Erhan
Mathematics and Science Education, Başkent University _____

Date: 27.06.2022

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name Last name: Anıl Ayseli Duran

Signature:

ABSTRACT

MIDDLE SCHOOL MATHEMATICS TEACHERS' VIEWS AND EXPERIENCES REGARDING TECHNOLOGY INTEGRATION

Duran, Anıl Ayseli
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The purpose of the study was to investigate the views and experiences of middle school mathematics teachers regarding technology integration. How they use technology, their perceived benefits of it, difficulties that they face, their ways of overcoming the difficulties, and teachers' suggestions that would be helpful for all teachers were determined based on their experiences. Qualitative research was conducted with nine middle school mathematics teachers using the snowball sampling method. The participants who actively use technology in their lessons work in public schools in Turkey. The data of the current study were collected in the 2021-2022 fall semester. Semi-structured interviews were conducted to collect the data. The findings of the study showed that teachers use technology to enhance the visibility of content, enrich the lesson process, and engage students. According to the findings, teachers found technology beneficial in terms of students' academic development, students' affective development, providing convenience for the lesson process, and teachers' development. Moreover, according to their experiences, barriers to technology use in mathematics classrooms were determined as student-related barriers, teacher-related barriers, time management issues, and technical and infrastructural problems. Their ways of overcoming student-related challenges were

determined by guiding students and being prepared. For the teacher-related challenges, their ways of overcoming were determined by being prepared, their instant solutions, and rewarding. Instant solutions and being prepared were defined as ways of time management issues, and instant solutions, technical assistance, and using textbooks and materials were defined as ways of overcoming technical and infrastructural problems. Their ways of overcoming these difficulties may be a good guide for the teachers who face them. Lastly, the participants argued that the use of technology in schools is not sufficient. They asserted the need for organizing seminars, motivating teachers' technology use, writing projects, support from school administration, collaborating with other teachers, making effective technological tools available, and improving students' technology use for increasing the use of technology. The implications of the study based on the findings offer some considerations about ways of overcoming the difficulties in using technology, and increasing technology use in schools.

Keywords: Technology Integration, Technology Use, Middle School Mathematics Teachers, Teacher's Views, Benefits, Barriers

ÖZ

ORTAOKUL MATEMATİK ÖĞRETMENLERİNİN TEKNOLOJİ ENTEGRASYONU İLE İLGİLİ GÖRÜŞ VE TECRÜBELERİ

Duran, Anıl Ayseli
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Araştırmanın amacı, ortaokul matematik öğretmenlerinin teknoloji entegrasyonuna ilişkin görüş ve deneyimlerini incelemektir. Teknolojiyi nasıl kullandıkları, teknolojinin yararları, karşılaştıkları zorluklar, bu zorlukların üstesinden gelme yolları ve tüm öğretmenlere faydalı olabilecek önerileri, deneyimlerinden yola çıkılarak belirlenmiştir. Kartopu örneklem yöntemi kullanılarak dokuz ortaokul matematik öğretmeni ile nitel araştırma yapılmıştır. Derslerinde teknolojiyi aktif olarak kullanan bu katılımcılar Türkiye'deki devlet okullarında görev yapmaktadır. Çalışmanın verileri, 2021-2022 Eğitim ve Öğretim Yılı Güz Döneminde toplanmıştır. Verileri toplamak için yarı yapılandırılmış birebir görüşmeler yürütülmüştür. Araştırmanın bulguları, öğretmenlerin içeriğin görselliğini artırmak, ders sürecini zenginleştirmek ve öğrencilerin ilgisini çekmek için teknolojiyi kullandığını göstermiştir. Elde edilen bulgulara göre öğretmenler, öğrencilerin akademik gelişimi, duyuşsal gelişimi, kolaylık sağlaması ve öğretmenlerin bireysel gelişimleri açısından teknolojiyi faydalı bulmuşlardır. Ayrıca öğretmenlerin deneyimlerine göre matematik sınıflarında teknoloji kullanımının önündeki engeller öğrenci ve öğretmen kaynaklı engeller, zaman yönetimi sorunları, teknik ve altyapı sorunları olarak belirlenmiştir. Öğrencilerle ilgili zorlukların üstesinden gelme yolları, öğrencilere rehberlik etmek ve iyi hazırlanmak olarak belirlenmiştir.

Öğretmenlerle ilgili zorlukların iyi hazırlanmak, anlık çözümler ve ödüllendirme ile üstesinden gelindiği belirlenmiştir. Anlık çözümler ve iyi hazırlanmak, zaman yönetimi sorunlarının üstesinden gelmenin yolları olarak, anlık çözümler, teknik yardım ve ders kitaplarını ve materyalleri kullanmak, teknik ve altyapı sorunlarının üstesinden gelmenin yolları olarak tanımlanmıştır. Son olarak, katılımcılar okullarda teknoloji kullanımının yeterli olmadığını savunmuşlardır. Teknoloji kullanımının arttırılması için seminerler düzenlenmesinin, öğretmenlerin teknoloji kullanımlarını motive etmenin, proje yazmanın, okul yönetiminden desteğin, diğer öğretmenlerle iş birliği yapmanın, daha fazla ve etkili teknolojik araçların bulunmasının ve öğrencilerin teknoloji kullanımlarını iyileştirmenin gerekliliğini belirtmişlerdir. Bulgulara dayalı çıkarımlar, teknoloji kullanımındaki zorlukların üstesinden gelmenin ve okullarda teknoloji kullanımını artırmanın yolları hakkında değerlendirmeler sunmaktadır.

Anahtar Kelimeler: Teknoloji Entegrasyonu, Teknoloji Kullanımı, Ortaokul Matematik Öğretmenleri, Öğretmen Görüşleri, Faydalar, Engeller

To my family

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ABBREVIATIONS	
SAMR	Substitution, Augmentation, Modification, Redefinition

CHAPTER 1

INTRODUCTION

With the rapid development of technology, innovations and changes have occurred in many areas of life. There have been many new developments in the fields, such as industry, health, banking, and trade. Therefore, technology has become an indispensable part of human life because the purpose of technology is actually to make human life easier. It is crucial to adapt to the changes in our world where technology is developing rapidly and to look at the world from a wider window.

These developments in technology bring along some innovations in education, as in many other fields. Education is a process that prepares individuals for life through gaining skills and knowledge (Ekici et al., 2012). Today, this process can be supported by technology because new technologies can improve the effectiveness of teaching (Taşçı et al., 2010). Teachers can benefit from technology in many ways during their teaching to attract students' attention and appeal to many senses.

Educational environments equipped with technological tools are necessary but insufficient to result in a significant change in schools. It is undeniable that teachers are an essential factor in using technology in educational environments because it is the vital element that gives meaning and spirit to education and makes it functional, effective and efficient are teachers (Çelik & Bindak, 2005). Without the guidance of teachers, students cannot benefit from the current technology alone at the desired level. For this reason, teachers should have the necessary competence in using technology. To raise individuals who can adapt to modern society and use technology effectively, teachers must first have qualifications in the use of technology.

Mathematics education is perhaps one of the essential building blocks of education. Mathematics education assumes a function beyond learning numbers and operations

and gaining calculation skills, which are indispensable in daily life. It provides essential support such as problem-solving (Umay, 2003). With the importance of mathematics education, studies on this subject are constantly increasing. In the studies conducted, issues such as students' failure, attitudes towards mathematics, better mathematics teaching, and the use of technology in mathematics teaching are discussed.

Considering the impact of technology on education and the great place of mathematics in education, teachers' experience of technology integration in mathematics education, the benefits they get from it, and the challenges they face are worth investigating.

1.1 Purpose of the Study

Technology integration into classes is a very critical issue (Mishra and Koehler, 2006). The use of technology has a great place in teaching mathematics and improving students' mathematics learning (NCTM, 2000). In addition, teachers have a fundamental and critical role in integrating technology into the classroom (Chen et al., 2009). Some teachers use technology as technology is easily accessible in the school. There is a need to understand further what experience these teachers have in using technology. Although there are studies on this subject in different countries, there is a need to examine the situation in Turkey in-depth in terms of teachers' experiences. According to Creswell (2007), phenomenological research focuses on how a group of individuals perceives a phenomenon with which they have shared experiences. The phenomenon discussed in this study is based on teachers' experiences using technology in their classrooms. Understanding these experiences is important in helping other teachers or identifying their needs.

The purpose of the study was to investigate how middle school mathematics teachers integrate technology into their lessons. In addition, this study aimed to examine teachers' opinions on the benefits of technology, the difficulties they encounter in using technology, their ways to overcome these difficulties, their suggestions to

teachers who want to use technology in their lessons, and their suggestions to increase the use of technology in mathematics lessons.

1.2 Research Questions of the Study

Main research questions and the sub-questions of the study were given in the following.

1. How do middle school mathematics teachers integrate technology into their lessons?
    a. What are the perceived benefits of technology use in mathematics classrooms?
    b. What difficulties do middle school mathematics teachers face in using technology in their lessons?
    c. What are the ways of overcoming the difficulties middle school mathematics teachers face in using technology in their lessons?
2. What are the suggestions of middle school mathematics teachers to teachers who want to use technology in their lessons and their suggestions to increase the use of technology in mathematics classrooms?

1.3 Significance of the Study

It is inevitable to use technology in education because of the developing technology age and the focus of attention of students. Since it is thought that technology has developed so much and its integration into education has many benefits, research examining teachers' experiences in this field can be considered a valuable study.

The findings obtained as a result of this research will offer an idea to mathematics teachers about how they can benefit from technology in their lessons because the way teachers use technology and how they benefit from these uses are included in the study. Pointing out the benefits of technology based on teachers' experiences will support teachers who want to use technology in their classes.

In the current study, the difficulties faced by middle school mathematics teachers in the use of technology in their lessons and their ways to overcome these difficulties are involved. In the literature, the challenges faced by the teachers in the use of technology have been included, but there are limited studies on the ways to overcome these difficulties. In this sense, including how teachers can overcome these difficulties will be a good guide for teachers who have or may experience similar problems. It is a fact that the information obtained based on the experiences of their colleagues will be more meaningful and useful for teachers. Moreover, studies on this subject in Turkey generally include findings about teachers' opinions, but there are very limited studies on the difficulties they experience and the ways they use to overcome these difficulties. In this context, this study differs from other studies and fills the gap in the literature.

In the light of the information obtained from the teachers' experiences, their suggestions are of a quality that can be beneficial for institutions and individuals providing teacher education. These institutions and individuals can use the results of this study to design professional development activities for teachers' needs. Middle school mathematics teachers' suggestions for increasing the use of technology in mathematics lessons were also given. These suggestions contain helpful information for teachers, administrators, and educators. It would be beneficial to consider, as it offers ideas for increasing the use of technology.

1.4 Definition of the Important Terms

Technology Integration: It is an effective process aimed at incorporating technical tools into teaching practices to enable students to progress, develop and evaluate the student as required by the curriculum, and involves the interaction of both teacher and student to carry out useful and effective activities in education. (Wang, 2012).

Technology Use: The use of technology in the study refers to digital resources used for teaching.

SAMR Model: It is a model that explains how technology can be integrated into schools and how digital tools can be used in the lessons. The acronym SAMR is based on the first letter of each of the four levels that describe the use of technology in the learning environment. These levels are Substitution, Augmentation, Modification, and Redefinition (Puentedura, 2006).

Substitution: Technology is substituted for any learning tool at the substitution level, and there is no functional change in the instruction process (Hamilton et al., 2016).

Augmentation: Technology is substituted for any learning tool at the augmentation level, and there is a functional change in the instruction process (Wijaya et al., 2021).

Modification: Learning and teaching styles are changed by integrating technology at the modification level (Hamilton et al., 2016).

Redefinition: At the redefinition level, tasks that cannot be understood without technology become understandable with the use of technology. Technology integration provides student-centered learning and a discussion environment (Binangbang, 2020).

CHAPTER 2

LITERATURE REVIEW

This chapter will review related literature regarding technology integration in mathematics classrooms, the benefits of technology integration in mathematics classrooms, and the challenges of technology integration for mathematics teachers.

2.1 Technology Integration in Mathematics Classrooms

Technology integration is the practical application of educational technology, which can be a medium used in the teaching and learning settings, to achieve the learning objectives to accomplish intentional learning outcomes (Davies, Sprague, & New, 2008). It incorporates technology into the lesson and incorporates technology-based practices into the teaching and learning process. Moreover, it includes appropriate technology in tasks, objectives, and evaluation of learning outcomes (Wachira & Keengwe, 2011). Technology integration in the school is not simply about teaching students how to use computers but using technology as a learning tool (Sheingold, 1990). In other words, the important thing is to enable technology to contribute to students learning and teaching process.

Technology integration can be helpful in student learning if it is used effectively. Therefore, it is critical how teachers integrate technology into their mathematics teaching. Cuban, Kirkpatrick, and Peck (2001) stated that many mathematics teachers use technology for making calculations and storing data. They use technology in ways that are unlikely to improve students' understanding, attract their attention, or increase their knowledge or conceptual understanding of mathematics (Ertmer, 2005). Gao et al. (2009) found out that teachers frequently use technology in their classrooms. They use it in a teacher-centered way rather than student-centered. It is essential to use technology effectively in the school.

2.1.1 Effective Technology Integration

Technology integration and effective use of technology in the classroom are more important than other factors in technology incorporation in the classroom (Nicholas & Ng, 2012). Davies and West (2014) found out that effective technology integration does not occur if students cannot access learning technologies and do not use them to achieve educational goals. Moreover, the fact that technology is used frequently does not mean that technology is being used effectively, and also it does not mean that it results in better learning. On the other hand, accessing technology is essential for effective technology integration (Ruggiero & Mong, 2015). Students need to be allowed to use their phones to take notes and record the lesson or use a calculator. Teachers should have a technological tool that they can keep with them throughout the day to communicate with other education stakeholders and record essential things related to the lesson. Moreover, there should be a platform where teachers can share course-related documents (Ruggiero & Mong, 2015).

Teachers have a crucial role for an efficient technology integration. In technology integration, teachers and their decisions are the most important things that make technology integration effective (Ertmer, 2005; Escuder, 2013).

Teachers' positive attitudes towards technology provide both an increase in technology use and effective technology integration (Ertmer & Ottenbreit-Leftwich, 2010). Additionally, Davies and West (2014) found that teachers' competencies play a vital role in the effective use of technology. It is necessary for teachers to gain experience in the use of technology and to feel comfortable in this regard. Moreover, collaboration with other teachers who are good at using technology integration increases the effectiveness of using technology in the classroom. In support of this idea, Hur and Brush (2009) found that it is beneficial for the teachers' development to share their knowledge. To ensure effective technology integration, the teacher needs to know which technological tool to use for which topic. Knowing this allows students to be successful and learn more efficiently (Cennamo, Ross, & Ertmer, 2010).

Ross and Lowther (2009) pointed out that another issue for effective technology integration is that technological tools or educational software used in the classroom need to be designed to make the instruction meaningful for each student. They need to allow to evaluate student achievement and observe the learning process. According to Davies and West (2014), educational software programs used in the classrooms generally focus on the instructional content, not the instruction students need. Since the teacher knows the needs of each student individually, these programs should complement the teacher's work to ensure effective technology integration.

It can be inferred from the related literature that teachers and the quality of the technological tools that are used are of great importance for effective technology integration.

2.1.2 The SAMR Model

SAMR (Substitution, Augmentation, Modification, and Redefinition) model proposed by Puentedura (2006), can be used to provide technology integration for students to be successful (Mejías, 2019). Puentedura's (2006) model can be considered a method for evaluating the effectiveness of technology integration. It encourages teachers to move away from using technology for traditional and straightforward purposes and integrate technology to provide innovative learning (Savignano, 2017). The SAMR model can assess how much technology impacts students learning. This model also aims to increase the quality of education provided using technology. Moreover, it is a framework developed to increase the use of technology in schools (Medel et al., 2008).

Gorman (n.d.) pointed out that the SAMR model is divided into two main teaching styles: enhancement and transformation. It is called enhancement and transformation because a task can enhance students' learning or transform the way learning occurs (Mejías, 2019). The model consists of four technology integration levels, substitution, augmentation, modification, and redefinition (Rowe, 2014). The enhancement part includes the levels of substitution and augmentation, and the

transformation part consists of the levels of modification and redefinition (Jude et al., 2014).

The visual representation of the SAMR model can be seen in Figure 2.1.

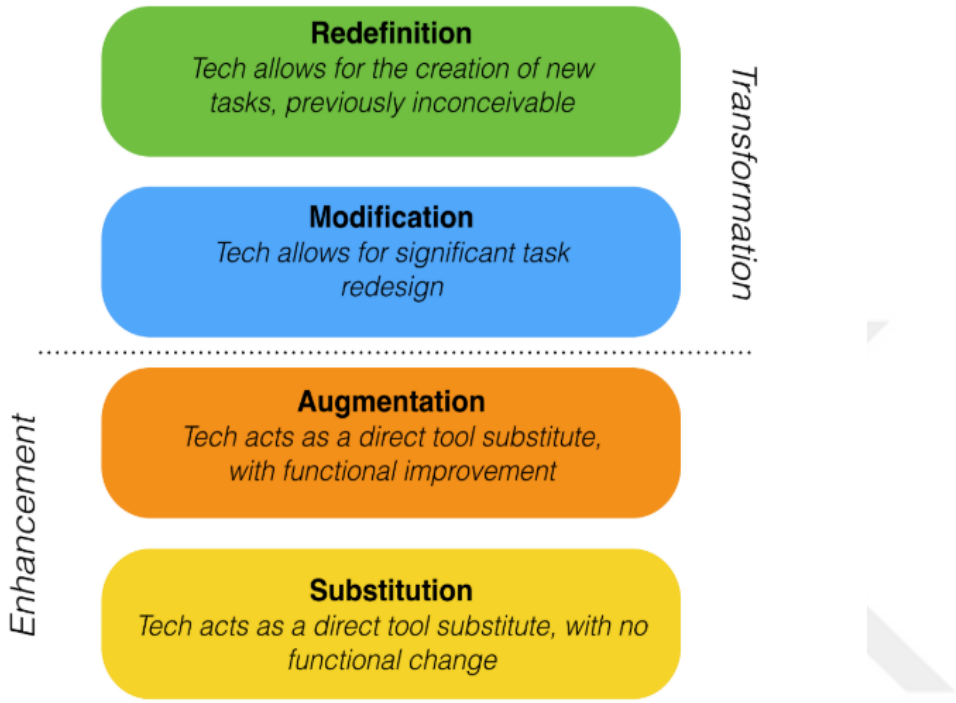

Figure 2.1. Substitution, Augmentation, Modification, and Redefinition (SAMR) model (Puentedura, 2010)

According to Hamilton et al. (2016), technology is substituted for any learning tool at the substitution level, and there is no functional change in the instruction process. It means that traditional tool changes, but teachers' methods do not change; for this reason, there is no significant improvement in the course achievements. In other words, the teacher teaches as usual, except for using the digital tool (Savignano, 2017). An example is presenting a mathematics test to the class using technology instead of paper (Hamilton et al., 2016).

According to Wijaya et al. (2021), technology is substituted for any learning tool at the augmentation level, and there is a functional change in the instruction process. It means that a digital tool is used instead of a traditional tool, but the activities at this

level enable the development of learning (Binangbang, 2020). Preparing material for the instruction or preparing a video for the review of the lesson are examples of technology integration methods at this level (Wijaya et al., 2021).

Hamilton et al. (2016) stated that learning and teaching styles are changed by integrating technology at the modification level. At this level, learning and teaching take place through digital tools, giving students access outside of school (Savignano, 2017). Instead of showing students a diagram, designing and showing a simulation of that diagram is an example of this level (Hamilton et al., 2016).

Binangbang (2020) stated that at the redefinition level, tasks that cannot be understood without technology become understandable with the use of technology. In other words, it includes teaching the tasks that cannot be accomplished with traditional tools with technology (Savignano, 2017). Technology integration provides student-centered learning and a discussion environment. Sharing documents with students and teachers on any social media platform and allowing anyone to comment and edit is an example of integrating technology at this level (Binangbang, 2020).

Educators' mastery of the SAMR model enables them to be more successful in technology integration and evaluate themselves. Thanks to this model, educators can see their level of technology integration and how much they have improved themselves in this regard (Gorman, n.d.). Moreover, this model can also be helpful for researchers to evaluate a teaching process. It plays an important role in examining how effectively technology is used in the teaching process.

2.2 Teachers' Views on the Benefits of Technology Integration in Mathematics Classrooms

According to the related literature, technology integration benefits mathematics classrooms regarding students' academic development, positive attitude, and teaching process development. The benefits of technology integration organized into these three categories are shown in Table 2.1.

Table 2.1 Teachers' Views on the Benefits of Technology Integration in the Related Literature

Students' Academic Development	Students' Positive Attitude	Development of the Teaching Process
Providing conceptual understanding 4*, 9*, 10*, 11*, 13*, 16*, 18*	Increasing motivation 3, 6*, 7*, 10*, 11*	Providing visualization and concretization 12*, 14*, 15, 16*
Providing student-centered learning 2, 11*, 15	Increasing willingness 6*	Providing real-life applications 4*, 11*, 16*
Providing permanent learning 10*, 15	Decreasing stress 8*	Saving time 12*, 13*, 14*, 15, 17*, 18*
Learning to collaborate 1	Making lesson enjoyable 1	Enabling different teaching methods 15
Developing basic computer skills 1	Attracting attention 3, 5*, 9*, 10*, 11*, 12*, 17*	Providing different representations 4*
	Providing concentration 5*	Providing more and different types of questions 4*, 11*, 13*, 15, 16*
	Increasing participation 11*, 12*, 13*, 15	Being a good facilitator 4*, 5*, 11*, 12*, 13*, 14*, 16*

The numbers with * represent the studies in mathematics education.

1 Jacobsen (1998)
2 Newhouse (1999)
3 Mumtaz (2000)
4* Bennison and Goos (2008)
5* Al-A'ali (2008)
6* Allsopp et al. (2010)
7* Rosas and Campbell (2010)
8* Meagher (2012)
9* Birişçi and Uzun (2014)
10* Ural (2015)
11* Akkaya (2016)
12* Önal and Çakır (2016)
13* Koştur and Türkoğlu (2017)
14* Sen and Ay (2017)
15 Yılmaz and Naci (2017)
16* Yazlık (2019)
17* Taş et al. (2020)
18* Korkmaz (2020)

According to the previous studies, as seen in Table 2.1, teachers believe that technology has benefits for students' academic success. Bennison and Goos (2008) found that technology use enables students to understand concepts compared to traditional ways. It was also indicated that technology use helps students construct knowledge and understand the concept (Akkaya, 2016).

Moreover, in Birişçi and Uzun's (2014) study, teachers associated the benefit of technology in improving students' understanding with its ability to visualize. In other words, since technology adds visuality to the lesson, it enables students to learn and understand better. Similar to this finding, Koştur and Türkoğlu (2017) found that, according to the teachers, using a smartboard in mathematics teaching supports the teaching and learning process and compatibility with the geometry course content. It supports conceptual and procedural learning. According to the study conducted by Korkmaz (2020), middle school mathematics teachers mostly use instructional technologies because they facilitate education and training. In support of the same idea, one of the positive views of mathematics teachers who are the participants of the study conducted by Ural (2015) on technology is facilitating students' learning. It was also found in another study with similar results that technology embodies facilitating learning and enabling students to discover mathematical concepts (Yazlık, 2019).

Technology integration provides student-centered learning. It was found that teachers use computers with constructivist tendencies to facilitate student-centered learning environments (Newhouse, 1999). In another study conducted by Akkaya (2016), technology use is helpful in teaching methods because it provides student-centered learning and a constructivist learning environment. Likewise, it has been determined in the study of Yılmaz and Naci (2017) that technology enables student-centered learning.

Another benefit of technology frequently stated in the literature is that technology helps permanent learning. Increasing permanence is a positive view of mathematics teachers who are the study participants conducted by Ural (2015) on technology.

Similarly, according to the study conducted by Yılmaz and Naci (2017), it makes it easier for the information to become permanent. According to the study by Jacobsen (1998), educators think that technology use provides students to learn basic computer skills and collaboration.

Teachers believe that technology has benefits for students' positive attitude development. For instance, according to the study conducted by Bennison and Goos (2008), technology use improves students' attitudes towards mathematics. Technology leads to a better attitude in students and positively contributes to students' ability to explore mathematics, especially low-achieving students (Ruthven & Hennessy, 2002)

Many studies have indicated that technology increases students' motivation and interest. Technology integration of lessons is essential to students' motivation and willingness to complete the task (Allsopp, McHatton, & Farmer, 2010). Thanks to the tools provided by technology, students can work independently, which motivates them. It increases students' interest in the lesson by enabling them to concentrate and understand with less effort (Al-A'ali, 2008). Similarly, in the study of Mumtaz (2000) on the use of technology by teachers, it is found that technology increased students' motivation and interest. Ural (2015) found that according to information received from teachers, technology use increases students' motivation and attracts their attention. Teachers need to get trained on using technology to motivate students (Rosas & Campbell, 2010).

According to the related literature, teachers think that technology use decreases students' stress. For example, it was found that, although not valid for every student, a study found that technology reduces students' test anxiety (Meagher, 2012). Moreover, technology use makes the lesson enjoyable (Jacobsen, 1998). It increases students' interest and excitement in their studies (Birişçi & Uzun, 2014). The integration of technology into the teaching environment increases the interest and attention of the students, and in this way, the students participate in the lessons effectively (Önal & Çakır, 2016). According to the study conducted by Taş et al.

(2020), from the point of middle school mathematics teachers, using technology in classrooms attracts students' attention. They stated that this is one of the reasons for using technology. Similar to these findings, Akkaya (2016) concluded that technology use increases the participation and motivation of students. Technology embodies students' active involvement and gaining a positive attitude towards mathematics. Due to some of these positive effects, the vast majority of mathematics teachers participating in the study conducted by Yazlık (2019) support the use of technology in mathematics lessons. Similarly, it was found that technology use in classrooms provides and supports students' active participation (Koştur & Türkoğlu, 2017; Yılmaz & Naci, 2017).

Teachers believe that technology has benefits for the development of the teaching process. According to the literature, the frequently mentioned benefit of technology use in teaching process development is visualization and concretization. According to the study conducted by Sen and Ay (2017), one of the positive aspects of technology use in mathematics classrooms is visualization. Providing visuality to the teaching by using the books in the digital environment is one of the uses of internet technologies for secondary school mathematics teachers (Önal & Çakır, 2016). Thanks to the technology, colorful, eye-catching visuals, presentations, and videos can be used (Yılmaz & Naci, 2017). Like these findings, Taş et al. (2020) concluded that middle school mathematics teachers think technology provides visualization, convenience, and concretization. Moreover, technology use is beneficial for students because of concretizes mathematical concepts (Yazlık, 2019).

Technology use enables students to study real-life applications (Bennison & Goos, 2008). Similarly, Akkaya (2016) found that technology use in classrooms is beneficial for teachers to make a relationship between the topic and real life. In addition to them, Yazlık (2019) also concluded that technology embodies ensuring that ideas are associated with daily life.

Another benefit frequently mentioned in the literature is that, according to teachers' views, technology saves time for them. It enables to use time efficiently and save

time in the teaching process (Sen & Ay, 2017; Önal & Çakır, 2016; Taş et al., 2020; Korkmaz, 2020; Koştur & Türkoğlu, 2017; Yılmaz & Naci, 2017).

According to Yılmaz and Naci (2017), technology integration is helpful for students with different learning styles. Teachers' views about using smartboards and tablet pc in teaching are generally positive because they think it appeals to multiple senses. It offers students diversity. For example, technology use helps students make relationships between different representations and see different types of questions (Bennison & Goos, 2008). It enables students to solve more questions and do more practices (Yılmaz & Naci, 2017; Koştur & Türkoğlu, 2017; Yazlık, 2019; Akkaya, 2016).

The literature has emphasized that technology provides great convenience in the course process. In other words, it is a good facilitator for both teachers and students. Technology use helps teachers to evaluate students more efficiently. For example, it provides students with rapid feedback. Many reports can be generated automatically about students' understandings of mathematics (Bennison & Goos, 2008).

Moreover, the conveniences offered by technology, such as computer tools, make the course easier. Teachers can easily share their works via technology (Al-A'ali, 2008). Technology use enables students to make calculations and graphing quicker (Bennison & Goos, 2008). It is also beneficial for teachers to have a more organized lesson, provide self-development, and create more practical and straightforward lessons (Akkaya, 2016). The opportunity to use different materials, simplification of teaching, and the opportunity to study outside the school are also facilitators of technology use (Sen & Ay, 2017). Preparing exam questions using web pages in the teaching environment, supporting the lectures, and ready-made slides on the internet are ways of using technology for secondary school mathematics teachers (Önal & Çakır, 2016). According to the study by Yazlık (2019), technology facilitates figure drawings and quickly accesses visuals. Similarly, Koştur and Türkoğlu (2017) found that automatically drawing mathematical figures thanks to technology was an example of supporting the learning and teaching process.

Familiarity with technology in mathematics classrooms benefits students by making them feel comfortable. Therefore, teachers should try to integrate technology into their pedagogy regularly. Teachers must have vocational training to use technology in the classroom and feel comfortable using technology. The instructor's proficiency in using technology and attitude toward technology may have the most effective effect on students' mathematics success (Yu-Liang, 2011).

In the related literature, it can be seen that there are so many positive aspects of technology use in classrooms. Integrating technology in the school is the most critical factor in taking advantage of the mentioned benefits.

2.3 Challenges of Technology Integration for Mathematics Teachers

The difficulties encountered in technology integration are frequently mentioned in the related literature.

According to Ertmer (1999), there are two kinds of barriers to technology integration: first-order and second-order barriers. First-order barriers are explained as external barriers, while second-order barriers are explained as internal barriers. External factors such as lack of access to digital tools like computers and software, insufficient time, and insufficient technical support are first-order barriers to technology integration. Internal factors such as teachers' attitudes towards technology use and classroom practices are second-order barriers to technology integration. Some teachers may not encounter these two types of barriers, but according to the literature, teachers often face two kinds of obstacles in their technology integration processes (Hadley & Sheingold, 1993; Moersch, 1995; OTA, 1995).

The difficulties encountered in technology integration in the literature using this framework are shown in Table 2.2.

Table 2.2 Challenges of Technology Integration in the Related Literature

External Barriers	Internal Barriers
Lack of time 2, 3, 4, 6, 7, 8, 10, 11, 12, 13, 14, 15, 17*, 18, 19*, 20, 21, 22, 23*, 24*, 25*, 27, 28	Lack of knowledge 2, 8, 12, 14, 17*, 20, 21, 24, 25*, 26*, 29*, 33*, 34
Financial issues 2, 6, 9, 14, 15, 23*	Lack of confidence 1, 5, 8, 12, 14, 18, 23*, 24*
Lack of access 2, 17*, 18, 20, 24*, 27	Negative attitudes 2, 9, 14, 34
Technical problems 8, 13, 14, 18, 24*, 25*, 26*, 29*, 32*, 33*	Lack of classroom management skills 26, 30*, 33*
Lack of training 9, 10, 11, 14, 15, 18, 20, 21, 24*, 25*, 28, 29*, 33*	
Lack of support 2, 9, 11, 14, 20, 21, 24*, 25*, 28	
Insufficient number of digital tools 10, 17*, 18, 33*	
Ergonomic problems 29*, 30*	
Content-related issues 2, 9, 13, 14, 16, 26*, 30*, 31*, 32*	
Student misuse 29*, 32*	

The numbers with * represent the studies in mathematics education.

[1] Hannafin and Savenye (1993); [2] Hadley and Sheingold (1993); [3] Hirschbuhl and Faseyitan (1994); [4] Sammons (1994); [5] Armstrong (1996); [6] Jacobsen (1998); [7] Nantz and Lundgren (1998); [8] Newhouse (1999); [9] Harris and Sullivan (2000); [10] Beggs (2000); [11] Cuban (2001); [12] Duhaney (2001); [13] Butler and Sellbom (2002); [14] Snoeyink and Ertmer (2002); [15] Dvorak and Buchanan (2002); [16] Norris et al. (2003); [17*] Bennison and Goos (2008); [18] Jones (2004); [19*] Coffland and Strickland (2004); [20] Chong Chee Keong et al. (2005); [21] Schoepp (2005); [22] Bauer and Kenton (2005); [23*] Pierce and Ball (2009); [24*] Wachira and Keengwe (2011); [25*] Agyei and Voogt (2011); [26*] Birişçi and Uzun (2014); [27] Francom (2016); [28] Hsu (2016); [29*] Koştur and Türkoğlu (2017); [30*] Kutluca and Tum (2018); [31*] McCulloch et al. (2018); [32*] Yazlık (2019); [33*] Taş et al. (2020); [34] Pamuk (2022)

Lack of time is a frequently mentioned obstacle to technology integration. Insufficient time for a lesson to be conducted using technology is a challenge in technology integration (Hadley & Sheingold, 1993; Jacobsen, 1998; Wachira & Keengwe, 2011; Butler & Sellbom, 2002; Chong Chee Keong et al., 2005; Beggs, 2000; Newhouse, 1999; Cuban, 2001; Schoepp, 2005; Pierce & Ball, 2009; Jones, 2004; Snoeyink & Ertmer, 2002; Dvorak & Buchanan, 2002; Hsu, 2016; Duhaney, 2001). There is not enough time for both teachers to research and use it effectively and teach students how to use technology (Bennison & Goos, 2008). Moreover, technology integration is time-consuming because it takes time for teachers to prepare and have limited time to cover the curriculum (Agyei & Voogt, 2011). Learning technology use and preparing course contents or materials with the help of technology takes time (Hirschbuhl & Faseyitan, 1994; Nantz & Lundgren, 1998; Sammons, 1994; Francom, 2016). Teachers need time to learn using technology effectively, plan the lesson with the help of technology, collaborate with colleagues, and integrate technology into the curriculum. Limited time is a significant obstacle for teachers to effectively integrate technology into their lessons (Bauer & Kenton, 2005). According to Coffland and Strickland (2004), traditional teaching methods are more advantageous than teaching with technology regarding time management because of these disadvantages.

Financial issues are a barrier to technology integration in the related literature. Shortage of computers is a common obstacle to technology integration (Snoeyink & Ertmer, 2002; Hadley & Sheingold, 1993). According to Pierce and Ball (2009), information obtained from mathematics teachers showed that the most mentioned barrier to technology integration is being expensive for students to access. Insufficient budget is a factor that prevents teachers from integrating technology into the lesson (Dvorak & Buchanan, 2002; Harris & Sullivan, 2000; Jacobsen, 1998).

Lack of access is a common barrier to technology integration as an external barrier (Wachira & Keengwe, 2011; Hadley & Sheingold, 1993). According to Francom (2016), one of the most significant barriers to technology integration is the accessibility problem to technology. Teachers do not have adequate technology

access to effectively integrate it into the class. Similarly, according to Bennison and Goos (2008), the most significant barrier stated by teachers was the problem of accessing computers and digital tools. Students' and teachers' lack of accessibility to technology at home is also an accessibility problem in technology integration (Chong Chee Keong et al., 2005; Jones, 2004).

Another challenge for technology integration, which has been highly emphasized in the literature, is technical problems. It has been determined that teachers have problems related to technical malfunctions while using technology (Wachira & Keengwe, 2011; Butler & Sellbom, 2002; Newhouse, 1999; Jones, 2004; Snoeyink & Ertmer, 2002; Agyei & Voogt, 2011; Yazlık, 2019). Due to technical problems, teachers could not use the interactive whiteboard effectively (Birişçi & Uzun, 2014). About this issue, Koştur and Türkoğlu (2017) found that technical problems are the most common problem that teachers encounter. Teachers, within the scope of technical problems, mentioned that students can disrupt the calibrations while playing, that the smartboard cannot work in case of a power cut, that some preparation such as calibration is required to start the smartboard, and that sometimes viruses can be infected from the sites opened, external memories and downloaded programs during use. Supporting these, according to the study conducted by Taş et al. (2020), middle school mathematics teachers stated that they mostly encountered difficulties in technical issues and at the point of installing the program in terms of infrastructure and equipment in the use of educational technology in their lesson.

Lack of training for teachers is a challenge to technology integration in the light of information from the literature. Insufficient technology-related training for teachers creates barriers to teachers' use of technology (Wachira & Keengwe, 2011; Chong Chee Keong et al., 2005; Beggs, 2000; Cuban, 2001; Schoepp, 2005; Jones, 2004; Snoeyink & Ertmer, 2002; Agyei & Voogt, 2011; Dvorak & Buchanan, 2002; Harris & Sullivan, 2000; Hsu, 2016; Koştur & Türkoğlu, 2017; Taş et al., 2020).

Lack of support from the administration is a barrier to technology integration (Chong Chee Keong et al., 2005; Hadley & Sheingold, 1993; Schoepp, 2005; Snoeyink &

Ertmer, 2002; Agyei & Voogt, 2011; Harris & Sullivan, 2000). On the other hand, lack of technical support is also a significant barrier to technology integration (Hadley & Sheingold, 1993; Cuban, 2001; Schoepp, 2005; Agyei & Voogt, 2011; Hsu, 2016). Similarly, according to the study conducted by Wachira and Keengwe (2011) by interviewing urban mathematics teachers, lack of technical support is a barrier.

In the related literature, an insufficient number of digital tools is a challenge for integrating technology into the mathematics classrooms. The lack of sufficient educational platforms and software is a difficulty faced by teachers who want to use technology in their lessons (Bennison & Goos, 2008; Beggs, 2000; Jones, 2004). Supporting the same view, Taş et al. (2020) concluded that teachers processing mathematics lessons with the help of technology stated that they had difficulties due to the lack of mathematical tools and the lack of installed programs based on the study with middle school mathematics teachers.

Ergonomic problems were mentioned as a barrier to technology integration in the literature. Teachers declare that while teaching using the smartboard, they cause physical discomfort and obstacles such as seeing and hearing in students (Kutluca & Tum, 2018). Similarly, in the study conducted by Koştur and Türkoğlu (2017), as ergonomic problems, opinions were made in the direction of eye fatigue due to the use of the pen on the smartboard and the intense light emission.

Another obstacle for teachers in integrating technology into the lesson is the problems related to the content of digital tools or software that can be used. Low level of quality of digital tools or software and problems with accessibility to practical and useful digital tools and software constitute a barrier to teachers' use of technology (Snoeyink & Ertmer, 2002; Hadley & Sheingold, 1993; Harris & Sullivan, 2000; Butler & Sellbom, 2002; Norris, Sullivan, Poirot, & Soloway, 2003; Birişçi & Uzun, 2014). Moreover, the absence of technology-appropriate teacher guidebooks is a disadvantage of using the smartboard in mathematics teaching (Kutluca & Tum, 2018). In addition, teachers prefer to use free applications and do

not require extra work before use, and they have difficulties accessing them (McCulloch et al., 2018). Yazlık (2019) found that the content of a digital tool is an essential issue because some images are not suitable for students, which makes technology integration a difficult process.

According to some studies in the literature, students' misuse of technology is a barrier to teachers' technology use. For example, according to the findings of Koştur and Türkoğlu (2017), the teachers stated that students use smartboards outside of the classroom, during breaks, out of purpose. Moreover, the study conducted by Yazlık (2019) showed that students visit other irrelevant sites, which poses a problem for the teachers.

According to the related literature, one of the internal barriers is a lack of knowledge. Knowledge of technology use, pedagogical knowledge for proper use of technology, and knowledge of integrating technology into the curriculum are mentioned types of knowledge in the literature. Their lack is a barrier to technology integration. Lack of knowledge of technology and lack of basic skills about computer and smartboard use was reported as a substantial challenge to technology integration (Bennison & Goos, 2008; Newhouse, 1999; Schoepp, 2005; Snoeyink & Ertmer, 2002; Wachira & Keengwe, 2011; Birişçi & Uzun, 2014). Some middle school mathematics teachers explained the challenges they encountered in using educational technologies associated with a lack of pedagogical knowledge (Hadley & Sheingold, 1993; Wachira & Keengwe, 2011; Taş et al., 2020). In addition, having difficulty integrating technology into the curriculum is a significant challenge to technology integration (Hadley & Sheingold, 1993; Duhaney, 2001; Snoeyink & Ertmer, 2002; Chong Chee Keong et al., 2005; Schoepp, 2005; Agyei & Voogt, 2011; Koştur & Türkoğlu, 2017). Pamuk (2022), mentioning all three types of knowledge, concluded that the constraints are primarily due to a lack of technical knowledge, pedagogical experience, and skills in technology integration. Based on this information, teachers who have competence in technology achieve much more successful results in classroom instruction (Duhaney, 2001).

Lack of confidence is an internal barrier to technology integration. According to Wachira and Keengwe (2011), lack of confidence is a barrier for the teachers because they fear making mistakes and damaging the technological tools. There are many factors in technology integration, but the most important is the fear of failing to use technology (Hannafin & Savenye, 1993). Similarly, according to the study conducted by Armstrong (1996), for teachers, the fear of failing to use technology in front of students and colleagues is a significant barrier to technology integration. Therefore, teachers avoid using technology because of the feeling uneasy and fear of encountering an unexpected problem (Newhouse, 1999; Duhaney, 2001; Snoeyink & Ertmer, 2002; Jones, 2004; Pierce & Ball, 2009).

Negative attitudes of teachers are a frequently mentioned challenge to technology integration. It was seen that teachers' attitudes towards conducting lessons using technology affect their effective use of technology in the classroom (Hadley & Sheingold, 1993; Harris & Sullivan, 2000; Snoeyink & Ertmer, 2002; Pamuk, 2022).

Classroom management problems are another challenge in integrating technology. According to the study of Birişçi and Uzun (2014), interactive whiteboard applications create chaos among students by attracting their attention. According to the teachers' experiences regarding smartboards in mathematics lessons, teaching with smartboards cannot be applied adequately in crowded and low-achievement classrooms. The student's attention is distracted after a certain period when using the smartboard in the lessons, and there is a decrease in motivation (Kutluca & Tum, 2018). Supporting these, Taş et al. (2020) found that the continuous use of technology makes students bored, and as a result, their interest in the lesson decreases.

2.4 Summary of the Literature

A review of the literature indicated that the use of technology in mathematics teaching has a great place. According to the related studies, teachers need to integrate technology effectively into their lessons for students to benefit from technology. It has been concluded that the SAMR model is a good guide for teachers to effectively integrate technology into their classes and evaluate the effectiveness of technology integration. Moreover, teachers' views on the benefits of technology integration were reviewed. According to the reviewed literature, technology use benefits students' academic development, positive attitudes, and teaching process development.

On the other hand, the difficulties faced by teachers in the use of technology are given in the literature. These difficulties were external or first-order barriers caused by external factors and internal or second-order barriers caused by internal factors (Ertmer, 1999). External problems include problems not related to the teacher, while internal problems include problems arising from the teacher.

It has been mentioned in the literature that it would be beneficial to use the SAMR model to evaluate teachers' technology integration. There is a need to use the SAMR model as a framework to determine this and to determine the technology integration levels of middle school mathematics teachers.

In the literature, the difficulties faced by teachers in technology integration are included, but there is not enough information about the ways to overcome these problems. Considering that the information gained from teachers' experiences can be a guide for other teachers, there is a need to investigate teachers' ways to overcome the problems encountered in the technology integration process in mathematics classrooms.

CHAPTER 3

METHOD

This chapter will include the method of the study in detail. Eight subtopics: the study's design, participants of the study, data collection tool, data collection process, data analysis, the trustworthiness of the study, ethical considerations of the study, and assumptions and limitations of the study will be explained.

3.1 Design of the Study

This study aimed to investigate middle school mathematics teachers' experiences with technology in mathematics classrooms. How teachers use technology, perceived benefits of technology, difficulties they face, their ways of overcoming these difficulties, their suggestions to teachers who want to use technology in their lessons, and their suggestions to increase the use of technology in mathematics lessons were investigated. To achieve this aim, a qualitative research design was used.

Qualitative researches are studies in which qualitative data collection methods such as interviews, observations, and document analyses are used. A qualitative process is followed to reveal perceptions and events in a natural environment realistically and holistically (Yıldırım & Şimşek, 2018). Researchers start by collecting detailed information from the participants in qualitative research methods. They form this information by creating categories or themes (Glesne, 2013).

This research is descriptive research aimed at identifying and analyzing an existing concept, so phenomenological research, one of the qualitative research designs, was used. According to Creswell (2007), phenomenological research focuses on how a group of individuals perceives a phenomenon with which they have shared experiences. As a result of the study, it has been tried to develop universal definitions that reflect individuals' common meanings and feelings regarding the focused

phenomenon. While emphasizing individual subjectivity, it is aimed to discover the essence based on multiple experiences (Merriam, 2009; Patton, 2002).

3.2 Participants of the Study

The study's target group was middle school mathematics teachers who integrate technology into their lessons in Turkey. In a qualitative research study, it was not possible and realistic to reach all of the individuals in the target group. Therefore, the purposive sampling method was used. Purposive sampling occurs when the researcher selects participants according to specific characteristics to understand a phenomenon (Creswell, 2012). The snowball sampling method, a type of purposive sampling method, was used to determine the participants in the current study. In the snowball sampling method, when selecting participants for the study, participants are asked to suggest other people who would like to be involved and contribute to the study (Creswell, 2012). In other words, after the first teacher was selected, other participating teachers were reached depending on the suggestions.

A teacher who can be easily reached from the researcher's close circle, suitable for the purpose of the research, was chosen as the first participant. With the suggestion of the first participant, the next participant teacher was selected, and the participants of the study were determined by continuing in this way. Other teachers selected in line with the suggestions of the participants were asked whether they used technology actively in their lessons and the teachers who used it were determined as participants. More participants were interviewed, but it was decided to choose 9 of them because their use of technology was insufficient. Moreover, while choosing the participants of the study, teachers, who have at least three years of teaching experience, were determined as criteria.

The study participants were nine middle school mathematics teachers who actively use technology in their lessons. Five of them were female, and four of them were male teachers. Moreover, they all had teaching experience at all middle school grade levels. All of them were teachers working in different public schools in a Central

Anatolian city. Demographic information about participating teachers is given in Table 3.1.

Table 3.1 Demographic Information about Participants

Code for Participant	Years of Experience	Undergraduate Education	Graduate Education
P1	3	Mathematics Education	M.S. in Mathematics Education
P2	17	Mathematics Education	-
P3	19	Mathematics Education	-
P4	16	Mathematics Education	-
P5	10	Mathematics Education	-
P6	16	Mathematics Education	-
P7	13	Mathematics Education	-
P8	10	Mathematics Education	-
P9	7	Mathematics Education	M.S. in Mathematics Education (ongoing)

3.3 Data Collection Tool

The study was conducted with nine middle school mathematics teachers. In this study, teachers' views on the use of technology in their lessons, their experiences, difficulties, and their ways of overcoming these difficulties were analyzed.

One of the data collection tools which can be used in qualitative research is the interview. The open-ended questions and examinations asked in the interviews ensure that in-depth answers are received about the individuals' experiences, feelings and thoughts, perceptions, and knowledge (Pattons, 2015). Therefore, interview is an essential method of revealing people's perspectives, perceptions, and feelings toward events (Yıldırım & Şimşek, 2018). The data was collected through face-to-face and semi-structured interviews with teachers in the current study. Based on all this information, in this study, the interview was used as a data collection tool to analyze the experiences and opinions of teachers in using technology in detail. Interviews were held with participating teachers to obtain information about their ways of technology use, perceived benefits of technology, difficulties they faced in using technology, and their ways of overcoming these difficulties based on their experiences. Moreover, their suggestions for teachers who want to use technology in their classrooms and recommendations for increasing technology use in schools were asked in the interviews.

A semi-structured interview with 21 questions was used for data collection (Appendix A). The interview questions started by asking the demographic information of the teachers, such as their educational background and teaching experience, and continued with detailed questions about the course processes and technology use. Before the interview form was prepared, a pilot interview was conducted with a mathematics teacher to check the questions' relevance, clarity, and intelligibility. In line with the suggestions of an expert, the interview form took its final form. The interview form of the current study can be found in Appendix A.

3.4 Data Collection Process

This study was carried out with 9 middle school mathematics teachers working in middle schools in the 2021-2022 academic year. Before the interviews, necessary permission was obtained from the Research Center for Applied Ethics of Middle East Technical University.

The data of the research were collected through semi-structured interviews. Participation in this study was on a voluntary basis, and the participants were informed about it. Before the interviews, the researcher informed the participants about the purpose of the research, the interview process, and the data analysis process. This information was also given to them with a written informed consent form, and they signed it to participate in the study. The consent form of the current study will be shown in Appendix B.

The interviews with the teachers were conducted face to face, and the interviews were audio-recorded. Permissions were obtained from the participants before recording the interview, and it was assured that the interviews would only be used for research purposes. The study data were collected in environments where the participants could express themselves comfortably, and audio recordings could be made during the periods they made an appointment. Interview questions were directed to each participant with the same words and intonations that would evoke the same meaning. The interviews were held in a single session and were not interrupted. In the one-to-one interviews with the teachers, the interview time lasted approximately 25 minutes for each teacher.

3.5 Data Analysis

The qualitative data obtained in the interview technique are verbal. Therefore, analyzes are carried out with words, sentences, and paragraphs instead of numbers obtained in quantitative research. In this study, the content analysis method was used to analyze the data obtained to examine the views of middle school mathematics teachers about the use of technology depending on their experiences in using technology in their classes. Content analysis is a systematic and repeatable analysis method in which a text is summarized by grouping it into smaller subunits, with coding done within the framework of specific rules (Büyüköztürk et al., 2018). The data in this study were obtained by analyzing the answers given by the teachers to the semi-structured interview questions prepared by the determining research questions. The interviews with the teachers were conducted face to face and were audio-recorded. The audio recordings were transcribed, and all the data were read and analyzed. Afterward, codes were created for each question that was thought to be related to the answers given by each teacher. After the researcher developed the codes in the data analysis part, sub-categories and main categories were created based on the codes. In the findings section, the code, sub-category, and main categories are given. Sample quotations from the teachers' answers, which are thought to be helpful for the research, are shown in the findings section.

3.6 The Trustworthiness of the Study

Various measures were taken to ensure the validity and reliability of the research. In qualitative research, validity is related to the accuracy of scientific findings, and reliability is associated with the reproducibility of scientific findings. (Yıldırım & Şimşek, 2018). Lincoln and Guba (1985) refer to validity and reliability as trustworthiness more in qualitative research, and they specified the criteria to increase credibility as credibility, transferability, dependability, and confirmability.

For the internal validity of the research, a literature review was done, and a conceptual framework was created first. Subsequently, interview questions were

prepared, evaluated by an expert, and given their final form. Afterward, the interviews were audio-recorded, and the recordings were transcribed. While the main themes created within the scope of the interview were then interpreted, they were divided into sub-themes and analyzed with the systematic analysis method. For the external validity of the research, the study's research design, participants of the study, data collection tool, data analysis method, and interpretation processes were explained in detail. In the research, some opinions were conveyed directly, and the rate of internal consistency was increased. To increase the study's external validity, how the study group was selected was mentioned in detail, and its demographic information was given in detail and presented in the research. The assurance also ensured the reliability of the research that the identity information and answers of the participants would be kept confidential. The study was carried out in an environment where the participating teachers could respond without feeling under pressure, in which they chose and made their own decisions. The first version of the data of the research was kept. As a result of the study, opposing views are also included in the findings and discussion chapters.

3.7 Ethical Considerations of the Study

To ensure confidentiality, the names of the participating teachers were not used. Instead, codes were used. Information received from participating teachers will be kept confidential unless for scientific purposes.

Before the interview with the participants, the purpose of the study was clearly stated. They were assured that the data received would not be used for any other purpose. Efforts have been made to ensure that they are not harmed physically or psychologically. The interviews were conducted on a voluntary basis. In other words, teachers participated in the research voluntarily. Moreover, before the interviews were conducted, ethical permission was obtained from METU Applied Ethics Research Center. It will be given in Appendix C.

3.8 Assumptions and Limitations of the Study

It was assumed that the interview questions were clear and understandable. It was assumed that all participating teachers had the same perception of the questions. It was also assumed that the teachers interviewed for the research were sincere in their answers. It was assumed that the number of interviewed participants was sufficient in line with the research method.

The participants of the study were 9 middle school mathematics teachers working in public schools. The interpretation is limited to this sample. As is usually the case in qualitative research, researcher bias was another limitation in the current study. In other words, the researcher's bias in collecting and analyzing data is a limitation.

CHAPTER 4

FINDINGS

This chapter will include the findings of the research. The study aimed to investigate the experiences of middle school mathematics teachers in using technology in their classrooms. This chapter is organized into five main parts, which are (i) how teachers use technology, (ii) perceived benefits of technology, (iii) barriers faced by teachers in using technology, (iv) methods of overcoming these barriers, and (v) suggestions about technology use.

4.1 How Teachers Use Technology

One purpose of this study was to identify how the participant teachers were using technology in their mathematics classrooms. According to interview data, they used technology in their lessons in three main ways, as seen in Table 4.1. The first column represents the main category of their use of technology. The second column represents the subcategories because they use technology differently in the same category. The third column represents the frequencies.

Table 4.1 Overall Information About the Teachers' Technology Use

Main Use Category	Subcategories	Frequency
Enhancing visibility of content	Showing problems on the smartboard	7
	Showing textbooks on the smartboard	3
	Showing graphs on the smartboard	1
Enriching lesson processes	Using z-books	5
	Using interactive virtual manipulatives	4
	Showing videos	2
Engaging students	Playing games	6
	Doing classroom activities	6

4.1.1 Enhancing Visibility of Content

According to Table 4.1, one purpose of the participants' technology use in their classrooms was to enhance content visibility. To enhance content visibility, teachers use smartboards to enable all students to see the lesson's content easily. This includes showing problems, pieces from the textbook's digital versions, and graphs on the smartboard.

A great majority of the participants show problems with the smartboard for enhancing content visibility. P6 mentioned its effectiveness:

> I prepare problems for the students and show them on the smartboard. It is helpful in terms of saving paper as well as all students can see the problems easily.

Moreover, P5 explained the use of books in her lessons:

> There are textbooks in front of the students, and also, they can see the textbook on the smartboard. In this way, I can show them anything on the smartboard from the textbook. This makes it easier for my lecturing process in the lesson.

One of the participating teachers mentioned the use of graphs in her lessons:

> I prepared graphs for some topics using excel, and I showed students them to the class using the smartboard. All students could see it easily.

4.1.2 Enriching Lesson Processes

This category of technology uses of the participating teachers includes mainly teacher-centered use of technology. They use technology to enrich the lesson process by using z-books, which are written and visual documents as enriched content on digital platforms containing the Ministry of National Education curriculum, using interactive virtual manipulatives and showing videos. For enriching lesson processes, the majority of the participating teachers use z-books. P1 explained her experiences with the z-books as follows:

> Z-books are excellent facilitators. If I were to write and draw by myself, half of the lesson would be over, but thanks to the z-books, all the explanations are ready in front of the students.

Teachers also use interactive virtual manipulatives to enrich lesson processes. Most of them stated that they use interactive manipulatives mostly in geometry topics because of the visual convenience it provides students. About this issue, P9 exemplified that with her experiences:

> I used GeoGebra in the stages of demonstrating and discovering geometry topics. I find it very useful, especially on views of three-dimensional objects. By using technology, it is easy to see the views of objects. We can rotate the object as we want, and students can easily see and understand it.

The participating teachers (P2 and P7) make students watch videos to enrich lesson processes. They made students watch a ten-minute video introducing the subject while beginning a new topic.

4.1.3 Engaging Students

More than half of the participating teachers made students play digital games and do classroom activities with digital content that they can usually access free of charge over the internet using the smartboard to engage students.

Six teachers stated that they use technology to make students play games after the end of the topic. In this manner, students practice what they have just learned. They also said that playing games increase students' motivation. P5 exemplified that based on her experiences:

> I provide students to play games, especially on the topic of multiplication. Playing games is very helpful for their learning because these games make students more willing to work and learn.

Similarly, P1 emphasized that the games played in the digital environment increase the motivation and desire of the students for the lesson:

> There are group-based games. For example, I divide the class into two. As two groups, students can play games in turns. It causes competition. This competition motivates students, and they learn mathematics without realizing it.

Six out of the nine teachers used technology to make classroom activities with their students. Some of them stated that they are doing this to make students practice their mathematical skills. In their opinion, at the end of the topic, doing activities contributes to students' learning. P8 explained her technology use in this manner:

> I use digital tools primarily for activities and solving problems. Activities such as matching or fill-in-the-blank enable students to reinforce what they have learned. The students themselves get up on the board, touch it, match it, or make their solution visually there.

Likewise, P9 also mentioned her use of technology in terms of doing activities for students to practice:

> There are many practical and interactive activities for students in matching styles instead of testing. They both enjoy those activities and reinforce what they have learned.

Three of these six teachers stated that they make students do classroom activities to target students' conceptual understanding. In other words, they think that these types of activities facilitate and improve students' conceptual understanding. P9 exemplified her experiences to emphasize this issue:

> I have some activities in the digital environment, such as fractions. Students can easily comprehend how the fractions change as the denominator changes thanks to these activities.

In the same way, P5 mentioned the importance of these activities for students' conceptual understanding by giving examples of views of three-dimensional objects:

> Especially in geometry topics, visuality is very important for students to understand. For example, in the topic of views of three-dimensional objects, we can easily see the objects from right, left, below, and top. Students create the cubes themselves, and the shape is spinning. Students can transform the shape as they wish. In this way, they can understand the concept clearly.

4.2 Perceived Benefits of Technology

Participating teachers were asked about their experiences using technology and how technology affects their lessons throughout the interviews. They often referred to the benefits of technology. These benefits are seen in the table below (Table 4.2). The first column shows the main categories of the benefits of using technology based on the information from participating teachers. The second column shows the subcategories of these benefits. The last column shows the frequencies.

Table 4.2 Perceived Effects of Technology

Main Category	Subcategories	Frequency
Students' academic development	Making students active	9
	Increasing memorability	4
	Students' conceptual understanding	4
	Student-centered learning	3
	Competitive environment	2
	Making students think deeply	1
Students' affective development	Attracting students' attention	7
	Increasing students' motivation	6
	Loving mathematics, and the teacher	1
Providing convenience for lesson process	Facilitator	8
	Time management	6
	Easily accessible	3
	Rich content	1
Teachers' development	Teachers' conceptual understanding	1

4.2.1 Students' Academic Development

The participants asserted that technology use develops students' academic success.

All of the participating teachers argued that technology use in mathematics classrooms makes students active. They pointed that out it makes them more willing to participate. For example, P3 expressed his opinion about this issue:

> When technology is used in the lesson, students are more willing to come to the board. Smartboard is a technological tool, and some students raise their hands even if they do not know because they want to use it.

Similarly, P5 shared her views about the students' participation and being active in the lesson, supporting P3's view:

> The use of technology encourages student participation in the lesson. When I solve problems on the board, for example, they are not very enthusiastic about solving problems on the board. However, they are more eager to get up on the smartboard.

Some of the participants stated that technology use in mathematics classrooms increases memorability. In other words, thanks to technology, students can remember easily what they learned before. For instance, P2 and P9 pointed out this issue in similar words. When they use technology in their lesson, students can easily remember what they did in the previous lesson. The students could easily remember which problem they solved on the smartboard or which activity they did in their last lesson. They emphasized that this is a situation they encounter very often.

Many participating teachers think that technology use in mathematics classrooms enhances students' conceptual understanding. P2 shared his experiences about the effects of technology on students' conceptual understanding:

> I use GeoGebra to show the relationship between polygon and circle concretely. Also, I use it to show the value of pi. Students know the value of pi is 3,14 or 22 over 7. Most of us do not know or have not researched the remaining digits. When I open it from there, students can see the millionth term. For example, there is a topic of rational and irrational numbers. We say

> that a pi is an irrational number. When students see the following digits, they understand why a pi is an irrational number.

P1, P5, and P8 emphasized that the visuality provided by technology enhances students' conceptual understanding. P1 explained this by giving an example from GeoGebra:

> On the topic of nets of three-dimensional shapes, I take advantage of GeoGebra. Instead of telling the students how the net of shape is and the number of sides and vertices, I help them see the process in three dimensions thanks to GeoGebra by using technology. In this way, students understand much more easily.

It is understood from the teacher's statements that GeoGebra enables students visual help, and this makes them enhance their conceptual understanding of the topic. Similarly, P5 and P8 also stated that technology improves students' learning. Since visuality brings concreteness, it ensures that students learn and understand the topic better.

Few teachers stated that technology is beneficial for students' academic development to create a competitive environment. According to their opinions, playing games with technology allows students to compete with each other and makes them ambitious in mathematics. P1 mentioned the effects of this competitive environment:

> I divide students into groups to play games. While they are playing games in the digital environment, students become ambitious. Since there is a competitive environment, they tend to work on the topic to win the game even if it does not usually attract their attention.

While a minority of teachers talked about the benefits of technology, they stated that it provides student-centered learning. About this issue, P2 expressed his opinion:

> There used to be teacher-centered learning. It has now become student-centered. For example, we have activities. Students can come and do the matching and fill-in-the-blank activities by touching the smartboard. All our students become active.

In addition to P2, P7 emphasized that technology leads to student-centered learning. She said that students learn by experience thanks to the use of technology, and this

contributes to their learning. She also said that it is more beneficial for students to learn by doing it themselves, rather than the teacher's direct teaching.

According to P1, a competitive environment makes students study mathematics, positively affecting their academic development. Similarly, when asked why she finds technology useful, P8 stated that using technology for playing games creates competition in the classroom and causes students to be ambitious.

One of them (P6) mentioned that it makes students think deeply. According to his answers to interview questions, he uses digital tools on the smartboard to make students play mind games such as Sudoku and Mancala. He argued that these games make students think deeply. He supported his thoughts:

> Especially for the mathematics lesson, the students need to think hard. These games are helpful. Students have to think about it and comment on it. In the high school entrance exam, there are questions based on interpretation. That's why it is beneficial for the students.

4.2.2 Students' Affective Development

In the light of the answers received from the interviews with the middle school mathematics teachers, technology use provides students' affective development. They emphasized that students' attitudes, beliefs, and emotions toward learning mathematics have improved thanks to the technology.

Almost all teachers referred to the students' affective development to attract their attention. From their point of view, technology use in the classroom enables students to increase interest in the lesson. P4 explained his opinion based on his experience:

> Since we are in the age of technology, and children are very good with technology, using technology in the classroom attracts their attention.

He explained his thoughts on this point by associating it with students' enjoyment of using technology. On the other hand, P5, P8, and P9 express their thoughts about this issue by making a relationship between visuality and increasing students' interest.

For example, P9 said visuality is very attractive, especially for middle school students. In addition to P9, P5 shared her observations based on her experience:

> While giving a lecture, I used unit cubes as concrete material. I also used technology to show the students the cubes. I realized that seeing on the smartboard is more attractive for them than the concrete materials they have.

The majority of the participating teachers pointed out that technology use increases students' motivation. P1 mentioned the competitive environment created by technology. Correspondingly, she said that this competitive environment increases the motivation of students. Also, P4 emphasized the importance of technology use:

> It increases students' interest and motivation. I think this is the essential feature of using technology.

Likewise, P5 stated that even using a smartboard and solving problems increases their motivation because they want to use it. They become more willing and enthusiastic about the lesson, she added.

One of the participating teachers (P1) stated that using technology in mathematics lessons allows students to like mathematics and the teacher. She supported this idea by describing an experience she had:

> We usually make students choose elective courses. The mathematics course was not chosen until last year. However, last year, I started using technology in mathematics classrooms. Students chose mathematics as an elective course at a very high level of participation.

It can be understood from this example that most of the teachers concluded that technology use might increase the students' desire and love for the lesson and the teacher.

4.2.3 Providing Convenience for Lesson Process

According to the information obtained by the teachers interviewed, the use of technology provides convenience for lesson process in many ways.

Most of them stated that technology use is a significant facilitator when writing, drawing geometric shapes, using ready-to-use exercises, and doing practice sessions. P1, P2, P3, P4, P5, P6, and P9 pointed out that technology is a good facilitator in writing and drawing shapes. They generally said that it is much easier to write and draw shapes on the smartboard than do these on the board. As an example of this, P1 said:

> We have z-books. A pencil tool, eraser tool, and geometric shapes tool are included. We can easily use them, and it is so helpful for us. We do not need to worry about writing and drawing on the board.

P2 also expressed his ideas with these words:

> Students may not be able to read what I wrote. Maybe my writing would be bad. Maybe there would be too long questions to fit on the board. In such situations, using technology helps us a lot.

In addition to these ideas, P4 supported them by saying that in geometry topics, there are ready-to-use shapes, and also you can use different colors with the help of technology.

P1, P8, and P9 emphasized the facilitating effect of technology in terms of students' practices. P1 explained this by talking about z-books again. She said:

> Z-books give feedback. For instance, there is a question mark button. After students solve the problems on the smartboard, they can see whether their answers are correct or wrong when they press that button.

Similarly, P9 shared her experiences with this issue:

> Students do activities or solve questions on the smartboard by using an application. If they made mistakes, the application says it is wrong. They have to find the right answer and correct their errors. For example, there is an activity to match fractions with decimal numbers. The student needs to find the decimal number by expanding the fraction. If the student made a calculation error and tried to match incorrectly, the application does not allow

> this. Thus, the student can think and find where s/he made a mistake and correct it.

Only P9 mentioned the benefit of technology in terms of providing ready-to-use exercises. She said that it is a good facilitator because there are ready-to-use exercises or activities, and therefore she does not have to make any preparations for them.

Most teachers think that technology use provides convenience in terms of time management. According to them, it speeds up the process and allows to solve more problems. P3 shared his ideas and experiences about speeding up the process:

> Technology speeds up my work a lot. I do not have to have students write the questions and solve them. We are just trying to solve them.

P6 supported P3 by saying, "If I try to draw a shape on the board, maybe 10 minutes will pass. Also, maybe I need to spend 10-15 minutes to solve a question, but thanks to technology, I solve 5-6 questions in 10-15 minutes."

At the same time, from this speech, it is clear that technology use allows teachers to solve more questions. As another example of this point of view, P5 emphasized that technology provides for solving more questions:

> Since the questions are ready, we can complete a test very quickly in one lesson, and students see different types of questions.

According to the answers obtained from the interviews with the teachers, one of the other reasons using technology provides convenience is that it is easily accessible. Three participating teachers (P3, P4, P9) mentioned this technology property. P3 said:

> Smartboard is a big project. It is available in every classroom. All teachers in Turkey can reach them very quickly. Internet connection is not a problem at all.

P4 and P9 supported this opinion. They pointed out that since there is the internet, they have instant access to all kinds of information and everything they want to show the students.

One of the participating teachers (P7) stated that technology provides convenience due to its rich content. She emphasized that she can access all kinds of activities or course content related to any topic, making her work much easier.

4.2.4 Teachers' Development

One of the participating teachers (P1) mentioned that technology provides development to teachers while talking about the benefits of technology. She stated that technology use increases teachers' conceptual understanding. She used the following expressions to explain this opinion:

> 8th-grade topics such as net of a cube, net of a pyramid, and net of a prism are the topics that I have difficulty with. When I was a student, I had difficulties with these topics. These were the topics that I had difficulty teaching because it requires three-dimensional thinking. I believe that I have deficiencies in three-dimensional thinking. GeoGebra came into my life just in those parts. I used it in my lessons. I realized that I could teach better. I understood better and more comprehensively and transferred it to the students.

4.3 Barriers to Technology Use

The participants of this study, who are middle school mathematics teachers, were asked to describe the challenges they encountered in using technology in their classrooms if they have. In the light of the information obtained, barriers to technology use were grouped under four categories: (i) student-related challenges, (ii) teacher-related challenges, (iii) time management issues, and (iv) technical and infrastructural problems. Table 4.3 presents these categories and their subcategories with the frequencies for each subcategory.

Table 4.3 Barriers to Technology Use

Main Category	Subcategories	Frequency
Student-related challenges	Students' lack of prior knowledge of mathematics	2
	Students' difficulty in using technology	2
	Students' negative attitudes towards mathematics	2
	Students' difficulty in mathematics	1
Teacher-related challenges	Teachers' difficulty in using technology	3
	Classroom management problems	3
Time management issues	Increased preparation time	2
	Increased time for low achieving students	2
	Having limited time to cover the curriculum	1
Technical and infrastructural problems	Power & internet outages	5
	Problems with smartboard	3

4.3.1 Student-Related Challenges

A few of the teachers had difficulty because of the students' lack of prior knowledge of mathematics. P1 explained the problem she faced in this regard:

> Technology use increases students' participation in the lesson. However, some students lack prior knowledge. It is tough to enable them to participate in the lesson in such cases. Technology attracts their attention, but it would not be enough.

P4 supported what P1 said by expressing his thoughts about this challenge:

> Teaching mathematics is challenging. Very few students are successful in mathematics. Students lack prior knowledge, and it is tough to involve them in the lesson.

When asked teachers to share their difficulties in using technology, two of them mentioned students' difficulty using technology. P9 was one of them, and she stated that students might have problems using the smartboard. In addition to P9, P1 also emphasized the challenge of students' technology use:

> Since some students are not good at using technology, I have to explain how to use technology first. …Students may fail in technology use in the classroom, which may be demoralizing.

According to this point of view, students' difficulty in mathematics and technology use creates challenges for the teacher and the process of the lesson. Also, this challenge causes another challenge, a decrease in students' motivation.

Students' negative attitudes towards mathematics were another barrier that some teachers mentioned. They mentioned that students fear mathematics, which causes them to fall behind at every lesson stage. P2 explained this situation with the following sentences:

> Mathematics has become a fear in Turkey. There is a bias towards mathematics. Students think that they will not be successful, and therefore, they do not want to be active in the lessons. Sometimes, we cannot ensure student participation in the lesson.

One of the participating teachers (P1) mentioned students' difficulty in mathematics as a barrier. She shared her ideas based on her experiences:

> Students may fail when using technology due to their knowledge of mathematics. This may lead to a decrease in students' motivation.

In summary, teachers had difficulties using technology in their classrooms due to student-related problems: students' lack of prior knowledge of mathematics, technology use, negative attitudes towards mathematics, and difficulties in mathematics.

4.3.2 Teacher-Related Challenges

Some of the teachers remarked on their deficiency in using technology and stated that this was among their difficulties. To explain this barrier that he encountered, P2 said:

> It is a fact that, at first, I had difficulty using smartboards. I had problems writing on it, using applications, etc. In the distance education process, it was hard to instruct the lesson due to my deficiencies in using technology.

Additionally, P9 emphasized the importance of knowing technology use with the following words:

> It is necessary to be good at using technology. I do not have a problem because I know how to use it, but I could sometimes have problems first. Experiencing such difficulties caused a reaction from the students.

Classroom management problems are another teacher-related problem mentioned by participating teachers. P9 touched on this when talking about knowing how to use technology by saying, "Experiencing such difficulties caused the reaction from the students." Also, she added, "These reactions can create an atmosphere of chaos in the classroom and cause us to have problems with classroom management."

Moreover, P5 explained with a different example that she sometimes has problems with classroom management while using technology:

> Sometimes, an application we plan to do does not proceed as we imagined in the classroom. It can attract students' attention excessively. They always want to do it. For example, if they played the multiplication facts game in a lesson, they want to play the same game every lesson. Although it is very beneficial for the lesson, it can sometimes cause classroom management problems.

To sum up, according to teachers' perception, teachers' related challenges, which are teachers' difficulty in using technology and classroom management problems, are barriers to technology use in mathematics classrooms.

4.3.3 Time Management Issues

Two of the participating teachers (P1 and P4) think the use of technology is time-consuming because it increases the preparation time for the lesson. For example, P1 mentioned this barrier based on her experiences:

> I am not a person who uses technology perfectly. It takes a process for me to discover it first. This increases my preparation and planning process before the lesson. If I am going to get students to use technology, I first have to explain how to use it. …Normally, it does not take much time for me to plan a lesson, but if I am going to use technology in the lesson, I need to spend more time.

P1 and P5, who thought that the use of technology is time-consuming, pointed out that students' level of success affects this. They believe that if students' achievement level in mathematics is low, there is limited time to use technology. P5 exemplified this by describing her experiences:

> I used to work in a school with higher-level students. I was using technology much more active there because we made faster progress in the lesson. However, depending on the students' level, if our progress is slow, we can sometimes do an activity using technology. Sometimes we cannot. Therefore, students' level of success can be a barrier to using technology.

P1 supported the explanation of P5 by sharing her experiences. She pointed out that she chose a student and made her/him use a digital tool to make the discovery part. She said that if she chose a student with a low level of success, she would lose much time.

One of the teachers (P5) had difficulty having limited time to cover the curriculum. She said there is a curriculum, and she needs to follow it week by week. She added that she wants to do more technology activities but has limited time.

In conclusion, because of increased preparation time, students' level of success, and limited time to cover the curriculum, participating teachers think that technology use is time-consuming and a barrier to technology use.

4.3.4 Technical and Infrastructural Problems

The most mentioned barrier was technical and infrastructural problems. Seven of the nine teachers talked about technical and infrastructural issues. The majority of them noted that power and internet outages could be a barrier in the lesson. As an example, P6 said that he makes students play math-related games with digital content on the smartboard. He emphasized that the electricity or the internet could be cut off at that moment, which caused him difficulties. P2 supported what P6 said, "In one of our classrooms, there was a problem with the internet, which created difficulty for us in using technology in the classroom."

Some of the teachers stated that the problems with the smartboard are a barrier. P4 associated this situation with time management issues from his experiences and exemplified it as follows:

> Sometimes the smartboard takes too long to boot up. We waste time waiting for it to boot up in the classroom.

In addition to P4, P9 said that the smartboard sometimes freezes while using it, which was one of the difficulties she faced.

Briefly, teachers perceived technical and infrastructural problems as barriers to technology use in mathematics classrooms: power and internet outages and problems with the smartboard.

4.4 Teachers' Ways of Overcoming Barriers

The teachers were asked how they overcame these barriers. Table 4.4 shows their methods of overcoming the obstacles that were mentioned before. The first column of the table presents the barriers to technology use under the main categories. The second column shows the overcoming methods of the teachers, and the last column shows the frequencies.

Table 4.4 Teachers' Ways of Overcoming Barriers

Barriers	Overcoming Ways	Frequency
Student-related challenges	Guiding students	2
	Being prepared	1
Teacher-related challenges	Being prepared	2
	Instant solutions	2
	Rewarding	1
Time management issues	Instant solutions	2
	Being prepared	1
Technical and infrastructural problems	Instant solutions	4
	Technical assistance	2
	Using textbooks and materials	2

4.4.1 Overcoming Ways for Student-Related Challenges

The teachers mentioned four student-related challenges. These were students' lack of prior knowledge of mathematics, students' difficulty in mathematics, students' difficulty in using technology, and negative attitudes towards mathematics. Some teachers pointed out that they guide students to overcome these barriers. For example, P9 stated that if the students have difficulties using technology, she guides them. She said that she helps students with the points when they have problems. Like P9, P1 also stated that if students' motivation decreases because they fail in mathematics or use technology, she guides them and explains how they would do.

One of the participating teachers (P1) emphasized that it is essential to be prepared for student-related challenges such as students' difficulty in mathematics and using technology. She said:

> I prepare better beforehand to help students with their problems. I am trying to be more prepared and have full knowledge.

In summary, the teachers overcome student-related challenges by guiding students and being prepared.

4.4.2 Overcoming Ways for Teacher-Related Challenges

The teachers mentioned that as teacher-related challenges, teachers' difficulty using technology and classroom management problems are barriers to technology use. Some of the teachers pointed out that being prepared is a method for overcoming the obstacles of teacher-related difficulties in using technology. For instance, P2 mentioned that he had difficulties in using technology, and he explained his overcoming method:

> I had difficulties using the smartboard, but I learned as I used it. As I researched, I got used to using it. I no longer have a lesson without using the smartboard.

P1 mentioned that sometimes she has difficulties in using technology. She pointed out that being prepared is an overcoming method for student-related challenges. She also used this method while having difficulty using technology. She said that she prepared before the lesson and minimized this difficulty.

Some of the participants referred to using instant solutions when they have problems with classroom management. For instance, P5 explained how she managed to overcome the classroom management problem which was mentioned in the teacher-related challenges part:

> I allow students to play the game they want to play if we have enough time. However, if there is no time, I say let's finish the topic; if any time remains, we will play.

One of the participating teachers (P8) used rewarding as an overcoming method for the classroom management problem. She pointed out that while using technology in the classroom, especially when students are playing games, there is a chaotic environment in the school. She explained her overcoming method in such a case:

> I use the reward method when there is chaos in the classroom. I say that I will give a prize or give a high score to the winning group. In this way, I enable students to focus better.

To sum up, the teachers use overcoming methods which are being prepared, instant solutions, and rewarding to overcome teacher-related challenges.

4.4.3 Overcoming Ways for Time Management Issues

For the increased preparation time problem, one of the teachers (P4) used instant solutions. He mentioned the challenge of increasing preparation time by associating it with technical and infrastructural problems. He pointed out that the smartboard takes too long to boot up, which causes time problems. He shared his overcoming method:

> I usually assign students. Before I enter the class, they make the smartboard open and usable during the break. I do not have to deal with it again in the lesson.

P5 referred to having limited time to cover the curriculum as a barrier. She did not offer any overcoming method for this. She cited this as a disincentive factor for technology use.

Two of the teachers (P1 and P5) stated that low student achievement caused problems in time management. P5 mentioned this barrier as a disincentive factor for technology use and did not offer any overcoming method. Similar to P5, P1 also noted the difficulty of students' level of success as a time-consuming problem. She stated that if she chose a student with a low level of success for technology use, she lost time. To overcome this, she mentioned using instant solutions:

> I choose students with a high level of success because some students have deficient achievement levels. If I choose them, besides wasting time, I cannot get efficiency from the lesson. Rather than misdirecting the process, I select successful students.

For the barrier that technology is time-consuming in terms of increasing preparation time, one of the teachers (P1) mentioned the importance of being prepared as an overcoming method. She pointed out that the preparation time is getting longer

because of her lack of use of technology. As an overcoming method, she stated that she tried to prepare more and learn the use of technology better.

In short, instant solutions and being prepared are the methods used to help participants overcome the time management issues of technology use.

4.4.4 Overcoming Ways for Technical and Infrastructural Problems

The teachers referred to power and internet outages and problems with smartboard in terms of student level as technical and infrastructural problems.

Many of the teachers overcome technical problems by using instant solutions. P9 explained her method other than technical assistance for the problem with the smartboard and power outage:

> Since students' notebooks are open, I draw whatever the question or shape is on the board, or we just move on to another example.

P3 also mentioned that power or internet outages are barriers to technology use, and similar to P9, he transferred the contents of the smartboard to the board as an instant solution.

Some of the participating teachers mentioned that they received technical assistance to overcome technical issues. For example, P2 explained this method for overcoming internet outage problems based on his experiences. He pointed out an internet problem in one of the classes, and the school administration provided technical assistance to handle this problem. In addition to P2, P9 also emphasized getting technical assistance as an overcoming method for problems with the smartboard. She said that they received help from informatics teachers in such a case.

Two teachers (P6 and P7) stated that they use textbooks and materials to overcome technical problems. P6 cited power and internet outages as a challenge. He expressed his opinion:

> I want to acquire the games I make students play in the digital environment as material and use them.

To sum up, the teachers overcome technical and infrastructural problems by using instant solutions, getting technical assistance, and using textbooks and materials.

4.5 Teachers' Suggestions

The participants who are middle school mathematics teachers were asked to make suggestions (i) to teachers and (ii) to increase technology use. A summary of their recommendations is shown in Table 4.5.

Table 4.5 Teachers' Suggestions

Main Category	Subcategories	Frequency
Suggestions to Teachers	Practicing technology use	4
	Researching	4
	Knowing when to use technology	2
	Collaborating with other teachers	1
	Preparing technology integrated lesson plans	1
	Guiding and making all students active	1
Suggestions to Increase Technology Use in the Classrooms	Organizing seminars	4
	Motivating teachers' technology use	3
	Writing projects	2
	Support from school administration	2
	Collaborating with other teachers	2
	Making effective technological tools available	2
	Improving students' technology use	1

4.5.1 Suggestions to Teachers

The participants were asked their suggestions for teachers who want to use technology in their lessons.

One of the most mentioned suggestions is practicing technology use. To use technology in mathematics classrooms, they pointed out that it is essential to practice technology use for doing it successfully. For example, P7 said:

> I recommend them to use because the content is enriched. Visibility is important. Since visuality is essential, I think it should be used abundantly. It is necessary to have full knowledge of the use of technology. They need to know very well how to use the smartboard not to have any problems.

In addition to P7, P6 also mentioned the importance of practicing technology use:

> First of all, they must know how to use a computer. For example, we have teachers in our school who have difficulties. We have teachers who are not good with technology. There must be a technological background. If there is no background, they have to learn somehow. I think it should be used actively.

They pointed out that teachers need to know technology use well and develop themselves in this field.

Another suggestion most frequently mentioned by teachers is researching. They emphasized that teachers need to research and learn about technology. For instance, P5 expressed her request in these words:

> I think teachers need to be in constant development. Using technology is a significant advantage in mathematics. There is a wide range of content, applications, and activities in this field. They must be in constant research, and they need to educate themselves well in this regard. If we know which applications are available and which ones are more useful, that is, if we are always in development and have the knowledge, we will see much more benefit. Thus, we can provide this benefit to students to a great extent.

P1 supported this explanation by saying:

> They need to do some preliminary research. There is so much content for teachers who want to use it that I did not know this much until the distance education process. Therefore, it is necessary to do preliminary research first.

Some of the teachers emphasized the importance of knowing when to use technology. They mentioned that knowing this provides teachers to use technology more effectively. About this issue, P4 expressed his suggestion on this issue with the following words:

> It is necessary to utilize technology adequately and appropriately. A mathematics lesson should not be a class that only includes the use of technology, and the teacher loses her/his influence. The teacher needs to achieve this balance very well.

One of the participants (P1) suggested that teachers who want to use technology in their lessons collaborate with other teachers. She explained her thoughts by saying, "Collaboration with colleagues is necessary. There are many digital tools, games, and activities. In this way, it can be ensured that teachers are aware of them."

Preparing technology integrated lesson plans is a suggestion of one of the participating teachers (P9). She emphasized that teachers should make their lesson plans, including technology use.

One of the participants (P8) drew attention to the fact that all students should be active in the lesson. According to her, teachers need to guide students well to make all students active. She explained this suggestion:

> Guiding is important. While a student is doing something on the smartboard in the lesson, other students should be able to be included in some way. It is necessary to guide the students.

4.5.2 Suggestions to Increase Technology Use in Classrooms

The participants generally stated that technology should be used in mathematics classrooms, but it is not used sufficiently. They were asked what their suggestions were for increasing technology use.

The teachers' most common suggestion to increase technology use in the mathematics classrooms was to organize seminars about it. P3 mentioned this while talking about his suggestion:

> It would be good to have seminars for teachers about programs like GeoGebra, which I just mentioned. We attend seminars for a week. These are the best things that should improve us. …We spend our free time and do nothing in seminars. For example, I think it would be more beneficial for teachers from the same branch to gather in a single school and organize seminars.

P4 also pointed out this issue by supporting P3:

> Teachers should be trained in this regard. I think older teachers are cool toward technology use since they come from a traditional structure. I believe that there may be in-service training such as seminars for teachers to raise their awareness a little more. We received such training about technology. This training should be expanded.

They complained that seminars were wasted and emphasized that technology-related training should be given in the seminars.

Three of the teachers suggested that teachers should be motivated to use technology. It was mentioned that this could be achieved by recommending and supporting teachers who do not use technology in their classrooms. It was also said that the use of technology could be increased with motivation. P1 referred to this as:

> For project writing, some teachers may be given certificates of achievement. They can be assigned to participate in training abroad within the scope of Erasmus. Motivations like this can be helpful.

P4 supported P1's opinion by saying that he approached his colleagues in a supportive way, and some of them started to use technology thanks to his motivation.

Some of them think that writing projects will increase the use of technology in the classrooms. P1 suggested this by saying:

> Projects can be written. For example, active eTwinning and Erasmus projects are currently written very often. The most popular topic in these projects is Web 2.0 Tools. I think they might be of interest.

Some of the teachers pointed out that the school administration should support the teachers' technology use in schools. It was also mentioned that the school administration could control the use of technology by teachers. P6 shared his suggestion about this issue as follows:

> Teachers need to be guided. The usage hours in schools can be checked. It should be more encouraging. How many hours a teacher uses technology or smartboard can be checked.

Collaborating with other teachers was another suggestion by the participating teachers. They mentioned the importance of teachers sharing whatever content they use with each other. P3 explained his recommendation on this issue with the following sentences:

> There is a lot of content on the internet. These can be shared on some social platforms and inform more teachers.

P9 also made a similar suggestion, emphasizing the availability of technology integrated sample lesson plans, and said, "Lesson plans involving the use of technology should be prepared, and these lesson plans should be shared on the internet."

Another suggestion of teachers (P7 and P8) to increase technology use in classrooms was to make effective technological tools available. They stated that technological tools and the techniques used in these technological tools should be developed. They think that the availability of effective technological tools that enable students to participate more actively in the lesson will increase the use of technology.

One of the teachers (P5) remarked that students' use of technology should be improved to increase the use of technology in mathematics classrooms. She expressed her ideas as follows:

> I guess we need to increase the readiness level of our students. We need to introduce them to technology earlier. Our students see technology more like a field of entertainment. We need to introduce the teaching part to our students more.

CHAPTER 5

DISCUSSION

In this chapter, findings will be discussed. Then, the implications and recommendations of the study will be explained.

5.1 Discussion of the Findings

The findings will be discussed, considering the research questions. It means that how teachers use technology, perceived benefits of technology, barriers to technology use, methods of overcoming barriers, and teachers' suggestions will be discussed considering the findings of previous studies.

5.1.1 How Teachers Use Technology

The participant teachers of the study stated that they use technology to enhance the visibility of content, enrich lecturing processes, and engage students. These uses of technology will be discussed based on the study's findings in the previous chapter.

In the current study, the teachers argued that they use technology to enhance content visibility by showing problems, textbooks, and graphs on the smartboard. Most of them think it is essential in teaching mathematics and beneficial for students. They stated that projecting the problems, textbook, and graphics on the smartboard ensures that all students can see them quickly, which is very useful.

Similar findings were also obtained in some studies in the literature. For example, according to the study by Bozkurt and Cilavdaroğlu (2011) conducted with mathematics teachers, it was found that teachers use technology to project the lesson's content. Moreover, Taş et al. (2020) found that teachers use technology to get students to see the same questions in the same way. From this information, it can

be concluded that teachers use technology to project the questions and course contents on the smartboard in the literature studies. In other words, the findings of this study are consistent with similar studies in the literature on increasing the visibility of content.

The participant teachers stated that they use technology to enrich lesson processes by using z-books, interactive virtual manipulatives, and showing videos. The participant teachers of this study frequently use z-books. They use a digital book that includes instructions and examples about the topic. In their opinion, z-books are beneficial for the lesson process because they contain ready-made lesson content. In the lesson process, using interactive virtual manipulatives is also helpful. GeoGebra was generally mentioned for geometry topics. In other words, the teachers find GeoGebra useful for geometry. These interactive virtual manipulatives allow students to easily see geometric shapes in three dimensions, which helps them understand the topic better. Moreover, it was stated that technology is used to enrich lesson processes by showing short videos to students at the beginning of the new topic. The teachers think it provides students with a general knowledge of the subject and an exciting introduction.

In the study conducted by Tican and Toksoy Gökoğlu (2021), it was found that mathematics teachers use z-books in distance education in Turkey. In this study, it was determined that teachers use z-books to solve questions in distance education. In this regard, it has not been found in the literature that z-books are used because they enrich the lesson process. In other words, this study revealed that teachers use z-books to improve the lesson process in addition to previous literature. Consistent with the current study's findings, Koştur and Türkoğlu (2017) found that middle school mathematics teachers use GeoGebra to visualize the lesson content and show videos to students.

According to the information obtained from the participating middle school teachers, they use technology to engage students by making students play games and do classroom activities. It was concluded that this was one of the most frequently

mentioned goals for using technology in the classroom. They think that playing games increase students' motivation and desire to learn the lesson content. They generally make students play games about the topic towards the end of the subject for practice. In addition, they pointed out that making students do classroom activities supports learning and provides conceptual understanding.

In the literature, Ruggiero and Mong (2015) concluded that teachers use technology to get students to play games and do activities about the topic after the lecturing. It has been stated that these are among teachers' most frequently used technology. In this respect, it is consistent with the current study's findings.

From these results, it can be concluded that teachers integrate technology into their lessons at a basic level. Their technology uses are concentrated in the substitution and augmentation levels, called enhancement which are the first two steps of the SAMR model. For example, using z-books is at the substitution level of the SAMR model because there is no functional change. Using textbooks, teachers can reach the goals they have achieved in the lesson using z-books. In other words, z-books are used instead of textbooks. On the other hand, making students play games and do classroom activities are at the augmentation level of the SAMR model because according to the participating teachers, they increase students' motivation and understanding. In the augmentation level of the SAMR model, technology provides meaningful and conceptual learning and supports education (Yenmez & Gökçe, 2019).

It was concluded that technology integration was not achieved in modification and redefinition levels, called transformation, which are the more advanced steps of technology integration. This may be because teachers do not know how to properly integrate technology at these two levels. Therefore, teachers should develop themselves in this sense or they should be given opportunities to develop themselves.

5.1.2 Perceived Benefits of Technology

In the current study, perceived benefits of technology were described in terms of students' academic development, students' affective development, providing convenience, and teachers' development. These benefits will be discussed based on the findings in the previous chapter.

One of the findings of this study was that, according to the teachers, technology integration positively affects students' academic success as it makes students active, increases memorability, supports students' conceptual understanding, provides student-centered learning, creates a competitive environment, and makes students think deeply. Especially while playing games, there is a competitive environment because students want to win the game. To achieve this goal, they want to learn the topic. This increases their academic success. Teachers generally use digital tools in the classrooms, and the teachers argue that this provides students to improve conceptual understanding because of its visual effects. According to the participating teachers, the content of the digital tools and software used is beneficial to students in terms of relating and making sense of the subjects. In this sense, it can be concluded that the quality of the content of the digital tools and software to be used is of great importance. According to the current study's findings, student-centered learning is supported by technology because students actively participate in the lesson thanks to technology-supported activities and games. According to the participating teachers, technology allows students to do mathematics and develops students' academic life by making them active in the lesson. All of the participating teachers supported this opinion. Based on the findings of this study, the most significant positive effect of technology in ensuring students' academic development is that it enables students to be active in the lesson. As the reason for this, it can be said that technology increases students' desire and excitement for the lesson and supports their participation in the class. It also increases the retention of basic skills. The participating teachers argue that because technology increases students' interest in the lesson, the information about what is done and what they learned remains in

their minds. According to the current study's findings, the use of technology to play mind games such as Sudoku and Mancala encourages students to think deeply, which contributes to developing their abilities in commenting. This helps them be successful in their exams.

The impact of technology on students' academic development is a subject that is also mentioned in the literature. Unlike the current study's findings, providing conceptual understanding is the most cited benefit for students' academic life in the literature. The result that students' conceptual understanding develops because technology provides visuality was consistent with other studies (Birişçi & Uzun, 2014; Koştur & Türkoğlu, 2017). The benefit of offering student-centered learning was also compatible with the results of other studies (Newhouse, 1999; Akkaya, 2016; Yılmaz & Naci, 2017). Providing permanent learning is also mentioned as a benefit of technology use on students' academic development in the literature (Ural, 2015; Yılmaz & Naci, 2017). This finding is similar to the benefit of increasing memorability found in this study. As a different result, Jacobsen (1998) found that technology use provides students to learn to collaborate and develop essential computer skills.

According to the participants, technology integration positively affects students' affective development. According to the current study's findings, the teachers believe that technology integration attracts their attention, increases students' motivation, and makes them like mathematics and the teacher. According to the participants, technology increases students' motivation by providing visuality and creating a competitive environment. Since we are in the age of technology, the high interest of students in technology is also among the reasons for this. For similar reasons, using technology attracts students' attention and contributes to their affective development. Technology is interesting for students and positively affects their love for the lesson and the teacher.

In the related literature, it has been found that among the positive effects of technology, according to the opinions of teachers, it increases the motivation of

students (Mumtaz, 2000; Allsopp et al., 2010; Rosas & Campbell, 2010; Ural, 2015; Akkaya, 2016) and attracts their attention (Mumtaz, 2000; Al-A'ali, 2008; Birişçi & Uzun, 2014; Ural, 2015; Akkaya, 2016; Önal & Çakır, 2016; Taş et al., 2020), consistent with the findings of this study. It was stated in the study conducted by Meagher (2012) that technology use reduces stress and test anxiety as a benefit not included in the findings of this study. Another advantage of technology on students' affective development that has been found in other studies but not included in the findings of the current study is that it provides students with concentration (Al-A'ali, 2008). This is also a benefit obtained due to technology increasing students' interest. The finding that technology makes the teacher and the lesson loved by students is a finding obtained from the data of this study and not included in the literature studies exactly. As mentioned, some studies in the literature found that technology enables students to develop positive attitudes, according to the teachers' opinion. These positive attitudes are often associated with students' increased motivation and desire for the lesson. Based on these findings of the studies, it can be concluded that students like the lesson thanks to technology, similar to the current study's findings. On the other hand, the finding that students like the teacher thanks to technology is a finding that the current study adds to the literature.

According to the current study, the teachers argue that technology use provides convenience based on facilitating learning, saving time during the lesson, providing easy access to digital content, and providing rich content.

Its role in facilitating learning has been frequently mentioned in particular. It facilitates writing, drawing geometric shapes, accessing ready-made activities, and supporting students' practice. The writing tools and ready-made shapes provided by technology have a facilitating effect on the course. In addition, activities that are accessible and ready-to-use and can give feedback provide an excellent convenience for the teacher in the lesson. Technology use enables more effective and more work to be done in a short time. This is also a frequently mentioned view. The reason why technology saves time is the facilitating effects just mentioned. In other words, lessons can be conducted in a shorter time as it provides convenience in issues such

as writing, drawing shapes, and accessing ready-made activities. As a result of this, students have the opportunity to solve more questions and a variety of questions in mathematics classrooms. The current study concluded that, according to teachers, technology use provides convenience for teaching mathematics because it is easily accessible. Almost every teacher has internet access and can access any information whenever they want. In mathematics classrooms, teachers can easily access the internet and use online resources in teaching any topic with the help of technology. Moreover, the technological tools or software contents are essential for students' learning. Rich content tools provide convenience for the lesson because the quality of the content and the appropriateness of the topics provide more effective learning for the students.

The fact that technology is a good facilitator is also a finding in the literature. For example, Bennison and Goos (2004) found that technology's ability to provide rapid feedback and measure students' understanding facilitates the lesson. Moreover, saving time is also a benefit of technology that is frequently mentioned in the literature (Önal & Çakır, 2016; Koştur & Türkoğlu, 2017; Sen & Ay, 2017; Yılmaz & Naci, 2017; Taş et al., 2020; Korkmaz, 2020). In the current study, it was found that more and different types of questions can be solved because of time-saving. This finding is consistent with other studies that argue that technology allows students to solve more and various types of questions (Bennison & Goos, 2004) (Yılmaz & Naci, 2017).

Bennison and Goos (2004) found that technology provides different representations for mathematics problems. Moreover, it provides real-life examples for students, which improve their learning and reasoning skills in mathematics (Bennison & Goos, 2004; Akkaya, 2016; Yazlık, 2019). Providing visuality and concretization are also among the benefits found in the literature (Önal & Çakır, 2016; Sen & Ay, 2017; Yılmaz & Naci, 2017; Yazlık, 2019). These findings can be associated with the rich content finding in the current study. Providing different representations, real-life examples, and visuality and concretization are the benefits that can be obtained due to the rich content of the technological tool used.

Based on the information obtained from the current study's findings, technology use also helps teachers' professional development. The teachers argued that their mathematical knowledge has also improved because the digital tools provide visualization and support their reasoning ability. It can contribute to the development of teachers in the sense of realizing an idea that they were not aware of before or discovering different solution methods for a problem. Supporting the development of teachers is generally not included among the benefits of technology in studies conducted by interviewing teachers in the literature. In the current study, just one participant mentioned this benefit of technology. From this, it can be concluded that teachers think that technology positively affects students' development rather than their development.

In the findings part, Table 4.1 shows teachers' use of technology, while Table 4.2 shows the perceived benefits of technology. According to the findings in Table 4.2, teachers mentioned the benefits of technology a lot. However, when looking at their technology usage in Table 4.1, it was not encountered such a variety of findings. From this point of view, it can be concluded that although teachers are aware of the benefits of technology, they do not use it sufficiently and to the extent they mention.

5.1.3 Barriers to Technology Use

Student-related challenges, teacher-related challenges, time management, and technical and infrastructural problems are the barriers to technology use in the current study's findings. These barriers will be discussed based on the findings in the previous chapter.

In the current study, student-related challenges were classified as students' lack of prior knowledge of mathematics, their difficulty in using technology, their negative attitudes towards mathematics, and their difficulty in mathematics. Students' lack of prior knowledge causes them to lose interest in the lesson and have difficulty focusing on it. Students' difficulty in mathematics is also a challenge that causes the same undesirable results. Although the use of technology attracts their attention, in

such a case, it can cause them to break away from the lesson altogether. Students' problems using technology are an obstacle to technology integration because it becomes challenging to ensure that they participate in the class in such a case. In addition, it becomes necessary to spend extra time teaching them the use of technology. To effectively integrate technology into the classroom, students need to be involved, and students' difficulty in using technology is a significant obstacle. Students' negative attitudes are barriers because they badly affect the process, causing them to be reluctant to the lesson.

In the literature, the difficulties arising from the teachers were extensively studied, but the problems arising from students were not mentioned as much. As a student-related difficulty, only the misuse of technology by students appears as a disadvantage of technology use in the literature (Koştur & Türkoğlu, 2017; Yazlık, 2019). Students' use of smartboards and the internet for subjects unrelated to the course hinders technology integration.

According to the information obtained from the participating teachers in this study, teacher-related challenges were teachers' difficulty using technology and classroom management problems. If teachers are not competent enough in using technology, it becomes difficult for them to integrate it into the lesson. Moreover, using technology, especially playing games, attracts students' attention so much that it causes chaos in the classroom and makes classroom management difficult.

These findings are consistent with the studies that concluded teachers' difficulty in using technology (Bennison & Goos, 2004; Newhouse, 1999; Schoepp, 2005; Snoeyink & Ertmer, 2002; Wachira & Keengwe, 2011; Birişçi & Uzun, 2014) and classroom management problems (Birişçi & Uzun, 2014; Kutluca & Tum, 2018; Taş et al., 2020) as teacher-related challenges. Except for these, teachers' lack of confidence (Newhouse, 1999; Duhaney, 2001; Snoeyink & Ertmer, 2002; Jones, 2004; Pierce & Ball, 2009) and negative attitudes (Hadley & Sheingold, 1993; Harris & Sullivan, 2000; Snoeyink & Ertmer, 2002; (Pamuk, 2022) are teacher-related challenges for some studies. The reason why teachers do not feel comfortable is that

they are not good enough at using technology. In other words, it can be said that this is another challenge created by their difficulties in using technology.

Technology use was described as time-consuming because of increased preparation time, students' level of success, and having limited time to cover the curriculum. Preparing a technology-based course requires extra time and planning. According to the curriculum, there is a limited time for each subject, and teachers should provide training by this curriculum. This situation creates an obstacle in front of the activities that teachers can do using technology. Moreover, it is possible to lose time while doing technology-based activities or playing games with students with low academic success.

This finding overlapped with some other studies that mentioned increased preparation time (Hirschbuhl & Faseyitan, 1994; Nantz & Lundgren, 1998; Sammons, 1994; Francom, 2016) and having limited time to cover the curriculum (Agyei & Voogt, 2011) as a barrier to technology use. Time problem was found as the most mentioned barrier in the literature. It was also found that technology use saves time in the current study and the studies in the literature. It can be said that while the use of technology saves time in some cases, it also causes a loss of time in some cases. Using technology at the right time and in the right place allows you to experience the convenience of technology, not its difficulties.

In the light of the findings of the current study, the biggest obstacle to using technology was technical and infrastructural problems. The problems stated by teachers are power and internet outages and technical problems with the smartboard. When electricity or internet outages occur during the use of technology in the lesson, it causes the class to be disrupted. Problems such as taking a long time to turn on and off the smartboard or freezing are encountered. As a result of this, the issues with managing classroom time arise. It can be said that a problem encountered during technology integration causes another problem or occurs due to another problem. In other words, it is easy to relate problems to each other.

This finding regarding the barrier of technical and infrastructural problems as a challenge faced by mathematics teachers has been covered in other studies as well (Wachira & Keengwe, 2011; Agyei & Voogt, 2011; Yazlık, 2019). In this sense, these findings of the current study are consistent with the studies in the literature.

5.1.4 Ways of Overcoming Barriers

The participant middle school mathematics teachers shared their ways of overcoming the encountered barriers. For the obstacles like students' difficulty in mathematics and technology use, teachers guide students to improve their skills. To overcome the challenges that students experience due to their lack of mathematical knowledge, teachers aim to be better prepared and be helpful to students to make up for their deficiencies. When teachers have difficulties using technology, they overcome it by working harder and giving more importance to the preparation process before the lesson. Teachers stated that they try to overcome the classroom management problems by making agreements with students. Talking to them and getting their focus on the class or attracting their attention by rewarding them are used to overcome this difficulty in case of chaos in the classroom. Being competent in using technology is a solution to the time-consuming problem because a teacher who knows how to use technology well does not need to spend much time preparing beforehand. For this, it is necessary to prepare better; that is, it is essential to make an effort to learn and be competent. The problem can be overcome by producing instant solutions, such as assigning students to do this before the lesson, for the problem that it takes time to turn on the smartboard. When technical problems are encountered, they can be overcome by requesting technical support. When there is a problem, it can be ensured that the flow of the lesson is not disrupted by continuing from the book or transferring to the blackboard.

5.1.5 Teachers' Suggestions

The participant teachers were asked to make suggestions to teachers who want to use technology in their classrooms. In addition, they were asked to give recommendations to increase technology use in the classroom. Some of the suggestions to teachers were about the need to improve themselves, including practicing technology use and researching. These are the most frequently mentioned advice given to teachers in this study. It can be concluded that teachers' competence is an essential factor for technology integration to be effective. The other suggestions made to teachers were knowing when to use technology, collaborating with other teachers, preparing technology-integrated lesson plans, and guiding and making all students active.

Some of the suggestions of participating teachers to increase technology use in classrooms were to teachers. Some of them were to administrators, and some were to both teachers and administrators. Organizing seminars for improving teachers' technological knowledge and technology use, demanding support for teachers, and making effective technological tools available were the suggestions of the participants to the administrators. Collaborating with other teachers was a suggestion to teachers. Motivating teachers' technology use, writing projects such as eTwinning and Erasmus projects related to the use of technology or the content of digital tools, and improving students' technology use were the suggestions to both teachers and the administrators.

The most frequent suggestion of the participating teachers was to organize seminars by the school administration or national education to improve the teachers' use of technology and their knowledge on this subject. It can be deduced that teachers need training in technology use. Lack of training for teachers is a frequently mentioned problem in technology integration in the literature studies (Wachira & Keengwe, 2011; Chong Chee Keong et al., 2005; Beggs, 2000; Cuban, 2001; Schoepp, 2005; Jones, 2004; Snoeyink & Ertmer, 2002; Agyei & Voogt, 2011; Dvorak & Buchanan, 2002; Harris & Sullivan, 2000; Hsu, 2016; Koştur & Türkoğlu, 2017; Taş et al.,

2020). From this point of view, it can be concluded that studies in the literature support this suggestion of teachers. For example, Yazlık (2019) pointed out that teachers and students should be informed about the use of technology, especially training on smartboards should be given to both groups. Also, Birişçi and Uzun (2014) stated that it should be ensured that the quality of in-service training to be given to teachers should be increased, and these seminars should be organized for branch teachers.

5.2 Implications of the Study

The current study has implications based on teachers' opinions, experiences, and suggestions about technology integration in mathematics classrooms, included in the findings chapter.

When teachers' use of technology was classified within the framework of the SAMR model, it was observed that there was an intensity in the substitution and augmentation levels, and the technology use did not reach the upper levels. To ensure more effective technology integration, usage needs to be raised to higher levels. To achieve this, teachers need to be developed in technology integration. In other words, teachers should be encouraged to improve themselves, or they should be provided with opportunities to improve themselves with training on technology integration.

The study's findings revealed that technology use has many perceived positive effects on students and teachers. According to teachers, it is beneficial for students in their academic and affective development. In addition, technology integration provides convenience in the lecturing process. With the support of technology, the course process becomes easier for students' practices and especially for teachers. Apart from these, teachers also develop professionally thanks to the opportunities provided by technology. The improvement of teachers means that they provide better education to students. In other words, it can be concluded that technology indirectly has a positive effect on the development of students. Teachers who want to use

technology in their lessons need to create the appropriate environment and develop themselves in this area, considering the benefits of technology.

In other respects, the difficulties faced by teachers in the use of technology were put forward. These difficulties are related to students, teachers, time, and technical issues. The teachers shared the challenges they experienced as well as their methods of overcoming them. Strategies for overcoming problems are often geared towards better preparation and study. Except for these, getting help is presented as a solution in the face of technical difficulties. Teachers try to overcome the problems that students encounter to guide and help them. Technical issues were frequently mentioned as barriers. For this challenge, schools should provide the necessary support for the classrooms. Technical support should be ready to respond immediately to such a problem so that the flow of the lesson is not disrupted. To avoid these problems, the technical infrastructure should be solid. Necessary training in the use of technology should also be provided for the difficulties experienced by teachers, which is one of the biggest obstacles to technology integration.

Finally, there are implications for teachers' suggestions to teachers who want to integrate technology into their lessons. The recommendations for teachers are practicing technology use, collaborating with other teachers, researching, preparing technology integrated lesson plans, guiding and making all students active, and knowing when to use technology. Teachers who want to use technology in their classrooms effectively should take into consideration these suggestions in the process of planning their lessons. The tips for increasing technology use in the classrooms are organizing seminars, writing projects, support from school administration, motivating teachers' technology use, improving students' technology use, collaborating with other teachers, and making effective technological tools available. Teachers, school administrators, and parents can contribute to increasing the use of technology by considering their part of these suggestions.

5.3 Recommendations for Further Studies

In this part, some recommendations based on the current study's findings will be given for further studies. Firstly, similar studies can be conducted with more participating teachers. As the number of experiences with technology will increase with the information obtained from more participants, more diverse data can be obtained.

Secondly, studies on the use of technology in different subject areas can be conducted, and similarities or differences can be observed. In the current study, mathematics teachers' experiences regarding the use of technology in mathematics teaching were investigated. A study on teachers' experiences from different subject areas shows how the use of technology in other lessons shows similarities or differences. Thus, it can be distinguished whether the use of technology generally produces similar results or whether it differs according to the course.

Thirdly, it may be suggested to investigate in detail the methods of overcoming the difficulties experienced by teachers in the use of technology for further studies. Although there are many studies in the literature about the challenges experienced by teachers in technology integration, there are not many studies on the methods of overcoming these difficulties. Teachers' ways of overcoming the obstacles they encounter can be helpful as they can create ideas for other teachers. For this reason, it is recommended to increase the studies on this subject.

Lastly, within the framework of the SAMR model, it is recommended to investigate what can be done to maximize the use of technology by teachers in their lessons. In the current study, it was found that teachers' technology integrations were collected at the first two levels of the SAMR model, substitution and augmentation. To make technology integration more effective, teachers need to move their technology use to levels of modification and redefinition, which are the upper levels of the SAMR model (Hamilton et al., 2016). It can be said that studies on this subject will be beneficial as they can enable teachers to develop themselves to use technology effectively.

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APPENDICES

A. INTERVIEW PROTOCOL

Görüşme Soruları

Kişisel Bilgiler

- Mezun olduğunuz fakülte türü ve branşınız nedir?
- Öğrenim dereceniz nedir?
- Kaç yıldır öğretmenlik yapıyorsunuz?
- Bu okulda kaç yıldır çalışıyorsunuz?
- Bu dönem ders verdiğiniz sınıf düzeyleri nelerdir?
- Daha önceki dönemlerde hangi düzeylerde ders verdiniz?

Detaylı Bilgiler

1. Bir matematik dersiniz nasıl geçiyor? Bir konuyu öğretirken hangi adımları izliyorsunuz?
2. Sizce etkili bir matematik dersi nasıl olmalıdır?
3. Derslerinizde dijital araçlardan yararlanıyor musunuz? Hangilerinden? Nasıl?
4. Hangi uygulamalardan faydalanıyorsunuz? Nasıl?
5. Verdiğiniz ödevler teknoloji kullanımı gerektiriyor mu? Ne şekilde?
6. Bu uygulamayı kullanırken dersinizde kullanma sürecinizi anlatır mısınız?
7. Bu uygulamada öğrencilerinizin rolü nedir?
8. Bu uygulamada sizin rolünüz nedir?

9. Bu uygulamanın öğrencilerinize nasıl katkı yaptığını düşünüyorsunuz?

10. Bu uygulamayı kullanma gerekçeniz nedir?

11. Bu uygulamanın sizin için önemi nedir?

12. Sizi bu uygulamayı kullanmaya iten faktörler nelerdir?

13. Dijital uygulamaları kullanırken (varsa) karşılaştığınız güçlükler nelerdir?

14. Karşılaştığınız güçlüklerin üstesinden gelmek için neler yapıyorsunuz?

15. Bu uygulamayı kullanırken öğretmen olarak kendinizi nasıl hissediyorsunuz?

16. Dijital araçları dersinizde kullanmayla ilgili olarak diğer eğitim paydaşları (meslektaş, veli, yönetici) sürece dahil oldu mu? Nasıl?

17. Derslerinde dijital araç kullanmak isteyen öğretmenlere öneriniz ne olur?

18. Derslerde teknoloji kullanımını artırmak için neler yapılabilir?

19. Dijital araç kullandığınız dersinizin niteliğini nasıl değerlendiriyorsunuz?

20. Dijital araçları derslerinde kullanmak isteyen öğretmenleri destekleyen faktörler nelerdir?

21. Dijital araçları derslerinde kullanmak isteyen öğretmenleri engelleyen faktörler nelerdir?

B. CONSENT FORM

ARAŞTIRMAYA GÖNÜLLÜ KATILIM FORMU

Bu araştırma, ODTÜ Matematik Eğitimi Bölümü yüksek lisans öğrencisi Anıl Ayseli Duran tarafından Prof. Dr. Erdinç Çakıroğlu danışmanlığındaki yüksek lisans tezi kapsamında yürütülmektedir. Bu form sizi araştırma koşulları hakkında bilgilendirmek için hazırlanmıştır.

Çalışmanın Amacı Nedir?

Araştırmanın amacı, katılımcıların derslerinde teknoloji kullanımı konusundaki tecrübelerini değerlendirmek, bu süreçte yaşadıkları zorlukları ve bu zorluklarla mücadele etmede kullandıkları yöntemleri anlamaktır.

Bize Nasıl Yardımcı Olmanızı İsteyeceğiz?

Araştırmaya katılmayı kabul ederseniz, sizden beklenen, size sorulan bir dizi soruya cevap vermenizdir. Yaklaşık 40 dakika sürmesi beklenen görüşmede derslerinizde teknoloji kullanımı ile ilgili tecrübelerinizi paylaşmanız beklenmektedir. İçerik analizi ile değerlendirilmek üzere cevaplarınızın ses kaydı alınacaktır.

Sizden Topladığımız Bilgileri Nasıl Kullanacağız?

Araştırmaya katılımınız tamamen gönüllülük temelinde olmalıdır. Görüşmede, sizden kimlik veya kurum belirleyici hiçbir bilgi istenmemektedir. Sağladığınız veriler gönüllü katılım formlarında toplanan kimlik bilgileri ile eşleştirilmeyecektir.

Katılımınızla ilgili bilmeniz gerekenler:

Görüşme, kişisel rahatsızlık verecek sorular içermemektedir. Ancak, katılım sırasında sorulardan ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz cevaplama işini yarıda bırakmakta serbestsiniz. Böyle bir durumda çalışmayı uygulayan kişiye çalışmadan çıkmak istediğinizi söylemek yeterli olacaktır. Bu araştırmanın sonuçları bilimsel ve profesyonel yayınlarda veya eğitim amaçlı kullanılabilir, fakat katılımcıların kimliği gizli tutulacaktır.

Araştırmayla ilgili daha fazla bilgi almak isterseniz:

Görüşme sonunda, bu çalışmayla ilgili sorularınız cevaplanacaktır. Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için Matematik ve Fen Bilimleri Eğitimi öğretim üyelerinden Prof. Dr. Erdinç Çakıroğlu ya da yüksek lisans öğrencisi Anıl Ayseli Duran ile iletişim kurabilirsiniz.

Yukarıdaki bilgileri okudum ve bu çalışmaya tamamen gönüllü olarak katılıyorum.

(Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

İsim Soyad Tarih İmza

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C. METU HUMAN SUBJECTS ETHICS COMMITTEE APROVAL

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

DUMLUPINAR BULVARI 06800
ÇANKAYA ANKARA/TURKEY
T: +90 312 210 22 91
F: +90 312 210 79 59
ueam@metu.edu.tr
www.ueam.metu.edu.tr

Sayı: 28620816 /

14 OCAK 2022

Konu : Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi : İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Erdinç ÇAKIROĞLU

Danışmanlığını yürüttüğünüz Anıl Ayseli DURAN'ın "Ortaokul Matematik Öğretmenlerinin Derste Teknoloji Kullanımı ile İlgili Deneyimleri" başlıklı araştırmanız İnsan Araştırmaları Etik Kurulu tarafından uygun görülmüş ve **0003-ODTUİAEK-2022** protokol numarası ile onaylanmıştır.

Saygılarımızla bilgilerinize sunarız.

Prof.Dr. Mine MISIRLISOY
İAEK Başkan