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ORIGINAL ARTICLE

Interdisciplinary Comparative Analysis of Science and Mathematics Teachers' Level of Technology Use in Teaching Processes, Their Aims and Problems Encountered

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Ethical Statement
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ABSTRACT

The main purpose of this study is to examine the level of science and mathematics teachers' use of educational technologies in their lessons, the criteria they consider when choosing technologies, the purposes of their use and the problems they experience in the process in a comparative manner in terms of the two disciplines. The participant group of the study consisted of 40 science and mathematics teachers working in various schools in Eastern Anatolia and Southeastern Anatolia regions of Turkiye. The participants were selected using typical case sampling method, one of the purposeful sampling techniques. In this qualitative study in which phenomenological design was adopted, data were collected through semi-structured interviews and analyzed by inductive data analysis method. According to the findings, it was determined that teachers from both fields generally had high levels of using educational technologies in lessons, but science teachers used technologies more intensively than mathematics teachers. Teachers consider factors such as suitability to the content of the course subjects, ease of application, appealing to students' interest and motivation levels, and teachers' own knowledge and skill levels when choosing technology. In addition, it was determined that teachers mostly used technology to explain subjects, perform interactive activities and solve tests. However, technical and pedagogical problems such as frequent disconnection of the internet connection, inadequacy of the technological infrastructure and incompatibility of the applications used with the subject content limit the effective use of technology in lessons.

Keywords: Science Education, Mathematics Education, Educational Technology, Interactive Board, Education Information Network (EBA)

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INTRODUCTION

Technological developments have become an integral part of modern life by reshaping all areas of social life. The transformations that have emerged with technology in almost all areas of life, from industry to agricultural production, from defense industry to economy, from health to education, have not only been limited to practical changes in daily life, but have also brought about radical changes in individual and social needs, expectations and habits. With technological developments, the ability to access beyond geographical borders without time and space restrictions has enabled competition to reach a global dimension and this has placed technological superiority at the center of global competition. In order to have a say in the global arena and to maintain their existence, states have realized the importance of raising individuals who research, question, and restructure knowledge with critical thinking skills and who can produce innovative and creative solutions to problems, and in this direction, they have initiated efforts to carry out radical reforms in their education systems. Integration of technology into learning-teaching processes is important in terms of increasing the effectiveness and efficiency of the process (Lai & Bower, 2019; Murzabaev et al., 2024; OECD, 2010; Viberg et al., 2020).

The main goal of science and mathematics education is to create a learning ecosystem that enables individuals to research and question information, reconstruct knowledge using higher-order cognitive skills, and generate solutions to real-life problems, rather than a teaching environment that raises individuals who memorize the information presented to them by a teacher. Educational technologies can enable science and mathematics subjects, which include abstract and complex subjects, to acquire permanent learning by concretizing them with various animations, simulations and media content (Antonietti et al., 2022; Meylani, 2025; Purohit et al., 2022), enable learners to form hypotheses about the solution of the problem and test the hypotheses they have formed by bringing micro and macro problems in daily life to the learning environment and offer an interdisciplinary learning experience. In addition to increasing academic achievement, educational technologies also increase intrinsic motivation for learning, self-regulation skills and creative thinking skills (Jong et al., 2024; Kiv et al., 2024; Radović, 2023; Surana et al., 2020).

The integration of technological tools into the learning-teaching process has the potential to transform the learning-teaching process into an engaging and interactive practice beyond accelerating access to information without time and space constraints (Dagyar & Kasalak, 2020; Ozturk et al., 2024; Shin & Park, 2024). The integration of educational technologies into science and mathematics courses involves the use of digital applications in a way that is compatible with the pedagogical goals of the course and the subject beyond the mechanical use of digital applications in the learning-teaching process. The main purpose of integrating educational technologies into the learning-teaching process is to enable learners to establish relationships between abstract and complex science and mathematics topics and concepts, enrich their thinking skills by appealing to multiple sensory organs, and encourage them to develop a multidimensional perspective by providing a collaborative learning environment (Farion et al., 2019; Lees et al., 2024; Wijaya et al., 2024). Integrating educational technologies into the learning and teaching process in line with these purposes will enable teachers to achieve more effective results in their lessons compared to the rates of using technological applications and digital content alone (Rahmat et al., 2023; Siddiqui et al., 2023). Considering the cognitive and affective needs of learners by creating learning environments to develop critical and creative thinking skills will also produce effective results in increasing the efficiency and effectiveness of the integration process (AlAjimi, 2022; Chien & Wu, 2020; Phelps et al., 2021; Surana et al., 2020; Szymkowiak et al. 2021, Wilson et al. 2020).

Today, computers, interactive whiteboards, internet-based applications, online learning environments, simulations,

animations, virtual games for educational purposes, virtual laboratories that allow remote access, wiki-based platforms and augmented reality applications are widely used in learning-teaching processes (Da Silva Ramos et al., 2024; Fernandes et al., 2019; Flores-Chacón et al., 2023; Nungu et al., 2023). These technologies are divided into different categories according to the level of interaction of users in the process. For example, while animations are considered as low-interactive because they do not allow students to intervene in the learning process, simulations are defined as moderately interactive because they allow students to intervene, albeit to a limited extent. Technologies that allow students to actively participate in processes such as collecting, recording and organizing data are considered highly interactive. On the other hand, the situations where students cannot intervene in the variables in the learning process are called passive technologies (Ginzburg & Barak, 2023; Ricoy & Sánchez-Martínez, 2023).

It is primarily the responsibility of teachers to effectively integrate these educational technologies into learning-teaching environments and to use them actively in the process. It is much more important that teachers not only use new technologies but also incorporate them into their teaching processes in a meaningful way. In this context, it is emphasized that although many factors are effective in integrating technology into learning environments, the role of the teacher is of critical importance (Jong et al., 2024; Raveh et al., 2025). Pierson (1999) defines technology integration not only as the teacher's use of technology, but also as the teacher's selection and effective use of technology appropriate to his/her content knowledge and pedagogical competencies. From this perspective, it can be said that teachers should prioritize the technologies that will support the course content and the teaching methods they will apply.

There are many studies that reveal the situation of teachers regarding the integration of technology into educational processes. Lomos et al. (2023) aimed to determine the duration of teachers' use of educational technologies and the types of activities by analyzing the daily data of the online learning platform used for mathematics lessons in Luxembourg during the pandemic. 800 teachers' data on information technologies were examined and the data obtained in the study were coded with the Substitution, Augmentation, Modification, Redefinition (SAMR) model of teacher behaviors. As a result of the research, it was determined that the level of teachers' use of computing technologies varied; the duration of staying active on the platform increased significantly in proportion to the tasks that created meaningful learning experiences (augmentation-modification) and positioned the student in the position of active learner. In addition, the variables of experience in using technology, participation in incentive activities, and involvement in teacher training programs also explained a significant portion of the variance in time spent on the platform. In conclusion, the study revealed that learning analytics complementing self-report data is a powerful tool in describing teachers' actual ICT behaviors in detail, and that student-centered and restructured ICT practices encourage teachers to use online platforms more intensively and effectively. Kirindi and Durmus (2019) examined how science teachers use technology in their lessons and their level of knowledge about Technological Pedagogical Content Knowledge (TPACK). In this study, it was determined that 75 science teachers who participated in the study had various difficulties in using technology, had difficulty in integrating technology effectively into their lessons, and had difficulty adapting to technological innovations. Similarly, AlAjimi (2022) evaluated the change in technology integration skills of 404 teachers working in public schools in Kuwait during the pandemic period due to online education. As a result of the study, it was determined that online training practices positively affected teachers' technology integration skills. Wijaya et al. (2024) examined 489 mathematics teachers in China to determine their level of trust in AI, their AI literacy and their tendency to depend on AI and to examine the impact of these variables on 21st century skills such as creative thinking, critical thinking, problem solving and self-confidence. The findings of the study showed that as the levels of artificial intelligence literacy and confidence in artificial intelligence increased, teachers' dependency on artificial intelligence increased; on the other hand, self-confidence,

problem solving, critical thinking, creative thinking and collaboration skills decreased significantly. The results of the study indicate that the integration of AI in educational settings needs to be carefully balanced and emphasize that excessive reliance on AI can negatively affect the development of teachers' basic cognitive and social skills. Szymkowiak et al. (2021) examined the impact of teachers' technology use skills on the education of students called Generation Z. As a result of the research, it was determined that students of this generation prefer technological methods such as video content and mobile applications more than traditional methods. In addition, it was revealed that the lessons of teachers who effectively integrate technology into their lessons and take learning environments outside the classroom are more embraced by students. In another study, Phelps et al. (2021) investigated how physical education teachers use technology in lesson planning, instruction and assessment processes and found that teachers face some obstacles when using technology. Blackwell et al. (2013) examined preschool teachers' attitudes towards the use of technology and the barriers they face. According to the results of the study, it was seen that teachers use mobile tools as well as classical technologies such as computers and the internet, and that when technology is integrated into the educational process, a positive development is achieved in children's learning processes. However, factors such as teachers' beliefs about technology integration, their level of knowledge, professional development, readiness, and inadequate technical infrastructure in their schools were found to be important barriers that negatively affect integration. Chien and Wu (2020) investigated the impact of science teachers' technology integration practices and their attitudes on students' academic achievement. As a result, it was concluded that technology integration increased students' active participation in lessons and technological experiences.

In the literature, there are studies on the use of educational technologies by science and mathematics teachers in their lessons, but there are no studies comparing the use of educational technologies by science and mathematics teachers. In this study, the use of technology in the lessons of science and mathematics teachers working in the provinces in the Eastern and Southeastern Anatolia Regions of Turkey was compared according to their branches. In this direction, the main problem of the study is the question “How do science and mathematics teachers use educational technologies in their lessons?”. In the research, answers to the following questions were sought in line with this basic problem:

1. Do science and mathematics teachers' level of using educational technologies in their lessons differ?
2. According to which criteria do science and mathematics teachers determine the educational technologies to be used in their lessons?
3. How do science and mathematics teachers use educational technologies in their lessons?
4. What kind of problems do science and mathematics teachers encounter while using educational technologies?

METHOD

Research Model

In this study, which aims to reveal the levels of science and mathematics teachers' use of educational technologies in their lessons, the criteria for determining the technologies they prefer, the purposes of use and the difficulties they encounter, the phenomenology design, one of the qualitative approaches, was adopted. Phenomenology is a method that aims to understand the feelings, thoughts, perceptions and attitudes of individuals about a phenomenon in depth and to

reveal how they gain their experiences about the phenomenon in question (Creswell, 2016). This approach illuminates real-life experiences by focusing on routine events in daily life that have not been sufficiently examined before or have limited awareness (Yildirim & Simsek, 2018). Within the scope of the study, the experiences and opinions of science and mathematics teachers working in schools in the Eastern and Southeastern Anatolia regions of Turkey on the use of technology were examined in detail; teachers' technology preferences, implementation purposes, selection criteria and the problems they encountered during the process were meticulously compared.

Study Group

The study group of the research consists of 40 teachers working in various provinces in the Eastern and Southeastern Anatolia regions of Turkey. This participant group was determined by using the “typical case sampling” method, one of the purposive sampling techniques. This method allows for the selection of highly representative samples that have the defining characteristics of the population (Marshall & Rossman, 2014). In order to strengthen the representativeness of the sample, in-depth interviews were conducted with 20 teachers from mathematics and 20 teachers from science. Information on the demographic characteristics of the research group is given in Table 1.

Table 1. Findings on the demographic characteristics of the teachers participating in the study

Gender	**f**	**%**
Male	26	65,0
Female	14	35,0
TOTAL	40	100,0
Field		
Science Education	20	50
Mathematics Education	20	50
TOTAL	40	100,0
Professional experience		
1-5 year	12	30,0
6-10 year	4	10,0
11-15 year	7	17,5
16-20 year	10	25,0
21 years and above	9	22,5
TOPLAM	40	100,0
Duration of employment at current school		
1-5 year	18	45,0
6-10 year	14	35,0
11-15 year	8	20,0
TOTAL	40	100,0
Number of lessons per week		
9-16 hours	9	22,5
17-24 hours	17	42,5
25 hours and above	14	35,0
TOTAL	40	100,0
Place of duty		
Provincial Center	17	42,5
District	13	32,5
Village	10	25,0
TOTAL	30	100,0

When Table 1 is analyzed, it is seen that 65,0% of the teachers are male and 35,0% are female; 30,0% have 1-5 years of professional experience, 25,0% have 16-20 years, 22,5% have 21 years or more, 17,5% have 11-15 years and 10% have 6-10 years of professional experience; 45,0% of them worked in their current schools for 1-5 years, 35% for 6-10 years and 20% for 11-15 years; 42,5% of them had a weekly teaching load of 17-24 hours, 35,0% for 25 hours or more and 22,5% for 9-16 hours; and 42,5% of them worked in the city center, 32,5% in the district and 25,0% in the village.

Data Collection Tools

In this study, semi-structured interviews were conducted to determine the level of science and mathematics teachers' use of educational technologies in their lessons. During the preparation of the interview questions, the opinions of two faculty members from the Department of Elementary Mathematics Teaching and two faculty members from the Department of Science Teaching of Firat University Faculty of Education were consulted, and the questions were evaluated and finalized accordingly. During the 2023-2024 academic year, twenty-minute telephone and online interviews were conducted with science and mathematics teachers working in the Eastern Anatolia and Southeastern Anatolia regions of Turkey. In the interviews, teachers were asked four main questions: whether they use educational technologies in their lessons, what criteria they consider when determining their preferences for these technologies and digital applications, for what purposes they apply these tools in their educational processes, and what are the difficulties they face. All interviews were audio recorded with the consent of the participants.

Data Analysis

The data collected within the scope of the research were evaluated by descriptive analysis method. The audio recordings of the interviews were first transcribed into written texts, and then the science teachers were systematically named with the codes ST1, ST2,..., ST20; and the mathematics teachers were systematically named with the codes MT1, MT2,..., MT20. These written texts were categorized into various categories considering their similarities in terms of content and meaning and transferred to NVIVO software. Teachers' responses to the questions were coded meticulously through this program, and the resulting codes were grouped under certain thematic categories and appropriate themes were created in line with the purpose of the study. As a result, the findings that emerged during the analysis process were evaluated and interpreted in detail.

RESULTS

In this part of the study, general findings about science and mathematics teachers' use of educational technologies and specific findings comparing the level of technology use of teachers according to their branches are presented.

General Findings on Teachers' Use of Technology

In the study, 40 teachers were interviewed. Frequency distributions of the questions asked to the teachers and the answers of the teachers and the answers of some teachers are given. The frequency and percentage distributions of teachers' responses to the question “Do you use educational technologies and digital applications in your lessons?” are given in Table 2.

Table 2. Teachers' responses regarding their use of educational technologies and digital applications in their lessons

	Science Teachers		Mathematics Teachers		Total	
Do you use educational technologies and digital applications in your lessons?	**f**	**%**	**f**	**%**	**f**	**%**
YES	16	80,0	11	55,0	27	67,5
Yes, I use simulation contents	5	25,0	3	15,0	8	20,0
Yes, I use augmented reality applications	3	15,0	4	20,0	7	17,5
Yes, I use virtual laboratory applications to conduct experiments	4	20,0	0	0,0	4	10,0
Yes, I use technologies appropriate to the characteristics of the subject	4	20,0	4	20,0	8	20,0
NO	4	20,0	9	45,0	13	32,5
No, I mostly use traditional methods due to the conditions of my school	1	5,0	3	15,0	4	10,0
No, I cannot use technology because the technological equipment of our school is not sufficient	0	0,0	2	10,0	3	7,5
No, I cannot use technology fully because the internet connection is slow	2	5,0	2	10,0	3	7,5
No, I do not think technology is useful, so I do not use it	1	5,0	1	5,0	2	5,0
No, I do not use technology because it makes it difficult to perform mathematical operations	0	000	1	5,0	1	2,5

To the question “Do you use educational technologies and digital applications in your lessons?”, 67.5% of the participating teachers answered yes and 32.5% answered no; 80.0% of science teachers answered yes and 20% answered no; 55.0% of mathematics teachers answered yes and 45.0% answered no. It is seen that 20% of the participants used simulation content, 17.5% used augmented reality applications and 10% used virtual laboratory applications, while 20% stated that they used technologies appropriate to the characteristics of the subject.

The responses of some of the science teachers are as follows:

ST1: *Yes, I use educational technologies frequently in my lessons. I use digital applications with simulation content a lot, especially for better understanding and concretization of abstract subjects.*

ST4: *Yes, I use it a lot. There are many abstract concepts in science and if these concepts are not concretized enough, they are not fully understood by students. Therefore, applications such as virtual laboratory and Phet content make my job very easy.*

ST6: *Yes, science course cannot be separated from technology due to its structure. Especially for the concretization of abstract knowledge, I think technology is indispensable.*

ST9: *My school is located in a rural area and students have very limited access to technology here. There is no smart board or computer in my school. Sometimes I want to open video content on the subject with my personal computer, but internet access is very problematic. That's why I mostly don't use it.*

ST15: *No, I don't use it. My school is very weak in terms of technological equipment. Our smart board does not run many educational applications, so I do not prefer to use it.*

The responses of some of the mathematics teachers are as follows:

MT3: *Yes, I definitely use it. Mathematics is a subject that students are usually very afraid of because it is an abstract subject. Since educational technologies provide gamification of problems and subjects, I think they reduce fear and*

prejudices at a significant level.

MT12: *Yes, I use it. I use it in many subjects that I think visualization would be useful, especially geometric objects.*

M17: *Yes, I use it. With augmented reality, abstract concepts and numbers in mathematics attract students' attention more.*

MT5: *No, I don't prefer to use it. I think mathematics is a lesson that is mostly done with paper and pencil by nature. The conveniences that technology provides us in this regard are very limited. That's why I don't use it.*

MT11: *No, I don't use it. Children are too much involved with technology now and I think the harms are more than the benefits. Therefore, I prefer not to use it.*

The frequency and percentage distributions of science teachers' responses to the question "According to which criteria do you determine the educational technologies and digital applications you will use in your lessons?" are given in Table 3.

Table 3. Teachers' responses regarding the criteria for identifying educational technologies and digital applications

	Science Teachers		Mathematics Teachers		Total	
According to which criteria do you determine the educational technologies and digital applications you will use in your lessons?	**f**	**%**	**f**	**%**	**f**	**%**
Compliance with the structure of the course and the subject	9	45,0	7	35,0	16	40,0
Compliance with the technological infrastructure of the school	3	15,0	6	30,0	9	22,5
Compliance with the interests and expectations of the students	3	15,0	4	20,0	7	17,5
The duration of the subject	1	5,0	2	10,0	3	7,5
My knowledge and experience	4	20,0	1	5,0	5	12,5

In response to the question "According to which criteria do you determine the educational technologies and digital applications that you will use in your lessons?", 40.0% of the teachers who participated in the study answered that they consider "suitability to the structure of the lesson and the subject", 22.5% "suitability to the technological infrastructure of the school", 17.5% "suitability to the interests and expectations of the students", 12.5% "suitability to their knowledge and experience" and 7.5% "suitability to the duration of the subject". Some of the answers given by the teachers to the question are given below.

ST2: *I choose the technology according to the subject and objectives of the lesson. For example, if I am going to conduct an experiment, I prefer virtual laboratory applications.*

ST8: *I pay attention to the fact that the technology I use should be practical and easy for both me and my students to use.*

ST19: *I prefer technological tools according to the level and interest of my students, for example, some applications attract more attention.*

MT5: *I choose according to what the facilities such as computers and internet in our school can handle.*

MT9: *When I need to spend a lot of time on lesson preparation, I try to choose simple and fast applicable technologies.*

M20: *If the technology I use helps students understand the subject better, I prioritize it.*

The frequency and percentage distributions of teachers' responses to the question "How do you use educational technologies in your lessons?" are given in Table 4.

Table 4. Teachers' responses regarding how they use educational technologies and digital applications in their lessons

	Science Teachers		Mathematics Teachers		Total	
How do you use educational technologies in your lessons?	**f**	**%**	**f**	**%**	**f**	**%**
I use it in the presentation of subject content	9	45,0	6	30,0	15	37,5
I use it in question solutions	5	25,0	8	40,0	13	32,5
I use it in the measurement and evaluation process	3	15,0	3	15,0	6	15,0
I use it in activities that require interaction	2	10,0	1	5,0	3	7,5
I use it in project and presentation content	1	5,0	2	10,0	3	7,2

In response to the question "How do you use educational technologies in your lessons?", 37.5% of the teachers stated that they used them in the presentation of subject content; 32.5% used them in question solutions; 15.0% used them in the measurement and evaluation process; 7.5% used them in activities requiring interaction; and 7.5% used them in project and presentation content.

The responses of some of the teachers are as follows:

ST1: *I mostly use media tools such as videos, animations, simulations, etc. on EBA, Youtube and other platforms while explaining course topics.*

ST7: *I use them in interactive activities that will enable students to actively participate in the lesson.*

ST16: *I use simulation and animation content that makes abstract concepts such as space, microbes, atoms concrete.*

MT4: *By enabling students to solve questions in the digital environment, I both increase their interest and make subject repetitions fun.*

MT10: *I use digital tools in measurement and evaluation processes such as exams and quizzes.*

MT18: *I use technology to solve questions and do online exercises.*

The frequency and percentage distributions of teachers' responses to the question "What kind of problems do you encounter when using educational technologies in your lessons?" are given in Table 5.

Table 5. Teachers' responses to the problems they encounter in the process of using educational technologies in their lessons

	Science Teachers		Mathematics Teachers		Total	
What kind of problems do you encounter when using educational technologies in your lessons?	**f**	**%**	**f**	**%**	**f**	**%**
Technical problems	7	35,0	6	30,0	13	32,5
Inadequate technological equipment of the school	4	20,0	5	25,0	9	22,5
Incompatibility of applications and activities with subject contents	3	15,0	4	20,0	7	17,5
Low interest and motivation levels of students	3	15,0	2	10,0	5	12,5
Lack of knowledge on the use of educational technologies	2	10,0	2	10,0	4	10,0
Time management	1	5,0	1	5,0	2	5,0

In response to the question "What kind of problems do you encounter when using educational technologies in your lessons?", 32.5% of the teachers stated that they encountered technical problems such as interruption of the internet connection; 22.5% stated that the school's technological hardware infrastructure was insufficient; 17.5% stated that the applications and activities were incompatible with the subject content; 12.5% stated that students' interest and motivation levels were low; 10% stated that they lacked knowledge about the use of educational technologies and 5.0% stated that they encountered problems such as time management.

The responses of some of the teachers are as follows:

ST8: *Some digital tools are not fully compatible with the content we use, disrupting the flow of the lesson.*

ST12: *I have problems because there are not enough computers, tablets or smart boards in the school.*

ST17: *I sometimes have difficulties because I have not received enough training on the technologies I will use.*

MT3: *Internet connection is frequently interrupted, applications freeze or run slowly.*

MT14: *Students see digital tools as games and have trouble focusing.*

M20: *The time spent on the installation and use of technological tools reduces the lesson time.*

DISCUSSION AND CONCLUSION

Integrating technology into educational processes has become one of the primary goals of contemporary educational systems. To effectively leverage the advantages technology offers, its appropriate and efficient integration into teaching processes is critically important. Within this context, a review of the literature clearly indicates that research specifically focused on how science and mathematics teachers integrate technology into their instructional practices remains relatively limited.

Avci et al. (2019) investigated the technologies science teachers currently utilize and those they wish to incorporate in the future. Their findings revealed that teachers actively use or intend to use digital games, social media applications, Web 2.0 tools, coding, and online education platforms. Similarly, a study by Moon et al. (2021) found that science teachers integrated innovative technologies such as online coding platforms, physical computing tools, 3D printers, augmented reality (AR), virtual reality (VR), drones, the Internet of Things (IoT), big data, artificial intelligence (AI), and Metaverse into their teaching processes. The study concluded that these technologies concretize abstract concepts, increase the permanence of learning, and create enjoyable learning environments for students.

However, various challenges encountered by teachers in integrating technology into instructional processes are frequently highlighted in the literature. Chen (2008) noted inconsistencies between teachers' pedagogical beliefs and their actual use of technology, suggesting that limited technological knowledge, misconceptions about pedagogy, external factors, and conflicting beliefs contribute significantly to these inconsistencies. Similarly, Kirindi and Durmus (2019) concluded that science teachers lacked sufficient competence in effectively integrating technology, experienced difficulties using technological tools, and inadequately kept pace with technological innovations.

On the other hand, numerous studies indicate that although science and mathematics teachers generally exhibit a willingness to use technology, deficiencies in schools' existing technological infrastructure, problems related to internet

connectivity, and lack of technical support negatively impact instructional processes (Altunoglu, 2017; Aslan Efe & Baysal, 2017; Avci et al., 2019; Ayvaci et al., 2015; Ayvaci et al., 2018; Barut, 2015; Cakiroglu & Cetinkaya-Aydin, 2019; Demirbag, 2018; Demircioglu & Yadigaroglu, 2014; Durust, 2019; Erdem, 2018; Erdem, 2019; Farjon et al., 2019; Nakiboglu & Gacanoglu, 2019; Grimalt-Álvaro et al., 2019; Hosver, 2017; Kaya, 2019; Kirindi & Durmus, 2019; Kiray, 2016; Ozbay, 2016; Ozdemir & Bozdogan, 2014; Pinar & Donel-Akgul, 2020; Saklan, 2017; Sipahioglu, 2019; Taskin et al., 2014; Yilmaz, 2018). Such infrastructural and technical issues reportedly complicate technology integration and diminish teachers' motivation.

Studies on pre-service teachers' attitudes towards technology usage provide similar insights. Celik et al. (2021) identified that science teacher candidates generally have high tendencies toward technology usage, particularly in the affective domain, more so than in the behavioral domain. Furthermore, their tendency to use technology was found to increase with higher academic year levels. Similarly, Baydas and Yilmaz (2017) stated that pre-service teachers believe interactive whiteboards positively influence their professional performance. Teo and Noyes (2014) similarly demonstrated that teacher candidates exhibited a strong tendency to use information technologies, further amplified by peer influences.

The literature frequently emphasizes science and mathematics teacher candidates' views that technology integration enhances the fun and permanence of learning (Kahraman et al., 2013; Sahin & Arslan-Namli, 2019; Tanik Onal, 2017; Timur, 2011). Additionally, an experimental study by Kirbag Zengin et al. (2012) concluded that the use of interactive whiteboards in science lessons significantly improved student achievement and attitudes toward the subject.

In conclusion, research concerning the integration of technology into education is increasingly gaining attention both nationally and globally. The integration of technology into education is considered an indispensable requirement for international competitiveness and modern educational approaches. In this context, increasing teachers' awareness of technological opportunities, resolving infrastructure-related and pedagogical challenges they face, and developing their technological knowledge and skills are critically important. The success of educational reforms depends significantly on the acceptance and effective implementation of innovations by teachers. Therefore, ongoing assessment of teachers' technology integration practices and addressing encountered obstacles with solution-oriented approaches should constitute key objectives within educational policy.

REFERENCES

AlAjimi, M.K. (2022). The impact of digital leadership on teachers' technology integration during the COVID-19 pandemic in Kuwait. *International Journal of Educational Research*, 112, 1-10. https://doi.org/10.1016/j.ijer.2022.101928

Altunoglu, A. (2017). *Investigation of variable angle of various levels of science teachers TPCK.* [M.Sc. Thesis, Cumhuriyet University]. YOK National Thesis Center.

Antonietti, C.., Cattaneo, A., & Amenduni, F. (2022). Can teachers' digital competence influence technology acceptance in vocational education? *Computers in Human Behavior*, 132, 1-9. https://doi.org/10.1016/j.chb.2022.107266

Aslan Efe, H., Baysal, Y.E. (2017). Analysis of the relationship between science teachers' motivation towards using educational technology and their self regulation strategies. *Electronic Journal of Social Sciences*, 16 (63), 1391-1399. https://doi.org/10.17755/esosder.308979

Avci, U., Kula, A., & Haslaman, T. (2019). Teachers' opinions on technology that they want to integrate into the learning-teaching process. Acta Infologica, 3(1), 13-21. https://doi.org/10.26650/acin.556003

Ayvaci, H. S., Ozbek, D., & Sevim, S. (2018). Determining teachers' opinions towards the integration of interactive boards into teaching: Trabzon sample. *E-International Journal of Educational Research*, *9*(1), 1-13. https://doi.org/10.19160/ijer.361922

Barut, L. (2015). *Relationship between the attitudes of science and technology teachers towards the use of technology in the education with their computer self-efficacy*. [M.Sc. Thesis, Kahramanmaras Sutcu Imam University]. National Thesis Center.

Baydas, O., Yilmaz, R. M. (2017). A model for pre-service teachers' intention to use interactive white boards in their future lessons. *Journal of Higher Education & Science*, 7(1), 59-66.

Blackwell, C. K., Lauricella, A. R., Wartella, E., Robb, M., & Schomburg, R. (2013). Adoption and use of technology in early education: The interplay of extrinsic barriers and teacher attitudes. *Computers & Education*, *69*, 310–319. https://doi.org/10.1016/j.compedu.2013.07.024

Cakiroglu, J., & Cetinkaya-Aydin, G. (2019). Fen Bilimleri ogretiminde teknoloji kullanimi [Using technology in science teaching]. Akgunduz, D. (Ed.), *Fen ve matematik egitiminde teknolojik yaklasimlar [Technological approaches in science and mathematics education]*. (ss. 57-73). Ani Publishing.

Celik, C., Celik, B., & Alpaslan, M.M. (2021). Pre-service science teachers' tendencies towards using technology in class. *MSKU* Journal of Education, 8 (2), 503-519. https://doi.org/10.21666/muefd.835314

Chen, C. (2008). Why do teachers not practice what they believe regarding technology integration? *Journal of Educational* Research, 102, 65-75. https://doi.org/10.3200/JOER.102.1.65-75

Chien, S.P., Wu, H.K. (2020). Examining influences of science teachers' practices and beliefs about technology-based assessment on students' performances: A hierarchical linear modeling approach. *Computers&Education*, 157, 1-11. https://doi.org/10.1016/j.compedu.2020.103986

Creswell, J. W. (2016). Nitel araştirma yöntemleri beş yaklaşima göre nitel araştirma ve araştirma deseni [Qualitative inquiry and research design: Choosing among five approaches]. M. Butun & S. B. Demir (Edt.). Siyasal Publishing.

Da Silva Ramos, R., De Aguiar, M., Da Silva, E., Caetano, C., Pina, R., Neves, J., & De Oliveira, H. (2024). Educational technology to empower patients as participants in their care. *Revista Brasileira de Enfermagem*, 77(6), 1-8. https://doi.org/10.1590/0034-7167-2023-0359.

Dagyar, M., Kasalak, G., & Sezgin, E. (2020). What do primary school students think about mobile programming education?

"Developing my own mobile game". *World Journal on Educational Technology: Current Issues*, 12(4), 258 - 277. https://doi.org/10.18844/wjet.v12i4.5179

Demirbag, M. (2018). *Technology integration of science teachers from teacher beliefs perspective*. [Doctoral dissertation Uludag University]. YOK National Thesis Center

Demircioglu, G., Yadigaroglu, M. (2014). Views of chemistry teachers about the FATİH project. *Journal of Research in Education and Teaching*, 3 (2), 302-310.

Devran, P., Oztay, E.S., & Tarkin-Celikkiran, A. (2021). Content analysis of research on teachers' technology integration in science education in Turkey. *Cumhuriyet International Journal of Education*, 10 (4), 1789-1825. https://doi.org/10.30703/cije.938487

Durust, E. (2019). *Examining secondary school science teachers' smartboard usage in terms of various variables: Kirsehir province sample*. [M.Sc. Thesis, Kirsehir Ahi Evran University]. YOK National Thesis Center.

Erdem, A. (2018). Examination of teacher's views on the use of technology in physics education in high schools. *The Journal of International Social Research*, 11 (56), 505-520. https://doi.org/10.11114/jets.v7i4.4019

Farjon, D., Smits, A., & Voogt, J. (2019). Technology integration of pre-service teachers explained by attitudes and beliefs, competency, access, and experience. *Computers & Education*, 130, 81-93. https://doi.org/10.1016/j.compedu.2018.11.010

Fernandes, G.W.R., Rodrigues, A.M., & Ferreira, C.A.R. (2019). *Using ICT in inquiry-based science education*. Springer International Publishing.

Flores-Chacón, E., Pacheco, A., Gonzales-Ortiz, Y., Moreno-Vega, L., Del-Castillo-Palacios, F., & Perez-Rojas, E. (2023). Educational innovation: the architecture of digital technologies as a catalyst for change in university teacher training. *Scientific Reports*, 13, 1-8. https://doi.org/10.1038/s41598-023-48378-w.

Nakiboğlu, C., & Gacanoğlu, Ş. (2019). Examination of experienced chemistry teachers' usage of education information network (ein) contents in their chemistry courses. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, 13(2), 1141-1165. https://doi.org/10.17522/balikesirnef.633128

Ginzburg, T., & Barak, M. (2023). Technology-enhanced learning and its association with motivation to learn science from a cross-cultural perspective. *Journal of Science Education and Technology*, 35, 597-606. https://doi.org/10.1007/s10956-023-10048-x.

Grimalt-Álvaro, C., Ametller, J., & Pintó, R. (2019). Factors shaping the uptake of ICT in science classrooms. A study of a large-scale introduction of interactive whiteboards and computers. *International Journal of Innovation in Science and* Mathematics Education, 27(1), 18-36. https://doi.org/10.30722/IJISME.27.01.002

Hosver, Y. (2017). *A research on the investigation of technology usage qualifications about teachers in science lessons.* [M.Sc. Thesis, Yeditepe University]. YOK National Thesis Center.

Jong, M., Zhai, X., & Chen, W. (2024). Innovative uses of technologies in science, mathematics and STEM education in K-12 contexts. *International Journal of Science and Mathematics Education*. 22, 1-9. https://doi.org/10.1007/s10763-024-10530-x.

Kahraman, S., Yilmaz, Z. A., Erkol, M., & Altun Yalcin, S. (2013). Investigation of pre-service teachers' self-efficacy beliefs of educational internet use. *Elementary Education Online*, 12 (4), 1000-1015.

Kaya, S. (2019). *Chemistry teachers' views of using technology in chemistry teaching and levels of technology use.* [M.Sc. Thesis, Van Yuzuncu Yil University]. YOK National Thesis Center.

Kiray, S.A. (2016). Development of a TPACK self-efficacy scale for preservice science teachers. *International Journal of Research in Education and Science*, 2(2), 527-541.

Kirbag Zengin, F., Kirilmazkaya, G., & Kececi, G. (2012). Elemantary students use of smart board the effect of achievement and attitude in science and technology course. *e-Journal of New World Sciences Academy*, 7 (2), 526-537.

Kirindi, T., Durmus, G. (2019). Investigation of technological pedagogical field knowledge of science teachers. *Journal of Ahi Evran University Kirsehir Education Faculty*, 20 (3), 1340-1375. https://doi.org/10.29299/kefad.2019.20.03.010

Kiv, A., Semerikov, S., Striuk, A., Osadchyi, V., Vakaliuk, T., Nechypurenko, P., Bondarenko, O., Mintii, I., & Malchenko, S. (2024, 22 Ekim). *Advancing education in challenging times: A review of the xvi international conference on mathematics, science and technology education (ICon-MaSTEd 2024)* [Conference Presentatiton]. Journal of Physics: Conference Series. 2871,(2024) 011001 https://doi.org/10.1088/1742-6596/2871/1/011001.

Lai, J.W., Bower, M. (2019). How is the use of technology in education evaluated? A systematic review. *Computers & Education*, 133, 27-42. https://doi.org/10.1016/j.compedu.2019.01.010

Lees, J., Risør, T., Sweet, L., & Bearman, M. (2024). Integrating digital technologies into teaching embodied knowledge in the context of physical examination, *Medical Education*. 18, 1-17. https://doi.org/10.1111/medu.15599.

Lomos, C., Luyten, J., Kesting, F., & Da Cunha, F. (2023). Explaining variation in teachers' use of ICT: a learning analytics approach. *Interactive Learning Environments*, 1-19. https://doi.org/10.1080/10494820.2023.2170419.

Marshall, C. & Rossman, G.B. (2014). *Designing qualitative research.* Sage Publications.

Meylani, R. (2025). A critical glance at technology's role in mathematics education for a sustainable future: Advancing SDG 4 - quality education through a systematic review and qualitative synthesis. *Journal of Lifestyle and SDGs Review*. https://doi.org/10.47172/2965-730x.sdgsreview.v5.n02.pe04566

Moon, S., Lee, J., & Kim, J.B. (2021). A survey on teachers' perceptions of the use of advanced science and technology in education. *Brain, Digital & Learning*, 11(4), 645-658. https://doi.org/10.31216/BDL.20210041

Murzabaev, K.K., Apendiev, O.T., & Abdibait kyzy, M. (2024). Innovative technologies of integrated teaching of mathematics with science subjects. *Bulletin of Issyk-Kul University*, 5(7), 108-118. https://doi.org/10.69722/1694-8211-2024-56-108-118.

Nungu, L., Mukama, E., & Nsabayezu, E. (2023). Online collaborative learning and cognitive presence in mathematics and science education. Case study of university of Rwanda, college of education. *Education and Information Technologies*, 1-20. https://doi.org/10.1007/s10639-023-11607-w.

OECD. (2010). *Inspired by technology, driven by pedagogy: A systemic approach to technology-based school innovations*. OECD Publishing.

Ozbay, U. (2016). *Usage of science teachers' mobile applications and their views about usage of these applications in science education process.* [M.Sc. Thesis, Aksaray University]. YOK National Thesis Center.

Ozdemir, U., Bozdogan, A.E. (2014). Examination of science teachers' views related to tablet pc using in courses in terms of different variables: example of giresun province. *Cumhuriyet International Journal of Education-CIJE*, 3 (1), 59-73. https://doi.org/10.30703/cije.321335

Ozturk, E., Zhao, M., Hoffman, A., Joy, A., Marlow, C., Law, F., Deutsch, A., Mathews, C., McGuire, L., Balkwill, F., Burns, K., Butler, L., Drews, M., Fields, G., Smith, H., Winterbottom, M., Rutland, A., Hartstone-Rose, A., & Mulvey, K. (2024). Developmental trajectories of adolescents' math motivation: The role of mindset and perceptions of informal STEM learning

site inclusivity. *Journal of Youth and Adolescence*, 53(7), 1542-1563. https://doi.org/10.1007/s10964-024-01949-0.

Phelps, A., Colburn, J., Hodges, M., Knipe, R., Doherty, B., & Keating, X.D. (2021). A qualitative exploration of technology use among preservice physical education teachers in a secondary methods course. *Teaching and Teacher Education*, 105, 1-11. https://doi.org/10.1016/j.tate.2021.103400

Pinar, M.A., Donel-Akgul, G. (2020). Opinions of science teachers about the use interactive board. *e-Kafkas Journal of Educational Research*, 7, 52- 65. https://doi.org/10.30900/kafkasegt.658312

Purohit, M., Kumar, V., Solanki, V., & Kumar, V. (2022). Integrating mathematics education with technology. *World Journal of English Language*, 12(3), 25-31. https://doi.org/10.5430/wjel.v12n3p25

Radović, S. (2023). Is it only about technology? The interplay between educational technology for mathematics homework, teaching practice, and students' activities. *Journal of Computers in Education*, 11, 743-762. https://doi.org/10.1007/s40692-023-00277-9.

Rahmat, A., Kuswanto, H., & Wilujeng, I. (2023). Integrating technology into science learning in junior high school: perspective of teachers. *Jurnal Penelitian Pendidikan IPA*, 9(5), 2391-2396. https://doi.org/10.29303/jppipa.v9i5.2922.

Raveh, I., Lavie, I., Wagner-Gershgoren, I., Miedijensky, S., Segal, R., & Klemer, A. (2025). Mathematics and science teachers: How their perceptions of their TPACK and use of technology interrelate. *Eurasia Journal of Mathematics, Science and Technology Education*, 21(1), 1-15. https://doi.org/10.29333/ejmste/15803.

Ricoy, M., & Sánchez-Martínez, C. (2023). Tablet-based praxis developed for children in primary education studying natural sciences and mathematics. *Children*, 10(2), 1-15. https://doi.org/10.3390/children10020250

Sahin, M.C., Arslan-Namli, N. (2019). Attidutes of pre-service teachers' on technology use in education: Cukurova university sample. *Turkiye Sosyal Arastirmalar Dergisi [Turkish Journal of Social Studies]*, 23 (1), 95-112.

Saklan, H. (2017). *Teachers' opinions about education information network (EBA).* [M.Sc. Thesis, Gaziosmanpasa University]. YOK National Thesis Center.

Shin, M., & Park, J. (2024). Technology-assisted instruction with teacher prompts on fraction multiplication word problems: A single-case design with visual analysis and Bayesian multilevel modeling. *Assistive Technology: The Official Journal of RESNA*, 1-11. https://doi.org/10.1080/10400435.2024.2415366.

Siddiqui, A., Khowaja, K., Ghulamani, S., & Shah, A. (2023). Integrating technology with science in STEM education for K-12 students. *Journal of Information Systems and Digital Technologies*, 5(2), 142-154. https://doi.org/10.31436/jisdt.v5i2.386.

Sipahioglu, S. (2019). *Investigation of primary science teachers' attitudes toward use of technology in education according to various variables*. [M.Sc. Thesis, Ataturk University]. YOK National Thesis Center.

Surana, K., Singh, A. & Sagar, A.D. (2020). Strengthening science, technology, and innovation-based incubators to help achieve sustainable development goals: Lessons from India. *Technological Forecasting & Social Change*, 157, 1-17. https://doi.org/10.1016/j.techfore.2020.120057

Szymkowiak, A., Melovic, B., Dabic, M., Jeganathan K., & Singh Kundi, G. (2021). Information technology and Gen Z: The role of teachers, the internet, and technology in the education of young people. *Technology in Society*, 65, 1-10. https://doi.org/10.1016/j.techsoc.2021.101565

Tanik Onal, N. (2017). Use of information and communication technologies: science student teachers's perspectives. *International Journal of Active Learning*, 2 (1), 1-21.

Taskin-Ekici, F, Demirhan, S., Kara, İ., & Ekici, E. (2014). Science teachers' ICT use frequency and the barriers they were exposed. *International Journal of Assessment Tools in Education*, 1 (1-2), 26-46. https://doi.org/10.21449/ijate.239568

Teo, T., Noyes, J. (2014). Explaining the intention to use technology among pre-service teachers: A multi-group analysis of the unified theory of acceptance and use of technology. *Interactive Learning Environments*, 22(1), 51–66. https://doi.org/10.1080/10494820.2011.641674

Timur, B. (2011). *The development of pre-service science teachers' technological pedagogical content knowledge in force and movement subjects*. [Doctoral dissertation, Gazi University]. YOK National Thesis Center.

Viberg, O., Gronlund, Å., & Andersson, A. (2020). Integrating digital technology in mathematics education: a Swedish case study. *Interactive Learning Environments*, 31, 232 - 243. https://doi.org/10.1080/10494820.2020.1770801.

Wijaya, T., Yu, Q., Cao, Y., He, Y., & Leung, F. (2024). Latent Profile Analysis of AI Literacy and Trust in Mathematics Teachers and Their Relations with AI Dependency and 21st-Century Skills. *Behavioral Sciences*, 14(11), 1008. https://doi.org/10.3390/bs14111008.

Wilson, M.L., Ritzhaupt, A.D., & Cheng, L. (2020). The impact of teacher education courses for technology integration on pre-service teacher knowledge: A meta-analysis study. *Computers&Education*, 156, 1-16. https://doi.org/10.1016/j.compedu.2020.103941

Yildirim, A., Simsek, H. (2018). *Sosyal bilimlerde nitel arastirma yontemleri [Qualitative research methods in the social sciences]*. Seckin Publishing.

Yilmaz, E. (2018). Physics teachers' views on the use of technology in teaching, *Journal of Mehmet Akif Ersoy University Faculty of Education*, 47, 27-37. https://doi.org/10.21764/maeuefd.412324