EXPLORING MIDDLE SCHOOL MATHEMATICS TEACHERS' DIGITAL COMPETENCIES AFTER THE PANDEMIC: A MIXED-METHOD STUDY

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DECLARATION OF ORIGINALITY

I, Yeşim Nur Akar Hozman, certify that

- I am the sole author of this thesis and that I have fully acknowledged and documented in my thesis all source of ideas and words, including digital resources, which have been produced or published by another person or institution;

- this thesis contains no material that has been submitted or accepted for a degree or diploma in any other educational institution;

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ABSTRACT

Exploring Middle School Mathematics Teachers' Digital Competencies After the Pandemic: A Mixed-Method Study

This explanatory sequential mixed-method study aims to explore middle school mathematics teachers' digital competencies in the post-pandemic era, with a particular emphasis on exploring possible reasons stemming from their experiences during the COVID-19 pandemic. The study involved 44 participants for the quantitative and 10 participants for the qualitative phase. This research examines the digital competency levels and potential variations based on gender, educational background, and teaching experience. It also explores the participants' perceptions and practices related to digital competencies. Digital competency scale for educators and semi-structured interviews were used to collect data. The findings indicated that female participants had higher scores than males in all areas of the DigCompEdu framework except the Area 6, participants with a master's degree had higher scores than those with a bachelor's degree in the Professional Engagement area, and the year of teaching experience did not yield in any significant differences. Most participants perceived their digital competencies to be higher than their actual levels, and their experiences during the COVID-19 pandemic had varied effects including using more digital technologies for instruction and communication and their self-confidence. This study contributes to the literature by providing empirical data on middle school mathematics teachers' digital competency levels via in-depth analysis of both quantitative and qualitative data. The implications for research and practice, suggestions for curriculum designers and mathematics educators, and possible future directions for research are also discussed.

ÖZET

Pandemi Sonrası Ortaokul Matematik Öğretmenlerinin Dijital Yeterliliklerinin İncelenmesi: Karma Yöntemli Bir Çalışma

Bu sıralı açıklayıcı karma yöntem çalışması, ortaokul matematik öğretmenlerinin dijital yeterliliklerini pandemi sonrası dönemde araştırmayı amaçlamaktadır. Özellikle, pandemi deneyimlerinden kaynaklanabilecek olası nedenleri keşfetmek üzerinde durulmuştur. Çalışma, Türkiye'de 44 nicel ve 10 nitel evre katılımcısı ile yürütülmüştür Bu çalışma, dijital yeterlilik düzeylerinin cinsiyet, eğitim geçmişi ve öğretim deneyimine bağlı olası farklılıkları incelemektedir. Ayrıca, katılımcıların dijital yeterliliklerle ilgili algı ve uygulamalarını da araştırmaktadır. Veriler, eğitimciler için dijital yeterlilik ölçeği ve yarı yapılandırılmış görüşmeler yoluyla toplanmıştır. Bulgular, kadın katılımcıların alan 6 hariç tüm DigCompEdu çerçevesi alanlarında erkeklere göre daha yüksek puan aldığını, yüksek lisans derecesine sahip katılımcıların lisans derecesine sahip olanlara kıyasla Profesyonel İş Birliği alanında daha yüksek puan aldığını ve katılımcıların öğretim deneyimi yıllarına göre dijital yeterlilikleri açısından istatiksel olarak anlamlı bir farklılık göstermediğini belirtmektedir. Katılımcıların çoğu, dijital yeterliliklerinin gerçek düzeylerinden daha yüksek olduğunu algılamış ve COVID-19 pandemisi sırasındaki deneyimlerinin, öğretim ve iletişim için daha fazla dijital teknoloji kullanımı ve özgüvenlerini etkilediğini ortaya koymuştur. Bu çalışma, nicel ve nitel verilerin derinlemesine analizi aracılığıyla ortaokul matematik öğretmenlerinin dijital yeterlilik seviyelerine ilişkin ampirik veriler sunarak literatüre katkıda bulunmaktadır. Araştırma ve uygulama için sonuçlar, müfredat tasarımcıları ve matematik eğitimcileri için öneriler ve olası gelecek araştırma yönlendirmeleri de tartışılmaktadır.

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CHAPTER 1

INTRODUCTION

The COVID-19 global pandemic has created many educational challenges that most teachers have never experienced (DeCoito & Estaiteyeh, 2022). The delivery of instruction turned online because of the global pandemic. In the spring of 2020, the rapid shift to online teaching due to the COVID-19 pandemic was called as emergency remote teaching (ERT) period because ERT differs from deliberately planned online teaching methods (Hodges, Moore, Lockee, Trust, & Bond, 2020).

Teachers had to become familiar with various digital tools and integrate them into their lessons to keep their students engaged in online settings. Another challenge was to create quality materials for online instruction and assessment (Bao, 2020; Burgos, Tlili, & Tabacco, 2021). Effective online education should include interactive elements, tailored feedback, and a focus on community building using digital technologies; planning and implementing such instruction require teachers to have digital competencies (Burgos et al., 2021). Thus, the COVID-19 pandemic shed light on the importance of having a high level of digital competencies for educators.

Many studies reported a need for improving teachers' digital competencies before the pandemic (Ala-Mutka, 2011; Benali, Kaddouri, & Azzimani, 2018; Ilomäki, Paavola, Lakkala, & Kantosalo, 2014; Kaleli-Yilmaz, 2015; Krumsvik, 2008). However, teachers' digital competency became an urgent necessity during the COVID-19 period (Hoti, Dragusha, & Ndou, 2022; Myyry et al., 2022; Portillo, Garay, Tejada, & Bilbao, 2020; Zhao, Pinto-Llorente, Gómez, & Zhao, 2021). Some educational policymakers advocated using the COVID-19 pandemic crisis as an opportunity for preparing long-term plans to develop digital competencies and

digitalization in education (Mitescu-Manea, Safta-Zecheria, Neumann, Bodrug-Lungu, Milenkova, & Lendzhova, 2021). For example, the European Digital Education Action Plan (2021) was renewed in the middle of 2020 to optimize educational priorities after the challenges of COVID-19. One of the main goals of this action plan is to guide educators to enhance their digital literacy and to lead to receiving safe information from digital resources (European Commission, 2022).

The COVID-19 pandemic has highlighted the importance of teachers' digital competency, as teachers felt unprepared and had concerns regarding their digital competencies during ERT (Choi, Chung, & Ko, 2021; Pozas, 2021). Secondary mathematics teachers addressed the difficulty of the sudden shift to ERT and accepted the additional workload it necessitated (Rodríguez-Muñiz, Burón, Aguilar-González, & Muñiz-Rodríguez, 2021). According to Ogodo, Simon, Morris, and Akubo (2021) students' academic performance deteriorated, and their misconceptions were exacerbated during the pandemic by teachers' lack of digital competency in designing and facilitating online instruction.

Moreno, Palacios, Barreras, and Pascual (2020) stated that mathematics educators with a higher level of digital competence would exhibit greater comfort in employing innovative teaching techniques. Results of their study suggested that mathematics teachers may require assistance in comprehending the effective integration of digital technologies within pedagogical practices to enhance instruction. However, coordinating information and communication technology (ICT)-assisted mathematics activities that effectively promote the development of concrete concept representations and facilitate student learning presents a distinctive challenge (Moreno et al., 2020). Consequently, a thorough examination of the role of

mathematics teachers became crucial in successfully implementing technology in mathematics education.

According to Trgalová, Clark-Wilson, and Weigand (2018), mathematics teachers need to use technology in a purposeful manner; however, many currently do not have the adequate skills to do so. Teachers with high digital competency levels are better equipped to design effective learning activities and help students to develop essential 21st-century digital skills.

1.1 Significance of the study

While previous studies have acknowledged the importance of integrating digital technologies in mathematics education (Hillmayr, Ziernwald, Reinhold, Hofer, & Reiss, 2020), there was a need for further research focusing specifically on how middle school mathematics teachers utilize technology in their instructional practices and the factors that influence their practices, particularly in light of their experiences during the COVID-19 pandemic. Therefore, this study aims to address this gap by employing a mixed method approach a comprehensive exploration, conducting the DigCompEdu digital competence scale for educators and semi-structured interviews. The study mainly focuses on educators' pedagogical competencies. The qualitative component offers more profound insights into teachers' practices, illuminating their experiences and perspectives.The aim is to examine middle school mathematics teachers' practices and better understand their digital competence levels considering demographic factors such as gender, education, and experience.

There are studies on educators' digital competence levels and the participants' demographic information as variables (Çebi & Reisoğlu, 2020; Fraile, Peñalva-Vélez, & Lacambra, 2018; Keskin & Yazar, 2015; Şahin & Arcagök, 2014; Zhao et

al., 2021). However, the COVID-19 pandemic significantly impacted mathematics education, mathematics instructors, and their digital competency levels; this subject requires additional research (Bakker & Wagner, 2020). There is a gap in the literature on mathematics teachers' digital competency levels after the COVID-19 pandemic. The studies are limited to specific populations, and there is a need for studies teachers' current digital competency levels in the mathematics subject area with a focus on their experiences during the COVID-19 pandemic.

By utilizing the DigCompEdu framework to assess mathematics teachers' proficiency levels across various domains, this study provides valuable insights for educators, and researchers. The framework serves as a guide for identifying areas where middle school mathematics teachers perceive their competence and areas requiring further training and improvement. Such information can inform targeted interventions and professional development initiatives to enhance teachers' digital competencies in mathematics education.

In conclusion, this study contributes to the existing literature by adopting a mixed-methods approach to investigate the digital competencies of middle school mathematics teachers within the framework of DigCompEdu. The findings have practical implications for practitioners and researchers, informing decision-making processes and proactive measures to enhance the integration of digital technology in mathematics education. Moreover, the study addresses the current research gap by providing valuable insights into teachers' practices and the potential impacts of their COVID-19-related experiences.

1.2 Purpose of the study

The purpose of this study was to investigate middle school mathematics teachers' digital competencies in the post-pandemic era, with a particular emphasis on exploring possible reasons stemming from their experiences during the pandemic. The results of this study could provide helpful insight into the current state of digital competencies among middle school mathematics teachers and the effects of COVID-19 pandemic-related experiences on their current competency levels. It may inform educational policymakers to enhance professional development programs to promote the digital competency levels of educators. The research could inform educators about improving digital competency levels and being prepared for future pandemics or emergencies.

1.3 Research questions

The current study aimed to answer the following research questions:

Research Question 1: What are the levels of middle school mathematics teachers' digital competencies after the pandemic?

i. Is there any statistically significant difference in middle school mathematics teachers' digital competency levels after the pandemic in terms of their gender?
ii. Is there any statistically significant difference in middle school mathematics teachers' digital competency levels after the pandemic in terms of their years of teaching experience?
iii. Is there any statistically significant difference in middle school mathematics teachers' digital competency levels after the pandemic in terms of their educational background?

Research Question 2: What are the perceptions of middle school mathematics teachers on their digital competency levels after the pandemic?

i. How do middle school mathematics teachers use digital technologies in teaching and learning?
ii. How do middle school mathematics teachers use digital technologies to enhance assessment?
iii. How do middle school mathematics teachers use digital technologies to empower their students?

Research Question 3: What do middle school mathematics teachers think about the effects of ERT experiences on their current digital competency levels?

i. What do middle school mathematics teachers think about the effects of ERT experiences on their current use of digital technologies in teaching and learning?
ii. What do middle school mathematics teachers think about the effects of ERT experiences on their current use of digital technologies to enhance assessment?
iii. What do middle school mathematics teachers think about the effects of ERT experiences on their current use of digital technologies to empower their students?

1.4 Organizations of the sections

Chapter 1 covered the significance of the study, the purpose of the study, the research questions, organization of the sections. Chapter 2 covered a literature review of Digital competency in mathematics education, teachers' digital competencies, the Effects of COVID-19 on the digital competencies of educators, and the European

Framework for the Digital Competence of Educators (DigCompEdu). Chapter 3 discussed the research design, including context and participants, data collection instruments, data collection procedures, data analysis, and trustworthiness of the study. In Chapter 4, the results of the study were presented. Chapter 5 consisted of discussion of the findings, recommendations and implications for future studies, and limitation of the study.

CHAPTER 2

LITERATURE REVIEW

Over the years, technology integration in education has become a popular research topic, emphasizing its impact on teaching and learning (Ran, Kim, & Secada, 2021). There have been many studies demonstrating that technology can improve student engagement and performance in mathematics (OECD, 2010; Hillmayr et al., 2020). The successful integration of technology in mathematics education depends on the teacher's digital competence (Punie & Ala-Mutka, 2007). The COVID-19 pandemic has forced a rapid shift to remote learning, resulting in a greater reliance on digital technologies for instruction and learning (Choi et al., 2021; DeCoito & Estaiteyeh, 2022). According to Choi et al. (2021), teachers with higher levels of digital competency could adapt to this change more effectively and provide their students with higher-quality instruction. DeCoito and Estaiteyeh (2022) stated that digital competence was a crucial factor in teachers' ability to provide successful remote instruction during the pandemic. In addition, the authors emphasized the significance of ongoing professional development opportunities to assist educators in acquiring and maintaining the digital skills and knowledge necessary to adapt to future changes in the educational landscape. Many studies highlighted the importance of digital competency in facilitating effective teaching and learning in the present and future educational contexts (Bao, 2022; Burgos et al., 2021; Choi et al., 2021; DeCoito & Estaiteyeh, 2022; Lucas et al., 2021; Põldoja, Väljataga, Laanpere, & Tammets, 2012).

In this chapter, first, digital competency in mathematics education and teachers' digital competencies were explored. Then, the effects of COVID-19 on the

digital competencies of educators were examined. Finally, the literature on frameworks for the digital competency of educators and the European Framework for the Digital Competence of Educators (DigCompEdu) were examined and presented in detail.

2.1 Mathematics teachers' digital competencies

In a digital age, people might believe that technological tools have already been used at schools for years. However, according to Aslan and Zhu (2016), most teachers regularly use computers at a basic level, such as searching the internet for information and using presentation programs: A minority of educators truly integrate technology into their lessons which requires being digitally competent. According to Achuonye (2015), the lecture technique is a feasible alternative for mathematics teachers because it can efficiently cover a considerable amount of content while adjusting diverse group sizes. The findings of the study indicated that question-and-answer, and demonstration methods were utilized frequently, whereas simulation, game-based and inquiry-based learning were rare in teaching practices. Achuonye (2015) highlighted the need for curriculum planners to resolve teachers' concerns regarding course load and time constraints by reducing the number of objectives so it would allow instructors to experiment with innovative teaching techniques incorporating technology to enhance the learning experience.

European Parliament and Council (2006) stated that digital competency refers to using ICT for personal and professional purposes, along with work, education, self-development, and social involvement. They put an emphasis on using digital tools in a creative and critical manner while developing new ideas and materials, collaborating, and communicating in a digital environment. According to Krumsvik

(2008), digital competency for teachers refers to the ability to use information and communication technologies (ICT) in an educational setting with a clear understanding of its implications and importance. It is emphasized that teachers need to have a strong pedagogical understanding to integrate ICT effectively into their teaching practices. Krumsvik (2008) also stated that teachers should use digital technology in a way that is appropriate and relevant to the topic and support the learning goals of the course. According to Ala-Mutka (2011), competency should potentially include the integration of knowledge, skills, and attitude. From the education perspective, digital competence is more than simply using digital tools in the classroom. It should be considered as a combination of adequate knowledge, skills, and attitudes toward the context. In detail, it has three components: The first component is technical skills for using digital tools; the second component is fundamental knowledge about theory and principles of the technology; and the last one is the general approaches towards using technology innovatively and creatively (Ala-Mutka, 2010). Thus, competent educators should possess not only theoretical and technical knowledge but also practical skills, enabling them to apply technology appropriately in various educational contexts.

Since digital competence was defined as a key in lifelong learning in the early 2000s (EC, 2006), several studies explored ICT training approaches and empowering the digital competency levels of teachers (Strudler, Archambault, Bendixen, Anderson, & Weiss, 2003; Tømte, 2013). Additionally, other studies focused on the pedagogical strategies in faculties of education to promote the meaningful use of technology in classrooms (Strudler et al., 2003; Calvani, Fini, Ranieri, & Picci, 2012; Lucas et al., 2021; Santo et al., 2022). For example, the project THREAD (Technology Helping Restructure Educational Access and Delivery) aimed to

promote K-12 pre-service teachers' meaningful use of technology. They aimed to design teacher training programs to enhance the integration of technology according to International Society for Technology in Education (ISTE) standards (Strudler et al., 2003).

Numerous studies have been conducted in Turkey to investigate teachers' digital competency levels. These studies generally focus on exploring potential links between demographic information, years of experience, educational levels, and teachers' digital competency levels (Çebi & Reisoğlu, 2020; Keskin & Yazar, 2015; Şahin & Arcagök, 2014). Keskin and Yazar (2015) investigated and analyzed teachers' digital competency levels based on demographic data, years of experience, and educational background. The study was conducted with middle school and high school teachers in Turkey, and a survey was developed to collect data on digital competency levels. The results indicated that male teachers had higher scores than female teachers, and those with a master's degree had higher scores than teachers who had only completed undergraduate programs. Furthermore, science, mathematics, English, and computer education teachers had the highest scores.

Several studies have been conducted to investigate educators' digital competency, employing assessment tools grounded in diverse frameworks and models. Çebi and Reisoğlu (2020) aimed to investigate pre-service teachers' perceptions of their digital competencies and the relationships between their digital competency levels and their gender, field of study, and perceived level of digital competence. They created a questionnaire based on the European framework for digital competence for citizens (DigComp) (Carretero, Vuorikari, & Punie, 2017) to evaluate the digital competency levels of pre-service teachers. Kıranlı and Yıldırım (2013) and Põldoja et al. (2014) established their data collection tools on the

National Educational Technology Standards for Teachers (NETS*T) by International Society for Technology in Education (ISTE) (NETS, 2007). Kıranlı and Yıldırım (2013) studied high school teachers' digital competencies, and they found that teachers have low scores in creating e-learning materials. Fraile et al. (2018) conducted a study on the digital competence levels of secondary education teachers using rubrics based on the competencies of the Common Digital Competence Framework for Teachers (National Institute of Technology and Professional Development [INTEF], 2017), which is based on DigComp (Carretero et al., 2017), developed by the Spanish Ministry of Education. The study aimed to assess the digital competencies of pre-service teachers in DigComp areas, respectively information, communication, digital content creation, problem-solving, and safety. The results showed that pre-service teachers had the lowest scores in content creation, while their highest scores were in data processing and safety.

Zhao et al. (2021) conducted a study to analyze the self-perceptions of digital competence among in-service teachers in higher education and to investigate the influence of gender and teaching experience on college teachers' digital competence in China. The researchers gathered data through a questionnaire based on the DigComp framework. The results indicated that the participants positively perceived themselves in information and data literacy, communication and collaboration, security, and problem-solving abilities. However, they rated themselves low for their capacity to create digital content. There were gender differences in teachers' perceptions of digital competence, with male instructors holding more positive views than their female counterparts. Moreover, teachers with less experience rated themselves higher in communication and collaboration, digital content creation, security, and problem-solving skills. The study recommended comparing teachers'

self-perceived digital competence levels with their actual levels to assess digital competence levels reasonably.

Overall, numerous studies have been conducted to investigate the digital competency levels of teachers (Benali et al., 2018; Çebi & Reisoğlu, 2020; Fraile et al., 2018; Keskin & Yazar, 2015; Lucas et al., 2021; Põldoja et al., 2014; Santo et al., 2022; Strudler et al., 2003; Şahin & Arcagök, 2014; Zhao et al., 2021). Some of them focused on finding the relationship between demographic information with the digital competency levels of teachers (Benali et al., 2018; Çebi & Reisoğlu, 2020; Keskin & Yazar, 2015; Şahin & Arcagök, 2014), some of them designed training programs and examined the effects of training on the digital competency levels of educators (Lucas et al., 2021; Strudler et al., 2003).

While analyzing the digital competency levels of educators, several assessment tools have been developed (Çebi & Reisoğlu, 2020; Kıranlı & Yıldırım, 2013; Põldoja et al., 2014). Unsurprisingly, more studies conducted have investigated the impact of the COVID-19 pandemic on teachers' digital competencies after 2020 (Rodriguez, Mena-Guacas, Tobón, & Meneses, 2022). However, there is a need for a more comprehensive exploration since previous studies did not address the reasons behind these differences or mention the teachers' pedagogical practices. It is essential to conduct research on the actual teaching practices of educators, as well as the underlying reasons that shape their experiences and attitudes toward the use of digital technologies in teaching and learning. Such research is crucial to fully comprehend the present situation of the teachers’ practices and develop extensive plans aimed at enhancing the digital competency level of educators.

According to the National Council of Teachers of Mathematics (NCTM, 2007), mathematical discourse includes representing, reasoning, discussing, agreeing

with, and disagreeing with mathematical concepts. Teachers play a vital role in facilitating mathematical discourse by integrating technology into student-centered approaches and encouraging students to pose questions and demonstrate their knowledge through technological representations (White, 2003). Effective use of technology in mathematical discourse requires teachers to possess diverse competencies, such as designing new tasks, developing innovative explanations for mathematical concepts, and using information and communication technology (ICT) to enhance students' reasoning skills (Hegedus et al., 2017). Therefore, it is crucial to identify key competencies that need strengthening to support students' engagement and learning in mathematics (Hegedus et al., 2017; White, 2003).

Teachers' roles in using technology in education must be thoroughly examined. Even if the students are engaged, a disadvantageous environment for mathematical discourse may develop due to poor technology integration (Hoyles, Noss, & Kent, 2004). Hoyles et al. (2004) stated that the teacher's responsibility in technology integration in education is critical since they must interpret mathematical concepts while transforming them into activities. There are potential contradictions between traditional mathematics curricula and ICT-integrated mathematics. In mathematics education, abstraction is essential to developing mathematical understanding (Hoyles et al., 2004). While educational technologies provide a valuable tool for mathematical abstraction, their use in mathematics education remains a concern (Trouche, 2003). Teachers must be aware of the nature of mathematical knowledge and its relationship to learning outcomes and provide a technologically integrated learning environment (Hoyles et al., 2004; Trouche, 2003).

Trouche (2003) stated that when teachers use technological tools to improve the learning experience, they should consider learners' interactions, gains, and the relevance of learning outcomes in the curriculum because students may develop diverse interpretations of mathematics, which may differ from the curricula. Thus, they highlighted how technological tools could provide shared means of expressing mathematical concepts to address this issue.

Using digital technologies in mathematics education provides benefits for different learning styles (Ball et al., 2018). It enhances mathematical understanding by enabling multiple representations of mathematical concepts, and it encourages individualized learning by providing diverse problem-solving methods (Ball et al., 2018; Hoyles & Lagrange, 2010; Olive et al., 2010). Thurm and Barzel (2021) conducted a study on high school mathematics teachers' perceptions on using digital technologies and found that teachers' beliefs play a crucial role in using digital technologies in mathematics education. They highlighted that using digital technologies to provide multiple representations can be integrated into traditional classroom routines with fewer adjustments. They recommended that teachers with concerns about using digital technologies can start by integrating them to provide multiple representations and next stage could involve using ICT for creating individualized learning opportunities.

Mailizar and Fan (2020) conducted a study to explore secondary mathematics teachers' knowledge of using digital technologies in teaching. The findings of this study found that secondary school mathematics teachers had greater familiarity with general software like Microsoft Word and Excel, as opposed to specialized mathematical software such as dynamic geometry software. They stated that proficiency in general software did not significantly enhance students' mathematical

understanding and discourse. The study revealed that secondary mathematics teachers mostly used ICT for direct instruction rather than collaborative-based and discovery-based teaching (Mailizar & Fan, 2020). They recommended that mathematics teachers should be trained on the pedagogical strategies of integrating ICT rather than solely focusing on technical knowledge.

Kaleli-Yilmaz (2015) conducted a qualitative study about the factors that affect mathematics teachers' technology integration experiences. The researcher used semi-structured interviews to explore the possible factors that affect the use of digital technologies in mathematics classrooms. Furthermore, they also investigated how in-service mathematics teachers perceived the use of digital technologies in the classroom. Firstly, they provided a course on computer-assisted mathematics teaching for 14 weeks before the data collection process. According to the study results, teachers' attitudes toward technology integration were significantly related to their practices. For example, the researchers stated that teachers mostly do not know about using technology in mathematics and do not trust their digital competency skills, resulting in anxiety about adapting technology into their classrooms (Kaleli-Yılmaz, 2015). Although the study was not directly related to the digital competency levels of mathematics teachers, it asserted that more studies should be conducted on the digital competence of in-service mathematics teachers.

Agyei and Voogt (2011) conducted a study to investigate the factors influencing technology integration in education: teachers' attitudes, digital competencies, and the accessibility of technological tools. The study was grounded on the Will, Skill, Tool model (Christensen & Knezek, 2008). They found that digital competency levels are the most significant effect of using digital technologies in the

classroom. The study showed that mathematics teachers had low digital competencies in Ghana (Agyei &Voogt, 2011).

Previous research highlights the benefits of using digital technologies for discovery learning and enhancing students' comprehension of mathematical concepts (Ball et al., 2018; Hoyles & Lagrange, 2010; Olive et al., 2010). It is critical to evaluate middle school mathematics teachers' digital competency levels to identify their needs and support them in successfully integrating technology into their classroom practices (Agyei & Voogt, 2011; Kaleli-Yilmaz, 2015; Mailizar & Fan, 2020; Olive et al., 2010; Thurm & Barzel, 2021). Understanding and strengthening the digital competency of middle school mathematics teachers has become even more critical as the COVID-19 pandemic forced teachers to rely more heavily on technology during ERT. As a result, additional research is required to thoroughly investigate the digital competency levels of middle school mathematics teachers.

2.2 The effects of COVID-19 on digital competencies of educators

The COVID-19 pandemic has impacted teachers worldwide; it has affected the education system and transformed how instruction is delivered. Teachers had various experiences regarding these changes; thus, affecting their perspectives toward using digital technologies. According to Mulenga and Marbán (2020), preservice teachers believe that mathematics lessons were more interesting than traditional methods during the COVID-19 pandemic because digital technologies supported teachers in applying engaging teaching methods. On the other hand, Karakaya, Adıgüzel, Üçüncü, Çimen, & Yılmaz (2021) stated that teachers experienced poor interaction with learners during the ERT in Turkey because of insufficient technological infrastructure and the lack of teachers’ digital competencies.

Following the outbreak of COVID-19 pandemic, the significance of digital competency has been highlighted, leading to increased studies on teachers' digital competency, especially during the ERT period. There has been a significant increase in research on the digital competency of educators and related frameworks in 2020 (Rodriguez et al., 2022). Pozas (2021) conducted a study to identify the factors affecting pre-service teachers' technology use and digital competency levels by using the Will, Skill, Tool framework (Christensen & Knezek, 2008) in Germany. According to the results, although the pre-service teachers perceived themselves as digitally competent, no evidence supported this claim. During the pandemic, in-service teachers stated that they felt unprepared for ERT. Therefore, educators need to be aware of their digital competency levels to effectively use digital tools in the learning context in the future.

Csachová and Jureková (2020) conducted a study on the teaching experiences of secondary school mathematics teachers during COVID-19. They stated that the participants gradually improved their digital skills and used various applications in their instruction, such as PowerPoint presentations, Word and Excel documents, projects, and videos during the pandemic. They also created many worksheets that would be used after COVID-19. Some mathematics teachers devoted significant time preparing materials for their students and were eager and competent to teach online regularly using digital resources. However, some of them emerged hesitant to use digital technologies in online mathematics education, possibly because they were unprepared to adapt their methods by learning new abilities, so they chose to use textbooks to cover objectives during the pandemic.

The ERT presented teachers with several obstacles, such as classroom administration, student interaction, and the delivery of mathematics exercises (Cao,

Zhang, Chan, & Kang, 2021). Teachers needed to help monitor students' participation and ensure they listened and took notes since some students switched off their cameras and microphones. In their study, 69.7% of the participants stated that they had classroom management problems because they could not track the students' engagement during ERT. Teachers noticed a need for verbal and nonverbal communication and eye contact in online classes, making it challenging to develop one-on-one connections with students. Furthermore, mathematics teachers reported that online instruction limited their ability to teach topics requiring whole-class activities and peer collaboration during ERT (Cao et al., 2021).

During the ERT period, instructors encountered significant challenges in providing formative assessments and timely feedback (Hodgen et al., 2020). The absence of face-to-face interaction posed limitations on teachers' ability to administer formative assessments effectively. As a result, student participation and interaction declined, underscoring the importance of teacher-student engagement and personalized feedback in online learning environments (Hodgen et al., 2020). Feedback, often delivered through email or weekly live meetings, was frequently delayed and limited in nature. The adoption of distance learning during ERT reduced student engagement in mathematical discussions and hindered their access to formative feedback. Notably, the lack of interaction between students and instructors emerged as a significant drawback of distance education. Hodgen et al. (2020) suggested conducting further research to enhance teacher-student interactions and provide tailored feedback during future lockdown situations.

According to Choi et al. (2021), there has been a concern about teachers' digital competency during emergency remote teaching, and teachers mostly felt unprepared to use digital technologies in online learning. Hence, teachers believed

online teaching during the global pandemic was difficult. Their study aimed to guide educators and policymakers in improving educational practices for the post-covid era, especially rethinking teachers' role in the digital age. They stated that the focus should be on teachers' digital competencies. Educators were mainly unprepared for ERT; for example, only 48% had used the internet portal before the global pandemic in the US (Caglayan, Hodgman, Garet, & Rickles, 2021). According to Ogodo et al. (2021), students' academic performance dropped during the pandemic, and their misconceptions deepened. One of the causes of this was teachers' lack of digital competency in designing and facilitating online instruction.

Hoti et al. (2022) aimed to identify teachers' practices during the COVID-19 period and stated that online teaching improves educators' technical skills and interactivity with students using digital technologies. They reported that many educators mentioned online learning provided an alternative for supporting learners' active participation, online methods were found to be highly effective. Accordingly, educators planned to use digital technologies to enhance students' engagement after the pandemic (Hoti et al., 2022).

Research on teachers' experiences using digital technologies on learners' engagement reported conflicting results during the global pandemic. Some declared digital technologies as an opportunity to enhance the active participation of learners, and others mentioned that they experienced low engagement of students (Hoti et al., 2022; Karakaya et al., 2021). The findings were mainly related to teachers' digital competency skills because these are fundamental for the effective use of technology to enhance learners' engagement and motivation. Technology allows teachers to prepare interactive lessons and create diverse learning materials (Hegedus et al.,

2017). It is essential to conduct further research to understand the reasons behind the mixed results during the pandemic.

Fidan and Cura Yeleğen (2022) stated an increasing need for research on teachers' digital competence, which became even more apparent during the COVID-19 pandemic, and they conducted a study to examine teachers' digital competencies concerning various variables and their opinions on development of digital competence. They stated that the year of experience affects digital competency levels; teachers with 0-5 years of experience had higher levels of digital competency than 16-20 years of experienced teachers in Turkey. Additionally, they mentioned that teachers need more training on using digital technologies to improve their digital competencies. Although vocational training in digital competencies already exists, teachers believe it to be inefficient and express the need for more training to support their practices (Fidan & Cura Yeleğen, 2022).

Furthermore, their study highlighted a significant relationship between using web 2.0 tools in classrooms and teachers' levels of digital competencies. However, it was worth noting that the study sample was inadequate, limiting the generalizability of the results. Other studies have also suggested that teachers need more vocational training on digital technology to improve their digital competencies, especially regarding assessment methods and learner interaction in Turkey (Avcı & Guven, 2021; Fidan & Cura Yeleğen, 2022).

According to Darling-Hammond and Hyler (2020), the COVID-19 pandemic revealed the need to change teacher education programs. They discussed how the pandemic revealed insufficient levels of digital competency among numerous educators, resulting in difficulties adapting teaching methods during the ERT period. Therefore, policymakers and educators must redesign teacher preparation programs

to ensure that educators can effectively adapt to the post-pandemic period or future emergent cases, which may include an increase in online and blended learning environments. The objective is to equip instructors with the necessary digital skills and pedagogical knowledge to utilize technology for effective teaching and learning. In order to identify the areas that require improvement, it is essential to comprehend the present levels of digital competency among teachers and to investigate their beliefs. Educators and policymakers can then plan suitable development programs (Darling-Hammond & Hyler, 2020).

In conclusion, the significance of teachers' digital competency levels has been highlighted after the pandemic, resulting in increased research on this topic (Cao et al., 2021; Csachová & Jureková, 2020; Hodgen et al., 2020; Pozas, 2021). The COVID-19 pandemic has impacted teachers worldwide. While some teachers found using digital technologies in instruction supportive and engaging, others faced challenges due to limited infrastructure and insufficient digital competencies (Karakaya et al., 2021; Mulenga & Marbán, 2020; Rodriguez et al., 2022). Improving teacher education programs and developing teachers' digital competencies could ensure their effective adaptation to online and blended learning environments (Avcı & Guven, 2021; Fidan & Cura Yeleğen, 2022). By comprehending the current levels of digital competency and addressing areas that require improvement, educators and policymakers can enhance educational practices and better prepare for future challenges in the digital age (Darling-Hammond & Hyler, 2020).

2.3 Frameworks for the digital competency of educators

Digital competency has become crucial in today's technology-driven world, given the increasing reliance on technology. It contains the necessary skills required for

individuals to adapt and succeed in the digital age of the 21st century (Ilomäki et al., 2014). The role of teachers is key in this process, as they must guide learning and adapt their teaching methods to meet the unique needs of each student, placing them at the center of their learning experience (Punie & Ala-Mutka, 2007). Accordingly, several models and frameworks are described to define the components of digital competency for educators.

The UNESCO ICT Competency Framework for Teachers (2018) was developed to identify the competencies required for the professional development of teachers. The framework is divided into three levels: knowledge acquisition, knowledge deepening, and knowledge creation, and it consists of six aspects. In the first level of the UNESCO ICT Competency Framework for Teachers, educators are aware of the importance of ICT and have the technical skills for basic use. The second level involves teachers having digital competency to create a collaborative learning environment and use technology to solve problems. In the last level, teachers can allow learners to create knowledge by designing such learning environments, and they have advanced digital competency to support this process. The framework covers six aspects of digital competency, including understanding the role of digital technologies in education, applying knowledge and skills in education, using ICT in pedagogical practices, applying digital skills, creating and managing learning organizations, and self-learning on digital literacy.

The Digital Competence Framework for Citizens (DigComp) framework includes five areas and 21 competencies: Information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving (Carretero et al., 2017). Several countries' ministries of education have conducted conferences and presented action plans to enhance digital competency by

referring to the DigComp framework, such as KMK (2019) conference in Germany. Spain's Ministry of Education published a framework based on DigComp framework. The Common Digital Competence Framework for Teachers (INTEF, 2017) offers descriptors for educators, allowing them to assess their practices. In 2022, the new version of DigComp (2.2) was published to guide people in using digital technologies in a critical and engaging way (Vuorikari, Kluzer & Punie, 2022). It comprises examples of knowledge, skills, and attributes for learning and employment scenarios. However, the DigComp framework did not provide specific descriptors for educators.

International Society for Technology in Education [ISTE] Standards for Educators (2017) developed the National Educational Technology Standards (NETST, 2007) to describe the knowledge, skills, and attitudes that educators should have, to integrate technology into their teaching practices effectively. It involves effective teaching practices with technology-enhanced activities and assessment methods with technology for K-12 education. ISTE (2017) published ISTE Standards for Educators to guide teachers in promoting modern teaching practices and student-centered learning. The standards are divided into seven categories: Learner, Leader, Citizen, Collaborator, Designer, Facilitator, and Analyst. Firstly, Learner, emphasizes reaching learning goals effectively using technological pedagogical knowledge and enhancing learners' active participation. It encourages educators to continuously engage in research and professional development to improve their teaching practices. Secondly, Leader, focuses on creating digital content and differentiated learning materials to meet learners' needs. The following standard is Citizen, which emphasizes the importance of digital literacy and guides learners to use technology safely and ethically. The Collaborator standard highlights the

importance of creating collaborative learning environments to expand ideas and develop authentic solutions with a community. The following standard is Designer, which underlines the importance of designing authentic learning experiences by considering the individual differences of learners. The sixth category is Facilitator, giving prominence to the role of teachers in creating a supportive learning environment where students can express their ideas collaboratively and emerge with innovative solutions. The last category is Analyst, which focuses on using digital technologies to improve formative and summative assessments. Technology allows educators to collect and analyze assessment data to complement student learning outcomes. Educators can track student progress and adapt teaching methods using technology-enhanced assessment methods. Overall, ISTE standards provide a general understanding of the indicators for the effective use of technology in teaching practices. However, the standards do not provide explicit guidance for improving and developing skills nor do they help teachers to identify their digital competence levels while using technology in the classroom.

DigCompEdu framework (Redecker, 2017) was essential to this study because it explains the necessary pedagogical and technological competencies and focuses on using appropriate competence according to the context (Bozkurt, Hamutoğlu, Liman Kaban, Taşçı, & Aykul, 2021). Thus, the researcher evaluated the digital competence levels of middle school mathematics teachers and identify their strengths and weaknesses in different competence areas. It helped understand the effects of the global pandemic on middle school mathematics teachers' digital competence and provide an understanding of how to improve their digital competence levels. Additionally, the DigComEdu framework was developed through a process of incorporating existing models and instruments into a comprehensive

framework, making it a widely used and accepted reference (Benali et al., 2018; Rodriguez et al., 2022).

In conclusion, numerous frameworks have emerged to define and assess digital competency, such as those proposed by Carretero et al. (2017), INTEF (2017), and ISTE (2017). However, the DigCompEdu framework has stood out by not only providing a clear definition of digitally competency for educators but also offering guidance in identifying areas that require improvement (Redecker, 2017). Consequently, the researcher chose to utilize the DigCompEdu framework as an analytical tool for the purposes of this study.The following section provides a comprehensive examination of the DigCompEdu framework.

2.3.1 European framework for the digital competence of educators (DigCompEdu)

The DigCompEdu framework aims to promote technology integration in education and professional practice by identifying important pedagogical and professional areas for development. It emphasizes the integration of digital competencies with subject-specific teaching skills to give instructions with more efficient, personalized, and creative methods (Ghomi & Redecker, 2019). DigCompEdu framework has an online self-assessment tool that is free and accessible in many languages. Educators could complete the Digital Competency Scale for Educators to assess their current level of digital competency. By identifying their strengths and weaknesses, they will better understand their abilities and areas where they need improvement. This self-awareness can help them improve their teaching practices and integrate digital technologies more effectively into their lessons.

2.3.1.1 The areas of DigCompEdu framework

DigCompEdu Framework has six areas (see Figure 1). The six different areas consist of 22 competencies.

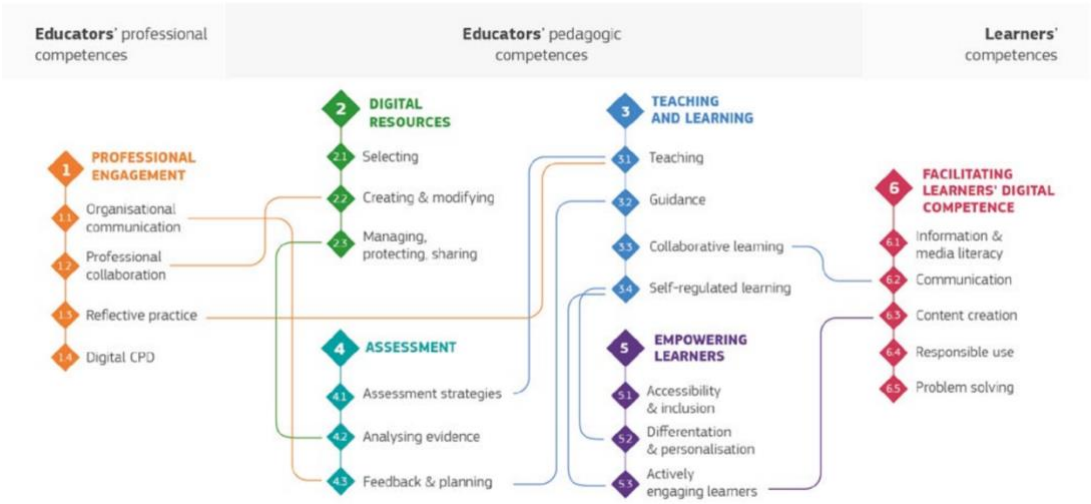

Figure 1. The DigCompEdu framework
Source: [Redecker, 2017]

The first area, Professional Engagement, includes four sub-competencies: Organizational communication, Professional collaboration, Reflective practice, and Digital Continuous Professional Development. It emphasizes using digital technology to enhance teaching and professional connections with coworkers, students, parents, and other stakeholders. It involves sharing practices with other participants of education and collaborating to improve professional development (Redecker, 2017).

The second area, Digital Resources, includes three sub-competencies: Selecting digital resources, Creating, and modifying digital resources, and managing, protecting, and sharing digital resources. It emphasizes that there are many educational digital tools and resources; it is necessary to consider learners' profiles

and instruction methods while using a resource. What teachers need to do is select appropriate resources and modify them if there is a need to do (Redecker, 2017).

The third area, Teaching and Learning, has four sub-competencies: Teaching, Guidance, Collaborative, and Self-regulated learning. It focuses on organizing various stages of the learning process using digital technologies, including innovative teaching techniques and effective management of digital teaching strategies. There are various stages in the learning process. Digitally competent educators organize them using digital technologies. Innovative teaching techniques and effective management of digital teaching strategies are parts of teaching. Digital technologies could be used in class or outside of it. It improves communication between students and teachers. Effective guidance from educators is necessary to improve the learning process. Digital resources allow the creation of collaborative learning environments. Through digital technologies, learners can communicate to share their knowledge and enhance their understanding collaboratively. Digital technologies help learners monitor and provide information about their progress to make their plans. Digital resources provide concrete evidence of learning progress and suggest solutions (Redecker, 2017).

The fourth area, Assessment, has three sub-competencies: Assessment strategies, Analyzing evidence, and Feedback and planning. Digital technologies could be used for formative and summative assessments. It improves assessment techniques. Educators could monitor and interpret learners' activity using digital resources. Teachers could give effective feedback by using digital technologies. They could use learners' activity results while planning lessons and improving teaching strategies (Redecker, 2017).

The fifth area, Empowering Learners, consists of three sub-competencies: Accessibility and inclusion, Differentiation and personalization, and actively engaging learners. It highlights the role of digital technologies in supporting active student participation throughout learning, adapting classroom activities to learners' different styles and levels, and increasing learners' engagement by investigating real-world examples of the context (Redecker, 2017).

Finally, Facilitating Learners' Digital Competence consists of five sub-competencies: Information and media literacy, Digital communication and collaboration, Digital content creation, Responsible use, and Digital problem-solving. The student should find valuable and reliable digital resources for homework or research. Skills in compiling, analyzing, and interpreting information are essential for the 21st century. Learners should be able to use digital technologies to communicate with their colleagues and express themselves in a digital environment. Using digital resources could have risks; educators should teach learners how to use them safely (Redecker, 2017).

In this study, educators' pedagogical competencies were examined. Because the researcher focused on the middle school mathematics teachers' digital competence levels in the effective use of digital technologies in teaching practices.

2.3.1.2 Proficiency stages in DigCompEdu framework

The DigCompEdu framework aims to guide educators to realize their strengths and weaknesses so that they describe six digital competence development levels. The scope ranges from A1 to C2 as a beginner to master used by the Common European Framework of Reference for Languages (CEFR) (see Figure 2). There are 22 competencies to inform educators about their levels. Educators could identify and

appreciate their achievements; they also realize the competencies they need to develop more (Redecker, 2017).

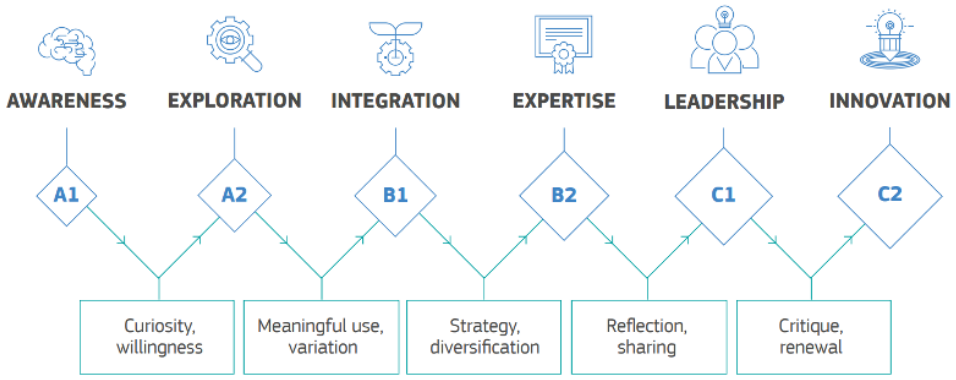

Figure 2. DigCompEdu progression model
Source: [Redecker, 2017]

Competence stages are described as follows:

Newcomers (A1) are aware of the opportunities to use digital technologies but have yet to gain experience with them. It is frequently used in class preparation. They rarely use digital technologies for communication and collaboration and mostly do not use them to create learning activities. They primarily do not modify existing digital resources or create new ones. Most do not use digital data on learners' performance to assess their levels. Newcomers require support and assistance to develop pedagogical practices. Explorers (A2) see the potential of digital technologies and are eager to investigate them for instructional improvement. They are unable to use technology consistently. Explorers need support and motivation to apply instructional practices enhanced with digital resources.

Integrators (B1) use digital technologies in their practice and integrate them for different purposes. They use them to improve other aspects of their teaching but still learn which tools work best in what situations. Integrators need more time to

experiment and criticize them using digital technologies. They can be experts with the help of collaborative encouragement and knowledge sharing. Experts (B2) use digital technologies with confidence, creativity, and critical thinking to improve their practices. They deliberately use digital technologies to understand their benefits and disadvantages in different topics. They are eager to learn and implement innovative ideas.

Leaders (C1) use digital technologies to improve pedagogical and professional practices. They are constantly reviewing and improving their teaching strategies. They learn about recent developments and ideas as they communicate with their peers. They have a wide range of knowledge, which allows them to select appropriate digital resources for educational purposes. Pioneers (C2) are concerned about the limitations of current digital and pedagogical practices. They are inspired to keep innovating in education. Pioneers evaluate complex digital technologies and develop novel pedagogical approaches. They encourage young educators.

Benali et al. (2018) explored the relationship between years of experience, gender, and self-perceptions of digital competency levels among Moroccan English teachers using the DigCompEdu framework. Data was collected using the DigCompEdu digital competency scale for educators. The study revealed that, in general, teachers who had more years of experience and higher self-perceived levels of digital competence also tended to have higher levels of digital competence. The participants were mostly in Integrator (B1) level. Considering the educators' pedagogical sub-competencies of the DigCompEdu, participants had the highest scores on selecting and using digital resources, and reflective practice, and the lowest scores on accessibility and inclusion, assessment strategies, and differentiation and personalization.

Lucas et al. (2021) designed in-service training with the collaboration of policy makers, university researchers, and teachers. They used DigCompEdu self-assessment tool to evaluate teachers' digital competency levels and focused mainly on the pedagogical areas of the DigCompEdu framework. They implemented training based on the DigCompEdu framework for teachers in A1 and A2 levels and the results indicated that trainings had a positive impact on teachers' digital competency levels according to pre-test and post-test results. Their research underlined the need to change teachers' practices and develop pedagogical ideas that enable teachers to operate with available resources to achieve meaningful use of technology. In the research of Santo et al. (2022), the global pandemic forced teachers to improve their digital competence levels and use digital technologies since face-to-face education was impossible during COVID-19. They collected data to analyze the digital competency of university professors in Brazil by using DigCompEdu self-assessment tool. According to the study results, the mean of university educators' digital competency levels was under integrators (B1). Specifically, in educators' pedagogical competencies area, they had the lowest points in the active engagement of learners and self-regulated learning, whereas the highest points were in content creation and accessibility, and inclusion (Santo et al., 2022).

The researcher chose The DigCompEdu framework because of several reasons. Firstly, it built on previous digital competence frameworks and integrated them into a comprehensive and coherent framework specific to the field of education (Cabero-Almenara, Romero-Tena, & Palacios-Rodríguez, 2020). The DigCompEdu framework involves extensive research and collaboration with experts and practitioners with experience in education. Secondly, this framework can be applied to middle school mathematics education contexts and used to assess middle school

mathematics teachers' digital competence. Additionally, the framework includes detailed descriptions of the competencies and sub-competencies that can be used to determine and evaluate digital competence in education. This can be particularly useful for identifying areas of strength and weakness and for middle school mathematics teachers.

In conclusion, educators can improve instructional methods and better prepare for future challenges in the digital era by understanding the current state of digital competency and addressing areas that require improvement (Darling-Hammond & Hyler, 2020; Moreno et al., 2020; Trgalová et al., 2018). According to the literature, several studies claimed that the global pandemic is an opportunity to enhance the digital competency levels of educators (Karakaya et al., 2021; Mulenga & Marbán, 2020; Rodriguez et al., 2022). However, no empirical evidence proved their assumptions after the pandemic. There is a gap in the literature about the current levels of teachers' digital competencies. There are few studies on middle school mathematics teachers' digital competency levels and their practices in Turkey (Avcı & Guven, 2021; Fidan & Cura Yeleğen, 2022; Karakaya et al., 2021). There is an obvious need to improve teachers' digital competency, and policymakers and educators should enhance future teacher education programs and in-service training (Mitescu-Manea et al., 2021).

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CHAPTER 3

METHOD

The aim of this study was to investigate the digital competency levels of middle school mathematics teachers in the post-pandemic era and explore the related experiences during the COVID-19 pandemic that may have affected their levels of digital competencies. This chapter covered (1) the research design of the study, (2) the study context and participants, (3) data collection instruments, (4) data collection procedures, (5) data analysis and (6) trustworthiness.

3.1 Research design

This study employed an explanatory sequential mixed method design (Creswell & Plano-Clark, 2018). There are two phases in an explanatory sequential design: quantitative and qualitative (Creswell, 2014). The quantitative data are collected and analyzed first so that researchers will have a general understanding of the research problem. Then, qualitative data is collected and analyzed to explain results with a deeper investigation of remarkable data from the quantitative phase (Creswell, 2014). The findings from quantitative data give information to the qualitative data collection and analysis process, and the results from both data are integrated (Ivankova, Creswell, & Stick, 2006). One advantage of using mixed methods is the opportunity to comprehensively analyze quantitative data (Ivankova et al., 2006). This study used a mixed-method approach to achieve complementarity, which improved the comprehensiveness of understanding the phenomenon (Greene, Caracelli, & Graham, 1989). By integrating the quantitative and qualitative methods, the mixed method aims to increase the interpretability, meaningfulness, and validity of the results. The

complementarity goal was demonstrated in this study by findings from semi-structured interviews, which were then integrated with quantitative data collected using the DigCompEdu scale for educators. Integrating these two methods can provide a more holistic and nuanced understanding of the teachers' digital competence levels.

Using the DigCompEdu Scale for Educators (Redecker, 2017), the researcher collected quantitative data on the digital competency levels of middle school mathematics teachers. The researcher then collected qualitative data by conducting semi-structured interviews to understand educators' digital practices, perceptions of their digital competencies, and the factors that may affect their digital competency levels stemming from their ERT experiences. Integrating quantitative and qualitative data facilitated a more thorough analysis of the quantitative data.

In the first research question, the independent variable of the study was the gender, years of teaching, and educational background of the participants. The dependent variable of the study was the middle school mathematics teachers' digital competency levels measured with the Digital Competency Scale for Educators (Redecker, 2017).

3.2 Context and participants

This study examines middle school mathematics teachers' digital competencies in the post-pandemic era, particularly exploring possible reasons stemming from their experiences during the pandemic. This research focused on educators' pedagogic competencies of the DigCompEdu framework (Areas 2, 3, 4 and 5). These areas cover the digital competencies teachers need to design, implement, and assess learning experiences, which are essential skills for effective technology integration.

The present study involved a sample of 44 middle school mathematics teachers from 14 different cities in Turkey. The participants' ages ranged from 23 to 45 years, with a mean age of 29. Among the sample, there were 8 male and 36 female teachers. 36 participants held a bachelor's degree, while 8 had obtained a master's degree in the field of education. There were eight middle school mathematics teachers who had 0-2 years of experience, 18 of them had 2-5 years, 11 of them had 5-10 years, and seven of them had 10+ years of experience (see Table 1).

Table 1. Demographic Information of Participants

	Number	Percentage
Gender		
Female	36	82
Male	08	18
Age		
20-30	30	68
30-40	12	27
40-50	02	05
Years of Teaching Experience		
0-2	08	18
2-5	18	41
5-10	11	25
10+	07	16
Education		
Bachelor	36	82
Master	08	18

The participants of the quantitative phase were selected through convenience sampling method (Creswell, 2014) based on the criteria of being a middle school mathematics teacher. The researcher invited the teachers through online social platforms to participate in the study. The survey was distributed online via Google Forms. The survey stayed open to accept answers for three weeks. Then, the survey

responses were transferred into an Excel spreadsheet. Afterward, the researcher coded the scores of the survey questions and demographic information into the spreadsheet and calculated participants' digital competency levels. Following this, the researcher sent an invitation email to the participants, which included the purpose of the research, and the significance of their attendance for the qualitative phase.

The purposive sampling method was used to select participants for the qualitative phase (Creswell, 2014). According to the analysis of survey results, volunteers for interviews were selected based on their digital competency levels and demographic information (see Table 2). There was at least one teacher from each level specifically 1 participant with an A1 level, 1 participant with an A2 level, 3 participants with B1 level, 4 participants with B2 level, 1 participant with C1 level. For maximal variation, the researcher identified volunteers from different cities and with varying educational backgrounds, and years of teaching experience. There were eight participants who worked in private schools, and two of the participants were from state schools. The semi-structured interviews were implemented via an online video conferencing tool.

Table 2. Participants for Semi-Structured Interviews

Participants	Digital Competency level	Age	Gender	Teaching Experience	City	Education
Teacher 1	A1. Newcomers	26	Male	2-5	İstanbul	Bachelor
Teacher 2	A2. Explorer	26	Female	0-2	Yalova	Bachelor
Teacher 3	B1. Integrator	27	Female	2-5	İstanbul	Bachelor
Teacher 4	B1. Integrator	25	Female	2-5	İstanbul	Bachelor
Teacher 5	B1. Integrator	26	Female	2-5	Van	Bachelor
Teacher 6	B2. Expert	26	Female	2-5	İstanbul	Master
Teacher 7	B2. Expert	27	Female	2-5	İstanbul	Bachelor
Teacher 8	B2. Expert	25	Female	2-5	İstanbul	Master
Teacher 9	B2. Expert	26	Female	0-2	Eskişehir	Master
Teacher 10	C1. Leader	26	Female	2-5	İstanbul	Bachelor

3.3 Data collection instruments

The quantitative data of the study were collected through the Digital Competency Scale for Educators (Redecker, 2017), and the qualitative data were collected using semi-structured interviews. Table 3 showed that how the data collected related to each research question in this study.

3.3.1 DigCompEdu digital competency scale for educators

The study aimed to identify middle school mathematics teachers' digital competency levels and examine any significant difference in middle school mathematics teachers' digital competency levels after the pandemic in terms of their years of teaching experience, gender, and educational background, so the Digital Competency Scale for Educators was used (see Appendix A). It is an online self-assessment tool to comprehend teachers' strengths and weaknesses in using digital technologies in education (Redecker, 2017). It aims to simplify key ideas of the DigCompEdu framework, explain competency level descriptions with concrete practice examples, and give specific feedback to educators according to their digital competence levels.

The Digital Competency Scale for Educators consists of 22 items and six factors.The items have five possible answers, and they are structured cumulatively according to proficiency levels (Ghomi & Redecker, 2019). The answers given to the scale items are valued between 0 and 4 points. The maximum score from the scale is 88 points, and the minimum score is 0 points.

Table 3. Data Matrix

Research Questions	Data Source		Related DigCompEdu Areas	Data Analysis
	Digital Competency Scale for Educators	Interviews		
1. What are the levels of middle school mathematics teachers' digital competencies after the pandemic?	X		Area 1,2,3,4,5,6	Descriptive Statistics
1.1 Is there any statistically significant difference in middle school mathematics teachers' digital competency levels after the pandemic in terms of their gender?	X		Area 1,2,3,4,5,6	Inferential Statistics
1.2. Is there any statistically significant difference in middle school mathematics teachers' digital competency levels after the pandemic in terms of their years of teaching experience?	X		Area 1,2,3,4,5,6	Inferential Statistics
1.3 Is there any statistically significant difference in middle school mathematics teachers' digital competency levels after the pandemic in terms of their educational background?	X		Area 1,2,3,4,5,6	Inferential Statistics
2. What are the perceptions of middle school mathematics teachers on their digital competency levels after the pandemic?	X		Area 1,2,3,4,5,6	Descriptive Statistics
2.1 How do middle school mathematics teachers use digital technologies in teaching and learning?	X	X	Area 3	Hybrid Thematic Analysis
2.2 How do middle school mathematics teachers use digital technologies to enhance assessment?	X	X	Area 4	Hybrid Thematic Analysis
2.3 How do middle school mathematics teachers use digital technologies to empower their students?	X	X	Area 5	Hybrid Thematic Analysis
3. What do middle school mathematics teachers think about the effects of ERT experiences on their current digital competency levels?	X	X	Area 1,2,3,4,5,6	Hybrid Thematic Analysis
3.1 What do middle school mathematics teachers think about the effects of ERT experiences on their current use of digital technologies in teaching and learning?	X	X	Area 2 and 3	Hybrid Thematic Analysis
3.2 What do middle school mathematics teachers think about the effects of ERT experiences on their current use of digital technologies to enhance assessment?	X	X	Area 4	Hybrid Thematic Analysis
3.3 What do middle school mathematics teachers think about the effects of ERT experiences on their current use of digital technologies to empower learners?	X	X	Area 5	Hybrid Thematic Analysis

As a result of the application of the scale, the participants can be evaluated under six categories: Newcomer, Explorer, Integrator, Expert, Leader, and Pioneer. In the first two stages, Newcomer (19 points and below, A1) and Explorer (20 -33 points, A2), teachers learn new material and develop fundamental digital skills; in the following two stages, Integrator (34-49 points, B1) and Expert (50-65 points, B2), teachers put their digital skills into practice, advance them, and reflect on them. In the highest stages, Leader (66-80 points, C1) and Pioneer (81 points and above, C2), teachers apply their digital skills in practice and further develop new practices (Redecker, 2017).

Toker, Akgün, Cömert, & Edip (2021) adapted the scale to the Turkish context and utilized confirmatory factor analysis to examine the construct validity of the translated scale (see APPENDIX B). The satisfactory factor loadings of the items on their respective factors indicated that the results had robust construct validity. Additionally, Cronbach's alpha was used to assess the internal consistency reliability of the scale, yielding a value of 0.94, indicating a high degree of reliability. Overall, these results suggest that the adapted scale is a valid and reliable instrument for measuring the level of digital competence among Turkish-speaking educators (Toker et al., 2021).

The researcher expanded quantitative data with demographic questions to investigate potential differences in digital competency levels based on gender, level of education, and years of teaching experience (see APPENDIX A). The researcher planned to gain a more comprehensive understanding of the factors that may influence middle school mathematics teachers' digital competency levels by including these demographic questions.

3.3.2 Semi-structured interviews

In the qualitative phase, there was an investigation to better understand middle school mathematics teachers' digital competency levels and how related experiences during the global pandemic affected their perceptions of current digital competency levels. The qualitative data were collected via semi-structured interviews (see Appendix C). The interviews were conducted in Turkish. Quotations from the interviews translated to English in the results sections.

The interviews were conducted online one-on-one with ten middle school mathematics teachers. The teachers who participated in the interviews were selected purposefully. Purposive sampling was used to guarantee the representation of various levels of digital competency, as determined by the Digital Competency Scale for Educators (Redecker, 2017), as well as demographic diversity. This included individuals from various cities and of varying gender, educational background, and teaching experience years (see Table 1). Specifically, the selection procedure ensured that at least one teacher from each level of digital competency was included: one volunteer from the A1 level, one volunteer from the A2 level, three volunteers from the B1 level, four volunteers from the B2 level, and one teacher from the C1 level. There was no C2 level participant in this study according to the results of quantitative data results.

The interview protocol has 8 main and 13 sub-questions. Before conducting the interviews, a pilot interview was conducted with a middle school mathematics teacher who did not participate in the study. The researcher and thesis advisor then discussed the flow of questions and potential follow-up questions. Open-ended questions were asked to examine their practices and the effects of the ERT on their current digital competency levels.

3.4 Data collection procedures

Before the data collection process started, ethical approval was obtained from the Ethics Committee in Social Sciences and Humanities (SOBETIK) of Boğaziçi University (see Appendix D), and participants were informed about the study and consent forms were collected for quantitative (see APPENDIX E) and qualitative phase (see Appendix F).

The researcher employed various methods to enlist participants for the survey, including social media announcements and dissemination of research information in WhatsApp teacher-specific groups. After selecting participants for the semi-structured interviews, the researcher emailed each individual an invitation clarifying the significance of their participation in the study. Digital consent documents were utilized to obtain the participation approval of study participants. The consent form included the aim and procedure of the study. Participants completed Digital Competency Scale for Educators (Redecker, 2017), an online self-assessment survey reflecting middle school mathematics teachers' digital competencies. It took 20-25 minutes to complete the survey. Then, according to the analysis of survey results, ten teachers were selected purposefully, with at least one teacher chosen from each competency level and diverse demographics.

Interviews took 35-45 minutes. The interviews were conducted online one-on-one with ten middle school mathematics teachers over Zoom and Google Meets. Before recording each interview, the researcher obtained the participants' consent. The interview process took three weeks (see table 4). The researcher integrated the findings from quantitative (Digital Competency Scale for Educators) and qualitative (semi structured interviews) data.

Table 4. The Data Collection Procedure

Duration	Procedure	Instrument
For three weeks	Volunteer teachers completed digital competency scale for educators online. The participants for the semi-structured interviews were selected.	Digital Competency Scale for Educators (Redecker, 2017). *Online Self-Assessment Tool for Educators*
For four weeks	The researcher interviewed volunteer teachers.	Semi-Structured Interviews

3.5 Data analysis

3.5.1 Quantitative analysis

The first research question (What are the levels of middle school mathematics teachers' digital competencies after the pandemic?) was answered using quantitative data. The answers of middle school mathematics teachers on the Digital Competency Scale for Educators items were collected and scored considering the proficiency levels. The IBM SPSS statistical software (Statistical Package for Social Sciences - Version 25) was used.

In the quantitative data analysis, the researcher started with data cleaning. She first organized the data from the DigCompEdu scale by writing the scores corresponding to the answers in an Excel document. After data cleaning, data analysis was processed to answer research questions. To analyze the data, descriptive and inferential statistics were used.

The demographic information of the participants was also organized in SPSS (gender, education level, years of teaching experience). The researcher checked whether the data were normally distributed to proceed with the analysis whether with the parametric or nonparametric tests. Since the sample size of the study was smaller than 50, the researcher used the Shapiro-Wilk normality test (Mishra et al., 2019).

In gender and education variables, one group had a substantially larger sample size than the other (36 females, 8 males; 36 bachelors, 8 masters) so the researcher used a nonparametric test (Mann-Whitney U test). In the years of experience variable, the researcher conducted one-way ANOVA to investigate the relationship between variables. Before carrying out the ANOVA test, parametric test's assumptions were controlled. Level of measurement, normal distribution, and homogeneity of variance were satisfied (Dahman, 2018). Level of measurement assumption was verified since dependent variable which was middle school mathematics teachers' digital competency levels was measured by DigCompEdu Scale for educators was continuous, and independent variable which was years of teaching experience was categorical. Normal distribution was provided by Shapiro-Wilk test. The assumption of homogeneity of variances was tested and Levene's test showed that the variances for digital competency scores were equal for all areas, $F(3,40) = .08$, $p = .97$ for total scores.

3.5.2 Qualitative analysis

The researcher transcribed the audio recordings using a software program and then manually edited the transcription to remedy any errors. Subsequently, the transcriptions were transferred from Microsoft Word to a qualitative analysis software (e.g., MAXQDA Pro 2022). Deductive thematic analysis was used for structures with predefined categories and theory-driven codes. Inductive thematic analysis was utilized when data-driven codes and categories arose. This methodology was called hybrid thematic analysis and it can yield a more in-depth study, allowing for structured coding and discovering previously unnoticed patterns (Fereday & Muir-Cochrane, 2006; Swark, 2018). This method allowed for data encoding by

referring to a predefined theoretical framework (DigCompEdu) and discovering new themes and subthemes. The data encoding using predefined categories was used as a starting point. Afterwards, new themes and subthemes were identified based on the participants' responses.

The researcher followed Braun and Clarke's (2006) six steps for the thematic analysis method. The researcher familiarized with the data from semi-structured interviews by taking notes during the interview and re-reading the transcriptions. She used DigCompEdu framework (Redecker, 2017) areas as initial codes for deductive thematic analysis. Then, she developed and modified data to identify new themes from participants' responses by open coding (Braun & Clarke, 2006). In the inductive thematic analysis, the researcher created new categories with codes, mainly in volunteers' pandemic-related and post-pandemic-related experiences using digital technologies in their teaching practices (see Appendix G).

The researcher examined similar themes, determined the essential characteristics of each theme, and concluded with defining themes. Digital competency levels were examined in interviews to explore the quantitative data results. Transcriptions of interviews were explored with MAXQDA Pro 2022 qualitative data analysis software. This approach was conducted to answer the second (What are the perceptions of middle school mathematics teachers on their digital competency levels after the pandemic?) and third research questions (What do middle school mathematics teachers think about the effects of ERT experiences on their current digital competency levels?).

3.6 Trustworthiness

Several strategies were employed to ensure the trustworthiness of this study. A mixed-method design was used to collect data from multiple data sources, including the DigCompEdu digital competency scale for educators and semi-structured interviews (Creswell & Plano-Clark, 2018). It allowed for a more comprehensive understanding of the research topic and increased the validity and reliability of the findings. The researcher integrated quantitative and qualitative data findings to identify common themes and patterns (Ivankova et al., 2006).

The sampling procedure used a purposive sampling method to select representative participants among middle school mathematics teachers (Creswell, 2014). Interview participants were selected based on their digital competency levels and various demographic backgrounds, with at least one participant chosen from each level. Thus, the researcher had more comprehensive findings and analyzed the similarities and differences in perceptions and experiences of the teachers across different digital competence levels and demographic information. The researcher coded semi-structured interviews with the assistance of critical peers, which involved multiple review and improvement processes (Stahl & King, 2020). The final code system was based on consensus, which minimized subjective interpretations.

The researcher was open and collaborative with the participants. The researcher used explicit language to avoid misunderstanding while communicating with the participants. The researcher explained any complex ideas or terms if necessary and provided the necessary instructions.

CHAPTER 4

RESULTS

The purpose of this mixed-methods study was to examine middle school mathematics teachers' digital competency levels of in the post-pandemic era while exploring their experiences that could have affected these competencies during the pandemic. Digital Competency Scale for Educators (Redecker, 2017) was conducted to measure the digital competency levels of middle school mathematics teachers. The researcher collected qualitative data through semi-structured interviews and analyzed the data using a hybrid thematic analysis approach. In this chapter, the results of the data analysis to examine the digital competency levels of middle school mathematics teachers in the post-pandemic era and explore the factors that may have affected their levels of digital competencies were shared in detail.

4.1 Investigating the effect of gender, years of teaching experience, and educational background on middle school mathematics teachers' digital competency levels after the pandemic

Research Question 1: What are the levels of middle school mathematics teachers' digital competencies after the pandemic?

The researcher calculated the scores for the 22 items in the survey and calculated the total scores of all participants to answer the first research question (What are the levels of middle school mathematics teachers' digital competencies after the pandemic?). After that, the scores for questions related to sub-areas were also calculated to specify participants' digital competency levels in six areas of the DigCompEdu framework.

The present study involved 44 participants. The scores of digital competencies for six areas and the total were calculated and analyzed according to the guidance of DigCompEdu Scale (Redecker, 2017). The mean scores for the six areas, including Professional Engagement, Digital Resources, Teaching and Learning, Assessment, Empowering Learners, and Facilitating Learners' Digital Competence were calculated based on the responses to 22 items. The means were compared to explore potential differences. According to the total scores of the participants, three of the participants were classified as Newcomers (19 points and below, A1), 13 were Explorers (20-33 points, A2), 14 were Integrators (34-49 points, B1), 12 were Experts (50-65 points, B2), and two were Leaders (66-80 points, C1) level. Notably, no participants were found to be at the Pioneer (81 points and above, C2) level as shown in Figure 3.

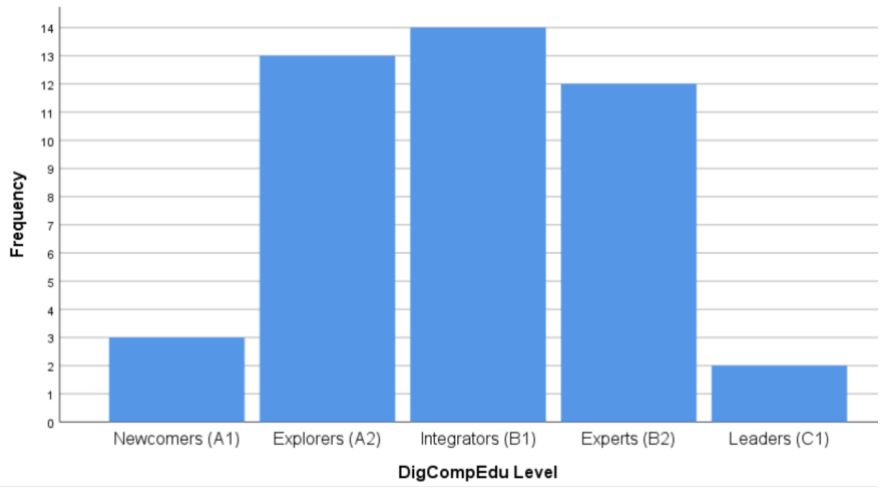

Figure 3. The frequency of participants' DigCompEdu levels

In Professional Engagement (Area 1), seven of the participants were classified as Newcomers (0-4 points, A1), 12 were Explorers (5-7 points, A2), 16 were Integrators (8-10 points, B1), six were Experts (11-13 points, B2), and three were Leaders (14-

15 points, C1) level. The mean of participants' total scores on the DigCompEdu scale for Area 1 was 8.02, which corresponds to the Integrators (B1) level on the scale.

In Digital Resources (Area 2), eight of the participants were classified as Newcomers (0-3 points, A1), nine were Explorers (4-5 points, A2), 14 were Integrators (6-7 points, B1), six were Experts (8-9 points, B2), and seven were Leaders (10-11 points, C1) level. The mean of participants' total scores on the DigCompEdu scale for Area 2 was 6.25, which corresponds to the Integrators (B1) level on the scale.

In Teaching and Learning (Area 3), 14 of the participants were classified as Newcomers (0-4 points, A1), 11 were Explorers (5-7 points, A2), nine were Integrators (8-10 points, B1), eight were Experts (11-13 points, B2), and two were Leaders (14-15 points, C1) level. The mean of participants' total scores on the DigCompEdu scale for Area 3 was 7.16, which corresponds to the Explorers (A2) level on the scale.

In Assessment (Area 4), seven of the participants were classified as Newcomers (0-3 points, A1), 13 were Explorers (4-5 points, A2), 14 were Integrators (6-7 points, B1), nine were Experts (8-9 points, B2), and one was Leaders (10-11 points, C1) level. The mean of participants' total scores on the DigCompEdu scale for Area 4 was 5.68, which corresponds to the Integrators (B1) level on the scale.

In Empowering Learners (Area 5), 11 of the participants were classified as Newcomers (0-3 points, A1), eight were Explorers (4-5 points, A2), 10 were Integrators (6-7 points, B1), 11 were Experts (8-9 points, B2), three were Leaders (10-11 points, C1), and one was Pioneer (C2) level. The mean of participants' total scores on the DigCompEdu scale for Area 2 was 6.02, which corresponds to the Integrators (B1) level on the scale.

In Facilitating Learners' Digital Competence (Area 6), 16 of the participants were classified as Newcomers (5-6 points, A1), 12 were Explorers (7-8 points, A2), nine were Integrators (9-12 points, B1), six were Experts (13-16 points, B2), and one was Leaders (17-19 points, C1) level. The mean of participants' total scores on the DigCompEdu scale for Area 2 was 8.13, which corresponds to the Explorers (A2) level on the scale.

The participants' total scores on the DigCompEdu scale were calculated and found to have a mean of 41.27, which corresponds to the B1 level on the scale. The standard deviation of the total scores was calculated as 15.45, which indicates a relatively high degree of variability among participants' responses.

The analysis revealed that the highest mean (M=2.36) score was obtained for question 17, which belonged to Empowering Learners (Area 5) area. This item involved using digital technologies for students to participate actively in class. On the other hand, the lowest mean (M=1.43) score was obtained for question 11, which belonged to the Teaching and Learning (Area 3) area. This item involved using digital technologies to allow students to plan, document, and monitor their own learning.

When the mean scores were examined, the highest means were observed in the Digital Resources (M=2.08), Professional Engagement (M=2.00), and Empowering Learners (M=2.00) areas, while the lowest mean was observed in the Teaching and Learning (M=1.79), Assessment (M=1.89) and Facilitating Learners' Digital Competence (M=1.63) areas (see Figure 4).

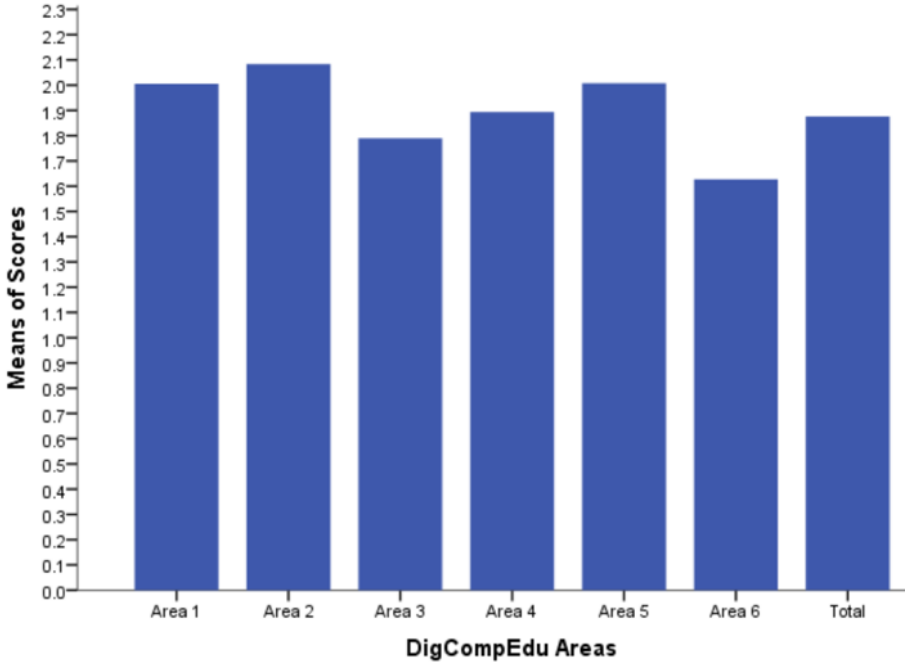

Figure 4. Means of scores for DigCompEdu areas

Descriptive statistics for the scale were calculated, and accordingly, mean (*M*), standard deviation (*SD*), skewness, and kurtosis values were presented in Table 5.

Table 5. Descriptive Statistics for Digital Proficiency Levels

Areas	*N*	*M* (*SD*)	Median	Min	Max	Skewness	Kurtosis
Professional Engagement	44	2.00 (.85)	2.00	.25	3.75	0.1	-.67
Digital Resources	44	2.08 (.94)	2.33	.33	3.67	-.14	-.70
Teaching and Learning	44	1.79 (.89)	1.75	.25	3.50	0.23	-.92
Assessment	44	1.89 (.69)	2.00	.67	3.67	0.23	-.41
Empowering Learners	44	2.00 (.88)	2.00	.67	4.00	0.11	-.90
Facilitating Learners' Digital Competence	44	1.63 (.86)	1.50	.00	3.60	0.28	-.61
Total Score	44	1.88 (.70)	1.81	.68	3.41	0.22	-.84

When Table 5 was examined, it was seen that the skewness and kurtosis values of the scores obtained from the digital competency scale are within the range of ±1.00.

4.1.1 Is there any statistically significant difference in middle school mathematics teachers' digital competency levels after the pandemic in terms of gender?

The digital competency scores of the females and males were normally distributed (p >.05) in all areas except the scores of males in Empowering Learners (Area 5) (p=.03) based on the results of the Shapiro-Wilk test (see Table 6).

Table 6. Shapiro-Wilk Result for Gender

Areas	Gender	Shapiro-Wilk		
		Statistic	*df*	*Sig.*
Professional Engagement	Female	.95	36	.18
	Male	.86	08	.14
Digital Resources	Female	.95	36	.19
	Male	.92	08	.50
Teaching and Learning	Female	.10	36	.29
	Male	.32	08	.12
Assessment	Female	.12	36	.16
	Male	.23	08	.17
Empowering Learners	Female	.12	36	.40
	Male	.28	08	0.03*
Facilitating Learners' Digital Competence	Female	.14	36	.64
	Male	.19	08	.50
Total Score	Female	.10	36	.64
	Male	.25	08	.07

**p <.05*

Since there was a small sample size for the male group, even if the data were normally distributed, the researcher conducted non-parametric tests. In order to investigate the differences between the scores of middle school mathematics teachers' digital competencies in terms of gender variable, a Mann-Whitney U test

was conducted (see Table 7). The results indicated that the females had significantly higher digital competency scores for all areas except Facilitating Learners' Digital Competence (Area 6), *U*=58.00 (Area 1), *U*=61.50 (Area 2), *U*=45.00 (Area 3), *U*=30.00 (Area 4), *U*=30.50 (Area 5), *U*=32.50 (total score).

Table 7. Mann-Whitney U Test for Gender

Areas	Female (n=36) Mean Rank	Male (n=8) Mean Rank	Z-value	*p*
Professional Engagement	24.89	11.75	-2.630	.009*
Digital Resources	24.79	12.19	-2.531	.011*
Teaching & Learning	25.25	10.13	-3.030	.002*
Assessment	25.67	8.25	-3.509	.000*
Empowering Learners	25.65	8.31	-3.478	.001*
Facilitating Learners' Digital Competence	24.19	14.88	-1.865	.062
Total Score	25.60	8.56	-3.395	.000*

**p <.05*

The independent sample t-Test was also conducted, and the results supported each other. The 36 female participants (*M*=2.04, *SD*=.64) compared to the 8 male participants (*M*=1.13, *SD*=.45) demonstrated significantly better digital competency scores in all areas except Facilitating Learners' Digital Competence (Area 6), $t(42) = 2.87$, $p=.006$ (Area 1); $t(42) = 2.67$, $p=.011$ (Area 2); $t(42) = 3.31$, $p=.002$ (Area 3); $t(42) = 4.05$, $p=.001$ (Area 4); $t(42) = 4.01$, $p=.001$ (Area 5); $t(42) = 3.76$, $p=.001$ (total). This significant difference is represented by a high effect size ($d=1.61$).

4.1.2 Is there any statistically significant difference in middle school mathematics teachers' digital competency levels after the pandemic regarding their years of teaching experience?

In the present study, participants were categorized according to their years of teaching experience, with 8 participants having 0-2 years of teaching experience, 18 participants having 2-5 years of teaching experience, 11 participants having 5-10 years of teaching experience, and 7 participants having ten or more years of teaching experience. Shapiro-Wilk test results showed that the data were normally distributed based on participants' years of experience (see Table 8).

Table 8. Shapiro Wilk Result for Experience Years

Areas	Experience Year	*M*	*SD*	Shapiro-Wilk		
				Statistic	df	Sig.
Professional Engagement	0-2	1.78	0.70	.95	8	.75
	2-5	1.90	0.91	.97	18	.78
	5-10	2.43	0.85	.98	11	.96
	10+	1.86	0.79	.90	7	.39
Digital Resources	0-2	2.01	0.85	.93	8	.56
	2-5	2.17	0.94	.95	18	.49
	5-10	2.24	0.80	.93	11	.38
	10+	2.03	1.10	.93	7	.53
Teaching and Learning	0-2	1.67	1.07	.97	8	.90
	2-5	2.08	0.94	.96	18	.55
	5-10	2.00	0.83	.95	11	.59
	10+	1.68	0.88	.84	7	.11
Assessment	0-2	1.93	0.90	.89	8	.24
	2-5	1.61	1.10	.97	18	.72
	5-10	1.79	0.89	.96	11	.75
	10+	2.00	0.64	.94	7	.63
Empowering Learners	0-2	1.78	0.65	.91	8	.36
	2-5	2.03	0.64	.96	18	.53
	5-10	1.86	1.00	.95	11	.62
	10+	1.89	0.69	.92	7	.44
Facilitating Learners' Digital Competence	0-2	2.29	0.70	.96	8	.81
	2-5	2.06	0.97	.91	18	.10
	5-10	2.00	0.87	.92	11	.32
	10+	1.57	0.83	.90	7	.37
Total Score	0-2	2.01	0.88	.90	8	.28
	2-5	1.88	0.76	.96	18	.56
	5-10	1.44	0.80	.90	11	.19
	10+	1.82	0.91	.84	7	.10

a. Lilliefors Significance Correction

The researcher conducted one-way ANOVA to analyze the digital competency scores of participants in terms of years of experience. Results showed that there was no statistically significant difference between participants' digital competency score

in terms of their years of teaching experience, F(3,40)=.50, p=.684 (see Table 9). Therefore, the researcher did not conduct any further post-hoc multiple comparisons.

Table 9. ANOVA for Experience Year

Areas		Sum of Squares	df	Mean Square	F	*P*
Professional Engagement	Between Groups	2.75	3	.91	1.282	.294
	Within Groups	28.57	40	.71		
	Total	31.31	43			
Digital Resources	Between Groups	1.75	3	.58	.65	.590
	Within Groups	36.05	40	.90		
	Total	37.80	43			
Teaching and Learning	Between Groups	1.02	3	.34	.41	.747
	Within Groups	33.34	40	.83		
	Total	34.37	43			
Assessment	Between Groups	.55	3	.18	.36	.780
	Within Groups	20.07	40	.50		
	Total	20.62	43			
Empowering Learners	Between Groups	2.02	3	.67	.87	.465
	Within Groups	30.98	40	.77		
	Total	32.99	43			
Facilitating Learners' Digital Competence	Between Groups	1.58	3	.53	.70	.556
	Within Groups	30.06	40	.75		
	Total	31.65	43			
Total Score	Between Groups	.77	3	.26	.50	.684
	Within Groups	20.44	40	.51		
	Total	21.21	43			

4.1.3 Is there any statistically significant difference in middle school mathematics teachers' digital competency levels after the pandemic in terms of their educational background?

According to Shapiro-Wilk test results, the digital competency scores of the bachelor and master's graduate teachers were normally distributed (p >.05) (see Table 10).

Table 10. Shapiro Wilk Result for Education

Areas	Education Level	*M*	*SD*	Shapiro-Wilk		
				Statistic	df	Sig.
Professional Engagement	Bachelor	1.87 2.62	0.85 0.61	.96	36	.27
	Master	1.93 2.58	0.92 0.77	.90	8	.32
Digital Resources	Bachelor	1.72 2.09	0.83 1.17	.95	36	.13
	Master	1.97 1.66	0.69 0.64	.93	8	.52
Teaching and Learning	Bachelor	2.02 2.04	0.88 0.86	.97	36	.35
	Master	1.66 1.57	0.87 0.78	.88	8	.18
Assessment	Bachelor	1.84 2.07	0.72 0.61	.96	36	.22
	Master	1.87 2.62	0.85 0.61	.96	8	.77
Empowering Learners	Bachelor	1.93 2.58	0.92 0.77	.95	36	.14
	Master	1.72 2.09	0.83 1.17	.92	8	.45
Facilitating Learners' Digital Competence	Bachelor	1.97 1.66	0.69 0.64	.96	36	.28
	Master	2.02 2.04	0.88 0.86	.92	8	.47
Total Score	Bachelor	1.66 1.57	0.87 0.78	.96	36	.27
	Master	1.84 2.07	0.72 0.61	.89	8	.26

a. Lilliefors Significance Correction

Since there was a small sample size for master group, even if the data were normally distributed, the researcher conducted a non-parametric test (e.g., Mann-Whitney U

test). The results indicated that middle school mathematics teachers who had a master's degree obtained statistically significantly higher scores than those who had a bachelor's degree for Professional Engagement (Area 1), U=69.00, p=.02 (see Table 11). According to independent samples t-test results, the 8 participants with master's degrees (M=2.62, SD=.61) compared to the 36 participants with bachelor's degrees (M=1.87, SD=.85) demonstrated significantly better digital competency scores in Professional Engagement (Area 1), $t(42) = -2.39$, p=.021 (Area 1). This significant difference is represented by a high effect size (d=1.04).

The results indicated that middle school mathematics teachers with a master's degree had statistically significantly higher scores than those with a bachelor's degree in professional Engagement (Area 1).

Table 11. Mann-Whitney U Test for Education

Areas	Bachelor (n=36) Mean Rank	Master's (n=8) Mean Rank	Z-value	*p*
Professional Engagement	20.42	31.88	-2.294	.022*
Digital Resources	20.94	29.50	-1.718	.086
Teaching & Learning	21.67	26.25	-.918	.359
Assessment	23.36	18.63	-.954	.340
Empowering Learners	22.33	23.25	-.184	.854
Facilitating Learners' Digital Competence	22.65	21.81	-.168	.866
Total Score	21.60	26.56	-.990	.322

**p <.05*

4.2 Middle school mathematics teachers' digital competencies in the post-pandemic era

Research Question 2: What are the perceptions of middle school mathematics teachers on their digital competency levels after the pandemic?

The DigCompEdu digital competency scale for educators included a question asking participants to select their perceived level of digital competency before answering further questions to investigate participants' digital competence levels. Additionally, the researcher provided summary descriptions for each level of digital competence in the survey to minimize confusion (see Appendix A). According to the Digital Competency Scale responses, five middle school mathematics teachers perceived themselves as Newcomers (A1). However, based on their total scores, only three participants were classified as Newcomers (19 points and below, A1). Similarly, eight teachers perceived themselves as Explorers (A2), but 13 were classified as Explorers (20-33 points, A2) based on their scores. Regarding the Integrator (B1) and Expert (B2) levels, 13 teachers perceived themselves as Integrators, and 13 perceived themselves as Experts. However, based on their scores, 14 were classified as Integrators (34-49 points, B1), and 12 were classified as Experts (50-65 points, B2). Two teachers perceived themselves as Leaders (C1), and two were classified as Leaders (66-80 points, C1). Three teachers perceived themselves as Pioneers (C2), but none scored at the Pioneer level (81 points and above, C2) on the Digital Competency Scale (see figure 5).

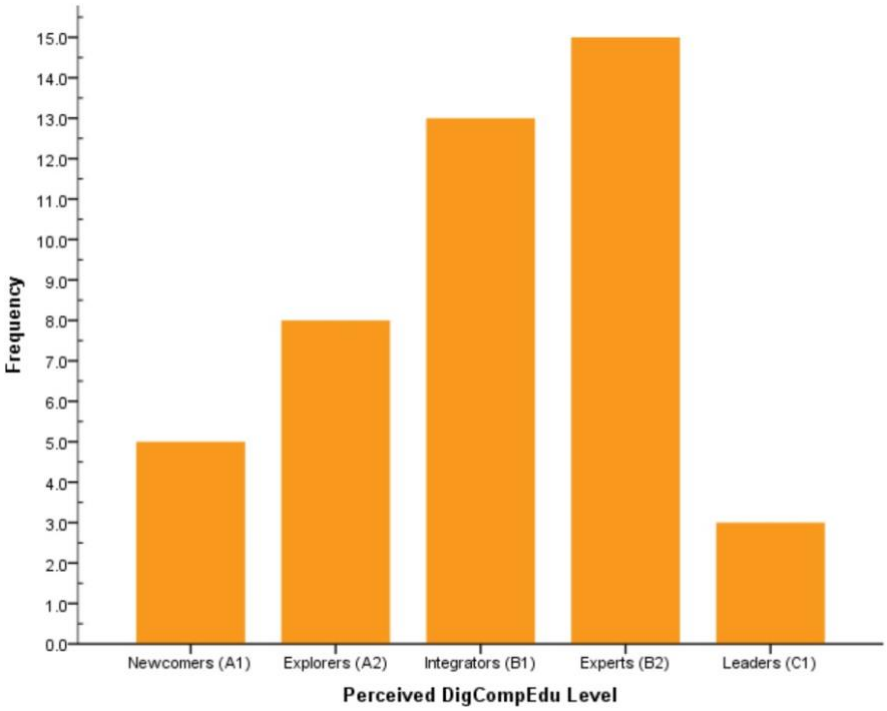

Figure 5. Participants' Self Perceived Digital Competence Levels

The researcher conducted semi-structured interviews with participants with different digital competence levels. In the case of Teacher 1, Teacher 4, Teacher 5, Teacher 6, Teacher 8, and Teacher 9, their actual and perceived levels were consistent. However, Teacher 2, Teacher 3, and Teacher 7 perceived themselves as having higher levels of digital competence compared to their actual levels. (see Table 12). Teacher 2 perceived themselves as Integrator (B1), but their level was found Explorer (A2). In the pedagogic competence areas (Area 3, 4, 5) their level was A1 and A2. Teacher 10 perceived herself as Expert (B2), but her level was Leader (C1).

Out of the 44 participants who took part in the survey, 18 of them perceived themselves as having a higher level of digital competence than their actual levels. 10 of them perceived themselves as having lower digital competence than their actual levels. 16 of them perceived themselves as their actual levels. The perceived levels and actual levels of digital competence for four participants were also different as shown in Table 12.

Table 12. DigCompEdu Levels of Interview Participants

Participants	Actual Level	Perceived Level	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6
Teacher 1	Newcomer (A1)	Newcomer (A1)	Newcomer (A1)	Newcomer (A1)	Newcomer (A1)	Newcomer (A1)	Newcomer (A1)	Newcomer (A1)
Teacher 2	Explorer (A2)	Integrator (B1)	Explorer (A2)	Integrator (B1)	Newcomer (A1)	Newcomer (A1)	Explorer (A2)	Explorer (A2)
Teacher 3	Integrator (B1)	Expert (B2)	Integrator (B1)	Integrator (B1)	Explorer (A2)	Explorer (A2)	Explorer (A2)	Newcomer (A1)
Teacher 4	Integrator (B1)	Integrator (B1)	Integrator (B1)	Integrator (B1)	Explorer (A2)	Integrator (B1)	Integrator (B1)	Newcomer (A1)
Teacher 5	Integrator (B1)	Integrator (B1)	Explorer (A2)	Explorer (A2)	Explorer (A2)	Integrator (B1)	Integrator (B1)	Explorer (A2)
Teacher 6	Expert (B2)	Expert (B2)	Integrator (B1)	Expert (B2)	Expert (B2)	Explorer (A2)	Expert (B2)	Integrator (B1)
Teacher 7	Expert (B2)	Pioneer (C2)	Integrator (B1)	Expert (B2)	Expert (B2)	Expert (B2)	Expert (B2)	Expert (B2)
Teacher 8	Expert (B2)	Expert (B2)	Expert (B2)	Expert (B2)	Integrator (B1)	Integrator (B1)	Leader (C1)	Explorer (A2)
Teacher 9	Expert (B2)	Expert (B2)	Expert (B2)	Expert (B2)	Leader (C1)	Expert (B2)	Integrator (B1)	Integrator (B1)
Teacher 10	Leader (C1)	Expert (B2)	Expert (B2)	Leader (C1)	Expert (B2)	Expert (B2)	Pioneer (C2)	Expert (B2)

To further explore middle school mathematics teachers, the researcher conducted deductive thematic analysis on semi-structured interview data, using DigCompEdu areas as categories. In Professional Engagement (Area 1) including four sub-categories, there were 150 codes. There were 145 codes in Digital Resources (Area 2) including three sub-areas. There were 133 codes in Teaching and Learning (Area 3) including four sub-areas. There were 143 codes in Assessment (Area 4) including three sub-areas. There were 97 codes in Empowering Learners (Area 5) including three sub-areas. There were 52 codes in Facilitating Learners' Digital Competence (Area 6) including five sub-areas (see Table 13).

Table 13. Frequency of Themes by DigCompEdu Areas

Category & Indicator	Total
Area 1: Professional Engagement	150
1.1 Organisational communication	29
1.2 Professional Collaboration	43
1.3 Reflective Practice	19
1.4 Digital Continuous Professional Development	59
Area 2: Digital Resources	145
2.1 Selecting digital resources	83
2.2 Creating and modifying digital content	43
2.3 Managing, protecting and sharing digital resources	19
Area 3: Teaching and Learning	133
3.1 Teaching	67
3.2 Guidance	25
3.3 Collaborative learning	36
3.4 Self-regulated learning	05
Area 4: Assessment	143
4.1 Assessment strategies	79
4.2 Analysing evidence	34
4.3 Feedback and Planning	30
Area 5: Empowering Learners	97
5.1 Accessibility and inclusion	02
5.2 Differentiation and personalisation	32
5.3 Actively engaging learners	63
Area 6: Facilitating Learners' Digital Competence	52
6.1 Information and media literacy	01
6.2 Digital communication and collaboration	22
6.3 Digital content creation	20
6.4 Responsible use	03
6.5 Digital Problem Solving	6

4.2.1 How do middle school mathematics teachers use digital technologies in teaching and learning?

In teaching and learning (Area 3) of the DigCompEdu survey, 14 participants were classified as A1, 11 people were classified as A2, 9 people were classified as B1, 8 people were classified as B2, and 2 people were classified as C1 (see Figure 6).

Qualitative analysis yielded 133 codes in this area. The most frequent codes were in teaching and collaborative learning sub-areas. The results for the sub-areas of teaching and learning area (Area 3), which are teaching, guidance, collaborative learning, and self-regulated learning, were described in the following paragraphs.

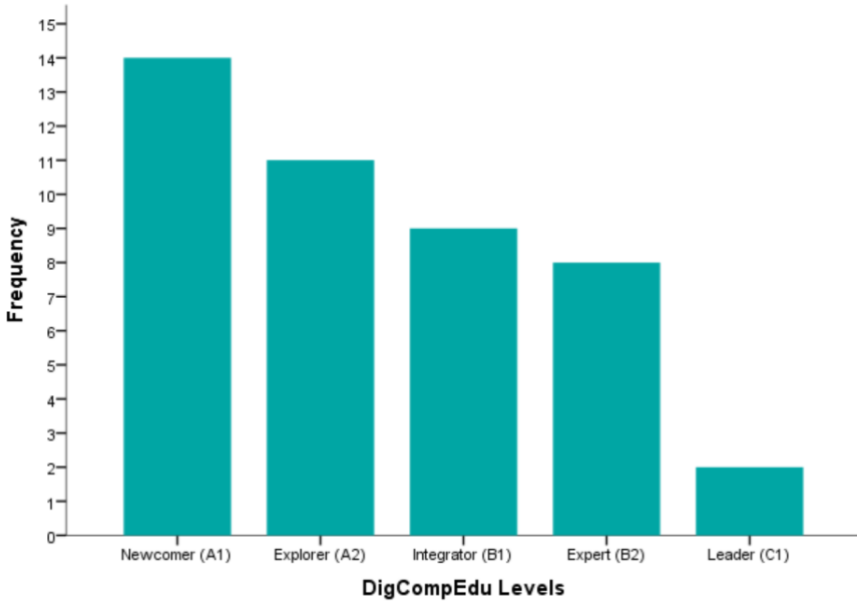

Figure 6. Frequency of DigCompEdu Levels for Area 3

In the teaching sub-area of Area 3, according to the DigCompEdu framework, Newcomers (A1) use digital technologies in the classroom infrequently, while Explorers (A2) use available classroom technologies such as projectors and digital whiteboards following the learning objective and context. Integrators (B1) are responsible for managing the integration of digital devices and content while integrating available digital technologies into the instructional process. Experts (B2) enhance their pedagogical strategies with digital technologies. Leaders (C1) orchestrate, monitor, and integrate digital technologies to enhance pedagogical strategies into their teaching strategies.

In the newcomer (A1) level, the findings from the interview with Teacher 1, who was a newcomer according to survey results, included indicators from the

proficiency statement of the framework. He mentioned that he rarely uses digital technologies in his teaching practices. He mentioned that the reason for not using digital technology is the overload of the learning objectives and book materials; he used digital technologies when he completed the test book and course book materials if he had extra time. Additionally, he mentioned that he avoids using these digital technologies in the classroom because his digital competence is low, and he cannot manage the class effectively while using digital resources. Additionally, he expressed concerns that if he tries to integrate them into his teaching and fails, he will feel disappointed and inadequate. Consequently, he stated that he does not want to step out of his comfort zone for these reasons. His practice included mainly lecturing and problem-solving sessions. All interview participants expressed that they use digital technology to provide differentiated learning materials for students who need to catch up and for learners who need to consolidate their knowledge. All of them except Teacher 10 (C1) mentioned that after identifying the level of learners' comprehension, they retained their traditional lecturing methods, but they did use technology as an alternative teaching method after the lecture. Teacher 1 (A1) mentioned that he could use digital technologies if they completed the lecturing and problem-solving session as follows:

> If we have any time left, we could designate a specific timeframe for the utilization of web 2.0 tools. However, we deal with skill-based questions, and we are trying to complete all the learning objectives. Alongside checking assignments and monitoring progress, even with a 5-hour class, it's not enough. For example, schools end in June, but we finish topics in early May in colleges. However, we have to rush and accelerate the process. The last month is usually dedicated to general review and problem solving sessions. Of course, we can use digital technologies for general review as well, but personally, I prefer to solve skill-based questions.

Teacher 2 (A2) stated that she used digital whiteboards to display the classroom materials aligned with the framework's proficiency statement, using available classroom technologies such as projectors and digital whiteboards.

Participants at Integrators (B1) levels supported the statements from the framework, which is meaningfully using digital technologies in the teaching process. For example, Teacher 3 (B1) mentioned that visual aids could help her students develop a concrete understanding of abstract concepts. Teacher 5 (B1) explained how she uses 3D animations to help students better recognize and comprehend complex topics as they struggle to understand the drawings on the whiteboard. She discovered that visual aids like videos help students learn an idea better. Teacher 3 and Teacher 5, who were Integrators, mentioned their experience: “Students are unable to visualize through my drawings on the board, so I show them videos that help them visualize in 3D.” (Teacher 5)

> Drawing by hand, demonstrating by hand, to be honest, these are not only exhausting, cumbersome, and time-consuming, but I also don't think the students can truly visualize it. Instead, we have many tools at our disposal. For example, there is a website called, weavesilk.com, where beautiful drawings can be created. Even as a quick reminder, as soon as it comes to my mind, I can quickly create demonstrations, and I believe it helps students visualize better. (Teacher 3)

Teacher 7 (B2) indicated that students might have misconceptions due to utilizing traditional drawing tools such as rulers and compasses in geometric tasks because it could cause calculation errors. These errors may emerge due to difficulty measuring and precisely drawing geometric objects. Teachers noted that employing digital tools in drawing exercises to solve this issue can help eliminate misconceptions by giving students more precise and accurate measurements. Students may readily edit and adjust geometric forms and sizes using digital sketching tools, creating a more interactive and engaging learning experience aligned with the proficiency statement

for the Expert (B2) level in the teaching area; teachers could use digital technologies purposefully to enhance their pedagogic strategies. Teacher 7 explained why she uses digital tools in geometry:

> They struggle a lot when drawing with a ruler. For example, one of my students had drawn something; and measured with a ruler. There was a line that was one and a half squares long. They tried to measure its length and draw it on top of the square with the ruler. It can be challenging for them, for example, when they said it should be a correct segment of equal length. Drawing on a digital platform prevents these misconceptions. Naturally, there is a high margin of error when drawn by hand. For instance, if they even try to use a compass, they can't use it properly. It has that thing where it slides or moves to the side. It does something that, in my opinion, is unnecessary. Digital environments have advanced quite a bit.

Teacher 10 (C1) reported that using digital platforms at the beginning of classes to pose thought-provoking questions requires brainstorming to interpret real-world problems. This pedagogical strategy was intended to increase students' interest in the subject. Additionally, she used videos to recall previously covered topics to students.

In the guidance sub-area, according to the DigCompEdu framework, newcomers (A1) rarely use digital tools to communicate with students. Explorers (A2) use online methods such as email or chat to answer students' questions or concerns. Integrated (B1) often communicates with students and assists with shared digital communication channels. Experts (B2) track behavior in collaborative digital environments and, if necessary, provide one-on-one counselling and support. Leaders (C1) strategically organize and use digital resources to guide students' learning activities.

According to participants' responses, teachers with an A1 level of digital competence reported using chat apps to answer students' queries and doubts regarding their homework, if necessary. He stated that learners are responsible for contacting them if they have concerns; they can do so via messaging; If they still

need to, he could provide face-to-face guidance in the classroom. Teacher 2 (A2) mentioned that she uses WhatsApp groups to communicate with students. Teacher 3 (B1) mentioned using Google Classroom channels to guide her students. Teacher 7 (B2) stated that they preferred using digital tools that allow monitoring learners' behaviors to guide group activities quickly. Teacher 7 explained her experience as follows: “I have used tools like Powtoon to create such presentations or boards. They allow students to write on them and I can see what they are writing.”

Teacher 10 (C1) indicated that she used digital tools to accurately interpret the learners' thought processes for some activities, especially for open-ended questions requiring calculation procedures. To address this issue, she used a digital platform that mirrors the learner's screen onto the teacher's computer, enabling her to observe and analyze the learners' procedural reasoning, identify misconceptions, and give them immediate feedback. In addition, the digital tool enabled her to share learners' screens with their peers.

In the collaborative learning sub-area, The DigCompEdu framework indicates that newcomers (A1) rarely use digital tools in collaborative learning activities and require assistance in understanding how students may use digital technologies. Explorers (A2) enables students to use digital technology to help in collaborative activities such as internet searching and presenting their findings. Integrators (B1) include digital technology in collaborative activity design by requiring learners to document their collaborative efforts with digital technologies such as digital presentations, videos, or blog entries. Experts (B2) organize collaborative activities in digital contexts, monitor and manage learner interactions, and use digital technologies to enable learners to share ideas and receive peer feedback. Leaders (C1) design and facilitate collaborative learning activities in physical and virtual

learning environments, where students use various technologies to conduct research, document discoveries, and reflect on their learning. They could use digital technologies for collaborative knowledge building. The responses from the participants supported the proficiency statements in the framework.

Teacher 1 (A1) mentioned that he rarely used digital technologies for collaboration. Teacher 2 (A2) mentioned that she displayed questions similar to book material and divided the classroom into groups. Learners solved questions on the digital whiteboard, and the teacher had autonomy during the activity. She mentioned that it gives a sense of responsibility to the teams and increases learners' motivation because of the excitement of the competition; learners present their results using digital whiteboards. Participants with B1 and B2 levels use digital technologies to provide learning experiences that involve creating concept maps collaboratively and generating ideas. They mentioned that using tools like Padlet helps share ideas with peers. They emphasized the importance of sharing insight with others to support peer learning. Teacher 8 (B2) shared her experience as follows:

> When brainstorming, the Padlet website proves to be helpful. They write on it, such as 'I remember this, I remember that.' We then transition from those ideas to a concept map. Then I said, 'Yes, you have prepared it correctly, so we can connect it to the topic.' By doing this, I prepare myself for the new topic and also get to assess their understanding. Moreover, as they can see their own posts and that of others, a collaborative learning environment is established in the classroom.

Teacher 10 (C1) shared an example of a collaborative learning activity she implemented in her classroom Firstly; she divided the students into groups based on their proficiency levels of current subject for group heterogeneous and then placed QR codes throughout the school's garden. The students scanned the barcodes with their iPads and engaged in collaborative activities to develop a shared knowledge

base. The teacher used the gallery walk technique. So, learners have become a common understanding with the help of peer feedback and insights.

In the self-regulated learning sub-area, The DigCompEdu framework indicates that newcomers (A1) rarely consider how students could use digital technologies in self-regulated activities or assignments. Explorers (A2) encourage students to use digital technologies to support their individual learning activities and assignments, such as retrieving and presenting information. Integrators (B1) encourage learners to use digital devices to collect evidence, such as making audio or video recordings, images, or texts. Experts (B2) employ digital technologies or environments (e.g., ePortfolios, blogs) to help learners manage and document all stages of learning, including planning, information retrieval, documentation, reflection, and self-assessment. Leaders (C1) reflect on the adequacy of my digital strategies in fostering self-directed learning and constantly improving them.

Participants with A1 and A2 levels reported not employing digital technologies to facilitate self-regulated learning. Participants with B1 and B2 levels reported that they enable learners to investigate learning materials outside of school by themselves; participants shared digital tools and explained how learners could use them so that students may independently investigate the learning materials. Some participants encouraged self-regulated learning by assigning various assignments, such as creating posters and digital games. Teacher 8 (B2) mentioned her experience as follows:

> In mid-term projects, we presented them with various topics, and they chose one among them. For instance, one of my students is designing an online digital game, a mathematical game. When we gathered together, they shared with me how they researched on the internet about the software and coding needed to create the game. The process is still ongoing, but they are developing the game with excitement.

4.2.2 How do middle school mathematics teachers use digital technologies to enhance assessment?

In Assessment related questions (Area 4), 7 participants were classified as A1, 13 people were classified as A2, 14 people were classified as B1, 9 people were classified as B2, and one participant was classified as C1 in Area 4 according to DigCompEdu Scale for Educators (see figure 7). Qualitative analysis yielded 143 codes in this area. The most frequent codes were in assessment strategies sub-area. The results for the sub-areas, which are assessment strategies, analyzing evidence, and feedback and planning, were described in the following paragraphs.

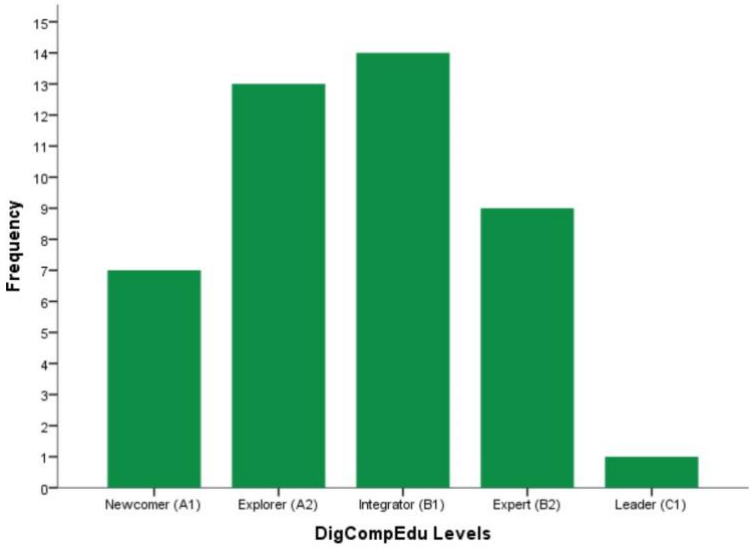

Figure 7. Frequency of DigCompEdu Levels for Area 4

In the assessment strategies sub-area, according to the DigCompEdu framework, newcomers (A1) do not or rarely use digital assessment formats, and Explorers (A2) integrate digital technology with traditional examinations. Integrators (B1) use extant digital assessment tools and formats, and Experts (B2) use a variety of digital assessment formats strategically and design their own tools. Leaders (C1) comprehensively and critically choose, construct, and modify digital assessment

forms, both digital and non-digital possibilities. They also analyze how they employ digital technology and improve their assessment method.

Teacher 1 (A1) stated that he rarely uses digital technologies for assessment due to a lack of ability to control monitoring of learners using them, which causes trust concerns. Teacher 1 (A1) and Teacher 2 (A2) used digital tools in the classroom, mostly Kahoot, for formative assessment to understand learners' learning outcomes in the classroom so that they could provide immediate feedback. The questions in digital quizzes are the same as in the textbook; they use games to arouse learners' attention. Teacher 4 (B1) mentioned that she used shallow questions in digital assessment tools, mainly in games, because the goal is to keep learners entertained while using digital technology in classrooms:

> I make an effort to avoid pushing them too much since they are, after all, playing a game and want to enjoy it. When it becomes excessively challenging, I believe their interest wanes. Consequently, I strive to craft surface-level yet educational questions that don't delve too deeply.

Teacher 8 (B2) uses formative assessment strategies; she adds some questions purposefully in the video. According to the learners' responses, the participant provided a differentiated learning path with learning material to consolidate or achieve higher-thinking level learning objectives. She could consider the learners' responses for lesson plan preparation.

In analyzing evidence sub-area, in the DigCompEdu framework, newcomers (A1) do not or rarely use digitally recorded data to analyze their students' progress. Explorers (A2) assess the attendance or grade data to provide personalized feedback and targeted interventions. Integrators (B1) evaluate various digital data, such as data from digital assessments and recorded activity in digital environments, to declare instruction. Experts (B2) strategically use digital tools to generate data, monitor

activity, and use data analysis tools to better understand individual learners' needs. Leaders (C1) regularly monitor digital activity, reflect on digitally recorded learner data, and synthesize data to evaluate the success of learning activities.

Teacher 1 (A1) and Teacher 2 (A2) mentioned that they did not use digital technologies for assessment by recording digital data. B1 and B2 level participants shared that they monitor their students' assessments using Microsoft Excel. They stated that the Class Dojo platform tracks students' academic progress and helps track classroom behavior, class participation, and assessment performance. Teacher 4 (B1) stated that it is time-consuming for a teacher to manage the assignments of many students and report them on their own. However, digital assessment tools generate a report to monitor a student's task completion, reducing the teacher's workload. The feedback reports provide information such as the learners' success rate, the number of correct and incorrect answers, the topics they need to consolidate, and the time for completing the quizzes. Teacher 4 (B1) explains why she use digital technologies as follows:

> It simplifies my work significantly. With a total of 80 students, if I assign homework from the textbook, I would have to individually check whether each student completed it or not. However, when I assign it online, a report is automatically generated for me, allowing me to analyze the results. I can then provide feedback on incorrect answers more efficiently.

Teacher 10 (C1) implements different assessment strategies based on the learners' academic achievement level. For a class where students struggle with completing assignments, she used ClassDojo, which increased the assignment completion rate. She values learner feedback and collects it through surveys at the end of assignments. In cases where problem-solving procedures need to be examined, she uses the drawing features of digital tools to analyze students' learning outcomes. She

facilitates peer learning by sharing one student's answer with others through their iPads and explaining the solution.

In feedback and planning sub-area of Assessment (Area 4), in the DigCompEdu framework, Newcomers (A1) rarely use digital technologies for feedback and planning, and Explorers (A2) use digital tools to create an overview of learners' development. Integrators (B1) evaluate and provide feedback on electronically submitted tasks, and Experts (B2) change their teaching approaches depending on digital technologies' data to personalize feedback and support. Leaders (C1) use the data generated by digital technologies to adapt their teaching strategies according to learners' different learning styles.

Teacher 1 (A1) mentioned that the digital quizzes assist them in understanding the needs of the learners and that she gives assignments based on the quiz results. B1 and B2 level participants shared that they provided summative feedback on digital assessment tools. Teacher 4 (B1) stated that since the school administration places a premium on standardized test scores, they primarily distributed exam questions and videos. Teacher 8 (B2) outlined the advantages of utilizing digital assessment tools; it assists in identifying students' misconceptions and learning difficulties, thereby facilitating lesson planning:

> It helps me to prepare for the new topic and allows me to see what my students know and do not know. I can identify any mistakes and consider the possibility that I might have inadequately explained certain concepts during instruction. Then I correct it by recalling the explanation or covering any gaps in knowledge by repeating the relevant information.

Teacher 10 (C1) reflects on the effectiveness and suitability of different assessment strategies by continuously monitoring learners' progress through digital tools and the help of understanding learners' readiness for the next topic. Teacher 10 (C1) gave an example of using digital data for improving her practices as follows:

> We have math activities where we send assignments through links. It provides us valuable feedback. These assignments serve as a weekly summary, highlighting areas where students have encountered difficulties and indicating the topics that require further review. While this serves as a primary purpose, the most significant benefit is assessing the students' readiness level at the beginning of the term and gaining a clear understanding of their proficiency in each specific topic.

4.2.3 How do middle school mathematics teachers use digital technologies to empower their students?

In Empowering Students (Area 5), 11 participants were classified as A1, 8 participants were classified as A2, 10 participants were classified as B1, 11 participants were classified as B2, 3 participants were classified as C1, and one participant was classified as C2 in Area 5 according to DigCompEdu Scale for Educators (see Figure 8). Qualitative analysis yielded 97 codes in this area. The most frequent codes were in actively engaging learners sub-area. The results for the sub-areas, which are accessibility and inclusion, differentiation, and personalization, actively engaging learners, were described in the following paragraphs.

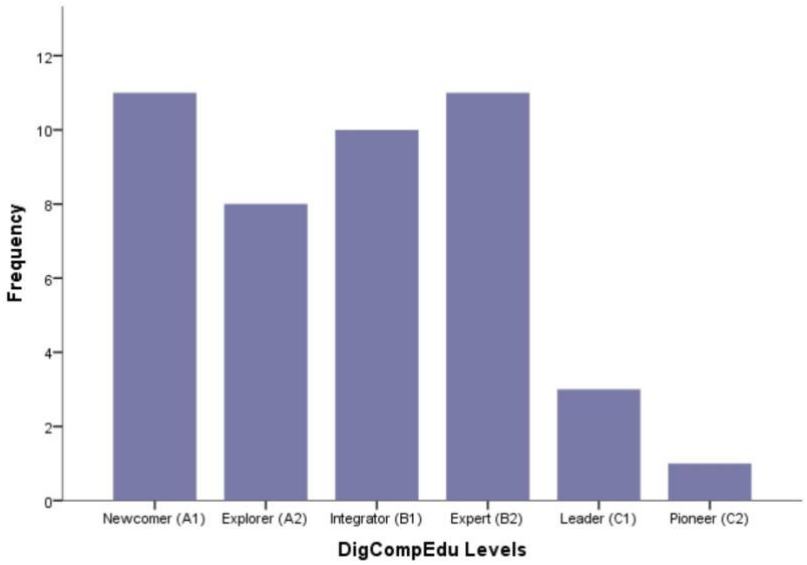

Figure 8. Frequency of DigCompEdu Levels for Area 5

In the accessibility and inclusion sub-area, according to DigCompEdu framework, Newcomers (A1) are worried about using technology because it could cause barriers for disadvantaged students to participate. Explorers (A2) are aware of accessibility and inclusion issues and technology's impact on them. Integrators (B1) address accessibility issues by ensuring all students have access to technology and by using compensatory digital technologies for learners with special needs. Experts (B2) enable accessibility by adapting pedagogical strategies to learners' digital contexts and employing assistive technologies. Leaders (C1) enhance accessibility by selecting strategies for learners' digital technology uses, employing design principles for increasing accessibility, and continuously monitoring and adapting their strategies.

Teacher 2 (A2) explained that some students in their school have greater access to digital tools, allowing her to assist those students by sharing additional digital resources. However, there were instances when the school experienced network connectivity issues, which affected all classrooms in the school. All participants mentioned that they consider all students should have equal access to digital tools. They stated that if the school supplied adequate digital tools, they could construct a variety of activities. Teacher 7 (B2) mentioned that the students had tablets and she could easily manage digital learning activities. Teacher 8 (B2) mentioned that if all students in the classroom had tablets, she could develop activities that took less effort and time. Teacher 8 gave an example how the accessibility affected her experience as follows:

> While using Padlet; students have to come up to the board and write on Padlet, which takes time, to be honest. But if everyone had a device like a tablet, or at least each group had one, I could get feedback more quickly without taking time away from the lesson. In addition, there could be more and different types of games available. Currently, students have to come up to

> the board one by one, but if everyone had a device, they could all get feedback individually and more quickly.

In differentiation and personalization sub-area, according to the DigCompEdu framework, Newcomers (A1) are still deciding how digital technologies can be applied to differentiate and personalize. Explorer (A2) is aware that digital technologies support differentiation and personalization. Integrators (B1) use many learning activities that allow students to proceed at varying rates and select from a variety of levels of difficulty. Experts (B2) strategically use digital technologies to design and implement differentiated and individualized learning activities, adapting to diverse requirements, levels, speeds, and preferences. Leaders (C1) comprehensively and critically implement differentiated and personalized learning, generate personalized learning plans, and adapt teaching strategies accordingly.

Teacher 1 (A1) mentioned that he did not know how to differentiate his lessons with the help of digital technologies. Nonetheless, he underlines the need to provide standardized examinations depending on the skill levels of learners. He divides the students into small groups based on test scores and gives lectures to each group individually. Teacher 2 (A2) mentioned that she emphasized creating instructional materials for everyone and believed that the students in her class had average scores without any significant outliers. Teacher 3 (B1) explained that she diligently analyzed the results of the summative examinations and used them as a basis for creating individualized assignments for her students. Using the school-provided digital platform, she designed assignments with varying difficulty levels to meet each student's specific requirements. Specifically, she focused on providing additional support for subjects where students had given incorrect responses in their exams. Teacher 8 (B2) used the correct answers and topics learners needed to

consolidate more for each student from their exams and homework and assigned different tasks accordingly. For example, she sends videos to students who learn better through auditory materials. Teacher 8 (B2) explained her practice as following:

> We determine our individual assignments based on the students' knowledge gaps. For example, one student may have a knowledge gap in decimal notation, while another may have a knowledge gap in polygons. I identify these gaps and assign homework accordingly through Google Classroom. For some students, I provide video links to reinforce the concept because they learn better through auditory means. I am aware of this.

Teacher 10 (C1) supported this by considering learners' assessment results, she mentioned that she considers learners' learning styles, for example sending videos for spatial learners, she provides personalized assignments. Teacher 10 (C1) explained her approach when selecting digital tools. She emphasized the importance of considering the diverse learning styles of students. She emphasized differentiation and administered multiple intelligence tests to her students in order to determine their manner of thinking and comprehension. She stated that considering their learning styles, she created and modified digital learning materials, such as videos, and voice notes.

In actively engaging learners sub-area, according to the DigCompEdu framework, Newcomers (A1) use digital technology to encourage or engage learners very rarely. Explorers (A2) use digital tools to visually represent and explain new concepts engagingly, such as through animations. Integrators (B1) foster learners' active use of digital tools in the educational process. Experts (B2) use various digital technologies to build a relevant and valuable digital learning environment by addressing diverse learning styles and teaching strategies. They evaluate the effectiveness of the teaching strategies in enhancing student engagement and active

learning. Leaders (C1) choose, design, use, and orchestrate digital technologies to support learners' active, creative, and critical engagement with the subject matter.

Teacher 1 (A1) stated that he rarely uses digital technologies to engage learners. He shared an experience where he used a simulation in the pHet platform. He noticed that it increased learners' attention to the topic among passive students. He also mentioned that the activity positively affected the emotional connection between himself and the learners who have rarely engaged in classroom activities. Teacher 2 (A2) mentioned that she used animations on EBA platform (educational content network in Turkey) to raise learners' attention.

Participants mentions that they were increasingly pursuing digital alternatives to traditional paper and pencil activities in response to their students' interest in digital technologies. They mentioned that digital tools can provide valuable chances to engage students and create engaging and stimulating learning experiences. Teacher 3 (B1) mentioned that she gave importance learners' interest while designing activities:

> Otherwise, there is a big disconnection. As the topics become more difficult in processes that may cause students who do not feel confident in mathematics to scatter, if there is a paper activity I can do, I think about how I can present it more technologically, because that is always their area of interest...

Teacher 8 (B2) mentioned their reasons for integrating technology to arouse learners' interests as follows:

> I believe that traditional lecturing alone is no longer sufficient to effectively teach a topic. It has become essential to find ways to capture students' interest, considering their easily diverted attention spans. Platforms like Instagram and TikTok offer very short videos that students quickly scroll past. However, our classroom lessons typically last for 40 minutes, so I need to create something that aligns with their use of those apps in order to maintain their attention.

Participants explained that using digital tools as rewarding students who pay close attention during lectures so they could motivate them using digital technology. They believed that learners would adore digital activities and they also helped to learn, so they supposed that they could use digital activities without hesitation if they had time. Besides that, participant with B1, B2, C1 levels mentioned the application (Class Dojo) to motivate learners to complete their assignments and reward their responsible classroom behaviors.

Teacher 10 (C1) stated that she utilized the class dojo tool to improve active participation in a classroom with low engagement. She awarded a badge to students who asked critical questions that could improve mathematical discourse. She explained her experience as follows:

> I found Classdojo to be a valuable tool as it significantly increased student engagement and facilitated easy tracking of their progress. One of its features includes awarding badges for active participation in class, and asking important questions about the topic. Imagine a scenario where the class remains quiet without much interaction, but when I introduce the idea of earning a badge, suddenly everyone becomes engaged and actively participates.

4.3 The effects of ERT experiences on middle school mathematics teachers' digital competency levels

Research Question 3: What do middle school mathematics teachers think about the effects of ERT experiences on their current digital competency levels?

In terms of professional engagement (Area 1), participants mentioned that the pandemic provided possibilities for teachers to experiment with digital tools that promote organizational communication and professional collaboration, allowing them to undertake their responsibilities with less effort. For example, some schools have branches in different cities, and the departments in the branches meet regularly for subject group meetings to discuss and develop lesson plans cooperatively.

Teacher 8 (B2) mentioned that prior to the COVID-19 pandemic, teachers held sessions over the phone, it was hard to track the communication and sharing the documents. However, with the COVID-19 pandemic, they became acquainted with video conferencing tools such as Zoom. This allowed them to share their screens, allowing everyone to engage in the conversation. As a result, during video conferences, teachers found it easier to keep track of who was speaking. Teachers continued the meeting with video conferences, shared documents, and discussed by identifying the speaker easily after the pandemic. Teacher 8 shared the experience as follows:

> Before the pandemic, we used to have conference calls on the phone. When we needed to show something, nobody could see it at the same time, and it was very difficult. With the pandemic, we started using Google Meet and we continue to use it. If we need to change something, we can instantly intervene in the shared document. The phone signal was bad, the sound was cutting out before... But now everyone can see each other, conversations are heard clearly, and materials can be seen clearly thanks to screen sharing.

Participants stated that the pandemic pushed them out of their comfort zones because they needed to adapt their teaching to online learning and explore new teaching methods and digital resources. Thus, they mentioned that they researched, experienced new ways of presenting a topic, and sought other resources. Teacher 5 (B1) explains her experience as "It developed me because now I constantly ask around or watch videos, research materials, and start recording the smallest thing I see so that I can figure out how to do it better." Teacher 3 mentioned her experience as follows:

> I was curious before, but I realized in that moment (during the pandemic) how much the need triggered us. I can say that I am constantly in a process of growth and change. I think it has a very positive impact. (Teacher 3)

Teacher 4 (B1) mentioned that even she was afraid of using computers and perceived using them stressful before the pandemic, she was forced to learn and became comfortable with using computers. She was initially hesitant, but she had no choice but to adjust to the new circumstances. The situation helped her to overcome self-efficacy on using digital technologies, she continued to use digital tools after the pandemic:

> I used to be very afraid of using computers. I felt a lot of anxiety during computer assignments. Even simple tasks like copy-pasting from Word would make me extremely nervous, and even the absence of a particular letter would stress me out. However, after the pandemic, I was forced to learn it out of necessity... It turns out it wasn't that difficult after all.

Teacher 10 (C1) mentioned the value of the professional development opportunities provided by colleagues. She remarked that attending a training session led by a colleague in different departments, like social studies, was beneficial because it inspired her. She also stated that she derives inspiration from her colleagues' teaching strategies with digital tools.

Regarding Digital Resources (Area 2), participants stated that they improved their ability to search for various digital learning materials and interactive components because they continually search materials to take learners' attention during the pandemic. In ERT, all participants mentioned that they used presentation tools and Z books. They mentioned that they continued to use Z book after the pandemic because they had become used to it. They mostly used digital resources without modifying them. Because their skills needed to be improved to change them, they investigated activities created by other teachers that were appropriate for their students' levels. All participants except Teacher 1 (A1), Teacher 2 (A2) and Teacher 5 (B1) use management platforms such as Google Classroom to share digital resources with their students, Teacher 1, Teacher 2, and Teacher 5 used social

platforms such as WhatsApp to share digital resources. Teacher 1 (A1) mentioned that he chose digital platforms with simple user interfaces. They primarily use Kahoot to produce quizzes during the pandemic, and they continued to do so because learners enjoy Kahoot activities and are engaged. Teacher 4 (B1) mentioned that while choosing the material, she considered the number of downloads; it feels reliable. Teacher 9 mentioned that she researched digital tools to enhance interaction in online learning. She believed that she has improved her knowledge of new applications due to her research during the pandemic:

> But now, after the pandemic, I have had to explore online applications that I can use with students, enabling their interactive participation when connected online. Through this exploration and research, I have gained a greater proficiency in utilizing these tools effectively.

Because of the global pandemic, participants have had the chance to experiment with different digital resources. Teacher 3 (B1) mentioned that she was usually unwilling to try new ideas, even though she knew how effective the planning seems, but the pandemic provided an opportunity for exploration. Teacher 5 (B1) highlighted the using visual representations in teaching, she stated that the pandemic helped the improve the searching appropriate materials for abstract concepts. She mentioned that she continues to use visual representation and it helps to comprehend the concept:

> The experiences during the pandemic have developed me because now I constantly seek ways to improve myself. I ask around, watch videos, research materials, or even save small bits of information that catch my attention. It doesn't matter if it's related to digital or physical activities, I value both. Whenever I see something, I think, "I should try this out, it seems better," or "I should watch this video." I have started to engage in more research or pay closer attention to things I come across.

Teacher 3 (B1) explained that she uses Google Classroom to share websites and resources with her students. She also uses the platform to send regular reminders and assignments, communicate with her students, and give them fast access to online tools and resources. She also said that when it was difficult to distribute physical resources like unit cubes during the pandemic, these online tools and resources were especially beneficial in teaching mathematical concepts like 3D visualization. Teacher 3's usage of Google Classroom and various digital tools demonstrates her competency in digital competence Area 6 of the DigCompEdu framework, which involves using digital resources to support digital communication and content creation.

> I use Google Classroom to share online resources and websites that we use during our lessons, as well as to distribute educational games that I believe will be beneficial. Additionally, we rely on Google Classroom to consistently assign and share homework, send reminders, and maintain active communication with students. (Teacher 3)

4.3.1 What do middle school mathematics teachers think about the effects of ERT experiences on their current use of digital technologies in teaching and learning?

Because of their experiences with ERT, participants have begun to use more interactive activities in the classroom rather than traditional teaching methods. For example, Teacher 9 (B2) explained that it has required to conduct more studies to discover applications allowing students to participate interactively. She believed that her research had increased her skills in this area. During the pandemic, she recognized that when students are actively involved, they participate more, engage more with the content, and have more fun:

> I conducted research to discover digital resources that would encourage student interaction. Through this process, I have developed greater proficiency in utilizing these resources. As we witnessed during the pandemic: if we involve students actively, they participate more, derive greater productivity, and have more fun, to be honest.

During the COVID-19 pandemic, Teacher 7 (B2) mentioned using a digital tool to create a collaborative learning environment. She noted students conducted conceptual work together, such as building a concept map and brainstorming on Padlet. The teacher guided the brainstorming process and encouraged students to express their thoughts, which led to more meaningful discussions. However, she also stated that, while these activities can still be conducted, they require extra planning and time and that, due to time restrictions, problem-solving sessions with standardized tests were more widely used after the pandemic:

> During the pandemic, we utilized digital tools for activities such as concept maps and brainstorming sessions. Although these approaches remain applicable, the current circumstances require more careful planning and consideration due to time constraints. Typically, we rely on paper-based testing techniques. It feels like we're not able to shift or make any progress in that direction.

Teacher 5 (B1) continued using the digital tools she learned during the pandemic in face-to-face teaching. She indicated that she used digital technologies more frequently nowadays, such as videos and activities on EBA (a digital education platform in Turkey). She also mentioned that she enjoyed integrating digital materials into her teaching:

> I have continued to apply the knowledge and skills I acquired during the pandemic in face-to-face teaching, and I can confidently say that I utilize them even more now. In addition, I have incorporated new elements into my face-to-face teaching, such as showing videos or utilizing the EBA platform, which has been personally fulfilling for me.

4.3.2 What do middle school mathematics teachers think about the effects of ERT experiences on their current use of digital technologies to enhance assessment?

Teacher 3 (B1) and Teacher 9 (B2) mentioned that ERT experiences have enhanced the usage and appreciation of digital tools for assessment purposes. Participants with B1 and B2 levels of digital competency believed that their ERT experiences had influenced their use of digital technology to improve assessment. Teacher 3 (B1) mentioned the advantages of using Google Classroom for homework assessment, where students can ask questions and get rapid feedback easily. She also emphasized the importance of technology enabling communication quickly; she stated that technology made her feedback process more accessible, and she used the tools which she learned during ERT after the pandemic. Similarly, Teacher 9 (B2) highlighted the importance of using digital settings to assign and manage assignments and creating a sense of continuity between in-person and online learning experiences.

> We continue to utilize Google Classroom to distribute assignments, just as we did during the pandemic. The comment section in Google Classroom remains accessible, allowing our students to reach out to us with any questions they may have. We are readily available to provide assistance and respond to their queries whenever needed. (Teacher 3)

> It appears that we are fostering a sense of awareness among our students by monitoring their progress even in the absence of physical presence. Through the assignments we assign on digital platforms and our online meetings, we continue to stay connected and ensure ongoing follow-up of their progress. (Teacher 9)

Teacher 10 (C1) utilized post-it notes for exit card activities before the pandemic as a formative assessment after each lesson. However, following the pandemic, she began utilizing digital tools such as Padlet. Teacher 10 (C1) utilized post-it notes for exit card activities before the pandemic as a formative assessment after each lesson.

However, following the pandemic, she began utilizing digital tools such as Padlet. She mentioned that digital tools provided easy access to learners' responses.

Teacher 9 (B2) stated both the advantages and disadvantages of online assessment and expressed her concerns regarding monitoring and following up on students during the assessment process. While she believed some students might be more productive while working independently, she also believed some attempt to find answers online. Teacher 4 (B1) mentioned that she did not continue to use digital tools for summative assessment because of the possibility of cheating and receiving assistance from their families. Teacher 4 explained her experience as follows:

> In-class exams, a student who received a very low grade in the exam is getting all the answers right in the online assignments. This raises questions about the reliability. I wonder if the student did the assignments on their own or not?

4.3.3 What do middle school mathematics teachers think about the effects of ERT experiences on their current use of digital technologies to empower their student? The participants mentioned that they investigated various strategies to increase student participation in the online classroom during the pandemic. They stated that they have researched digital tools and resources such as videos and visual materials. Teacher 1 (A1) stated that he noticed that his students were having trouble comprehending the concepts, and he began to question his teaching methods. He followed his colleagues' teaching practices on social media to learn about different teaching strategies and experiences. As a result, he implemented alternative approaches to traditional lecturing to engage his students.

During the pandemic, Teacher 7 (B2) used Peardeck and Mathigon to improve student interest and active participation in the classroom. She had two

computers, one for monitoring student behavior and the other for sharing her screen. Teacher 7 began to use Kahoot more frequently after the pandemic since it is a fun and exciting for learners. She also found it easier because all students have tablets, allowing for more outstanding management and monitoring of student behavior.

> During ERT, I utilized two computers to facilitate my teaching approach. On one computer, I monitored and assessed the students' activities, while on the other, I shared my screen to deliver instructional materials. This allowed me to ensure their active participation and engagement during the class. Additionally, I frequently incorporate Kahoot as a learning tool during in-person sessions because it brings a great deal of enjoyment to the students.

Teacher 4 (B1) explained her experience while she used digital technologies in her classroom and her reason for using more because of the increase on learners' interest:

> The other day, topic was symmetry, and we found a wonderful website. We drew a picture together that contained symmetrical patterns, and I observed that students are more excited in classes where technology is involved, rather than just material-based classes. So, I thought to myself, I should use these online resources we learned more often...

Teacher 3 (B1) discussed how using technology in the classroom has helped to enhance and motivate positive attitudes such as helpfulness, responsibility, and completion of assignments through class Dojo points which motivates learners as a competition. She stated that it effectively drew students' attention and improved their attitudes in classroom:

> Things such being helpful to others, fulfilling their duties or doing their homework enables students to earn ClassDojo points...The version combined with technology is, frankly, much better than the version we did without technology before. It's very good at capturing the students' attention.

In conclusion, the participants in this research investigated various strategies to increase student engagement and participation in online classrooms during the pandemic. They conducted extensive research and utilized digital tools to enhance

the learning experience. The experiences and observations of participants highlighted the benefits of integrating technology into the classroom, including enhanced understanding of abstract concepts, increased student interest and enthusiasm, and the promotion of positive attitudes and behaviors among students.

4.4 Integration of findings

The findings from the qualitative analysis of semi-structured interviews which was employed to assess the practices of teachers largely corroborated the quantitative data obtained from the DigCompEdu scale. The researcher evaluated the practices of teachers by using the DigCompEdu levels indicators. According to the results, teachers' practices were consistent with the proficiency statements provided by the DigCompEdu framework. The investigation of code frequencies revealed that the lowest occurrences of codes were observed in Facilitating Learners' Digital Competence (Area 6). Aligned with this result, participants obtained the lowest scores in Area 6 based on the quantitative data analysis. However, there were some conflicts in certain aspects. For example, while according to the DigCompEdu framework, an expert (B2) level teacher should use digital technology to enhance pedagogic strategies, participant responses reveal a different situation. Participants stated that they used digital technology when they realized that learners were exhausted, and they needed to take their attention. Teacher 6, Teacher 2 and Teacher 8 shared their experiences of using technology as an attention grabber. Teacher 6 (B2) mentioned that she must continue lecturing; she uses technology rather than to enhance teaching strategies but as entertainment so that learners can focus on lectures later. She explained her point of view as follows:

> Just let them have fun. My students always say we have too many worksheets and sometimes we get bored of them. So, to break away from that, I use some

> activities that have fun games in them, you know, just to make things more enjoyable.

Participants with different digital competence levels mentioned using digital technology to attract their students' attention, mostly with videos and games. According to the DigCompEdu framework, Experts (B2) use various digital technologies to create a relevant and rich digital learning environment by addressing different learning styles to engage learners in the subject. On the other hand, participants believed that games could be distracting, so they preferred to use them for a limited time before returning to their lectures. They implement technology as a means of grabbing the learners' attention and then proceed to deliver lectures. Teacher 9 (B2) mentioned the habit of using games in classrooms: “After a while, games can distract students from their focus. Using them for a limited time is more efficient. We use them briefly and then move on to teaching.”

Teacher 9, Teacher 2, and Teacher 5 mentioned that they display questions on the smartboard with questions precisely the same as in the book which generated more interest and enthusiasm among learners. This aligns with the DigCompEdu proficiency statement that experts (B2) use digital technologies to create a relevant and engaging learning environment. Teacher 9 (B2) mentioned that by presenting the questions in a test book as a Z book, learners become more interested in the questions and solve them more enthusiastically as follows:

> When students solve questions displayed on the screen, which are similar to those found in traditional test books, they often approach them with more enthusiasm compared to solving them in a regular book. Maybe having more fun while solving it on the screen.

Even though Teacher 7 (B2) had a higher level of digital competency, she also highlighted the memorization in education which indicated a potential misalignment

with the DigCompEdu framework's proficiency statement, which promotes the use of digital technologies to foster active and creative learning experiences. She mentioned the reasons for the situation as follows:

> Once students reach eighth grade, they are completely immersed in exams. It becomes all about teaching test techniques—how to solve questions, how to read quickly. We even offer speed reading courses. It all revolves around that. Due to the exam-oriented system, if a student doesn't have the opportunity to study abroad, they are forced to achieve a high score in order to secure admission to a prestigious school. As a result, the content and quality of education become focused solely on rote memorization.

In response to questions about when teachers use technology in the classroom, participants indicated that they prefer to use digital technologies after students have a basic comprehension of the subject, allowing them to consolidate their knowledge. They determined when students would be ready to access digital resources after they had a conceptual comprehension of the subject. This strategy is consistent with the DigCompEdu proficiency statement, which encourages using digital technologies to support learners' comprehension, reflection, and knowledge construction. However, concerns have been raised about teachers' use of technology merely as a reward mechanism. Participants stated that they usually plan their lectures and estimate how long it will take to complete them. If they had more time, they might use digital technologies to reward students, particularly those who listened attentively and were not disruptive. The digital activities contain educational content, and students perceive it as a reward, allowing instructors to use it confidently. It is not aligned with the DigCompEdu framework, which emphasize promoting deeper engagement among learners and encouraging innovative pedagogical practices.

Teacher 6 (B2) mentioned that she primarily uses technology to teach geometry and 3D object topics. This practice aligns with the DigCompEdu proficiency statement that experts use digital technologies to enhance methodological

variations. However, she also highlighted the limitations of using digital technologies due to the course load. Teacher 6 stated that she used technology restrictedly because of the curriculum's rigour as follows: “I still have limited options for using technology because the curriculum is very packed. I use applications to teach geometric shapes or show 3D objects.”

As a result, the practices mentioned by participants have a range of potential for improvement and development areas according to DigCompEdu framework. By addressing the framework principles and leveraging digital technologies, participants could develop innovative teaching practices, foster an engaging learning environment, and enhance their pedagogical practices.

CHAPTER 5

DISCUSSION AND CONCLUSION

The current study examined the digital competence levels of middle school mathematics teachers after the COVID-19 pandemic. Quantitative data was collected using the digital competence scale for educators. Qualitative data were obtained through semi-structured interviews with ten participants in four weeks. Integrating findings from quantitative and qualitative data allowed for a comprehensive understanding of the middle school mathematics teachers' digital competence levels and the effects of pandemic-related experiences on their current competence levels.

In the following sections, the findings are discussed concerning the relevant literature, and the potential implications are presented. Finally, the study's recommendations for future research, and limitations are discussed.

5.1 Middle school mathematics teachers' digital competence levels

The objective of the first research question was to investigate two essential areas: the levels of digital competence of middle school mathematics teachers and the potential relationship between digital competence levels and certain demographic factors. Specifically, the study sought to determine whether there was a statistically significant difference between digital competence levels in terms of gender, years of teaching experience, and education levels. By investigating these factors, this research question aimed to gain insight into the extent to which demographic factors may influence teachers' digital competencies. The findings revealed that the majority of participants had a B1 level of digital competence, which is consistent with the results of previous studies conducted by Benali et al. (2018) and Santo et al. (2022). This study found that female participants performed higher scores across all areas of

DigCompEdu framework except Facilitating Learners' Digital Competence (Area 6), which contradicts the findings of Keskin and Yazar's (2015) study. Their study revealed that male participants had higher digital competence levels than females. The observed discrepancy between the present study and Keskin and Yazar's (2015) study on the difference between digital competence levels regarding gender could be attributed to two reasons. Firstly, the present study consisted of more female participants than males, whereas Keskin and Yazar's study included an equal distribution of male and female participants. This difference in the sample composition could have affected the overall results, as females in the present study demonstrated higher digital competency scores across all areas of the DigCompEdu framework except Facilitating Learners' Digital Competence (area 6). Secondly, the two studies' measurement tools utilized to assess digital competencies were different. Keskin and Yazar (2015) developed their instrument, while the present study utilized the DigCompEdu Scale for Educators. This variance in measurement instruments could have resulted in discrepancies in the results between the two studies.

The current research indicated that participants had the highest scores in actively engaging learners area (Area 5). Conversely, Benali et al.'s (2018) study found that participants had the highest scores in the areas of selecting and utilizing digital resources (Area 2) and reflective practice (Area 1). In Santo et al.'s (2022) study, the highest scores were noticed in content creation (Area 6), and accessibility and inclusion area (Area 5). The present study found that participants had the lowest scores in self-regulated learning (Area 3). This finding contrasts with the results of previous studies. Benali et al. (2018) reported the lowest scores in accessibility and inclusion (Area 5) and assessment strategies (Area 4), while Santo et al. (2022) found the lowest scores in the active engagement of learners (Area 5) and self-regulated

learning (Area 3) among their participants. The discrepancy in findings may be attributed to differences in participant demographics and context. Although three studies used the same measurement instruments to evaluate digital competencies, Benali et al. (2018) examined Moroccan English teachers, and Santo et al. (2022) surveyed Brazilian university professors. These differences in the background of participants may impact their digital competencies, which may explain the varying results. This study contributed to the literature by portraying mathematics teachers' digital competency levels in Turkey.

The study indicates no statistically significant difference between the digital competency scores of middle school mathematics teachers regarding their years of experience. The findings of this study are consistent with the results of the study conducted by Benali et al. (2018). However, this finding is inconsistent with the results found by Fidan and Cura Yeleğen (2022), who noticed that teachers with 0-5 years of experience had higher levels of digital competency than those with 16-20 years of experience in Turkey. The discrepancy in findings may be because Fidan and Cura Yeleğen's (2022) study was conducted in public schools in the Black Sea region of Turkey and included teachers from different subjects. In contrast, this study focused specifically on middle school mathematics teachers. Fidan and Cura-Yeleğen (2022) conducted their study two years after the COVID-19 pandemic. In contrast, the current study was conducted three years after the pandemic. This timing disparity between the two studies may have caused the inconsistency in the findings. The one-year gap between the two studies may have resulted in changes in instructional practices and the implementation of digital technologies.

The present study's results also indicated that education level had a statistically significant relationship with digital competence levels, with those

holding a master's degree scoring higher than those with a bachelor's degree in professional engagement (Area 1). This finding aligns with the results of previous research that found a positive relationship between education level and digital competence (Keskin & Yazar, 2015).

The second research question of the study examined the perceptions of middle school mathematics teachers on their digital competency levels after the pandemic, and their experiences on using digital technologies in teaching and learning, assessment, and empowering learners.

Most of the participants perceived themselves as integrators (B1) and experts (B2). There were inconsistencies of some of the teachers' perceived digital competence levels and their actual levels. Most participants perceived their digital competency levels to be higher than their actual digital competency levels, which could be attributed to a lack of awareness regarding their use of digital technologies and a limited understanding of technology's transformative power in supporting learning and enhancing the development of mathematical skills and understanding (Moreno et al., 2020). The researcher used both qualitative data to further explore these inconsistencies in the following sub-sections.

5.2 Using digital technologies in teaching and learning and effects of ERT experiences

In the context of integrating digital technologies in teaching and learning, the participants with B1, B2 and C1 levels revealed their utilization of a wide range of digital platforms and tools. Notable examples include popular Web 2.0 tools such as Padlet for collaborative learning, Kahoot for formative assessment, and digital games in teaching. Furthermore, they expressed the belief that they would be more inclined

to utilize digital technologies extensively if certain favorable conditions were met. These conditions encompassed having sufficient time, access to high-quality digital resources, and ensuring that all learners could access digital devices. However, the participants' utilization of digital technologies was subordinate to their reliance on traditional methods, which predominantly adhered to a teacher-centered pedagogical approach. Their primary use of digital technologies revolved around displaying pages from textbooks and engaging in games related to questions on textbooks. This finding aligned with the literature, which indicated that teachers used digital tools frequently to support traditional methods (Hyde & Jones, 2013). The identified discrepancy highlighted a clear need for better alignment between the participants' intended use of digital technologies and their desired goal of transitioning towards a student-centered approach in mathematics education. This approach emphasizes the importance of promoting modeling, experimentation, and the testing of understanding to facilitate students' mathematical development (Olive et al., 2010). By addressing this misalignment, educators can better integrate digital technologies in a manner that supports the shift towards student-centered learning, where students are actively involved in constructing their mathematical knowledge through hands-on experiences and problem-solving.

Digital resources were predominantly employed for visualization purposes, often aimed at capturing students' attention or for entertainment-related activities such as competitive games among participants. This finding aligns with previous research on the use of educational digital games. Educators face the challenge of seamlessly guiding students from the gaming environment to a mathematical learning setting, where they can effectively harness the learning opportunities presented by the game (Matić, Karavakou, & Grizioti, 2023; Olive et al., 2010).

Participants frequently used digital resources once students had achieved a solid understanding of a subject, viewing them as a means of facilitating consolidation. Digital tools, including videos and interactive activities, were perceived as effective in captivating and sustaining students' attention, particularly after traditional lecture-based instruction. For instance, playing a video or engaging in educational games served this purpose. The participants' reluctance to utilize digital games as a primary teaching tool may have stemmed from their limited knowledge regarding effective teaching methods with digital games and a lack of suitable games designed for teaching middle school mathematics (Matić et al., 2023).

Furthermore, participants disclosed their utilization of digital tools to motivate students, exemplified by the provision of digital activities as rewards for attentive behavior during traditional lectures. These findings may indicate a tendency to view technology as a secondary component rather than an integral facet of educational practice, potentially hindering its seamless integration into pedagogical approaches (Ertmer, Ottenbreit-Leftwich, Sadik, Şendurur, & Şendurur, 2012). The application of technology primarily for recreational purposes rather than as a central component of the instructional process may underlie these observations. Participants' experiences revealed that they preferred asking simple questions while using digital resources and focusing on the learners' amusement. One possible explanation for teachers' tendency to ask more uncomplicated questions could be their hesitancy in using technology in the classroom for exploration, particularly to avoid triggering deductive questions from learners. Despite being aware that using digital technologies offers opportunities for modeling and activities that promote deductive learning and facilitate the implementation of various mathematical practices, teachers may have felt inadequate in facilitating the learning activities. This sense of

inadequacy becomes more when encountered with deductive questions, resulting in a less open-minded approach toward encouraging students' exploration (Sinclair, 2003).

Participants mentioned that they utilized digital technologies as an instrument to tackle misconceptions. Some of the participants, for instance, used digital sketching tools in geometry lessons to help students better understand and visualize geometric objects, as well as visual aids such as 3D animations, to aid students' comprehension of complex topics (Olive et al., 2010; Sinclair, 2003).

Some participants hesitated to integrate digital technology into their classrooms for various reasons. They believed that the current situation results from the academic burden of preparing students for high school examinations, which leads to prioritizing memorization techniques and formula procedures. Moreover, they stated that time constraints imposed by curriculum requirements and standardized testing may limit the use of digital technologies in the classroom, which is consistent with the findings of Achuonye (2015) that teachers commonly use the lecture method because it allows them to cover a large number of learning objectives in a short amount of time. These participants explained that heavy course loads and learning objectives of the curriculum are some of the factors that discourage them from using digital tools. However, they used digital tools when they have extra time after completing their learning objectives.

The participants had low level of digital competency stated that lack of use of digital technologies stemmed from their perceived inadequacy in digital competencies. Additionally, they expressed apprehension regarding the potential loss of classroom control and management that may arise from experimenting with digital tools in the classroom. Consequently, they avoided trying to include digital tools in

the classroom due to the potential disappointment that may ensue. This finding coincides with the conclusion drawn from the literature (Kaleli-Yılmaz, 2015), which suggests that educators who lack confidence in digital competence experience anxiety when including technology in their instructional practices.

Following their experiences with ERT during the COVID-19 pandemic, participants in this study reported improvements in their use of digital technologies in teaching and learning. In particular, they had shifted towards more interactive teaching activities and away from traditional teaching techniques. For example, one participant revealed that she had to conduct extensive research to identify interactive applications for student participation during the pandemic. She believed that this investigation has improved her digital competence in this area. The participant observed that when students are actively engaged, they participate more, are more engaged with the content, and enjoy learning more. After the pandemic, she utilized digital tools frequently.

Regardless of their level of digital competence, participants stated that they experimented with various digital tools and conducted further research to discover how to deliver their subject matter in innovative methods that would engage students during the pandemic. The goal was primarily to grab students' interest. They continued to use digital resources to engage learners with the content after the pandemic. The study conducted by Csachová and Jureková (2020) indicated that instructors intended to use digital tools more in the future. The results of the qualitative data analysis confirmed that teachers expanded their use of digital resources. This finding agreed with Csachová and Jureková's study, which shows a consistent trend toward increased use of digital tools among teachers.

The results suggested a disparity in the use of group activities across different digital competence levels of teachers. Specifically, participants in the A1 and A2 levels tended to avoid group activities, citing time constraints as the primary reason. In contrast, participants at the B1 level employed digital tools to enhance classroom management during group activities, actively involving students in the process of assessing and promoting acceptable behavior to maintain a harmonious learning environment. This finding contradicted the statement made by Cao et al. (2021) regarding the limited use of group activities in online education. While the A1 and A2 level participants may struggle with implementing group activities due to time constraints and difficulty in class management, participants with higher digital competence used digital tools, demonstrating that overcoming these challenges is possible. There may be differences in the adoption of these tools based on the level of the teacher and their approach to classroom management.

Similarly, the results indicated that using a digital tool to facilitate collaborative learning during the pandemic impacted educators' digital competence as a facilitator. Participants emphasized that students engaged in collaborative conceptual work using digital tools, such as concept mapping and brainstorming. One of the participants encouraged student expression and facilitated meaningful discussions. She also noted that these activities are still possible after the pandemic but require additional planning and effort. After the pandemic, the prevalence of standardized tests has increased due to time constraints. These instances illustrated the potential benefits of ERT for enhancing educators' digital proficiency. The transition toward more interactive teaching methods indicated that ERT experiences have encouraged participants to implement innovative pedagogical strategies in their practice.

The findings of this study indicated that the COVID-19 pandemic had pushed teachers out of their comfort zones, requiring them to adapt to online learning and explore new teaching methods and digital resources. Participants mentioned that the pandemic has allowed teachers to experiment with digital tools that promote organizational communication and professional collaboration, allowing them to undertake their responsibilities with less effort. The participants of this study shared that they improved their ability to search for digital learning materials and interactive components by utilizing management platforms to share digital resources with their students. Additionally, many participants have used digital formative assessment tools during the pandemic and continued to do so because learners enjoy using them and are engaged. Overall, the participants highlighted that the pandemic had offered exploration and development opportunities in using digital resources for teaching and learning.

5.3 Using digital technologies in assessment and the effects of ERT experiences

The utilization of digital assessment tools in the classroom exhibited variation based on the participants' levels of digital competence. Participants at lower competence levels (A1 and A2) predominantly relied on traditional paper-based formats for both summative and formative assessments. Conversely, participants at the B1 level displayed a stronger inclination towards integrating digital technology in their assessment methods. They mentioned employing digital assessment tools when appropriate activities aligned with their students' achievement levels. They expressed a preference for utilizing existing digital assessment tools rather than creating or modifying them. They mentioned that this preference was primarily due to constraints in their school schedules and limited time, and their capacity to create or

modify digital technologies stemmed from their limited technical skills and creativity. The extent of their usage depended on the availability of suitable tools that corresponded to their students' knowledge levels.

Participants at the B2 level demonstrated adaptability and competence in effectively utilizing digital tools by modifying existing digital assessment activities to better suit their students' needs and abilities. On the other hand, they mentioned employing simple questions in online quizzes and games to sustain students' interest; they believed that presenting too many challenging questions would diminish interest and engagement. This particular approach may indicate a tendency to view digital technologies as sources of entertainment within the assessment process.

Most participants relied on traditional paper and pencil assessment methods instead of digital technologies when assessing topics requiring step-by-step problem-solving. This approach, which focuses on evaluating students' procedural steps during problem-solving and understanding their algorithmic thinking, aligns with the findings in the existing literature. There is still a reliance on traditional paper-and-pencil assessment methods in mathematics classrooms (Usiskin, 2018). In contrast, Teacher 10 (C1) utilized a digital tool with draw-it functionality, enabling easy access and sharing of learners' assignments while effectively examining these procedures. She mentioned that she could assess her students' algorithmic thinking, detect misconceptions immediately, and plan extra learning materials and individual study sessions accordingly. Further application could be automatizing the additional feedback and planning as stated in the literature. Usiskin (2018) stated that it is worth considering that algorithms, in their essence, are highly suitable for the electronic setting and mentioned the automated feedback and additional practices provided by the software.

Furthermore, some participants employed digital tools to monitor their student's academic progress and classroom behaviour. These digital assessment tools generated feedback reports that offered valuable data on learners' success rates, the number of correct and incorrect answers, topics requiring additional reinforcement, and the time taken to complete quizzes. Participants found these reports particularly beneficial as they facilitated an understanding of learners' achievement levels, identification of misconceptions, and recognition of learning difficulties which is aligned with the literature (Buzzetto-More & Alade, 2006; McKnight et al., 2016). Moreover, this information informed their lesson planning, enabling targeted instruction delivery. Additionally, participants reported that digital assessment tools facilitated their preparation for new topics by addressing learners' prior knowledge. These findings align with the literature, emphasizing the importance of leveraging digital technologies to give immediate feedback and build upon students' existing knowledge (McKnight et al., 2016). These findings underscore the diverse approaches participants adopt when using digital technologies for assessment.

The findings of this study indicated that ERT experiences had influenced educators' use of digital technology to improve assessment. For instance, one participant discussed how using digital platforms for assignments enabled students to ask questions and receive rapid feedback, highlighting the importance of technology in facilitating quick communication and making the feedback process more accessible. This finding contradicted the findings of Cao et al. (2021), which indicated that collecting assignments and providing feedback can be challenging during the ERT period. The results of this study suggested potential solutions for educators to enhance the quality of online formative assessment, addressing the concerns raised in previous studies (Cao et al., 2021; Hodgen et al., 2020). Moreover,

the results indicated that participants had trust issues when using digital tools for summative assessments, primarily due to concerns about cheating and outside assistance from family members. This is aligned with the literature (Chirumamilla, Sindre, & Nguyen-Duc, 2020).

The impact of ERT experiences extends to developing new habits among educators. For instance, one participant in the study mentioned a shift from using post-it notes to employing Padlet as a formative assessment tool after the pandemic. This change was driven by the convenience of digital platforms in accessing and storing learners' responses. It is a clear example of how ERT experiences can lead to adopting digital assessment instruments.

The findings of the study suggest that the ERT context has significantly influenced educators' use of digital assessment tools, which has implications for the improvement of assessment practices.

5.4 Using digital technologies for empowering learners and the effects of ERT experiences

Participants in this study were aware that students are digital natives who are highly engaged with technology, connected to their peers online, and spend significant time on the Internet. Consequently, the participants with high level of digital competence made active efforts to adapt their instructional practices by incorporating technology and considering their students' life experiences inside and outside the classroom. It included observations made during non-academic periods, such as break times and school transportation. This acknowledgement of the need for pedagogical adaptation in response to 21st-century students demonstrates educators' growing awareness that

traditional instructional methods may no longer be sufficient to effectively engage and motivate modern students (Ertmer et al., 2012).

Researchers have expressed concerns regarding the digital competency levels of students, highlighting the importance of developing cognitive capacities among digital natives (Calvani et al., 2012; Li & Ranieri, 2010). The participants who had A1 and A2 levels expressed their desire to increase their usage of digital technologies due to their current dissatisfaction with them. It aligns with the existing literature, which states that while many students and teachers employ digital tools creatively daily, their utilization in educational contexts is less prevalent (Hyde & Jones, 2013). It should be emphasized that educators should utilize digital technologies in meaningful ways to improve their students' digital competencies while also engaging in continuous learning to improve their own digital skills (NCTM, 2007). To address this issue, participants discussed their efforts to bridge the gap between the personal technology experiences of their students and the classroom experiences, aiming to create engaging and stimulating learning environments.

Participants with higher levels of digital competency stated using various strategies, such as assigning homework that involved creating digital content and presenting their work. They emphasized the importance of tailoring activities to align with learners' interests, recognizing that personalized and engaging tasks can enhance student motivation and participation (Hyde & Jones; 2013). It is consistent with research that emphasizes the role of technology in supporting student-centered approaches and encouraging student participation (McKnight et al., 2016; White, 2003).

During the pandemic, digital technologies played a crucial role in enhancing student engagement and classroom participation, as revealed in the findings of this

study. Additionally, participants with a higher level of digital competence employed diverse techniques to monitor and assess student behavior, including observing their computer displays. This approach allowed for immediate feedback and the maintenance of a permanent record of assessment results (NCTM, 2007). Some participants mentioned utilizing platforms like ClassDojo to track student behaviors and Google Classroom to store academic results. In response to the concern raised in the literature regarding the decrease in timely feedback during the pandemic (Hodgen et al., 2020), this study highlights the potential of utilizing digital technologies to ensure prompt and effective feedback for students. The findings also indicated that participants had addressed the challenges associated with active participation during the pandemic, such as monitoring learners' attentiveness and note-taking, as discussed in Cao et al.'s study (2021). Moreover, some participants continued to use mentioned digital tools after the pandemic, as they found them advantageous for providing efficient monitoring.

In addition to participants' efforts to adapt instructional practices using technology and considering students' life experiences, participants also emphasized the crucial issue of accessibility and inclusion. They expressed the unequal access to digital education tools. One participant mentioned that some students have better access to digital devices, allowing her to support them by providing supplementary materials. Some participants also expressed that various activities could be developed if the school had adequate digital tools. They highlighted how having devices in the classroom simplified the administration of digital learning activities. Moreover, they discussed the potential benefits of equipping every student with a device enabling less time-consuming activities. These perspectives underscored the significance of

equal access to digital tools and resources, which can significantly enhance students' learning experiences and opportunities (Hyde & Jones, 2013).

Most of the participants emphasized the importance of schools investing in the essential infrastructure and equipment to ensure equitable access to digital technologies and resources for all students. This emphasis aligns with the acknowledgement that the limits of accessibility bind educators' practices. Despite educators' recognition of the benefits of utilizing digital technologies to empower learners, the presence of accessibility issues places constraints on their instructional practices (Ertmer et al., 2012). One participant from a private school emphasized the advantages of equipping all students with tablets, emphasizing how these technological resources greatly enhanced the organization of activities. Conversely, one participant from a state school raised concerns about occasional connectivity issues, which created difficulties when conducting online educational activities. These accessibility problems, directly attributable to the type of educational institutions, have the potential to significantly impact the practices of middle school mathematics teachers.

In this study, participants mentioned that using digital technologies has increased active participation among students. Furthermore, in considering the pandemic, participants expressed an interest in further integrating more digital tools into their pedagogical approach to enhance student engagement. This finding aligned with the goals of educators to use digital technologies to enhance student engagement after the pandemic, as outlined in the study conducted by Hoti et al. (2022).

5.5 Recommendations and implications for future studies

This research contributed to the literature on the middle school mathematics teachers' digital competency levels in the post-pandemic era, with a particular emphasis on exploring potential reasons relating to their experiences during the pandemic. By observing their classrooms and analyzing their lesson plans, additional research could be conducted to investigate teachers' digital competency in practice. In addition, although this study was limited to middle school mathematics teachers, further research could be conducted with teachers of other subjects. The present study revealed that the Facilitating Learners' Digital Competence (Area 6) obtained the lowest scores among the DigCompEdu areas. Further investigation could be conducted to comprehensively explore instructors' practices, thereby clarifying the underlying reasons for the marked lower scores. Additionally, the findings suggested the potential for designing targeted professional development programs to enhance educators' skills in this domain. Even though the researcher attempted to increase the diversity of demographic information during the qualitative phase, the teaching experience of the participants in the semi-structured interviews ranged from 0 to 2 years to 2 to 5 years. Additional qualitative research could be conducted with teachers with more years of experience. In the self-regulated learning sub-area of teaching, the researcher had few codes in the semi-structured interviews, so further research could conduct to understand teachers' perceptions of this area. When analyzing qualitative data, the researcher employed a hybrid thematic analysis; future research employing a variety of methodologies could yield extensive findings. It was possible to conduct research with a larger sample size, as the sample size was 44 middle school mathematics teachers.

5.6 Limitations

This study has potential limitations. The sample size could be inadequate to generalize the results of the study. The data collected from the survey, and interviews may not accurately reflect the actual classroom practices. It could lead to an inaccurate understanding of the relationship between pedagogical competencies and digital technology use in teaching mathematics. The researcher integrated the findings from quantitative and qualitative data analysis to minimize this possibility. The researcher's own biases and subjectivity could also impact the study's findings.

The study's findings were constrained by the small sample size and the low number of participants from each DigCompEdu level, particularly in relation to the scarcity of Pioneer (C2) level participants. This constraint limited the generalizability of the study's findings.

Because there needs to be more research on digital competency in middle school mathematics, this study has several limitations. Although attempts were made to review the available literature, the limited quantity of published research on the topic inevitably limited the scope of this study. Nonetheless, this study lays the groundwork for future research on the subject and contributes to the more extensive discussion on the use of technology in middle school mathematics education. In addition, the DigCompEdu framework did not provide subject-specific interpretations for its proficiency statements, making it difficult to interpret the qualitative findings about middle school mathematics instructors' practices.

APPENDIX A

DIGITAL COMPETENCY SCALE FOR EDUCATORS

Demographic Questions

1. Located City: …
2. Age: …
3. Gender: ….
4. Your Years of Teaching Experience:
   - 0-2 years
   - 2-5 years
   - 5-10 years
   - 10+ years
5. Your Level of Education:
   - Bachelor
   - Master's

Part 1. How do you currently assess your digital competence? Assign a level of competence from A1 to C2, where A1 is the lowest and C2 the highest level.
I am probably a(n)

□ A1. Newcomer (Aware of the potential of digital technologies to enhance pedagogical and professional practices.)
□ A2. Explorer (Aware of the potential of digital technologies and interested in exploring them to enhance pedagogical and professional practices.)
□ B1. Integrator (Integrates digital technologies into most of their practices by experimenting with them in various contexts and for various purposes.)
□ B2. Expert (Confidently, creatively, and critically uses multiple digital technologies to enhance their professional activities.)
□ C1. Leader (Demonstrates a consistent and comprehensive approach to using digital technologies for enhancing pedagogical and professional practices.)
□ C2. Pioneer (Questions the adequacy of contemporary digital and pedagogical practices. Driven by a desire to innovate further in education.)

Part 2.

Area 1: Professional Engagement

1. I systematically use different digital channels to enhance communication with students and fellow academics (e.g., emails, blogs, the department's website, Apps)

□ I rarely use digital communication channels
□ I use basic digital communication channels (e.g., e-mail)
□ I combine different communication channels (e.g., e-mail and class blog or

the department's website)
□ I systematically select, adjust and combine different digital solutions to communicate effectively
□ I reflect on, discuss and proactively develop my communication strategies

2. I use digital technologies to work together with colleagues inside and outside my educational organization

□ I rarely have the opportunity to collaborate with other academics
□ Sometimes I exchange materials with colleagues (e.g., via e-mail)
□ Among colleagues, we work together in collaborative environments or use shared drives
□ I exchange ideas and materials, also with academics outside my organization, (e.g., in an online professional network)
□ I jointly create materials with other academics in an online network

3. I actively develop my digital teaching skills

□ I rarely have the time to work on my digital teaching skills
□ I improve my skills through reflection and experimentation
□ I use a range of resources to develop my digital teaching skills
□ I discuss with peers how to use digital technologies to innovate and improve educational practice.
□ I help colleagues in developing their digital teaching strategies.

4. I participate in online training opportunities (e.g., online courses, MOOCs, webinars, virtual conferences)

□ This is a new area that I have not yet considered
□ Not yet, but I am definitely interested
□ I have participated in online training once or twice
□ I have tried out various different online training opportunities
□ I frequently participate in all kinds of online training

Area 2: Digital Resources
1.I use different internet sites and search strategies to find and select a range of different digital resources

□ I only rarely use the internet to find resources
□ I use search engines and resource platforms to find relevant resources
□ I evaluate and select resources on the basis of their suitability for my learner group
□ I compare resources using a range of relevant criteria (e.g., reliability, quality, fit, design, interactivity, appeal)
□ I advise colleagues on suitable resources and search strategies

2. I create my own digital resources and modify existing ones to adapt them to my needs

□ I do not create my own digital resources
□ I do create lecture notes or reading lists with a computer, but then I print them
□ I create digital presentations, but not much more
□ I create and modify different types of resources
□ I set up and adapt complex, interactive resources

3. I effectively protect sensitive content (e.g., exams, students' grades, personal data)

□ I do not need to do that, because the department takes care of this
□ I avoid storing personal data electronically
□ I protect some personal data
□ I password protect files with personal data
□ I comprehensively protect personal data (e.g., combining hard-to-guess passwords with encryption and frequent software updates)

Area 3: Teaching and Learning

1. I carefully consider how, when and why to use digital technologies in teaching, to ensure that they are used with added value

□ I do not or only rarely use technology in class
□ I make basic use of available equipment (e.g., digital whiteboards or projectors)
□ I use a variety of digital strategies in my teaching
□ I use digital tools to systematically enhance teaching
□ I use digital tools to implement innovative pedagogic strategies

2. I monitor my students' activities and interactions in the collaborative online environments we use

□ I do not use digital environments with my students
□ I do not monitor student activity in the online environments we use
□ I occasionally check on them and their discussions
□ I regularly monitor and analyze my students' online activity
□ I regularly intervene with motivating or corrective comments

3. When my students work in groups or teams, they use digital technologies to acquire and document evidence

□ My students do not work in groups
□ It is not possible for me to integrate digital technologies into group work
□ I encourage students working in groups to search for information online or to present their results in digital format
□ I require students working in teams to use the internet to find information and present their results in a digital format
□ My students exchange evidence and jointly create knowledge in a collaborative online space

4. I use digital technologies to allow students to plan, document and monitor their learning themselves (e.g., quizzes for self-assessment, ePortfolios for documentation and showcasing, online diaries/blogs for reflection)

□ Not possible in my work environment
□ My students do reflect on their learning, but not with digital technologies
□ Sometimes I use, for example, quizzes for self-assessment
□ I use a variety of digital tools to allow learners to plan, document or reflect on their learning
□ I systematically integrate different digital tools to allow learners to plan, monitor and reflect on their progress

Area 4: Assessment

1. I use digital assessment formats to monitor student progress
□ I do not monitor students' progress
□ I do monitor students' progress regularly, but not with digital means
□ Sometimes I use a digital tool (e.g., a quiz, to check on students' progress)
□ I use a variety of digital tools to monitor student progress
□ I systematically use a variety of digital tools to monitor student progress

2. I analyze all data available to me to timely identify students who need additional support "Data" includes students' engagement, performance, grades, attendance; activities and social interactions in (online) environments; "Students who need additional support" are students who are at risk of dropping out or underperforming; students who have learning disorders or specific learning needs, students who lack transversal skills, e.g. social, verbal or study skills.

□ These data are not available and/or it is not my responsibility to analyze them
□ I only analyze academically relevant data (e.g., performance and grades)
□ I also consider data on student activity and behavior to identify students who need additional support
□ I regularly screen all available evidence to identify students who need additional support
□ I systematically analyze data and intervene in a timely manner

3. I use digital technologies to provide effective feedback

□ Feedback is not necessary in my work environment
□ I do provide feedback to students, but not in digital format
□ Sometimes I use digital ways of providing feedback (e.g., automatic scores in online quizzes, comments or "likes" in online environments)
□ I use a variety of digital ways of providing feedback
□ I systematically use digital approaches to provide feedback

Area 5: Empowering Learners

1. When I create digital assignments for students I consider and address potential digital problems (e.g., equal access to digital devices and resources; interoperability and conversion problems; lack of digital skills)

□ I do not create digital assignments
□ My students do not have problems with using digital technology
□ I adapt the task so as to minimize difficulties
□ I discuss possible obstacles with students and outline solutions
□ I allow for variety, e.g. I adapt the task, discuss solutions, and provide alternative ways for completing the task

2. I use digital technologies to offer students personalized learning opportunities (e.g., I give different students different digital tasks to address individual learning needs, preferences, and interests)

□ In my work environment, all students are required to do the same activities, irrespective of their level
□ I do provide students with recommendations for additional resources
□ I provide optional digital activities for those who are advanced or lagging behind
□ Whenever possible, I use digital technologies to offer differentiated learning opportunities
□ I systematically adapt my teaching to link to students' individual learning needs, preferences, and interests

3. I use digital technologies for students to actively participate in classes

□ In my work environment it is not possible to actively involve students in class
□ I do involve students actively, but not with digital technologies
□ When instructing, I use motivating stimuli (e.g., videos, animations, cartoons)
□ My students engage with digital media in my classes (e.g., electronic worksheets, games, quizzes)
□ My students systematically use digital technologies to investigate, discuss and create knowledge

Area 6: Facilitating Learners’ Digital Competence

1. I teach students how to assess the reliability of information and to identify misinformation and bias

□ This is not possible in my subject or work environment
□ I occasionally remind them that not all online information is reliable
□ I teach them how to discern reliable and unreliable sources
□ I discuss with students how to verify the accuracy of information
□ We comprehensively discuss how information is generated and can be distorted

2. I set up assignments which require students to use digital means to communicate

and collaborate with each other or with an outside audience

□ This is not possible in my subject or work environment
□ Only on rare occasions are my students required to communicate or collaborate online
□ My students use digital communication and cooperation mainly among each other
□ My students use digital ways to communicate and to cooperate with each other and with an external audience
□ I systematically set assignments that allow students to slowly expand their skills

3. I set up assignments which require students to create digital content (e.g., videos, audios, photos, digital presentations, blogs, wikis)

□ This is not possible in my subject or work environment
□ This is difficult to implement with my students
□ Sometimes, for diversion and motivation
□ My students create digital content as integral part of their study
□ This is an integral part of their learning and I systematically increase the level of difficulty to further develop their skills

4. I teach students how to behave safely and responsibly online

□ This is not possible in my subject or work environment
□ I inform them that they have to be careful with relaying personal information online
□ I explain the basic rules for safely and responsibly acting in online environments
□ We discuss and agree on rules of conduct
□ I systematically develop my students' use of social rules in the different digital environments we use

5. I encourage students to use digital technologies creatively to solve concrete problems (e.g., to overcome obstacles or challenges emerging in the learning process)

□ This is not possible with my students, in my work environment
□ I rarely have the opportunity to foster students' digital problem solving
□ Occasionally, whenever an opportunity arises
□ We often experiment with technological solutions to problems
□ I systematically integrate opportunities for creative digital problem solving

APPENDIX B

EĞİTİMCİLER İÇİN DİJİTAL YETERLİLİK ÖLÇEĞİ

Part 1. Şu anda dijital yeterliliğinizi nasıl değerlendiriyorsunuz? A1'den C2'ye kadar bir yeterlilik seviyesi seçiniz; burada A1 en düşük ve C2 en yüksek seviyedir. Dijital yeterlilik seviyem muhtemelen,

□ A1. Başlangıç (Pedagojik ve profesyonel uygulamaları geliştirmek için dijital teknolojilerin potansiyelinin farkındadır.)
□ A2. Kaşif (Dijital teknolojilerin potansiyelinin farkındadır ve pedagojik ve profesyonel uygulamaları geliştirmek için bunları keşfetmekle ilgilenirler.)
□ B1. Bütünleştirici (Dijital teknolojileri çeşitli bağlamlarda ve çeşitli amaçlarla deneyerek, bunları pratiklerinin çoğuna entegre eder.)
□ B2. Uzman (Profesyonel faaliyetlerini geliştirmek için bir çok dijital teknolojiyi kendinden emin, yaratıcı ve eleştirel bir şekilde kullanır.)
□ C1. Lider (Pedagojik ve profesyonel uygulamaları geliştirmek için dijital teknolojileri kullanma konusunda tutarlı ve kapsamlı bir yaklaşıma sahiptir.)
□ C2. Öncü (Çağdaş dijital ve pedagojik uygulamaların yeterliliğini sorgularlar. Eğitimde daha fazla yenilik yapma dürtüsüyle hareket ederler.)

Part 2.

1) Mesleğinde Dijital Becerilerin Kullanımı

Öğretmenlerin dijital yeterlikleri, dijital teknolojilerin sadece okul ve sınıf ortamında eğitim-öğretim amaçlı kullanılmasıyla sınırlı değildir. Bunun yanında, diğer öğretmenler, öğrenciler, veliler ve eğitimle ilgili tüm paydaşlarla mesleki etkileşim kurmayı, kişisel mesleki gelişim sağlamayı, eğitim-öğretim için en iyi olanı bulmayı ve kullanmayı da kapsamaktadır.
Bölüm 1 bu alandaki durumunuzu ele almaktadır.

1-) Öğrenciler, veliler ve meslektaşlarımla iletişimi geliştirmek için farklı dijital iletişim kanallarını sistematik olarak kullanabilirim (e-posta, blog, okulun web sitesi, uygulamalar vb).

- □ Dijital iletişim kanallarını nadiren kullanırım.
- □ Temel dijital iletişim kanallarını kullanırım.
- □ Farklı dijital iletişim kanallarını birleştirerek kullanırım.. (e-posta, bloglar veya okul web sitesi)
- □ Etkili iletişim kurmak için farklı dijital iletişim kanallarını sistematik olarak seçer, uyarlar ve birleştiririm.
- □ Kullanacağım iletişim stratejileri üzerine düşünürüm, tartışırım ve etkin bir şekilde geliştiririm.

2-) Okul içindeki ve dışındaki meslektaşlarımla birlikte çalışmak için dijital teknolojileri kullanırım.

- □ Meslektaşlarımla dijital ortamda işbirliği yapmak için nadiren fırsat bulurum.
- □ Meslektaşlarımla bazen e-posta yoluyla materyal alışverişi yaparım.
- □ Meslektaşlarımla çevrimiçi işbirlikçi ortamlarında birlikte çalışırız veya ortak depolama alanlarını (googledrive, dropbox, icloud…vb.) birlikte kullanırız.
- □ Çevrimiçi öğretmen ağlarında (EBA vb.) okulum dışındaki öğretmenlerle de fikir ve materyal alışverişinde bulunurum.
- □ Çevrimiçi öğretmen ağlarındaki (EBA vb.) diğer öğretmenlerle ortaklaşa materyaller oluştururum.

3-) Dijital öğretim becerilerimi aktif olarak geliştirmeye çalışırım.

- □ Dijital öğretim becerilerimi geliştirmek için nadiren vaktim oluyor.
- □ Dijital öğretim becerilerimi deneyimlerle geliştiririm.
- □ Dijital öğretim becerilerimi geliştirmek için çeşitli kaynaklar kullanırım.
- □ Meslektaşlarımla yenilikçi yöntemlerin geliştirilmesinde ve eğitim uygulamalarının iyileştirilmesinde dijital teknolojinin nasıl kullanılacağını tartışırım.
- □ Meslektaşlarımın dijital öğretim stratejilerini geliştirmelerine yardımcı olurum.

4-) Çevrimiçi eğitimlere katılırım. (online kurslar, webinarlar, MOOC tabanlı eğitimler vb.)

- □ Bu, üzerinde henüz dikkate almadığım yeni bir alan.
- □ İlgimi çekiyor ancak henüz katılmadım.
- □ Bu tür bir çevrimiçi eğitime bir veya iki defa katıldım.
- □ Farklı farklı çevrimiçi eğitimlere katıldım.
- □ Her türlü Çevrimiçi eğitimlere sık sık katılırım.

2) Dijital Kaynaklar

Eğitimciler günümüzde oldukça fazla ve çeşitli eğitsel dijital kaynakla karşılaşabilmektedir.Herhangi bir eğitimcinin geliştirmek için ihtiyaç duyduğu temel yeterliklerden bazıları; bu çeşitlilik ile başa çıkmak, öğrenme hedeflerine en uygun kaynakları etkili bir şekilde tanımlamak, materyal zenginliğini yapılandırmak, bağlantılar kurmak ve değiştirmek, öğretimi desteklemek için kendi dijital kaynaklarını geliştirebilmektir. Aynı zamanda, eğitimcilerin dijital içerikleri bilinçli bir şekilde nasıl kullanacaklarının ve yöneteceklerinin farkında olmaları gerekir. Kaynakları kullanırken, değiştirirken ve paylaşırken telif hakkı kurallarına saygı duymalı ve dijital sınavlar veya öğrencilerin notları gibi kişisel verileri korumalıdır. Bölüm 2 bu alandaki durumunuzu ele almaktadır.

1-) Farklı dijital kaynaklar bulmak ve seçmek için farklı internet siteleri ve arama stratejileri kullanırım.

- □ Dijital kaynak bulmak için İnterneti nadiren kullanırım.
- □ Kendi derslerimle ilgili dijital kaynakları bulmak için arama motorlarını ve eğitim platformlarını kullanırım.

- □ Dijital kaynakları öğrencilerimin seviyelerine göre değerlendirip seçerim.
- □ Dijital kaynakları çeşitli kriterler kullanarak karşılaştırırım. (Örneğin güvenilirlik, kalite, uygunluk, tasarım, etkileşim, çekicilik.)
- □ Meslektaşlarıma uygun dijital kaynaklar ve arama stratejileri hakkında önerilerde bulunurum.

2-) Kendi dijital kaynaklarımı oluşturur ve var olan kaynakları ihtiyaçlarıma göre değiştiririm.

- □ Kendi dijital kaynaklarımı oluşturmam.
- □ Bilgisayarla çalışma sayfaları oluştururum ama kullanacağım zaman yazdırıyorum.
- □ Bazen dijital sunumlar oluştururum.
- □ Farklı türden dijital kaynaklar oluşturur ve mevcut kaynakları uyarlarım.
- □ Karmaşık ve etkileşimli dijital kaynakları geliştiririm ve uyarlarım.

3-) Sınav, öğrenci notları, kişisel veriler vb. hassas içeriği etkin bir şekilde korurum.

- □ Bunu yapmama gerek yok çünkü bu bilgilerin korunmasından okul sorumludur.
- □ Kişisel verileri elektronik olarak saklamaktan kaçınırım.
- □ Bazı kişisel verileri korurum.
- □ Kişisel verilerin olduğu dosyalara şifre koyarak koruma sağlarım.
- □ Kişisel verileri kapsamlı bir şekilde korurum. (Örneğin tahmin edilmesi zor parolaları şifreleme ve yazılım güncellemeleriyle birleştirme.)

3) Öğretme ve Öğrenme

Bilgi ve iletişim teknolojilerini eğitimde kullanmanın en temel yetkinliği, dijital teknolojilerin kullanımını öğretme ve öğrenme sürecinin farklı aşamalarında tasarlamak, planlamak ve uygulamaktır. Ancak, bunu yaparken amaç, dersin odağını öğretmen liderliğinden öğrenci
merkezli süreçlere kaydırmak olmalıdır.
Bölüm 3 bu alandaki durumunuzu ele almaktadır.

1-) Dijital teknolojilerin sınıfta etkili bir şekilde kullanılmasını sağlamak için nasıl, ne zaman ve neden kullanılacağını özellikle düşünürüm.

- □ Sınıfta teknolojiyi kullanmam ya da nadiren kullanırım.
- □ Mevcut ekipmanı temel olarak kullanırım. (örneğin; etkileşimli tahta veya projeksiyon.)
- □ Derslerimde çeşitli dijital kaynaklar ve araçlar kullanırım.
- □ Dijital araçları öğretimi sürecini sistematik olarak geliştirmek için kullanırım.
- □ Yenilikçi pedagojik stratejileri uygulamak için dijital araçlar kullanırım.

2-) Öğrencilerimin işbirlikçi çevrimiçi ortamlardaki etkinliklerini ve etkileşimlerini izlerim.

- □ Dijital ortamları öğrencilerimle birlikte kullanmam.
- □ Kullandığımız çevrimiçi ortamlarda öğrencilerimin etkinliğini takip etmem.
- □ Öğrencilerimi ve onların tartışmalarını bazen kontrol ederim.

- □ Öğrencilerimin çevrimiçi etkinliklerini düzenli olarak takip ve analiz ederim.
- □ Öğrencilerimin etkinliklerine motive edici veya düzeltici yorumlarla düzenli olarak dâhil olurum.

3-) Öğrencilerim gruplar halinde çalışırken öğrenme çıktısı elde etmek ve belgelemek için dijital teknolojileri kullanırlar

- □ Öğrencilerim gruplar halinde çalışmaz.
- □ Öğrencilerimin grup çalışmalarında dijital teknolojileri bütünleştirmem mümkün değil.
- □ Öğrencilerimi grup çalışmalarında internet üzerinden bilgi aramaya ve çalışmalarının sonuçlarını dijital formatta sunmaya teşvik ederim.
- □ Öğrencilerimden grup çalışmalarında araştırma yapmak ve sonuçlarını dijital formatta sunmak için interneti kullanmalarını isterim.
- □ Öğrencilerim gruplar halinde çalışmak için ortak bir çevirim içi öğrenme ortamı kullanır ve birlikte projeler oluştururlar.

4-) Öğrencilerin, kendi öğrenme süreçlerini planlamalarını, belgelemelerini ve izlemelerini sağlamak için dijital teknolojileri kullanıyorum. (Örneğin öz değerlendirme için sınavlar, dokümantasyon ve sergileme için e-portfolyolar vb.)

- □ Çalışma ortamımda bunu yapmam mümkün değil.
- □ Öğrencilerim öğrenme süreçleri üzerinde düşünür ancak bunu dijital teknolojilerle yapmazlar.
- □ Bazen öz değerlendirme sınavlarını dijital teknolojiler kullanarak yaparım.
- □ Öğrencilerimin öğrenmelerini planlamalarını, belgelemelerini veya ortaya koymalarını sağlamak için çeşitli dijital araçlar kullanırım.
- □ Öğrencilerin ilerlemelerini, planlamalarını, izlemelerini ve ortaya koymalarını sağlamak için farklı dijital araçları sistematik olarak bir arada kullanırım.

4) Değerlendirme

Dijital teknolojiler mevcut değerlendirme stratejilerini geliştirmekte ve yeni ve daha iyi
değerlendirme yöntemlerini mümkün kılabilmektedir. Ayrıca, öğrencinin kişisel eylemlerinde
mevcut olan (dijital) veri zenginliğini analiz ederek, öğretmenler daha iyi geribildirim ve destek sunabilme imkânına erişmektedir.
Bölüm 4 bu alandaki durumunuzu ele almaktadır.

1-) Öğrencinin gelişimin izlemek için dijital değerlendirme araçlarını kullanırım.

- □ Öğrencilerin gelişimini izlemem.
- □ Öğrencilerin gelişimini düzenli olarak izlerim, ancak dijital yöntemler kullanmam.
- □ Öğrencilerin gelişimini izlemek için bazen dijital bir araç kullanırım. (Örneğin öğrencilerin ilerlemelerini kontrol etmek için dijital bir sınav.)
- □ Öğrencinin gelişimini izlemek için çeşitli dijital araçlar kullanırım.

□ Öğrenci gelişimini izlemek için çeşitli dijital araçları sistematik olarak kullanırım.

2-) Ek desteğe ihtiyacı olan öğrencileri zamanında belirlemek için elimdeki tüm verileri analiz ederim.
Veri"; öğrencilerin katılımı, performansı, notları, devam durumları; (çevrimiçi) ortamlardaki etkinlikler ve sosyal etkileşimleri içermektedir.
"Ek desteğe ihtiyaç duyan öğrenciler"; ,okulu bırakma düşük performans riski taşıyan öğrenciler; öğrenme bozukluğu olan veya özel eğitime ihtiyacı olan öğrencilerdir.

□ Bu veriler elimde mevcut değil ve / veya bunları analiz etmek benim sorumluluğumda değildir.
□ Sadece akademik verileri analiz ederim. (Örneğin performans ve notlar.)
□ Ek desteğe ihtiyacı olan öğrencileri belirlemek için öğrencilerin etkinlikleri ve davranışları hakkındaki verileri de dikkate alırım.
□ Ek desteğe ihtiyacı olan öğrencileri belirlemek için mevcut tüm verileri düzenli olarak izlerim.
□ Verileri sistematik olarak analiz eder ve zamanında müdahale ederim.

3-) Etkili geri bildirim sağlamak için dijital teknolojileri kullanırım.

□ Çalışma ortamımda geri bildirim gerekli değil.
□ Öğrencilere geri bildirim veriyorum ancak dijital format kullanmam.
□ Geri bildirim sağlamak için bazen dijital yollar kullanırım. (Örneğin çevrimiçi sınavlarda otomatik puan verme, çevrimiçi ortamda yorum veya "beğenme".)
□ Geri bildirim sağlamak için çeşitli dijital yöntemler kullanırım.
□ Geri bildirim sağlamak için dijital yaklaşımları sistematik olarak kullanırım.

5) Öğrencilerin Güçlendirilmesi

Dijital teknolojilerin eğitimdeki en güçlü yönlerinden bazıları öğrencilerin öğrenme sürecine aktif katılımını sağlamak ve öğrencileri aktif hale getirmektir. Dijital teknolojiler ayrıca her öğrencinin yeterlik seviyesine, ilgi alanlarına ve öğrenme gereksinimlerine uyarlanmış öğrenme etkinlikleri sunmak için de kullanılabilir. Bununla birlikte mevcut eşitsizlikleri (örneğin dijital teknolojilere erişimde) azaltmaya ve özel eğitim ihtiyacı olanlar da dâhil tüm öğrenciler için erişilebilirliği sağlamaya özen gösterilmelidir.
Bölüm 5 bu alandaki durumunuzu ele almaktadır.

1-) Öğrenciler için dijital ödevler oluştururken karşılaşabilecekleri potansiyel dijital güçlükleri göz önünde bulundururum. (Örneğin dijital cihazlara ve kaynaklara eşit erişim; birlikte çalışma sorunları; dijital becerilerin eksikliği)

□ Dijital ödevler oluşturmam.
□ Öğrencilerim dijital teknolojiyi kullanırken sorun yaşamaz.
□ Dijital ödevleri, öğrencilerimin karşılaşabilecekleri sorunları en aza indirecek şekilde uyarlıyorum.
□ Öğrencilerimle olası sorunlar ve bu sorunların çözümleri hakkında tartışırım.

□ Dijital kaynakların erişimindeki ve kullanımındaki farklılıkları hesaba katarak çeşitliliğe izin veriyorum. (Örneğin ödevi uyarlarım, çözümleri tartışırım ve ödevi tamamlamak için alternatif yollar sunarım.)

2-) Öğrencilere bireyselleştirilmiş öğrenme ortamları sunmak için dijital teknolojileri kullanırım. (Örneğin farklı öğrencilere bireysel öğrenme ihtiyaçlarını, tercihlerini ve ilgi alanlarını ele almak için farklı dijital görevler veririm.)

□ Sınıfta, tüm öğrencilerin, seviyelerine bakılmaksızın aynı etkinlikleri yapmaları gerekmektedir.
□ Öğrencilere ek kaynaklar için önerilerde bulunurum.
□ İleri seviyedeki veya geride kalmış öğrencilerim için isteğe bağlı dijital etkinlikler yaparım.
□ Dijital teknolojileri, mümkün olduğunca farklı öğrenme seçenekleri sunmak için kullanırım.
□ Derslerimi öğrencilerin bireysel öğrenme ihtiyaçlarına, tercihlerine ve ilgi alanlarına göre sistematik olarak dijital teknolojiler yardımıyla uyarlarım.

3-) Öğrencilerin derse aktif olarak katılması için dijital teknolojileri kullanırım.

□ Derslerimde öğrencilerin derse aktif bir şekilde katılmalarını sağlamak mümkün değil.
□ Öğrencileri derse aktif olarak dâhil ediyorum ama bunu yaparken dijital teknolojileri kullanmam.
□ Derslerimde motive edici materyalleri kullanırım. (Örneğin videolar, animasyonlar, çizgi filmler.)
□ Derslerimde kullandığım dijital araçlar öğrencilerimin ilgisini çeker. (Örneğin elektronik çalışma sayfaları, oyunlar, kısa sınavlar.)
□ Öğrencilerim düzenli olarak araştırma, tartışma ve bilgi oluşturmak için dijital teknolojileri kullanır.

6) Öğrencilerin Dijital Yetkinliklerinin Kolaylaştırılması

Öğrencilerinin dijital okuryazarlığını geliştirebilmesi, bir öğretmenin dijital yeterliliğinin ayrılmaz bir parçasıdır. Bölüm 6 bu alandaki durumunuzu ele almaktadır.

1-) Öğrencilere bilgilerin güvenilirliğini nasıl değerlendireceklerini, yanlış bilgilendirme ve önyargıları nasıl tespit edebileceklerini öğretirim.

□ Bunu yapmak derslerimde/sınıfımda mümkün değil.
□ Onlara zaman zaman tüm çevrimiçi bilgilerin güvenilir olmadığını hatırlatırım.
□ Onlara internetteki güvenilir ve güvenilmez kaynakları ayırt etmeyi öğretirim.
□ Öğrencilerimle bilgiyi nasıl doğrulayacağımızı tartışırım.
□ Öğrencilerimle bilginin nasıl üretildiği ve nasıl çarpıtılabileceği hakkında kapsamlı bir şekilde tartışırız.

2-) Öğrencilerimin birbirleriyle veya çevreleriyle iletişim kurmak ve işbirliği yapmak için dijital araçları kullanmalarını gerektiren ödevler veririm.

□ Bunu yapmak derslerimde/sınıfımda mümkün değil.
□ Sadece nadir durumlarda öğrencilerimin çevrimiçi iletişim kurmaları veya işbirliği yapmaları gerekir.
□ Öğrencilerim, aralarında dijital yollarla iletişim kurar ve işbirliği yaparlar.
□ Öğrencilerim birbirleriyle ve okul dışındaki çevreyle iletişim kurmak ve işbirliği yapmak için dijital araçlar kullanırlar.
□ Düzenli olarak öğrencilerin dijital becerilerini geliştirmelerini sağlayan ödevler hazırlarım.

3-) Öğrencilerin dijital içerik oluşturmalarını gerektiren ödevler veririm. (Örneğin videolar, müzikler, fotoğraflar, dijital sunumlar, bloglar, wiki'ler ...vb.)
□ Bunu yapmak derslerimde/sınıfımda mümkün değil.
□ Bunu öğrencilerimle uygulamak zordur.
□ Bazen eğlenceli bir aktivite olarak uygularım.
□ Öğrencilerim çalışmalarının ayrılmaz bir parçası olarak dijital içerik oluşturur.
□ Öğrenmelerinin ayrılmaz bir parçası olduğu için ve öğrencilerimin becerilerini daha da geliştirmek için sistematik olarak zorluk seviyesini yükseltirim.

4-) Öğrencilere güvenli ve sorumlu bir şekilde çevrimiçi platformlarda nasıl davranacaklarını öğretiyorum.
□ Bunu yapmak derslerimde/sınıfımda mümkün değil.
□ Kişisel bilgileri çevrimiçi olarak aktarırken dikkatli olmaları gerektiğini onlara bildiririm.
□ Çevrimiçi ortamlarda güvenli ve sorumlu davranmak için temel kuralları açıklarım.
□ Çevrimiçi ortamlarda sorumlu davranış kurallarını tartışır ve bunlara uymayı kabul ederiz.
□ Öğrencilerimin, dijital ortamlarda genel olarak kabul görmüş kurallara uymalarını sistematik olarak geliştiririm

5-) Öğrencilerimi somut problemleri çözmek için dijital teknolojileri yaratıcı bir şekilde kullanmaya teşvik ederim. (Örneğin öğrenme sürecinde ortaya çıkan engellerin
veya zorlukların üstesinden gelmek için)
□ Bunu yapmak derslerimde/sınıfımda mümkün değil.
□ Nadiren öğrencilerin dijital problem çözme becerisini geliştirme fırsatım oluyor.
□ Arada bir, bir fırsat ortaya çıktığında öğrencilerimi teşvik ederim.
□ Sorunları çözmek için sık sık teknolojik yöntemler kullanırız.
□ Dijital problem çözme fırsatlarını sistematik olarak bir arada kullanırım.

APPENDIX C

SEMI-STRUCTURED INTERVIEW PROTOCOL

Time of interview:

Date:

Interviewer:

Interviewee: Yeşim Nur Akar Hozman

Position of interviewee: One-on-one

Turkish Version	English Version
Merhaba, ben Yeşim Akar Hozman. Öncelikle bu mülakata katılmayı kabul ettiğiniz için çok teşekkürler. Yüksek lisans tezim kapsamında sizlere, ortaokul matematik öğretmeni olarak dijital teknolojileri öğretim sürecinde nasıl kullandığınız ve pandemi sonrası dijital yeterliliğinizin gelişimi hakkında sorular soracağım. Sorularıma mümkün olduğunca örnekler vererek ve ayrıntılı bir şekilde cevap vermeniz araştırmam için çok önemli. Görüşmemiz yaklaşık yarım saat sürecek. Burada paylaşacağınız görüşleriniz araştırma ekibi hariç hiçkimse ile paylaşılmayacak, ve araştırma raporlarında da takma isim kullanılarak sunulacaktır. Görüşmemiz sırasında söylediklerinizi kaydetmek istiyorum, sizin için uygun mudur? Peki, çok teşekkürler. Öncelikle… 1- Kendinizi kısaca tanıtabilir misiniz? Eğitim seviyeniz, deneyim yılınız hakkında bilgi verebilir misiniz ? Hangi sınıfların matematik eğitiminden sorumlusunuz? 2- Pandemi başladığından beri dijital yeterliliğiniz nasıl gelişti ve dijital yeterliliğinizi geliştirmek için herhangi bir fırsatınız oldu mu? 3- Pandemi başladığından beri hangi yeni dijital teknolojileri öğrendiniz ve bunları etkili bir şekilde kullanma konusunda ne kadar kendinize güveniyorsunuz? Şimdi dijital yeterliliğinizi daha iyi anlamak için daha detaylı birkaç soru soracağım:	Hello, I'm Yeşim Nur Akar Hozman. First of all, thank you very much for agreeing to participate in this interview. As part of my master's thesis, I will ask you questions about how you use digital technologies in the instructional process as a middle school mathematics teacher and about developing your digital competency after the COVID-19 pandemic. It is important for my research that you provide detailed answers with examples whenever possible. Our interview is expected to take about half an hour. Your opinions shared during this interview will be kept confidential, known only to the research team, and presented using pseudonyms in research reports. I would like to record our conversation if it's convenient for you. Great, thank you. First of all, ... 1. Could you briefly introduce yourself? Could you provide information about your educational level, years of experience, and the grade levels for which you are responsible for teaching mathematics? 2. How has your digital competency developed since the beginning of the pandemic, and have you had any opportunities to enhance your digital competency? 3. What new digital technologies have you learned since the pandemic began, and how confident are you in using them effectively? Now, I will ask a few more detailed questions to better understand your digital competency: 4. How would you evaluate your digital competency as a middle school mathematics teacher? a. How do you use digital technologies to work with your colleagues and students? (Area 1)

4- Ortaokul matematik öğretmeni olarak dijital yeterliliğinizi nasıl değerlendirirsiniz? a. Meslektaşlarınız ve öğrencilerinizle çalışmak için dijital teknolojileri nasıl kullanıyorsunuz? (Alan 1) b. Çevrimiçi eğitim fırsatlarına katılıyor musunuz? (Alan 1) c. Öğretimde farklı dijital kaynakları nasıl kullanıyorsunuz? (mevcut olanları değiştiriyor musunuz?) (Alan 2) d. Dijital teknolojileri öğretimde nasıl, ne zaman ve neden kullanacağınıza nasıl karar veriyorsunuz? (Alan 3) e. Öğrencilerin işbirliği içinde çalışmasına olanak sağlamak için dijital teknolojileri nasıl kullanıyorsunuz? (Alan 3) f. Ölçme ve değerlendirme için dijital teknolojileri nasıl kullanıyorsunuz? (örneğin, öğrenci ilerlemesini izlemek, ek desteğe ihtiyaç duyan öğrencileri belirlemek ve etkili geri bildirim sağlamak) (Alan 4) g. Öğrencilerin aktif ders katılımını desteklemek için dijital teknolojileri nasıl kullanıyorsunuz? (Alan 5) h. Dijital teknolojileri öğrencilere kişiselleştirilmiş öğrenme fırsatları sunmak için nasıl kullanıyorsunuz? (Alan 5) i. Öğrencilerin dijital yeterliliklerini geliştirmesine nasıl olanak sağlıyorsunuz? (Alan 6) 5- Öğrenciler için ilgi çekici ve etkili öğrenme deneyimlerini dijital teknolojileri kullanarak nasıl tasarlıyor ve uyguluyorsunuz? • Özellikle, aktif katılım, etkili geri bildirim, sınıf tartışmaları vb. içeren öğrenme etkinliklerini (örneğin, projeler,sınıf tartışmaları, aktif katılım ve etkili geri bildirim içeren eş zamanlı oturumlarda (canlı sınıflar) akranlarla çalışma gibi) paylaşabilir misiniz? Neden faydalı olduklarına dair açıklamalar yapabilir misiniz? • Böyle aktiviteler tasarlayabilmenizde pandemi sırasındaki deneyimlerinizin bir katkısı oldu mu?	b. Do you participate in online learning opportunities? (Area 1) c. How do you utilize different digital resources in your instruction? (Do you modify existing resources?) (Area 2) d. How do you decide when and why to use digital technologies in instruction? (Area 3) e. How do you use digital technologies to enable collaborative work among students? (Area 3) f. How do you utilize digital technologies for assessment and evaluation purposes? (e.g., tracking student progress, identifying students in need of additional support, providing effective feedback) (Area 4) g. How do you use digital technologies to support active classroom engagement? (Area 5) h. How do you use digital technologies to provide personalized learning opportunities for students? (Area 5) i. How do you facilitate the development of students' digital competencies? (Area 6) 5. How do you design and implement engaging and effective learning experiences for students using digital technologies? • In particular, can you share examples of learning activities that involve active participation, effective feedback, class discussions, etc. (e.g., projects, working with peers in synchronous sessions involving active participation, effective feedback, and class discussions)? Can you explain why these activities are beneficial? • Did your experiences during the pandemic contribute to your ability to design such activities? 6. Can you explain your approaches to assessing student learning in a digital environment? • Do you use any specific digital assessment tools or resources? (Can you provide a particular example?) • How did using digital technologies during the pandemic affect the quality and frequency of assessments you could provide students post-pandemic? 7. What challenges have you encountered in using digital technologies to support post-pandemic teaching and learning, and how have you overcome these challenges? 8. In your opinion, what training or professional development do you think you need to enhance your digital competency?

6- Öğrencilerin öğrenmesini dijital bir ortamda değerlendirmeye yönelik yaklaşımlarınızı açıklayabilir misiniz? • Kullandığınız herhangi bir dijital değerlendirme aracı veya kaynağı var mı? (Belirli bir örnek verebilir misiniz?) • Pandemi sırasında dijital teknolojileri kullanmak, pandemi sonrasında öğrencilere verebileceğiniz değerlendirmelerin kalitesini ve sıklığını nasıl etkiledi? 7- Pandemi sonrası öğretim ve öğrenmeyi desteklemek için dijital teknolojiler kullanırken karşılaştığınız zorluklar nelerdir ve bu zorlukları nasıl aştınız? 8- Dijital yeterliliğinizi geliştirmek için nasıl eğitimlere ihtiyacınız olduğunu düşünüyorsunuz?	

APPENDIX D

ETHICS COMMITTEE APPROVAL

T.C.
BOĞAZİÇİ ÜNİVERSİTESİ
SOSYAL VE BEŞERİ BİLİMLER YÜKSEK LİSANS VE DOKTORA TEZLERİ ETİK İNCELEME KOMİSYONU
TOPLANTI KARAR TUTANAĞI

Toplantı Sayısı	:	41
Toplantı Tarihi	:	01.03.2023
Toplantı Saati	:	14:00
Toplantı Yeri	:	Zoom Sanal Toplantı
Bulunanlar	:	Prof. Dr. Feyza Çorapçı, Doç. Dr. Arhan S. Ertan, Doç. Dr. Senem Yıldız, Dr. Öğr. Üyesi Yasemin Sohtorik İlkmen, Dr. Öğr. Üyesi Ayşegül Metindoğan
Bulunmayanlar	:	

Yeşim Nur Akar Hozman
Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü

Sayın Araştırmacı,

"Exploring Middle School Mathematics Teachers' Digital Competencies after the Pandemic: A Mixed-Method Study" başlıklı projeniz ile ilgili olarak yaptığınız SBB-EAK 2023/25 sayılı başvuru komisyonumuz tarafından 1 Mart 2023 tarihli toplantıda incelenmiş ve uygun bulunmuştur.

Bu karar üyelerin toplantıya çevrimiçi olarak katılımı ve oy birliği ile alınmıştır. Onay mektubu üye ve raportör olarak Yasemin Sohtorik İlkmen tarafından toplantıya katılan bütün üyeler adına e-imzalanmıştır.

Saygılarımızla, bilgilerinizi rica ederiz.

Dr. Öğr. Üyesi Yasemin
SOHTORİK İLKMEN
Öğretim Üyesi

e-imzalıdır
Dr. Öğr. ÜyesiYasemin Sohtorik
İlkmen
Öğretim Üyesi
Raportör

APPENDIX E

PARTICIPANT INFORMATION AND CONSENT FORM FOR THE DIGITAL COMPETENCY SCALE FOR EDUCATORS

Institution supporting the research: Boğaziçi University

Name of the research: Exploring Middle School Mathematics Teachers' Digital Competencies After The Pandemic

Project Manager: Assist. Prof. Mutlu Şen-Akbulut

E-mail:

Phone:

Name of researcher: Yeşim Nur Akar Hozman

E-mail:

Dear Teacher,

Boğaziçi University Department of Computer Education and Educational Technology faculty member Dr. Mutlu Şen-Akbulut conducts a scientific research project under the name of "Exploring Middle School Mathematics Teachers' Digital Competencies After the Pandemic". The aim of this study is to examine the middle school mathematics teachers' digital competency levels after the pandemic. We invite you, middle school math teachers, to help us with this research. We would like to inform you about the research before your decision. If you would like to participate in the research after reading this information, please sign this form and send it to us. If you agree to participate in this research, we will first ask you to fill out a form containing information such as your age and gender.

In the second step, we will ask you to complete the online digital competency self-assessment scale. The form is expected to take 25-30 minutes to complete. Some of the participants will be invited to the second stage, considering the different levels of experience. This research is conducted for a scientific purpose and is based on the confidentiality of participant information.

The names of the participants and the demographic information they share will be kept confidential and no personally identifiable information will be shared in the publications. Participation in this research is entirely optional. If you participate, you have the right to withdraw your consent at any stage of the work without giving any reason. If you withdraw from the survey, the collected data will be securely deleted from the researcher's storage. If you would like to receive additional

information about the research project, please contact Boğaziçi University Computer Education and Educational Technology Department faculty member Dr. Mutlu Sen-Akbulut (phone: address: Boğaziçi University, Faculty of Education, 34342 Bebek, Istanbul). You can consult Boğaziçi University Social and Humanities Master's and Doctoral Theses Ethics Review Commission (SOBETIK) regarding your rights in the research. This study has no harm or risk to participants. At the end of the study, there are no gifts or payments for the participants.

I, (name of participant) ..... read the above text and fully understood the scope and purpose of the research I was asked to participate in, and the responsibilities that have been placed on me voluntarily. I had the opportunity to ask questions about the research. I understood that I could leave this research whenever I wanted and without having to give any reason, and that if I did, I would not experience any negativity. In these circumstances, I agree to participate in the research of my own volition, without any pressure or coercion.

- □ I got a copy of the form.
- □ I do not want to take a copy of the form (in this case the researcher will keep this copy).

Name of the participant……

Signature: .....

E-mail: .....

Date (day/month/year)/...../.....

Name of researcher: Yeşim Nur Akar Hozman

Signature: .....

Date (day/month/year)/...../.....

APPENDIX F

PARTICIPANT INFORMATION AND CONSENT FORM FOR SEMI-STRUCTURED INTERVIEWS

Institution supporting the research: Boğaziçi University
Name of the Research: Exploring Middle School Mathematics Teachers' Digital Competencies After the Pandemic
Project Manager: Assist. Prof. Mutlu Şen-Akbulut
E-mail:
Phone:
Name of researcher: Yeşim Nur Akar Hozman
E-mail:

Dear Teacher,

Boğaziçi University Computer Education and Educational Technology Department faculty member Dr. Mutlu Şen-Akbulut conducts a scientific research project under the name of "Exploring Middle School Mathematics Teachers' Digital Competencies After the Pandemic". The aim of this study is to examine middle school mathematics teachers' digital competency levels after the pandemic. We invite you to the second phase of the study as we have determined that you can provide more detailed information for us to work based on the survey results. The second phase includes online interviews. Online interviews are scheduled to take 30-45 minutes. The researcher will examine online interviews for a better data analysis. These conversations will be conducted via Zoom or Google Meets, with your permission, your voice will be recorded by the researcher for data analysis. This research is carried out for a scientific purpose and confidentiality of participant information is maintained. The names of the participants and the demographic information they share will be kept confidential and no personally identifiable information will be shared in the publications.

Participation in this research is voluntary. If you participate, you have the right to withdraw your consent at any stage of the research without giving any reason. If you withdraw from the survey, the collected data will be securely deleted from the researcher's storage. If you would like to receive additional information about the research project, please contact Boğaziçi University Computer Education and Educational Technology Department faculty member Dr. Mutlu Sen-Akbulut (phone: address: Boğaziçi University, Faculty of Education, 34342 Bebek, Istanbul). You can consult Boğaziçi University Social and Humanities Master's and Doctoral Theses Ethics Review Commission (SOBETIK) regarding your rights in the research. This study has no harm or risk to participants. At the end of the study, there are no gifts or payments for the participants.

I, (name of participant) ..... read the above text and fully understood the scope and purpose of the research I was asked to participate in, and the responsibilities that have been placed on me voluntarily. I had the opportunity to ask questions about the research. I understood that I could leave this work whenever I wanted and without having to give any reason, and that if I did, I would not experience any negativity.

In these circumstances, I agree to participate in the research of my own volition, without any pressure or coercion.

- □ I got a copy of the form.
- □ I do not want to take a copy of the form (in this case the researcher will keep this copy).

Name of the participant: .....
Signature: .....
E-mail: .....
Date (day/month/year)/...../.....

- □ I agree to be recorded.

Name of researcher: Yeşim Nur Akar Hozman
Signature: .....
Date (day/month/year)/...../.....

APPENDIX G

CODEBOOK

Theme	Description	Examples from Transcriptions	Example Codes
Pandemic as a catalyst for teacher's professional development	The COVID-19 pandemic has accelerated teachers' professional development. Many teachers have had to adjust to changing instructional environments and technologies, necessitating the development of new skills and practices. Teachers collaborate and examine for new materials to improve their teaching practices and students' engagement. Some teachers have even overcome their execration to technology and grown more experienced at utilizing digital tools and platforms. The pandemic has forced teachers to reconsider their teaching practices more innovative.	Teacher 3 (B1): *"I can easily display resources, receive instant feedback., I use them at future which greatly simplified my life."* Teacher 4 (B1): *"I used to be very afraid of using computers. I got very anxious when doing computer assignments. Even copying and pasting from Word, the absence of a single letter would make me very anxious. But, after the pandemic, I had no choice but to learn it. So, I did."* Teacher 9 (B2): *"During the pandemic, we realized that when we involve students, they participate more, learn more, and actually have more fun."* Teacher 10 (C1): "*The pandemic made me think about what more I can do online, how can I complete my tasks easier or more effectively."*	- Exploring online teaching opportunities - Seeking more effective teaching methods -Technological awareness and utilization -Overcoming Technological Fear and Anxiety
Easy interaction with learners with help of technology	Participants demonstrated how digital technologies can enhance and transform the teaching and learning experience, enabling more efficient and effective interactions between teachers and students.	Teacher 3 (B1): *"Before the pandemic, homework papers were printed and hung on the board and announced in class. After the pandemic, thanks to using Google Classroom, those who forget their homework can now send a message on the google classroom and send assignment as a PDF, which I think reduces the excuses of students. The process of distributing papers, reading, preparing, and sharing took a very long time. But now, I can prepare a test on a single online platform and instantly share it with everyone and receive feedback very quickly, I can quickly see the correct and incorrect answers and success reports, which saves my time."*	-Transition from physical to digital homework submissions -Reduction of student excuses for forgotten homework -Ease in distributing and sharing materials -Remote monitoring of student progress and participation

		Teacher 9 (B2): *"I think that giving the assignments and conducting our meetings in digital environments create a sense of awareness for students that we are still monitoring them even when we are at home."*	
The inadequacy of traditional methods to arouse learners' interests	Participants addressed using digital technology in the classroom to engage students and improve learning experiences. They discussed the advantages of delivering immediate feedback and the difficulties in balancing entertainment and teaching.	Teacher 1 (A1): *"In order for students to actively participate, there must be things that will interest them. These things generally include technological tools, games, and so on, since we are in the age of technology."* Teacher 4 (B1): *"If I, as an educator, do not embrace technology and still rely on traditional methods while they are immersed in technology, I cannot capture the students' interest and create a good learning environment."* Teacher 8 (B2): *"Because I don't believe there is such a thing as just teaching a subject matter with lecturing anymore. I need to find a way to capture the students' interest because their attention spans are very short. There are very short videos on platforms like Instagram and TikTok. They quickly move on, but our lessons are 40 minutes long and I need to do something related to the apps they are currently using to capture their interest."* Teacher 9 (B2): *"I had to research interactive applications that students can participate in. After this research, I think I have gained more competence in them. I no longer make students bored with paper and scissors because they have reacted to me in that way. I know this because they complained to me, "Are we going to do a project assignment by cutting cardboard like in kindergarten?" After that, I came up with the idea that since you are bored with it, and you all love to use computers and play games, I assigned them a project task to prepare something on Kahoot, or to create a quiz competition on Kahoot."*	-Necessity of appealing to student interests -Ineffectiveness of traditional methods in capturing interest -Acknowledgment of the need for a more engaging approach -Recognition of students' short attention spans

Lack of Trust in Online Assessments	In online assessments, participants had trust issues on cheating.	Teacher 4 (B1): "This situation makes me think about the reliability of the online assignments, as there is a student who gets very low grades in the in-class exams but gets all the answers correct in the online assignments. I wonder whether this student did the work on their own or if someone else helped them." Teacher 9 (B2): *"We give an online assignment to the student, but the process of who is actually doing the assignment - whether the student is doing it themselves or getting someone else to do it - is still a bit unclear and unresolved. We have not yet been able to figure it out."*	-Discrepancy between in-class exam performance and online assignment results. -Questioning whether students receive external assistance with online assignments
Technology as a Source of Excitement	Participants emphasized the importance of maintaining students' attention and motivation. To change the monotony of lectures, they suggested including exciting digital activities and games while still using traditional teaching approaches.	Teacher 6 (B2): *"Just let them have fun. My students often complain about having to work from textbooks all the time and sometimes they get bored. So, to break the monotony, I try to incorporate fun activities or games into our lessons. It's a way to keep them engaged and motivated."* Teacher 8 (B2): "*So, I try to do one of these every week. It's not possible for every class because the lecturing needs to continue in some way, but as I said, I try to do something at least once a week that will pique their interest*." Teacher 9 (B2): *"The student selects a card and solves a question that is found in a regular test book on the screen, and they solve it more entertainingly because they may have been bored while solving the same question in a book, but now they have fun because it earns them points for their team, such as 10 or 5 points."*	-Introducing fun activities and games to alleviate boredom -Utilizing technology to make learning more entertaining -Addressing student complaints about textbook-based learning
Technology as a second thought in teaching	Participants highlighted the use of digital technology after students have achieved learning objectives.	Teacher 1 (A1): *"Maybe not in teaching the topic itself, but as a different teaching technique to reinforce the topic or to fill the gaps of a student who lacks understanding."* Teacher 4 (B1): "*You have a book in front of you that needs to be finished, but when you use digital technologies in the class, it may take one or even two lessons. Since we have a plan to follow and books to complete, I need to*	-Adjusting the pace of lessons to accommodate digital activities -Implementing digital activities for a limited duration

		move through the lessons a bit faster that week and create free time for myself in order to be able to bring these kinds of activities to the students." Teacher 7 (B2): *"I can say that I use it when I say "Let the student improve a little. Let them become capable of doing something about it".* Teacher 9 (B2)*: "After a while, the game can distract students from the lesson. Using it for a limited time is more efficient. We use it for a short period of time and then switch to the lecturing."*	
Using digital technology for visualization	Participants mentioned they use digital technologies with visual aids to enhance students' understanding	Teacher 3 (B1): *"I immediately remember to use a quick reminder just to make a quick demonstration when it comes to my mind, and I think it helps the students to visualize better."* Teacher 5 (B1): "*Students cannot directly visualize or see the drawings I make on the board, so I show them videos that help them visualize and understand the material better. After watching the videos, we create the material ourselves as a class activity, which they also enjoy. These kinds of videos, which help to create three-dimensional visualizations, are what I prefer to show to my students."*	-Recognizing the positive impact of visual demonstrations on student understanding -Addressing limitations of board drawings in visualizing concepts -Utilizing videos to enhance visualization -Using visuals while teaching abstract concepts
Traditional Methods Prioritized Over Technology Integration for Academic Achievement	Academic achievement pressure impacts the use of digital technologies in the classroom.	Teacher 7 (B2): "*Since the exam system works in this way, if a student doesn't have the chance to study abroad, they have to get a high score on that exam to be able to attend a high-ranking school. Therefore, the content and quality of education become completely based on memorization."* Teacher1 (A1): "*Even if there are 2-3 missing topics, we will allocate a time period for web 2.0 tools. We are dealing with skill-based questions while trying to ensure the acquisition of knowledge."* Teacher 6 (B2): *"I don't think this is a specific situation for this institution. I would say it's the same everywhere, including private schools. The curriculum is like this, and you're*	-Emphasis on memorization due to exam-oriented education -Influence of curriculum on the intensity of course load -Pressure to perform well in standardized tests

		trying to educate students based on that. You're trying to cultivate something."	

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