Journal of Teacher Education and Lifelong Learning (TELL)

Volume: 5 Issue: 2 Year: 2023 Research Article ISSN: 2687-5713

How IT Course Improves Digital Competencies: An Experimental Study in Science Education

Mustafa Tevfik Hebebci[1] **Helen Crompton**[2]

[1] Necmettin Erbakan University, Konya, Turkiye
mhebebci@gmail.com

[2] Old Dominion University, Norfolk, VA, United States
crompton@odu.edu

Article Info

Article History
Received: 10/04/2023
Accepted: 27/09/2023
Published: 26/10/2023

Keywords:
digital competency,
higher education,
IT course

ABSTRACT

The rising significance of technology in society has caused a surge in the requirement of individuals possessing digital competencies. In the current era, digital skills are progressively vital for both personal and occupational growth. Governments have acknowledged the value of digital competencies and have incorporated them as part of fundamental proficiencies in numerous countries. Pre-service teachers have a paramount role in molding forthcoming generations, highlighting their necessity to possess robust digital competencies. This research centers on how an "Information Technologies in Science Education" course influences the digital competency progression in pre-service teachers. The study deployed a pre-test post-test experimental design with a single group to gauge the course's efficacy in enriching pre-service teachers' digital literacy abilities. The study results show that the IT course designed for the science field had an evidently positive effect on the digital competency of pre-service teachers. The mean scores in the post-test indicate a noteworthy level of digital competency in the study group. Moreover, the study notes the absence of experimental research in this domain, highlighting the necessity of further investigation into this area. The study's outcomes have implications for education of science teachers and the integration of digital technologies. The study recommends that programs for teacher education enable future teachers to develop their digital expertise via courses and training schemes. Additionally, it is crucial to incorporate digital technologies into scientific education to provide pupils with the essential abilities to flourish in a digital world.

Citation: Hebebci, M. T. & Crompton, H. (2023). How IT course improves digital competencies: an experimental study in science education. *Journal of Teacher Education and Lifelong Learning*, *5*(2), 466-476.

INTRODUCTION

In the modern world, societies that want to live in peace and affluence must adapt to the demands of the age in which they live. It has taken centuries. In fact, societies that meet the demands of the industrial revolution lead the world in science and technology, especially in economics, while societies that cannot adapt to these developments lag. Industry and urbanization gained momentum in the period that began with the use of water and steam instead of human labor in production. The industrial revolution improved production possibilities, and this led to changes and needs in consumption. The emerging new needs have led to new technologies, and new technologies have led to the further development of industry and industrial revolutions (Yener, 2022). Especially with Industry 4.0 (Schwab, 2016), artificial intelligence and robotic technologies have been widely used in production. This situation pushes societies toward innovation and development.

The concept of digital competency is one of the priority agenda items in developed countries (Ilomäki et al., 2016; Pettersson, 2018). With the fourth industrial revolution, digital competencies have been identified as a basic competency (Choi, 2018). These competencies are effectively involved in accessing, evaluating, producing, and sharing information using digital technologies. In today's world, individuals who are not at the desired level of digital competence have problems adapting to society. Moreover, societies with low levels of digital literacy lag with regard to economic competition and other social aspects (Bejakovic & Mrnjavac, 2020). Digital competencies are essential for success and social development in today's rapidly evolving world. Thus, the development of digital skills by individuals is vital for the future of societies.

Digital literacy and digital competence are often used synonymously (Godhe, 2019; Pettersson, 2018; Sánchez-Caballé et al., 2020). Digital literacy includes individuals' ability to acquire, evaluate, use, and share information in digital environments (Fraillon et al., 2019). Digital literacies can be categorized as digital literacies, media literacies, and information literacies (Coiro et al., 2014; Fraillon et al., 2019). On the other hand, digital competency is often associated with education and includes individuals' ability to learn, work, communicate, entertain, and perform other activities throughout life using digital technologies effectively. Digital competence is not only about IT skills but also about the ability to use, manage, and solve problems with technology effectively (Falloon, 2020; Tømte, 2013). To summarize, digital literacy encompasses the processes individuals use to access, understand, and evaluate information in digital environments, while digital competence involves the effective use and management of technology in a broader context (European Commission, 2013; Fraillon et al., 2019).

There are many projects, initiatives, and protocols to develop digital competencies. Some examples include the European Digital Skills Framework (DigComp, DigComp 2.0, and DigComp 2.1), the Digital Skills Framework for Educators (DigCompEdu) (European Commission, 2013; 2017), and the UNESCO Information and Communication Technologies Skills Framework for Educators (UNESCO, 2018). Additionally, specific projects such as Microsoft's "Microsoft Education" program, which provides access to technology in education; Intel's "Intel Teach" program, developed to support the use of technology in education; and Google's "Google for Education" program, where Google provides digital competency training for educators, are among other examples of digital competency initiatives.

The European Commission (2017) launched a "Digital Education Action Plan" to support using technology and developing digital competency in education. It contains measures to help EU Member States meet education challenges in the digital age. Figure 1 shows digital education in schools in Europe.

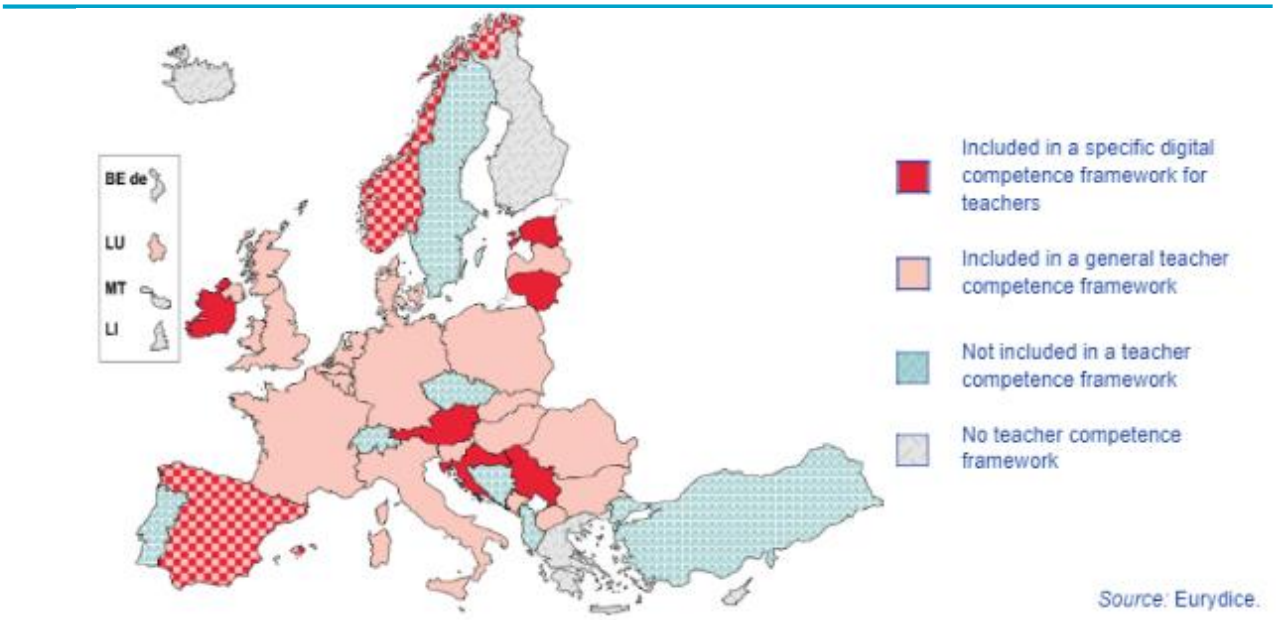

Figure 1. *Digital Education at Schools in Europe (Eurydice, 2019)*

Most European education systems recognize digital competencies as a basic requirement in their teacher qualification frameworks. Countries such as Spain, Croatia, and Lithuania have developed specific frameworks for teacher digital competencies. Estonia and Ireland have frameworks for only basic competencies. The teaching qualification frameworks in the Czech Republic, Portugal, Bosnia and Herzegovina, and Switzerland do not yet cover digital competencies (Eurydice, 2019).

The development of digital competency in the education system is a crucial issue for the future of society (Redecker et al., 2017). Educational programs and technology-enhanced learning methods develop these skills and competencies (Sang et al., 2010). IT education is believed to have an important place in developing these competencies. This is because the information technologies course allows students to learn using technological tools and devices. An IT course aims to increase students' skills and knowledge in the use of technology (Ertmer & Ottenbreit-Leftwich, 2010). IT courses also enable students to adapt to the evolving technological world's demands and use technology creatively (Ertmer & Ottenbreit-Leftwich, 2010; Sang et al., 2010). IT courses emphasize that digital competencies are not limited to technical skills but include digital citizenship, ethics, security, and privacy (Fraillon et al., 2014; Ribble et al., 2004; Ohler, 2011).

Examining the literature reveals that there are several research on digital competence. The studies are often aimed at determining the level of digital competence (Barri, 2020; Cote & Milliner, 2018; Kuzminska, 2018). Spiteri and Chang Rundgren (2017) conducted a study in Malta, and the results showed that teachers' digital competence was low. Contrary to this study, another study by Karakuş and Ocak (2019) concluded that pre-service teachers' digital competencies were high. In another study, it was found that digital competencies were at medium levels (Dias-Trindade & Moreira, 2020). On the other hand, some studies have examined the concept of digital competencies according to variables such as gender and seniority (Goswami & Dutta, 2015; Karakuş & Ocak, 2019; Keskin & Yazar, 2015; Keskin, 2016). However, experimental studies on digital competencies are limited (Çebi & Reisoğlu, 2019).

Teachers play a critical role in the development of digital competencies (Cavanaugh et al., 2011; Ertmer & Ottenbreit-Leftwich, 2010). Teachers need to model the use of technology for students and teach them according to the demands of the digital age. Research shows that teachers' strengths in technology are used to increase students' motivation, sense of self-efficacy, and digital competencies (Ertmer & Ottenbreit-Leftwich, 2010). Therefore, developing teachers' digital competence and using technology in teacher education programs will contribute to developing students' technological

competence (Pettersson, 2018). This study investigated the effect of information technologies in science education (ITSE), structured by science courses, on the digital competence of pre-service teachers. Since the course content was structured according to the science course, this study differs from many studies in the literature. The aim of this study is to determine the effect of IT courses taken by university students on their digital competencies. In this context, the difference between the digital competence scores of the students before and after the IT course was examined.

METHOD

Research Design

The study used one of the weak experimental designs, the one-group pre-test-post-test design. It tests the significant difference between the pre-test and post-test scores of one group (Fraenkel et al., 2012). This method involves applying an independent variable to a random group and administering pre-test and post-test measures before the experiment (Karasar, 2013).

Table 1. *Research model*

Group	Pre-Test	Procedures	Post-test
G	$T_{1.1}$	X	$T_{1.2}$
	Digital Competencies Scale	ITSE Procedures	Digital Competencies Scale

The study's dependent variable is the students' Digital Competencies Scale scores. The independent variable is the ITSE implemented for 14 weeks.

Study Group

The research study group comprised 24 pre-service teachers who took the ITSE course in the Department of Science Education at the Faculty of Education. Nineteen were women and five were men. Students' demographics are shown in Table 2.

Table 2. *Demographic information about the study group*

		f	%
I have already taken an information technologies course	Yes	19	79.2
	No	5	20.8
I know something about digital competency	Yes	16	66.7
	No	8	33.3
Graduated school type	Anatolian high school	19	79.2
	Science high school	2	8.3
	Vocational high school	3	12.5
I have a computer	Yes	16	66.7
	No	8	33.3
I have internet access	Yes	21	87.5
	No	3	12.5
Interest levels in technology	Very little	5	20.8
	Middle	11	45.8
	Too much	8	33.4

Table 2 shows that they had previous experience with an IT course (f=19; 79.2%). Most of them have heard of terms such as digital and technological competency (f=16; 66.7%). Anatolian high schools are an exception regarding the type of school graduates (f=19; 79.2%). All pre-service teachers have smartphones. 87.5% have Internet access, and 66.7% have a computer.

Data Collection Tools

Personal Information Form

Researchers developed the “Personal Information Form” to collect study group personal information. The form includes questions such as gender, school of graduation, etc.

Digital Competences Scale

The Digital Competences Scale was developed by López-Meneses et al. (2013). It is based on the Basic Digital Competencies of University Students 2.0 (COBADI®) scale and the European Commission’s Digital Competence (DigCom) framework (Adanır & Gülbahar, 2022). The original scale consisted of 4 factors and 31 items. Adanır and Gülbahar (2022) adapted the scale into Turkish. The adapted scale consisted of five factors and 29 items. Factor 1 was named "digital content development", factor 2 "information and data literacy", factor 3 "communication", factor 4 "virtual tools and social communication at the university", and factor 5 "problem solving". Cronbach`s alpha was calculated to be .907).

Data Collection and Analysis

Research data were collected through electronic forms in the fall semester of 2022-2023. Descriptive analysis and paired sample t-tests were used. A descriptive statistical analysis was conducted to obtain a picture of the data. The paired sample t-test was used to determine the effect of the experimental procedure. All statistical analyses used a 0.05 significance level.

Procedures

The research was conducted in the fall semester of 2022–2023 in the ITSE course. The researcher conducted this course. The course "Information Technologies in Science Education" is 3 hours per week. The duration of the experimental procedures was 14 weeks. The pre-test was conducted in the first week, and the post-test in the last week. The experimental implementation was conducted in a computer lab with 30 desktop computers connected to the Internet and a projector. All research activities occurred in this lab. In the first week, the students received information about the research to conduct, the content and scope of the study, and the issues to consider during the study. Then, the pre-tests were done online.

The course is structured to maximize the benefits for pre-service teachers. The course includes Microsoft Word, Microsoft PowerPoint, and Microsoft Excel programs that pre-service teachers frequently use in their education and professional lives. The basic features of these programs have been explained to pre-service teachers. All examples and applications were designed to cover science education. The last 30 minutes of the lessons were dedicated to Web 2.0 applications that would be useful in professional life. The Web 2.0 applications introduced are: 1. Kahoot, 2. Canva, 3. Tinkercad, 4. Mindmeister, 5. Onedrive, 6. Padlet, 7. Wordart, Classdojo, 8., 9. Wix, 10. Aurasma, 11. Scratch, and 12. Google Forms. All pre-service teachers had the opportunity to create sample applications.

In the 14th week, the experimental procedures were completed by conducting post-tests.

RESULTS

In this study, the data were tested for normality before analysis. The analysis was performed for the whole scale and its sub-factors. Table 3 shows the results of the descriptive statistics for the pre-test and post-test scores of the experimental group.

Table 3. *Descriptive analysis results of the students' scores on the Digital Competences Scale*

	Factors	N	Min	Max	X̄	Sd	S-W
Pre-test	Digital Content Development	24	10	23	15.04	3.90	0.06
	Information and Data Literacy	24	19	36	28	5.33	0.26
	Contact	24	4	11	7	2.10	0.06
	The University's Virtual Tools and Social Communication	24	6	15	10.33	2.35	0.41
	Problem Solving	24	4	12	7.92	1.86	0.17
	Total	24	52	90	68.04	11.04	0.24
Post-test	Digital Content Development	24	11	26	19	3.96	0.32
	Information and Data Literacy	24	10	40	31.67	5.16	0.56
	Contact	24	6	11	7.46	1.69	0.05
	The University's Virtual Tools and Social Communication	24	4	15	10.54	2.87	0.11
	Problem Solving	24	5	11	7.92	1.61	0.29
	Total	24	56	94	77.58	9.92	0.46

The pre-test and post-test scores are both within acceptable normalcy ranges (Table 3). As a result, a paired sample t-test was performed to evaluate whether there was a significant link between the experimental group's pre-test and post-test results. These findings are shown in Table 4.

Tablo 4. *t-test results of pre-test and post-test mean scores on the digital competences scale*

Factors		N	X̄	Sd	df	t	p
Digital Content Development	**Pre-test**	24	15.0	3.9	23	-3.872	<0.001
	Post-test	24	19.0	3.9			
Information and Data Literacy	**Pre-test**	24	28.0	5.3	23	-3.177	0.00
	Post-test	24	31.6	5.1			
Contact	**Pre-test**	24	7.0	2.1	23	-2.676	0.01
	Post-test	24	8.4	1.6			
The University's Virtual Tools and Social Communication	**Pre-test**	24	10.3	2.3	23	-0.426	0.67
	Post-test	24	10.5	2.8			
Problem Solving	**Pre-test**	24	7.9	1.8	23	0.000	1.00
	Post-test	24	7.9	1.6			
Total	**Pre-test**	24	68.0	11	23	-5.000	<0.001
	Post-test	24	77.5	9.9			

($p<0.05$)

Table 3 shows that there is a significant difference in favour of the post-test between the averages of the experimental group's pre-test and post-test total scores ($t(23)=-5.000$; $p<0.05$). The mean score of the students before the experimental procedures were calculated as $\bar{X} = 68$; after the experimental procedures, it was calculated as $\bar{X} = 77.5$. This result can be considered that the course positively impacted students' digital competency.

Considering the factors, t-test results for the digital content development ($t(23)=-3.872$; $p<0.05$),

information and data literacy ($t(23)=-3.177$; $p<0.05$), and contact ($t(23)=-2.676$) show that there is a significant difference between the pre-test and post-test mean scores in favor of the post-test. However, no significant difference was found between the pre-test and post-test mean scores in the problem solving ($t(23)=-0.000$; $p>0.05$) and virtual tools, and social communication of the university ($t(23)=-0.426$; $p<0.05$).

DISCUSSION

Digital competencies are recognized as essential competencies for teachers. It has been observed that teachers' classroom practices and professional approaches change depending on their level of digital competence (Moltudal et al., 2019). Teachers' digital competence levels significantly influence students' digital competence development (Krumsvik, 2008; Ovcharuk, 2020). Although digital competencies are still a new concept, they are considered a basic skill for future generations (Toker et al., 2021). In fact, many developed countries have defined digital competencies as one of the basic competencies for the future (Sefton-Green et al., 2009).

As can be seen, the findings of research on digital competencies are highly disparate. In some studies, the level of digital competence of individuals is high (Benali et al., 2018; Sciumbata, 2020). In some, it is medium (Çebi & Reisoğlu, 2020; Dias-Trindade & Moreira, 2020), and in some, it is low (Komsu, 2017; Spiteri & Chang Rundgren, 2017). This may be due to the differences in methodology, sample groups, and geographical locations of the studies. Furthermore, studies are generally seen as survey models (Ghomi & Redecker, 2019; Sciumbata, 2020).

Teachers have a critical role in transferring digital competencies to future generations. For this reason, improving teachers' digital competency skills is essential for the well-being of societies. This study implemented a 14-week training program to increase pre-service teachers' digital competencies. The training program significantly improved the students' average digital competency scores. Studies with similar results can be found in the literature. A study by Çebi and Reisoğlu (2019) investigated the effect of a digital competence training program. As part of the study, pre-service teachers' pre- and post-training situations in computer education, instructional technology, and other fields were also compared. The study found generally positive results.

Studies on digital competencies have been conducted with students (Calatayud et al., 2018; Escario et al., 2017) and teachers (Ghomi & Redecker, 2019; Kožuh et al., 2021). A study of students at the University of Zaragoza found a 1-point increase between the pre-test and post-test (Escario et al., 2017). Kožuh et al. (2021) found similar results in a study with 500 Serbian primary and secondary teachers. In his research, Ergül (2019) applied a digital competence learning module integrated into the field of statistics. The study results showed that the module positively affected the students.

The factors were analyzed separately, following the research objectives. While digital content development, information, and data literacy increased significantly, virtual tools and university social communication and problem-solving factors did not significantly increase. Ramírez-Montoya et al. (2017) state that practices related to increasing digital competence improve information and data literacy. Çebi and Reisoğlu (2019) state that competency training is effective in creating digital content. Šerbec et al.'s (2016) study in Macedonia found similar results in problem-solving factors. In another study, the mean scores were quite low before experimental problem solving, knowledge, and content-creation procedures. After the training, all the mean values were higher than those at the beginning of the course (Calatayud et al., 2018). In contrast to this study, another study found a significant improvement in problem solving (Çebi & Reisoğlu, 2019).

A review of the literature reveals that there is a limited amount of experimental research on the digital competencies of teachers or pre-service teachers. The researchers state that there is a need for experimental studies on developing the digital competencies of pre-service teachers (Ramírez-Montoya et al., 2017; Røkenes & Krumsvik, 2016). These studies can be a guide for teachers in the development of their digital

competencies appropriately and effectively. Furthermore, increasing the number of experimental studies on teachers' digital competencies is also essential for the education system to keep pace with technological developments.

CONCLUSION

The purpose of the study was to investigate the impact of an information technology course structured for science education on digital competencies. The study used a one-group, pretest-posttest experimental design, and the sample consisted of 24 pre-service teachers who had taken the course.

The results of the study indicated that the IT course had a significant impact on the development of digital competencies among pre-service teachers. When considering the different sub-factors of digital competencies, significance was found in favor of the post-test in all factors except problem solving. This indicates that the course was effective in the development of digital competencies among pre-service teachers in areas such as communication, collaboration, and digital content creation.

The mean scores of the post-test indicated that the pre-service teachers had a high level of digital competencies, indicating that the course had a strong positive impact. It is noteworthy that there are few experimental studies in this area, indicating the need for further research on the effectiveness of similar courses in improving pre-service teachers' digital competencies.

Limitations and Future Research

This study has been done with 24 participants. Other studies can be done with larger groups, including experimental and control groups, and comparing the results. More comprehensive evaluations can be conducted by including qualitative research. Digital literacy activities for pre-service teachers can be developed. The current study can be replicated in a variety of settings, and the results can be subject to comparison. A variety of experimental studies can be carried out to increase the digital literacy of pre-service teachers.

REFERENCES

Adanır, G. A., & Güven, Y. G. Üniversite öğrencileri dijital yeterlikler ölçeğinin türkçeye uyarlama çalışması [Turkish adaptation of university students' basic digital competences scale]. *Yükseköğretim ve Bilim Dergisi*, *12*(1), 122-132.

Barri, M. A. (2020). Evaluation of digital competency of public university students for web-facilitated learning: The case of Saudi Arabia. *International Education Studies*, *13*(12), 58-69. https://doi.org10.5539/ies.v13n12p58

Bejakovic, P. & Mrnjavac, Ž. (2020). The importance of digital literacy on the labour market. *Employee Relations: The International Journal*, *42*(4), 921–932.

Benali, M., Kaddouri, M. and Azzimani, T. (2018). Digital competence of Moroccan teachers of English. *International Journal of Education and Development using ICT, 14*(2).

Calatayud, V. G., García, M. R., & Espinosa, M. P. P. (2018). Formación en competencias digitales para estudiantes universitarios basada en el modelo DigComp. *Edutec. Revista Electrónica de Tecnología Educativa*, (65), 1-15.

Cavanaugh, S., Gillan, K. J., Kromrey, J., Hess, M., & Blomeyer, R. (2011). *The effects of distance education on K-12 student outcomes: A meta-analysis*. Learning Point Associates.

Çebi, A., & Reisoğlu, I. (2019). A training activity for improving the digital competences of pre-service teachers: The views of pre-service teacher in CEIT and other disciplines. *Educational Technology Theory and Practice*, *9*(2), 539-565.

Çebi, A., & Reisoğlu, İ. (2020). Digital competence: A Study from the perspective of pre-service teachers in Turkey. *Journal of New Approaches in Educational Research (NAER Journal)*, *9*(2), 294-308.

Choi, S. Y. (2018). A study on the digital competency for the fourth industrial revolution. *The Journal of Korean Association of Computer Education, 21*(5), 25-35. https://doi.org/10.32431/kace.2018.21.5.003

Coiro, J., Knobel, M., Lankshear, C., & Leu, D. J. (Eds.). (2014). *Handbook of research on new literacies*. Routledge.

Dias-Trindade, S., & Moreira, J. A. (2020). Assessment of high school teachers on their digital competences. MAGIS, *Revista Internacional de Investigación en Educación*, 13, 1-21.

Ergül, K. (2019). *Developing 9th grade students' digital competencies as a part of statistics lesson*. [Master thesis]. Yeditepe University.

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education, 42*(3), 255-284.

Escario, I., Lapeña, M. J., Hermoso, R., Zapata, M. A., Bordonaba, L., Soriano, L., & Escar, E. (2017). Training students to become digitally competent: an experience on the DigComp 2.0 Framework. *EDULEARN proceedings*, Barcelona, Spain, 5598-5608. https://doi.org/10.21125/edulearn.2017.2274

European Commission (2013). DigComp: A *framework for developing and understanding digital competence in Europe*. European Commission, Joint Research Centre, Institute for Prospective Technological Studies. https://ec.europa.eu/jrc/en/digcomp/digital-competence-framework

European Commission. (2017). *The European digital competence framework for educators: DigCompEdu*. Joint Research Centre, Institute for Prospective Technological Studies. https://ec.europa.eu/jrc/en/digcompedu

Eurydice [European Education and Culture Executive Agency]. (2019). *Digital education at school in Europe.* Publications Office of the European Union. https://data.europa.eu/doi/10.2797/763

Falloon, G. (2020). From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Educational Technology Research and Development*, *68*, 2449-2472.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education*. McGraw-hill.

Fraillon, J., Ainley, J., Schulz, W., Duckworth, D., & Friedman, T. (2019). *IEA international computer and information literacy study 2018 assessment framework*. Springer Nature.

Fraillon, J., Ainley, J., Schulz, W., Friedman, T., & Gebhardt, E. (2014). Preparing for life in a digital age: The IEA International computer and information literacy study international report. Springer.

Ghomi, M., & Redecker, C. (2019). Digital competence of educators (DigCompEdu): development and evaluation of a self-assessment instrument for teachers' digital competence. *Proceedings of the 11th International Conference on Computer Supported Education (CSEDU 2019)*, 541-548. https://doi.org/10.5220/0007679005410548

Godhe, A. L. (2019). Digital literacies or digital competence: Conceptualizations in Nordic curricula. *Media and Communication, 7*(2), 25-35. https://doi.org/10.17645/mac.v7i2.1888

Goswami, A., & Dutta, S. (2015). Gender differences in technology usage—A literature review. *Open Journal of Business and Management*, *4*(1), 51-59.

Ilomäki, L., Paavola, S., Lakkala, M., & Kantosalo, A. (2016). Digital competence – an emergent boundary concept for policy and educational research. *European Journal of Education, 51*(4), 655-679. https://doi.org/10.1007/s10639-014-9346-4

Karakuş, G. ve Ocak, G. (2019). Öğretmen adaylarının dijital okuryazarlık öz-yeterlilik becerilerinin farklı değişkenler açısından incelenmesi [An investigation of digital literacy self-efficacy skills of pre-service teachers in terms of different variables]. *Afyon Kocatepe Üniversitesi Sosyal Bilimler Dergisi*, 21(1), 129-147.

Karasar, N. (2013). *Bilimsel araştırma yöntemi [Scientific research method]*. Nobel.

Keskin, İ. (2016). Öğretmen adaylarının yaşam boyu öğrenme bağlamında dijital yeterliklerinin incelenmesi [Examination of prospective teachers' digital competence in the context of lifelong learning]. *Uluslararası Eğitim Programları ve Öğretim Çalışmaları Dergisi*, *6*(12), 133-149.

Keskin, İ., & Yazar, T. (2015). Öğretmenlerin yirmi birinci yüzyıl becerileri ışığında ve yaşam boyu öğrenme bağlamında dijital yeterliliklerinin incelenmesi [Examining digital competence of teachers within the context of lifelong learning based on of the twenty-first century skills]. *International Journal of Human Sciences, 12*(2), 1691-1711.

Komsu, U. (2017). The lifelong learning competencies of trainers who work for public education centres: Case of Mersin. *Journal of Theoretical Educational Science, 10*(1), 117-145.

Kožuh, A., Maksimović, J., & Osmanović Zajić, J. (2021). Fourth Industrial Revolution and digital competences of teachers. *World Journal on Educational Technology: Current Issues, 13*(2), 160-177.

Krumsvik, R. (2008). Situated learning and teachers' digital competence. *Education & Information Technologies, 13*(4), 279–290.

Kuzminska O., Mazorchuk M., Morze N., Pavlenko V., & Prokhorov A. (2019). Study of Digital Competence of the Students and Teachers in Ukraine. In: Ermolayev V., Suárez-Figueroa M., Yakovyna V., Mayr H., Nikitchenko M., Spivakovsky A. (eds) Information and Communication Technologies in Education, Research, and Industrial Applications. *ICTERI 2018. Communications in Computer and Information Science*, vol 1007. Springer, Cham.

López-Meneses, E., Sirignano, F. M., Vázquez-Cano, E., & RamírezHurtado, J. M. (2020). University students' digital competence in three areas of the DigCom 2.1 model: A comparative study at three European universities. *Australasian Journal of Educational Technology, 36*(3), 69-88. https://doi.org/10.14742/ajet.5583

Moltudal, S., Krumsvik, R., Jones, L., Eikeland, O. J., & Johnson, B. (2019). The relationship between teachers' perceived classroom management abilities and their professional digital competence: Experiences from Upper secondary classrooms a qualitative driven mixed method study. *Designs for Learning, 11*(1), 80-98.

Ohler, J. (2011). *Digital storytelling in the classroom: New media pathways to literacy, learning, and creativity*. Corwin Press.

Ovcharuk, O. V. (2020). Current approaches to the development of digital competence of human and digital citizenship in European countries. *Information Technologies and Learning Tools, 76*(2), 1-13.

Pettersson, F. (2018). On the issues of digital competence in educational contexts–a review of literature. *Education and Information Technologies*, *23*(3), 1005-1021.

Ramírez-Montoya, M. S., Mena, J., & Rodríguez-Arroyo, J. A. (2017). In-service teachers' self-perceptions of digital competence and OER use as determined by a xMOOC training course. *Computers in Human Behavior, 77*, 356-364. https://doi.org/10.1016/j.chb.2017.09.010

Redecker, C., Leis, M., Leendertse, M., Punie, Y., Gijsbers, G., Kirschner, P. A., & Stoyanov, S. (2017). *The future of learning: Insights and prospects*. Publications Office of the European Union.

Ribble, M. S., Bailey, G. D., & Ross, T. W. (2004). Digital citizenship: Addressing appropriate technology behavior. *Learning & Leading with technology*, *32*(1), 6-10.

Røkenes, F. M., & Krumsvik, R. J. (2016). Prepared to teach ESL with ICT? A study of digital competence in Norwegian teacher education. *Computers & Education, 97*, 1-20. https://doi.org/10.1016/j.compedu.2016.02.014

Sánchez-Caballé, A., Gisbert Cervera, M., & Esteve-Mon, F. M. (2020). The digital competence of university students: a systematic literature review. *Revista de Psicologia, Ciències de l'Eduació i de l'Espor*, *38*(1), 63-74

Sang, G., Valcke, M., van Braak, J., & Tondeur J. (2010). Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. *Computers & Education, 54*(1), 103–112.

Schwab, K. (2016). *The Fourth Industrial Revolution: What it means, how to respond*. World Economic Forum. https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

Sciumbata, F. (2020). Students of humanities and digital skills: A survey on Italian university students. *Umanistica Digitale, 4*(8), 7-27. https://doi.org/10.6092/issn.2532-8816/9877

Sefton-Green, J., Nixon, H. & Erstad, O. (2009). Reviewing approaches and perspectives on "Digital literacy". *Pedagogies, 4*(2), 107–125.

Šerbec, I. N., Žerovnik, A., Juvan, N., Rečkoska-Šikoska, U., & Davčev, D. (2016). Digital competences of selected university students from Macedonia and Slovenia. *ICT Innovations 2016*, 82-92.

Spiteri, M., & Chang Rundgren, S. N. (2017). Maltese primary teachers' digital competence: implications for continuing professional development. *European Journal of Teacher Education, 40*(4), 521-534.

Toker, T., Akgün, E., Cömert, Z., & Edip, S. (2021). Eğitimciler için dijital yeterlilik ölçeği: uyarlama, geçerlik ve güvenirlik çalışması [Digital competency scale for educators: Adaptation, validity and reliability study]. *Milli Eğitim Dergisi, 50*(230), 301-328.

UNESCO (2018). Öğretmenlere yönelik bilgi ve iletişim teknolojileri yetkinlik çerçevesi [UNESCO for teachers' information and communication technologies competence framework]. United Nations Educational, Scientific and Cultural Organization.

Yener, İ. (2022). Coğrafya öğretmenlerinin endüstri 4.0 bilgi düzeyleri ile dijital yetkinlik seviyelerinin belirlenmesi [Determination of geography teachers' industry 4.0 knowledge levels and digital competency levels]. [Master thesis]. Çanakkale Onsekiz Mart University