www.ijemst.net

Analysis of Digital and Technological Competencies of University Students

Deniz Koyuncuoğlu
Kirklareli University, Turkey

To cite this article:

Koyuncuoglu, D. (2022). Analysis of digital and technological competencies of university students. *International Journal of Education in Mathematics, Science, and Technology (IJEMST), 10*(4), 971-988. https://doi.org/10.46328/ijemst.2583

International Journal of Education in Mathematics, Science and Technology

2022, Vol. 10, No. 4, 971-988 https://doi.org/10.46328/ijemst.2583

Analysis of Digital and Technological Competencies of University Students

Deniz Koyuncuoğlu

Article Info

Article History

Received:
09 November 2021
Accepted:
11 June 2022

Keywords

Digital competence
Technological competence
Self-efficacy
University student
Higher education

Abstract

This study aims to examine the digital and technological competencies of university students studying at different faculties. In this context, digital and technological competencies of university students were examined based on the comparative relational screening model according to gender, class and academic achievement variables. The participants of the study are 373 students studying at different faculties of Dokuz Eylül University, Düzce University, Kırklareli University and Necmettin Erbakan University. Data were collected through digital competence and technological competence scales. The findings showed that the digital competence and technological competence of university students were high in some dimensions and moderate in some dimensions. In addition, the digital competencies and technological competencies of university students differed in terms of grade level and achievement status. On the other hand, no significant difference was found in the digital competencies and technological competencies of the participants with regard to gender. Finally, a significant positive relationship was found between the digital competencies and technological competencies of the participating university students.

Introduction

The training of qualified personnel that a country needs can be realized with the help of educational institutions since we can only find the latest data of science and technology and the people who own these data in educational institutions. Higher education institutions, which have the most important position among our educational institutions, constitute both a high-level manpower resource and the focal point in the production of information. Therefore, considering a country's higher education system independently of that country's science and technology system may lead to incomplete or even wrong conclusions (Cafoglu, 1997). Youngsters, who are the guarantee of our future, are given the most up-to-date professional information at universities.

It is a well-known fact that today's rapidly developing science and technology have also changed the structure of society. Parallel to these changes, changes are needed in educational institutions. This situation necessitates the regulation of educational institutions in a way that will adapt to changing and developing social, cultural, economic and technological conditions and requirements (Alharthi, 2020; Kara, 2021; Hartono & Ozturk, 2022; Kibici & Sarıkaya, 2021). Educational institutions will survive as long as they meet the needs of the society, and

when they do not respond to the needs, they will either change or disappear and leave their place to a new one. Today, the technological progress of nations and their social and cultural changes are manifested as a result of education. When this change process is evaluated in terms of gaining an international structure and providing international interaction, it is necessary for students to have certain competencies in universities.

In this development process, especially information technologies have taken their place in the education system by showing a significant development. There are four main reasons for computerization in the field of education. These are the thoughts that it is a basic need to participate in the computer literate societies of tomorrow, a prerequisite for the success of the individual in his/her career, providing efficiency in education, programming or computer programs to develop mental abilities (Cavalier & Reeves, 1993). The 'Future Jobs Report' prepared by the OECD (2014) indicates that digital skills will be needed in order to maintain the functions of the many professions that exist today and in the forthcoming years.

There is a great relationship between the digitalization of education and the change of individuals. In a way, the increase in the level of people's integration with technology has enabled them to use technology in every conceivable field. Therefore, the digital transformation of education manifests itself as in the routine flow of life. Above all, education becomes a subject that gets its share from digital transformation processes, and education processes that continue almost every day throughout the year are offered to individuals digitally without going to educational institutions (Sahin, 2009). There are two basic elements, namely the students and the teacher, which are crucial for education in the digital environment. Digitalization in education has a very positive effect on the transformation of people who are first-hand followers of technology. Considering the closeness of the employees in the education service with technology, the structure formed according to the picture that emerges as the education, which has a character in digital areas, moves together with technology is beneficial in many areas. In the past, educators' adopting traditional methods and being away from innovations prevented developments in the field of education (Krel et al., 2022; Oksuz, Demir, & İci, 2016). In this context, universities around the world are trying to effectively implement digital and computer-based technologies such as multimedia classes and social media internet applications in order to increase the quality of their education programs (Tang & Austin, 2009). With this aspect, technology has become an indispensable part of daily personal and professional life in universities (Mendoza Velazco et al., 2021). The integration of technology and education enables the education and training process to be carried out more qualified. In this direction, both developed and developing countries are developing different projects in order to benefit more from technology in the field of education. In this context, the positive contribution of technology to education is undeniable (Kaleli, 2020; Kaleli, 2021; Beard et al., 2011).

Self-efficacy beliefs underlie the phenomenon of technological and digital competence. Self-efficacy beliefs increase commitment, effort and perseverance, leading individuals to achieve excellent performance and skills (Dogru, 2020; Morris & Usher, 2011; Schunk & Pajares, 2005; Woods et al., 2021). Undoubtedly, one of the basic elements of success of new teaching technologies in the teaching environment is the self-efficacy perception of university students. This perception determines the quality of teaching and the effectiveness of teaching technologies, methods and techniques (Rimm-Kaufman & Sawyer, 2004; Kibici, 2022; Koyuncuoglu, 2021). According to Mishra and Kohler (2006), the key to the successful learning-teaching process is the effective

integration of technology and subject areas with pedagogy by students and instructors. In this respect, it can be mentioned that there is a close and positive relationship between technological and digital competence and self-efficacy.

Developing technologies in universities have created learning opportunities that challenge traditional pedagogical approaches in university learning through mobile services and web conferencing software (Cho et al., 2019; Kibici, 2022; Sabet, 2020). However, there seem to be several factors that hinder the effective integration of technology into teaching. In particular, some authors have suggested that the digital competencies of faculty and students, their behavior and readiness for technology can significantly affect the integration of technology into education (Brill & Galloway, 2007; Wickersham & McElhany, 2010). As such, university students have to adapt and improve their knowledge and skills in parallel with the development of digital technologies. According to Hung et al. (2010), it has become a necessity to have ICT technologies, computer and internet self-efficacy and digital competencies in today's high-level learning-teaching processes (Lesniak, 2005; Tsai & Lin, 2004).

Digital technologies have improved the integration between information systems, social media, communication and education in a variety of aspects. Therefore, university students have to adapt and improve their knowledge and skills in parallel with the development of digital technologies (Gesualdi, 2019; Hebebci & Maya Hebebci, (2021; Koyuncuoglu, 2021; Serhan & Almeqdadi, 2021). In this context, one of the growing focus areas in universities has been online digital skills. However, this issue has not been given much attention in various academic branches in universities. The digital and technological competencies of university students have dramatically grown and diversified, especially in recent years (Freberg & Kim, 2018). According to Kiesenbauer and Zerfass (2015), university students need to connect their competencies in digital technologies with their applications in the field in order to be successful in their fields. In addition, many studies focusing on universities argue that digital and technology competencies should be given more space in academic programs in this field (Walters et al., 2019).

One of the prominent factors of technology use is the digital competence of individuals. Until recently, there was no common understanding of what digital competences are and which ones are necessary for learners (Ala-Mutka, 2011). Digital competence is a broad term that encompasses not only skills but also knowledge and attitudes towards technology. In this respect, "digital competence" includes "Information Society Technologies", multifaceted uses in the fields of business, entertainment and communication. In this respect, competence in digital technologies includes the effective use of computers to collect, evaluate, store, produce, present, exchange information, communicate via the internet and participate in collaborative networks (European Parliament and the Council, 2006).

The origin of the concept of digital competence refers to the technological competences that an individual should have throughout his/her life, starting from the skills and abilities that a person needs to acquire and consolidate as a basic tool to advance in his academic career, then in formal studies within the framework of a new learning vision (Gisbert et al., 2016). Named by the term key competence, this type of learning has been identified by the European Higher Education Area (EHEA) which advocates for the need to promote in students a compendium of

key skills that make them a competent figure to meet the demands of society (Baterna et al., 2020).

The concept of digital competence emerged simultaneously with technological development, and the society gradually realized the need for new competences. The development of technologies constantly creates new activities and goals, and thus the importance of digital competence is constantly changing (see Table 1). For that reason, digital competence should always be viewed in relation to current technology and its applications. Digital competence refers to the confident and critical use of all digital technologies for information, communication and basic problem solving in all aspects of life (Ala-Mutka, 2008; Walters et al., 2019). This may sound simple to most of us, but according to the Digital Agenda Scoreboard 2015, 40% of the EU population has insufficient digital proficiency. It is also important to consider, as Riina Vuorikari writes in her article, "Digital competence as a cross-qualification also helps us to master other core competences such as communication, language skills or basic skills in mathematics and science" (Garzón-Artacho et al., 2021).

According to Skov (2016), digital competence should be understood as the ability to combine knowledge, skills and attitudes appropriate to the context. Digital competence is therefore divided into the following areas: (1) Instrumental skills to use digital tools and media; (2) Information, theory and principles related to technology; (3) Attitudes towards strategic use, openness, critical understanding, creativity, accountability and independence. These three dimensions are called learning spaces. The point in this three-pronged part of digital competence is to highlight the fact that strong digital competences are not created organically just because of high consumption of digital technology (Ala-Mutka, 2008; Hargittai, 2009; Redecker et al., 2010).

Table 1. Areas Constituting Digital Learning Competence

Information and Information Literacy	Identifying, finding, acquiring, storing, organizing and analyzing digital information, data and digital content, evaluating its purpose and relevance to learning tasks.
Communication and Collaboration	Communicating in digital environments, sharing resources through online tools, connecting and collaborating with others through digital tools, interacting and participating in communities and networks, intercultural awareness.
Creating digital content	Creating and editing new digital content, integrating and reprocessing previous information and content, making artistic productions, multimedia content and computer programming, knowing how to enforce intellectual property rights and use licenses.
Security	Protection of information and personal data, protection of digital identity, protection of digital content, security measures and responsible and safe use of technology.
Problem solving	Identifying the needs to use digital resources, making informed decisions about the most appropriate digital tools according to the purpose or need, solving conceptual problems through digital media, using technologies creatively, solving technical problems and updating their own and others' competences.

Source: INTEF, 2017.

Developing the digital competences of university students is vital to their success in higher education. Those who have high digital proficiency can easily interpret and understand online learning materials and perform well in online learning (López-Meneses et al., 2020). However, there are limited empirical studies that investigate the digital competence of students, especially university students (Maderick et al., 2016; He & Li, 2019). Moreover, while the importance of digital competence has been widely recognized and emphasized in school settings (Hatlevik et al., 2015 ; López-Meneses et al., 2020), there is limited empirical information on how digital competence empowers students to cope with them.

The technological knowledge that individuals acquire during their education prepares them for their professional life. Among the most important of these technological developments are digital competence, technological competence and related skills. In this context, it will be useful to first determine the technology usage and skill levels of students in order to gain these competencies and skills. In order to achieve this aim, in this study, technology and digital competencies of university students were examined in terms of some variables. For this purpose, answers were sought to the following questions:

- In general, what are the technological and digital competencies of university students?
- Do university students' technological competencies and digital competencies differ according to the gender variable?
- Do university students' technological competencies and digital competencies differ according to the class variable?
- Do university students' technological competencies and digital competencies differ according to their success?
- To what extent do university students' digital competencies predict their technological competencies?

Method

In line with the purpose and sub-problems of the research, the comparative relational survey model, one of the quantitative research methods, was used in this study. Within the scope of the comparative relational survey model, firstly, university students' technological competence and digital competencies were described in the study, and then these dependent variables were compared according to faculty, gender, class and academic success factors. In this study, quantitative empirical research was conducted based on the results of the questionnaire shown below. In this context, the following stages were followed:

(i) research approach and tool design;
(ii) collecting responses to the questionnaire;
(iii) verification and analysis of results.

After contacting the participants, collecting the answers and checking their validity, the different aspects of the tool were verified. At the last stage, comparative analyses were made in the dependent variable measurements as to the independent variables of the research; and they were tabulated in a summary way, explained and interpreted.

In the study, a total of 373 university students, selected by the non-probabilistic convenience sampling process, participated in the research. The students participated in the study from 4 universities (Dokuz Eylül University,

Düzce University, Kırklareli University and Necmettin Erbakan Universities) from four different cities in Turkey. The students in the research sample are studying at the Faculty of Dentistry, Faculty of Education, Faculty of Aviation and Space Sciences, Faculty of Law, Faculty of Economic and Administrative sciences, Faculty of Engineering, Faculty of Political Sciences, Faculty of Tourism, Faculty of Applied Sciences, School of Health Services and Vocational School of Technical Sciences. These university students were contacted via e-mail and applications were made through the questionnaire, which was used as a tool, through Google Forms. All participants answered the questionnaire voluntarily, freely and anonymously. The validity of all answers was checked in the study.

The main independent variable of the research was the technological and digital competencies of the participants. Gender, grade level and faculty-school area of the participants were taken into account as independent variables. The dependent variables examined in this research are: (i) assessment of the aspects specified in digital competence; (ii) assessment of specified aspects of technological competence.

Data Collection Tools

Digital Competence Scale: In this study, the 'Digital Literacy Scale' developed by Bayrakcı (2020) was used to measure the digital competencies of university students. Explanatory and confirmatory factor analyses performed on the scale consisting of 29 items in the Likert form revealed a 6-factor structure. In this context, the sub-factors of the scale are Ethics and Responsibility Dimension, General Knowledge and Functional Skills Dimension, Daily Use Dimension, Professional Production Dimension, Confidentiality and Security Dimension and Social Dimension. The analyses performed on the sample of this study show that the sub-dimension of the digital competence scale and the total Cronbach's Alpha reliability coefficient vary between .73 and .92.

Technological Competence Scale: In this study, the technology proficiency scale developed by Bayraktar (2015) was used as a second measurement tool. The scale in the Likert-type form consists of two sub-factors: 'technology literacy' and 'integrating technology into the lesson'. The exploratory and confirmatory factor analyses performed on the scale items supported the structure with 2 sub-factors. The Cronbach Alpha reliability coefficient for the whole scale was calculated as 0.89 on university students. High scores obtained from the scale indicate that university students have high technological competence in total and subscales.

Data Analysis Techniques

In this study, data were analyzed using independent sample t-test, one-way analysis of variance and multiple regression analysis techniques. In the study, the skewness and kurtosis coefficients of the digital competence and technological competence data of university students were calculated and their distribution was examined. In order to provide the assumption of normal distribution, the skewness coefficient should be less than 2 and the kurtosis coefficient should be less than 2 (Yurt, 2011). The values found showed that the scores on the two scales met the assumptions of normal distribution. Tukey test was used to determine the source of the difference found as a result of variance analysis.

Findings

The descriptive analysis is performed on the digital competence scale data of university students (see Table 2). According to the analyses, the mean score of the 'ethics and responsibility' dimension of the digital competence scale was 4.38±0.57; the mean score of the 'general knowledge and functional skills' dimension was 3.76±0.93; the mean score of the 'daily use' dimension was 4.38±0.63; the mean score of the 'professional production' dimension was 3.00±1.30; the mean score of the 'privacy and security' dimension was calculated as 4.48±0.67, and the mean score of the 'social dimension' was calculated as 3.69±1.00. According to these findings, university students' digital competencies in the dimensions of "Ethics and Responsibility", "Daily Use", and "Privacy and Security" are at a very high level. However, the digital competencies of the participants in the fields of "General Knowledge and Functional Skills", "Professional Production", and "Social Dimension" are at medium level.

Table 2. Descriptive Data on Digital Competencies of University Students

Digital Competencies	N	Minimum	Maximum	Mean	Std. Deviation
Ethics and Responsibility	373	1.29	5.00	4.38	0.57
General Knowledge and Functional Skills	373	1.00	5.00	3.76	0.93
Daily use	373	1.00	5.00	4.38	0.63
Professional Production	373	1.00	5.00	3.00	1.30
Privacy and Security	373	1.25	5.00	4.48	0.67
Social Dimension	373	1.00	5.00	3.69	1.00

Table 3 shows the results of the descriptive analysis performed on the technological competence scale data of university students. According to the analyses, the technological competence scale mean score of the participants was 3.11±1.59. According to these findings, the participants generally have a medium level of technological competence.

Table 3. Descriptive Data on the Technological Competencies of University Students

	N	Minimum	Maximum	Mean	Std. Deviation
Technological Competence	373	1.00	5.00	3.11	1.59

Table 4 shows the results of comparing the digital competence scores of university students by gender. According to the analyses, it is seen that there is no significant difference between girls and boys in terms of "Ethics and Responsibility", "Daily Use", "Professional Production", "Privacy and Security", and "Social Dimension" mean scores of the digital competence scale ($p>0.05$). However, significant differences were found between male and female university students in terms of "General Knowledge and Functional Skills" ($p<0.05$). When the averages of the groups are examined, it is seen that male students have significantly higher digital competencies in terms of "General Knowledge and Functional Skills" compared to their female peers.

Table 4. Comparison of University Students' Digital Competencies by Gender Variable

Digital Competencies	Gender	N	Mean	Std. Deviation	t	p
Ethics and Responsibility	Female	225	4.40	0.56	0.213	0.832
	Male	148	4.38	0.56		
General Knowledge and Functional Skills	Female	225	3.55	0.91	-5.576	0.000
	Male	148	4.09	0.87		
Daily use	Female	225	4.38	0.64	-0.158	0.874
	Male	148	4.39	0.60		
Professional Production	Female	225	3.03	1.28	0.454	0.650
	Male	148	2.97	1.36		
Privacy and Security	Female	225	4.51	0.66	0.633	0.527
	Male	148	4.46	0.69		
Social Dimension	Female	225	3.72	0.94	0.726	0.468
	Male	148	3.64	1.09		

Table 5 shows the results of comparing technological competence scores of university students by gender. According to the analyses, it is seen that there is no significant difference between females and males in terms of the total mean scores of the technological competence scale ($p>0.05$).

Table 5. Comparison of University Students' Technological Competencies by Gender Variable

	Gender	N	Mean	Std. Deviation	t	p
Technological Competence	Male	225	3.13	1.55	0.378	0.706
	Female	148	3.07	1.66		

Table 6 shows the results of comparing the digital competence scores of university students according to their grade levels. According to the analyses, it is seen that there is no significant difference between grade levels in terms of “General Knowledge and Functional Skills”, “Daily Use”, “Professional Production”, “Privacy and Security”, and “Social Dimension” mean scores of the digital competence scale ($p>0.05$). However, significant differences were found between grade levels in Ethics and Responsibility dimensions ($p<0.05$). According to Scheffe's analysis, it was seen that the students studying in the 1st and 2nd grades had significantly higher digital competencies in terms of ethics and responsibility compared to the students in the 3rd and 4th grades.

Table 6. Comparison of University Students' Digital Competencies by Grade Level Variable

Digital Competencies	Grade Level	N	Mean	Std. Deviation	F	p	Scheffe Test
Ethics and Responsibility	1	57	4.61	0.52	3.333	0.020	1>3
	2	195	4.51	0.55			1>4
	3	81	4.23	0.64			2>3
	4	40	4.24	0.41			2>4
	Total	373	4.39	0.56			

Digital Competencies	Grade Level	N	Mean	Std. Deviation	F	p	Scheffe Test
General Knowledge and Functional Skills	1	57	3.79	0.95	0.807	0.490	
	2	195	3.73	0.99			
	3	81	3.71	0.74			
	4	40	3.98	1.01			
	Total	373	3.76	0.93			
Daily use	1	57	4.43	0.61	0.934	0.424	
	2	195	4.41	0.61			
	3	81	4.29	0.72			
	4	40	4.44	0.54			
	Total	373	4.39	0.63			
Professional Production	1	57	3.37	1.31	1.796	0.148	
	2	195	2.94	1.35			
	3	81	2.98	1.16			
	4	40	2.86	1.38			
	Total	373	3.01	1.31			
Privacy and Security	1	57	4.53	0.73	1.578	0.194	
	2	195	4.54	0.61			
	3	81	4.37	0.75			
	4	40	4.39	0.67			
	Total	369	4.49	0.67			
Social Dimension	1	57	3.86	0.92	0.937	0.423	
	2	195	3.71	0.97			
	3	81	3.61	0.92			
	4	40	3.56	1.40			
	Total	373	3.69	1.00			

Table 7 shows the results of comparing technological competence scores of university students according to their grade levels. According to the analyses, it is seen that there is no significant difference between the grade levels in terms of the total mean score of the technological competence scale ($p>0.05$).

Table 7. Comparison of University Students' Technological Competencies by Grade Level Variable

	Grade Level	N	Mean	Std. Deviation	F	p
Technological Competence	1	57	3.17	1.62	0.524	0.666
	2	195	3.02	1.62		
	3	81	3.18	1.51		
	4	40	3.33	1.57		
	Total	369	3.11	1.59		

Table 8 shows the results of comparing the digital competence scores of university students according to their success. According to the analyses, it is seen that there is no significant difference in terms of success in the "Ethics and Responsibility", "Professional Production", and "Social Dimension" mean scores of the digital competence scale ($p>0.05$). However, significant differences were found in terms of success in "General Knowledge and Functional Skills", "Daily Use", and "Privacy and Security" dimensions ($p<0.05$). According to Scheffe's analysis, students with very high success levels were found to have significantly higher digital competencies compared to students with low and moderate achievement.

Table 8. Comparison of University Students' Digital Competencies by Success Status

Digital Competencies	Success	N	Mean	Std. Deviation	F	p	Scheffe Test
Ethics and Responsibility	1. Low	31	4.25	0.64	0.264	0.768	
	2. Moderate	233	4.39	0.55			
	3. High	109	4.40	0.57			
	Total	373	4.39	0.56			
General Knowledge and Functional Skills	1. Low	31	3.04	1.23	5.313	0.005	3>1
	2. Moderate	233	3.70	0.95			3>2
	3. High	109	3.95	0.82			2>1
	Total	373	3.76	0.93			
Daily use	1. Low	31	4.23	0.71	3.660	0.027	3>1
	2. Moderate	233	4.34	0.64			3>2
	3. High	109	4.52	0.58			
	Total	373	4.39	0.63			
Professional Production	1. Low	31	3.06	1.50	0.111	0.895	
	2. Moderate	233	2.98	1.27			
	3. High	109	3.05	1.40			
	Total	373	3.00	1.31			
Privacy and Security	1. Low	31	4.19	1.31	3.058	0.048	3>1
	2. Moderate	233	4.44	0.70			3>2
	3. High	109	4.61	0.50			2>1
	Total	373	4.49	0.67			
Social Dimension	1. Low	31	3.09	1.48	2.351	0.097	
	2. Moderate	233	3.65	0.95			
	3. High	109	3.81	1.05			
	Total	373	3.69	1.00			

Table 9 shows the results of comparing the technological competence scores of university students according to their success status. According to the analyses, it is seen that there is no significant difference in terms of success in the total mean score of technological competence ($p>0.05$).

Table 9. Comparison of University Students' Technological Competencies by Success Status

	Success	N	Mean	Std. Deviation	F	p	Scheffe Test
Technological Competence	Low	31	3.43	1.56	0.297	0.743	-
	Moderate	233	3.08	1.56			
	High	109	3.17	1.68			
	Total	373	3.11	1.59			

Table 10 shows the results of the regression analysis developed to test the effect of university students' digital competencies on their technological competencies.

Table 10. Regression Analysis Results Regarding the Prediction Level of Technological Competencies of University Students' Digital Competencies

Variables	β	t	p
(Constant)	5.15	7.52	0.00
Ethics and Responsibility	0.18	2.72	0.01
General Knowledge and Functional Skills	0.07	1.02	0.31
Daily use	0.01	0.10	0.92
Professional Production	0.17	2.38	0.02
Privacy and Security	0.00	0.05	0.96
Social Dimension	0.09	1.04	0.30

According to the analyses, the regression model showing the effect of the competence scale scores, which are the independent variables, on the technological competence scores was found to be significant ($R=0.27$; $R2=0.055$; $p<0.05$). Digital competencies of university students explain approximately 5.5% of the total variance in their technological competence scores. This indicates a significant but moderate effect. When the significance values of the calculated standardized path coefficients are examined, it is understood that the predictive variables of digital competence, “Ethics and Responsibility” and “Professional Production” dimensions are significant predictors of technological competences ($p<0.05$).

Discussion and Conclusion

In this study, in which the digital competencies and technology competencies of university students are examined comparatively in terms of some variables, it is seen that the average score of the participants regarding the relevant variables varies between medium and high levels. In general, university students' digital competencies in the dimensions of “Ethics and Responsibility”, “Daily Use”, and “Privacy and Security” are at a very high level, however, digital competencies in the fields of “General Knowledge and Functional Skills”, “Professional Production”, and “Social Dimension” technological competencies are at medium level. These findings are similar to the results of research by Brennan et al. (2004), Dogru (2021), Hatlevik et al. (2015), Kibici & Sarıkaya (2021), Kibici (2022), López-Meneses et al. (2020) and Pooparadai (2016). According to Brennan (2004), the aim of

higher education is to enable students to learn and apply their versatile knowledge for self-development and study. One of this information includes digital and technological skills. According to Pooparadai (2016), universities should take the responsibility of preparing graduates in order to achieve national digital policy goals of countries and develop a digital workforce that can meet national and international economic needs. However, there are problems in many business lines in terms of digital and technological competencies of graduates. In terms of digital and technological competencies, there are problems especially in the production of professional knowledge and the use of techniques. According to Oksuz et al. (2009), digital and technology education at universities in Turkey is generally limited to knowledge and skills. For this reason, students acquire the skills of using digital and technologies related to their field at a limited level and cannot develop a practical understanding of how to use their competencies related to this scope.

Another finding in this study is the comparison of digital competence and technological competencies of university students according to their gender. According to the research results, no significant differences were found in the digital competence and technology competences of the participating university students in general according to their gender. There are many studies that focus on analyzing digital and technological competencies by gender variable. Some of these studies emphasize that women's average scores are higher than men's (Guillén-Gámez et al., 2020, Krumsvik et al., 2016). Others argue that men have higher levels of digital and technological competence (Cai et al., 2017; Scherera et al., 2017). However, Cabero-Almenara et al. (2021), Hatlevik and Hatlevik (2018) suggested that there is no difference between male and female participants in gender-comparative digital competence studies.

Another finding reached in the study is the comparison of digital competence and technological competencies of university students according to their grade levels and success status. According to the research findings, no significant difference was found in technological competencies of university students according to their grade and success levels. However, there are significant differences in the digital competencies of the participants in terms of classroom success variables. In general, students with very high success levels were found to have higher digital competencies compared to students with low and medium success levels. And again, as a meaningful result, it has been observed that the students studying in the 1st and 2nd grade have a high level of digital competencies in the dimension of ethics and responsibility compared to the students in the 3rd and 4th grades. These findings are similar to the findings of studies conducted by Cabero-Almenara et al. (2021), He and Li (2019), Mannerström et al. (2018), Dogru (2021), and Kara (2021). Cabero-Almenara et al. (2021) suggested that there are significant relationships between digital competencies and variables such as age, experience, years of technology use, time spent on technologies, and mastery of technologies.

The last finding of the study is about the relationship between the digital competencies of university students and their technological competencies. Technological competencies of university students increase depending on digital competence. According to the regression analysis, it was seen that the predictive variables of digital competence, “Ethics and Responsibility” and “Professional Production” dimensions significantly affect technological competences. These findings were reported by Bozkurt et al. (2021), Cai et al. (2017), Dogru (2020), Fernández-Luque (2019), which are similar to the results of research. According to Bozkurt et al. (2021), in the

digital information age, since information provides information and knowledge provides wisdom, processing data and transforming it into information and holistic technologies is one of the most basic actions. It has been stated that tangible and intangible technologies should be used in digital education processes to complement each other, and that digital education can be operational with digital competence, technological competencies, and literacy. Accordingly, it can be said that there are many things that need to be done at the university level regarding the weaknesses arising from university education, the lack of technology, the lack of educational resources to be used in distance virtual education and the effectiveness of this education method. Therefore, it is recommended to make educational arrangements to develop digital and technological competencies, to pay special attention to technological empowerment of students, and to develop strategies and action plans in higher education in this context.

The main limitations of this study include the methodology used quantitatively and the geographic area of the population studied. Consequently, further studies can use qualitative methodologies to explore the underlying causes of the impact of the variables analyzed here on digital competence, technological competence, and adaptability to digital learning environments for university students and faculty.

Learning how to use digital information and tools safely is essential both during university education and in professional life. Therefore, coordinated programs should be developed to strengthen digital skills for students. On the one hand, these programs should ensure that graduates have general digital competencies, and on the other hand, they should meet subject-specific requirements of the courses. In addition to introductory programs for dealing with digital information and tools, the development of new interdisciplinary teaching modules (for example for computer and data-driven analytics or information scientific research) could be considered to develop the necessary advanced methodological competencies related to advanced research stages.

The prospect of radical and transformative change for economies and societies is a challenge for policy makers and higher education leaders alike. Technological advances such as digitalization and artificial intelligence can offer solutions to global problems, while also presenting new challenges. It should be the task of higher education leaders to offer new working conditions and opportunities to internal and external stakeholders of the university while navigating these choppy waters.

References

Ala-Mutka, K. (2008). *Social computing: Study on the use and impacts of collaborative content - IPTS exploratory research on the socio-economic impact of social computing*. Institute for Prospective Technological Studies, Joint Research Centre, European Commission.

Ala-Mutka, K. (2011). Mapping digital competence: Towards a conceptual understanding. Sevilla: Institute for Prospective Technological Studies, 7-60.

Alharthi, M. (2020). Students' Attitudes toward the use of technology in online courses. *International Journal of Technology in Education, 3*(1), 14-23.

Baterna, H. B., Mina, T. D. G., & Rogayan, D. V. Jr. (2020). Digital literacy of STEM senior high school students: Basis for enhancement program. *International Journal of Technology in Education, 3*(2), 105-117. https://doi.org/10.46328/ijte.v3i2.28

Bayraktar, R. (2015). *Öğretmenlerin eğitim teknolojileri kullanım düzeylerinin belirlenmesi: Ölçek geliştirme çalışması [Determination of teachers' educational technology usage levels: Scale development study]*. Unpublished master thesis, Karadeniz Technical University, Institute of Educational Sciences, Trabzon, Turkey.

Beard, L. A., Carpenter, L. B., & Johnston, L. B. (2011). *Assistive technology access for all students.* US: Pearson.

Bozkurt, A., Hamutoğlu, N. B., Liman Kaban, A., Taşçı, G., & Aykul, M. (2021). Dijital bilgi çağı: Dijital toplum, dijital dönüşüm, dijital eğitim ve dijital yeterlilikler [Digital information age: Digital society, digital transformation, digital education and digital competences]. *Açıköğretim Uygulamaları ve Araştırmaları Dergisi, 7*(2), 35-63. https://doi.org/10.51948/auad.911584

Brennan, J., King, R., & Lebea, Y. (2004). *The Role of universities in the transformation of societies: an international research project.* Centre for Higher Education Research and Information/Association of Commonwealth Universities, UK.

Brill, J. M., & Galloway, C. (2007). Perils and Promises: University instructors' integration of technology in classroom-based practices. *British Journal of Educational Technology, 38*(1), 95-105. https://doi.org/10.1111/j.1467-8535.2006.00601.x

Cabero-Almenara, J., Barroso-Osuna, J., Gutiérrez-Castillo, J. J., & Palacios-Rodríguez, A. (2021). The teaching digital competence of health sciences teachers. A study at Andalusian Universities (Spain). *International Journal of Environmental Eesearch and Public Health, 18*(5), 2552. https://doi.org/10.3390/ijerph18052552

Cafoglu, Z. (1997). Yükseköğretim ve öğrenci kalitesi [higher education and student quality]. In M. Çoruh (Ed.), *Yüksek öğretimde sürekli kalite iyileştirme [continuous quality improvement in higher education]* (pp. 91-110). Ankara: Haberal Eğitim Vakfı.

Cai, Z., Fan, X., & Du, J. (2017). Gender and attitudes toward technology use: A meta-analysis. *Computers & Education, 105*, 1-13. https://doi.org/10.1016/j.compedu.2016.11.003

Cavalier, R., & Reeves T. L. (1993). International perspectives on the impact of computing in education to special issue. *Education Technology,* September, 7-10.

Doğru, O. (2020). An investigation of pre-service visual arts teachers' perceptions of computer self-efficacy and attitudes towards web-based instruction. *International Journal of Research in Education and Science, 6*(4), 629-637.

European Parliament and the Council. (2006). Recommendation of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning. Official Journal of the European Union, L394/310.

Fernández-Luque, A. (2019). On-the-job digital competence training for health professionals. *Revista Cubana de Información en Ciencias de la Salud, 30*(2), 1–21.

Freberg, K., & Kim, C.M. (2018). Social media education: Industry leader recommendations for curriculum and faculty competencies. *Journalism & Mass Communication Educator, 73*(4), 379-391. https://doi.org/10.1177/1077695817725414

Garzón-Artacho, E., Sola-Martínez, T., Romero-Rodríguez, J. M., & Gómez-García, G. (2021). Teachers' perceptions of digital competence at the lifelong learning stage. *Heliyon, 7*(7), e07513. https://doi.org/10.1016/j.heliyon.2021.e07513

Gisbert, M., González, J., & Esteve, F. (2016). Competencia digital y competencia digital docente: una panorámica sobre el estado de la cuestión. *Revista Interuniversitaria de Investigación en Tecnología Educativa, 0*, 74-83. https://doi.org/10.6018/riite2016/257631

Guillén-Gámez, F. D., Mayorga-Fernández, M. J., Bravo-Agapito, J., & Escribano-Ortiz, D. (2020). Analysis of teachers' pedagogical digital competence: Identification of factors predicting their acquisition. *Tech Know Learn*, 26, 481–498. https://doi.org/10.1007/s10758-019-09432-7

Hargittai, E. (2009). An update on survey measures of web-oriented digital literacy. *Social Science Computer Review, 27*(1), 130-137. https://doi.org/10.1177/0894439308318213

Hartono, R., & Ozturk, O. T. (Eds.). (2022). *Studies on Social and Education Sciences 2021*. ISTES Organization.

Hatlevik, I., & Hatlevik, E. (2018). Students' evaluation of digital information: The role teachers play and factors that influence variability in teacher behaviour. *Computers in Human Behavior*, 83, 56–63. https://doi.org/10.1016/j.chb.2018.01.022

Hatlevik, O. E., Ottestad, G., & Throndsen, I. (2015). Predictors of digital competence in 7th grade: A multilevel analysis. *Journal of Computer Assisted Learning, 31*(3), 220-231. https://doi.org/10.1111/jcal.12065

He, T., & Li, S. (2019). A comparative study of digital informal learning: The effects of digital competence and technology expectancy. *British Journal of Educational Technology, 50*(4), 1744–1758. https://doi.org/10.1111/bjet.12778

Hebebci, M. T., & Maya Hebebci, G. (2021). Evaluation of 3D Design Applications in STEM Education. In S. Jackowicz & O. T. Ozturk (Eds.), *Proceedings of ICSES 2021-- International Conference on Studies in Education and Social Sciences* (pp. 28-39), Antalya, Turkey. ISTES Organization.

Hung, M. L., Chou, C., Chen, C. H., & Own, Z. Y. (2010). Learner readiness for online learning: Scale development and student perceptions. *Computers & Education, 55*(3), 1080-1090. https://doi.org/10.1016/j.compedu.2010.05.004

INTEF (2017). Marco de Competencia Digital. Ministerio de Education, Ciencia y Deportes, Madrid.

Kaleli, Y. S. (2020). The effect of computer-assisted instruction on piano education: An experimental study with pre-service music teachers. *International Journal of Technology in Education and Science, 4*(3), 235-246. https://doi.org/10.46328/ijtes.v4i3.115

Kaleli, Y. S. (2021). The effect of individualized online instruction on TPACK skills and achievement in piano lessons. *International Journal of Technology in Education, 4*(3), 399-412. https://doi.org/10.46328/ijte.143

Kara, S. (2021). An investigation of technological pedagogical and content knowledge (TPACK) competencies of pre-service visual arts teachers. *International Journal of Technology in Education, 4*(3), 527-541. https://doi.org/10.46328/ijte.184

Kibici, V. B., & Sarıkaya, M. (2021). Readiness levels of music teachers for online learning during the COVID 19 Pandemic. *International Journal of Technology in Education, 4*(3), 501-515. https://doi.org/10.46328/ijte.192

Kibici, V. B. (2022). An investigation into music teachers' perceptions of technological competencies. *International Journal of Technology in Education and Science, 6*(1), 111-123. https://doi.org/10.46328/ijtes.344

Kiesenbauer, J., & Zerfass, A. (2015). Today's and tomorrow's challenges in public relations: Comparing the views of chief communication officers and next generation leaders. *Public Relations Review, 41*(4), 422-434. https://doi.org/10.1016/j.pubrev.2015.05.013

Kilincer, O. (2021). An investigation of pre-service music teachers' attitudes towards online learning during the COVID-19 Pandemic. *International Journal of Technology in Education and Science, 5*(4), 587-600. https://doi.org/10.46328/ijtes.304

Koyuncuoğlu, Ö. (2021). Eine Untersuchung über die akademische Selbstwirksamkeit von Studierenden in der türkischen Hochschulbildung. *Diyalog Interkulturelle Zeitschrift für Germanistik, 9*(2), 760-781. https://doi.org/10.37583/diyalog.1030828

Krel, C., Vrbnjak, D., Bevc, S., Štiglic, G., & Pajnkihar, M. (2022). Technological competency as caring in nursing: A description, analysis and evaluation of the theory. *Slovenian Journal of Public Health, 61*(2), 115-123. https://doi.org/10.2478/sjph-2022-0016

Krumsvik, R., Jones, L., Øfstegaard, M., & Eikeland, O. (2016). Upper secondary school teachers' digital competence: Analysed by demographic, personal and professional characteristics. *Nordic Journal of Digital Literacy, 11*(3), 143–164. https://doi.org/10.18261/issn.1891-943x-2016-03-02

Lesniak, R. (2005). Caring through technological competency. *The Journal of School Nursing, 21*(4), 194-195.

López-Meneses, E., Sirignano, F. M., Vázquez-Cano, E., & Ramírez-Hurtado, 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

Maderick, J. A., Zhang, S., Hartley, K., & Marchand, G. (2016). Preservice teachers and self-assessing digital competence. *Journal of Educational Computing Research 54*(3), 326–351. https://doi.org/10.1177/0735633115620432

Mannerström, R., Hietajärvi, L., Muotka, J., & Salmela-Aro, K. (2018). Identity profiles and digital engagement among Finnish high school students. *Cyberpsychology, 12*(1), 2–15. https://doi.org/10.5817/CP2018-1-2

Mendoza Velazco, D. J., Cejas, N. M., Cejas Martinez, M. F., Vinueza Naranjo, P. G., & Falcón, V. V. (2021). Digital andragogical competences of ecuadorian higher education teachers during the COVID-19 pandemic. *European Journal of Educational Research, 10*(3), 1341-1358. https://doi.org/10.12973/eu-jer.10.3.1341

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for integrating technology in teachers' knowledge. *Teachers College Record, 108*(6), 1017–1054. http://dx.doi.org/10.1111/j.1467-9620.2006.00684.x

Morris, D. B., & Usher, E. L. (2011). Developing teaching self-efficacy in research institutions: A study of award-winning professors. *Contemporary Educational Psychology, 36*(3), 232–245. https://doi.org/10.1016/j.cedpsych.2010.10.005

Öksüz, C., Ak, Ş., & Uça, S. (2009). İlköğretim matematik öğretiminde teknoloji kullanımına ilişkin algı ölçeği [A perception scale for technology use in the teaching of elementary mathematics]. *Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi, 6*(1), 270-287.

Öksüz, Y., Demir, E. G., & İci, A. (2016). Öğretmenlerin dijital okuryazarlık kavramına ilişkin metaforlarının incelenmesi [Examination of teachers' metaphors regarding the concept of digital literacy]. *The Journal of Academic Social Science Studies*, 50, 387-396.

Pooparadai, K. (2016). Thailand Digital Economy. Retrieved 10.04.2022, from MICT: http://www.mict.go.th/assets/portals/1/files/590613_1DE_27-5-59-Dr.kasititorn.pdf

Redecker, C., Hache, A., & Centeno, C. (2010). *Using information and communication technologies to promote education and employment opportunities for immigrants and ethnic minorities*. Institute for prospective technological studies, Joint Research Centre, European Commission.

Rimm-Kaufman, S. E., & Sawyer, B. E. (2004). Primary-grade teachers‘ self-efficacy beliefs, attitudes toward teaching, and discipline and teaching practice priorities in relation to the responsive classroom approach. *The Elementary School Journal, 104*(4), 321-341. https://doi.org/10.1086/499756

Sarikaya, M. (2022). An investigation of music teachers' perceived self-efficacy for technology integration. *International Journal of Technology in Education and Science, 6*(2), 204-217. https://doi.org/10.46328/ijtes.369

Scherera R., Tondeurb, J., & Siddiqc, F. (2017). On the quest for validity: Testing the factor structure and measurement invariance of the technology-dimensions in the Technological, Pedagogical, and Content Knowledge (TPACK) model. *Computers & Education, 112,* 1-17. https://doi.org/10.1016/j.compedu.2017.04.012

Schunk, D. H., & Pajares, F. (2005). Competence perceptions and academic functioning. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 85–104). Guilford Publications.

Serhan, D., & Almeqdadi, F. (2021). Exploring middle school students’ interest and their perceptions of the effect of STEM education on their future careers. In M. Shelley, I. Chiang, & O. T. Ozturk (Eds.), *Proceedings of ICRES 2021-- International Conference on Research in Education and Science* (pp. 1-10), Antalya, Turkey. ISTES Organization.

Skov, A. (2016). What is digital competence? https://digital-competence.eu/dc/front/what-is-digital-competence/

Şahin, M. C. (2009). Yeni binyılın öğrencilerinin özellikleri [Characteristics of students of the new millennium]. *Anadolu Üniversitesi Sosyal Bilimler Dergisi*, *9*(2), 155–172.

Tang, T. L. P., & Austin, M. J. (2009). Students' perceptions of teaching technologies, application of technologies, and academic performance. *Computers and Education, 53*(4), 1241–1255. https://doi.org/10.1016/j.compedu.2009.06.007

Tsai, C.-C., & Lin, C.-C. (2004). Taiwanese adolescents’ perceptions and attitudes regarding the Internet: Exploring gender differences. *Adolescence*, *39*(156), 725–734.

Walters, M. G., Gee, D., & Mohammed, S. (2019). A literature review: Digital citizenship and the elementary educator. *International Journal of Technology in Education*, *2*(1), 1-21.

Wickersham, L. E., & McElhany, J. (2010). Bridging the divide: Reconciling administrator and faculty concerns regarding online education. Quarterly Review of Distance Education.

Woods, K., Wendt, J. L., Barrios, A., & Lunde, R. (2021). Digital examination of the relationship between generation, gender, subject area, and technology efficacy among secondary teachers in the United States. *International Journal of Technology in Education, 4*(4), 589-604. https://doi.org/10.46328/ijte.126

Yurt, E. (2011). *Sanal ortam ve somut nesneler kullanılarak gerçekleştirilen modellemeye dayalı etkinliklerin uzamsal düşünme ve zihinsel çevirme becerilerine etkisi [The effect of modeling-based activities using virtual environment and concrete objects on spatial thinking and mental translation skills]*. Unpublished doctoral dissertation, Necmettin Erbakan University Institute of Educational Sciences, Konya, Turkey.

Author Information

Deniz Koyuncuoglu

http://orcid.org/0000-0002-4068-8386

Kirklareli University

Turkey

Contact e-mail: *denizbas4@hotmail.com*