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Research Article

Analysis of Teachers' Digital Technology Literacy Competencies in terms of Various Variables

Elvan GÖKÇEN [1,*] Eyüp İZCİ [2]

[1] Izmir Democracy University, İzmir, Türkiye, elvan.gokcen@idu.edu.tr
[2] Inonu University, Malatya, Türkiye, eyup.izci@inonu.edu.tr
[*] Corresponding Author: elvan.gokcen@idu.edu.tr

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Abstract

This study examines high school teachers' digital technological literacy perceptions and competencies based on various variables. Using a quantitative paradigm, the research employed a survey method with 412 randomly selected teachers. Data were collected using the "Digital Technology Literacy Scale," which includes two sub-dimensions: necessity of digital technology and self-efficacy. Parametric statistical techniques (e.g., t-test, ANOVA) were applied to normally distributed data, while non-parametric methods (e.g., MWU, KWH) were used for non-normally distributed data. The results revealed that teachers' perceptions of the necessity of digital technology and their self-efficacy were at a moderate level and varied according to demographic variables. The study highlights that teachers' moderate self-efficacy is a critical issue for the Turkish education system, as digital pedagogy requires higher technological competency. To address this deficiency, professional development programs are recommended to enhance teachers' digital technology self-efficacy and equip them with the necessary skills to adapt to the demands of the Information Age.

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Introduction

One of the most dominant features of the Information Age we live in is technological knowledge and its reflection, digitalization. Digitalization refers to the new cyber era in the human journey (Karabacak & Sezgin, 2019). This new era, which some societies are already experiencing and others, such as Turkey, are on the brink of, is also referred to by various terms such as Industry 4.0 and Smart Society 5.0. While the theoretical signs of this era could be observed much earlier, this new era, known as the digital revolution, has spread primarily after the Fourth Industrial Revolution. Today, especially in developed societies, we witness digital transformation in every stage and aspect of life. So, what is digitalization? Although much has been said about digitalization, it is first useful to look at the origins of this concept.

The term "digital," which entered our literature from foreign languages, is defined as "the recording, storing, or transferring of data in the form of '1' and '0' numbers to indicate the presence/absence of a signal in an electronic circuit in connection with computer use and the internet" (Bayrakçı, 2020: 8). When we look at the etymology of the word, we see that the term "digital" is derived from the Latin word "digitus," meaning "finger." Its current meaning, however, refers to the concept of digitization, which forms the foundation of modern communication systems (Klein, 2020: 998). Technically, the term "digital" represents the binary sequence between "0" and "1," which refers to the conversion of content in the physical universe into a binary number format (Sezgin & Karabacak, 2020: 18). In this sense, digitalization (digitization) is primarily the conversion of analog signals (information) into "bits" in the form of "1s" and "0s." In short, digitalization refers to the transformation of analog material into a digital form, enabling easier and faster transmission, processing, and storage of information (Yankın, 2019: 9). On the other hand, digitalization also transforms analog data into a format that computers can process (Klein, 2020: 998), opening new doors to information and communication.

The concept of "digital," as discussed above in terms of its origin, meaning, and scope, is understood as a paradigm shift called "digitalization," whose effects can be seen in almost every stage of life in social and human sciences. Digitalization, closely tied to science, knowledge, and technology, means the technologization of the learning phenomenon in the educational process in pedagogical terms. This implies that in the teaching process, the sources, methods, forms, and knowledge positions undergo radical changes. This transformation, where information technology has become an obligatory partner with education, can be described as digital pedagogy. Digital pedagogy, which refers to the transformation of education along with all its components into an information technology-based framework, indicates significant changes in the learning environment, student, curriculum, and the role and function of the teacher. In this transformation, the school, traditionally the center of formal education, evolves into a decentralized virtual ecology, and the content of the curriculum (knowledge) is converted into a digital format. In this digital pedagogy based on virtual environments and digital information, the student turns into an avatar, a blend of their real self and virtual self, and the teacher's role becomes that of a technology moderator in the virtual ecosystem (Akpınar & Akyıldız, 2022; Kaya et al., 2023). In this virtual ecological pedagogy, which abstracts from real time and space, the most

striking change is the transformation of the "knowledge" concept, which is the main input of technology today. In this evolution, which erodes the current positions of the school, student, and teacher, the curriculum turns into a "digital program," pushing the "knowledge-student" interaction in the learning process far beyond its traditional form. To understand these transformations, the experience of distance education during the COVID-19 pandemic, both globally and in Turkey, can be considered a rehearsal of digital pedagogy. This process has also been an excellent opportunity to test Turkey's readiness for the digital pedagogy paradigm of the Information Age. Indeed, research on this topic (Aksu, 2021; Mutdoğan & Mutdoğan, 2022) suggests that Turkey still has a long way to go in transitioning to digital pedagogy. A critical factor in taking these steps is teachers' perspectives on digital pedagogy. This is because a paradigm or change that teachers are unaware of or do not prioritize has very little chance of succeeding in practice. In this regard, this study, which aims to analyze high school teachers' perceptions and self-efficacy regarding digital technology literacy, is of significant importance.

Method

Research Design

This study, which aims to analyze high school teachers' perceptions of the necessity of digital technology and their self-efficacy, as well as examine these factors based on various demographic variables, was conducted using the general survey model, one of the quantitative research methods. Studies described as surveys or descriptive surveys are quantitative in perspective and are suitable for research in social and human sciences, focusing on observing and describing the current state of a topic. In survey research, the views, perceptions, interests, and attitudes of participants included in the sample regarding an event, phenomenon, or topic are determined (Karasar, 2009). In the survey model, referred to as a descriptive survey, the current state of events, objects, entities, institutions, groups, and various fields is described and attempts are made to explain them (Kaptan, 1998). According to Yıldırım and Şimşek (2013), the descriptive survey model involves observation, recording, identifying relationships between events, and making generalizations based on controlled invariant principles.

Population and Sample

The population of this study consists of a total of 852 teachers and school administrators enrolled in the non-thesis master's program at the Institutes of Educational Sciences of Fırat and İnönü Universities during the 2022-2023 academic year (www.firat.edu.tr; www.inonu.edu.tr). The sample, however, consists of 412 teachers and school administrators who were easily accessible and voluntarily agreed to participate in the study. Convenience sampling, a type of non-probability sampling, includes anyone from the population who is willing to participate in the study. This sampling process continues until the desired number of participants is reached. Convenience sampling offers significant practical advantages in terms of time and cost in social science research (Ural & Kılıç, 2011). Regarding the representativeness of the sample, the following reference from the literature has been used: "In a scientific study, for a population size of 4000, a sample of 351 participants is sufficient with a margin of error of .05" (Balcı, 2009: 10). Based on this, it can be stated that the sample of 412 participants, drawn from the total population of 852, is sufficient to represent the population. The demographic distribution of the participants in the research sample is shown in Table 1.

Table 1. Demographic characteristics of the teachers in the sample

Variables		f	%
Gender	Female	247	60.0
	Erkek	165	40.0
Department/Field of Study	Verbal-Linguistic	117	28.4
	Science-Numerical	295	71.6
Seniority	1-5 Years	133	32.3
	6-10 Years	82	19.9
	11-15 Years	114	27.7
	16-20 Years	16	3.9
	21 Years and Above	67	16.3
Status of Taking Courses Related to Digital Education	Yes	67	16.3
	Partially	97	23.5
	No	248	60.2
Total		412	100.00

Data Analysis

The research data were collected using the "Digital Technology Literacy Scale" (DTLS), developed by the first author of the study. In the development of the scale, the relevant literature was reviewed, and a draft item pool consisting of 70 items was created through

interviews with seven faculty members (two from the Computer and Instructional Technologies Department and five from the Educational Sciences Department) working at Fırat and Inonu Universities. Then, these draft items were presented to nine experts from the Educational Sciences Department and the Computer and Instructional Technologies Department at the Faculties of Education of Fırat, Inonu, and Harran Universities. The credentials of these experts are as follows: two professors, four associate professors, and one assistant professor from the Educational Sciences Departments of the three universities; one professor and one associate professor from the Computer and Instructional Technologies Department of Fırat University. Based on the feedback received from these experts, the items in the draft form were examined for relevance, clarity, and comprehensibility concerning the research topic. As a result, three items were deemed inappropriate and removed. Thus, the DTLS, consisting of 67 items related to the study topic and four personal information items, was prepared for analysis. After obtaining the necessary permissions, a pilot application of the DTLS was conducted, and the data obtained were analyzed using the SPSS software. Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were performed in the analyses. As a result of the Confirmatory Factor Analysis (CFA), a two-factor structure (DTOÖ) was obtained. The first factor, consisting of a total of 5 items, was named "Necessity of Digital Technology", and the second factor, consisting of 20 items, was named "Self-Efficacy". The CFA values, which are found to be consistent with the relevant literature, are presented below:

Table 2. Fit indices for the DTLS CFA model

X^2/df	RMSEA	CFI	GFI	AGFI	NNFI	NFI	RMR	SRMR
1,144	0,018	0,99	0,95	0,94	0,99	0,99	0,040	0,022
The AVE and CR values for the DTLS								
Values and Names						CR		AVE
F1	Necessity of Digital Technology					0.93		0.73
F2	Digital Technology Literacy Self-efficacy					0.98		0.73

The items related to digital literacy in the DTLS were rated on a five-point Likert scale. The scale points are as follows: "5: Strongly Agree, 4: Mostly Agree, 3: Neutral, 2: Disagree, and 1: Strongly Disagree." The scoring for these levels is as follows: Strongly Agree (4.21-5.00), Mostly Agree (3.41-4.20), Neutral (2.61-3.40), Disagree (1.81-2.60), and Strongly Disagree (1.00-1.80). Subsequently, the DTLS was presented online in the form of a Google

Form to the teachers included in the sample. After a ten-day waiting period, a total of 447 scale forms were returned. Thirty-five forms were excluded due to missing, duplicate, or incorrectly filled responses, leaving 412 scale forms for analysis. These forms were uploaded to a digital platform for further analysis. SPSS-22 software was used for data analysis, applying descriptive statistical techniques such as arithmetic mean and standard deviation. In the analysis of teachers' digital literacy perceptions based on demographic variables, the distribution of the data was examined first. The Levene test indicated that the data were normally distributed. Therefore, the independent samples t-test was used for comparing two groups, and one-way ANOVA was used for multiple groups. To identify which groups had significant differences in the ANOVA test, the Scheffe Test was applied. A significance level of p=0.05 was accepted for all analyses. Cronbach's Alpha reliability analysis was conducted to examine the overall reliability of the scale, resulting in a score of 0.976. The Cronbach's Alpha values for the sub-dimensions are 0.928 for Necessity of Digital Technology and 0.982 for Self-Efficacy.

Finding

High School Teachers' Perception Level of the Necessity of Digital Technology

The data regarding the perception levels of high school teachers participating in the study on the necessity of digital technology are presented in Table 3.

Table 3. High school teachers' perception level of the necessity of digital technology

No	Items	Participation	
		x	ss
1	The use of digital technologies for educational purposes is necessary in the current teaching process	3.45	.89
2	The use of digital technologies for learning purposes is essential for academic development	3.28	1.04
3	Turkey is legally prepared for the use of digital technologies for learning purposes	2.15	.92
4	I believe that the online lessons I conducted during the COVID-19 period were effective and efficient	2.07	1.07
5	During the COVID-19 period, I conducted my online lessons remotely	4.31	1.95
TOTAL		**3.05**	**1.01**

When Table 3 is examined, it is observed that the overall perception levels of high school teachers participating in the study regarding the necessity of digital technology are at a moderate level (X = 3.05). When the items in Table 3 are examined individually, it is observed that "all" of the participating teachers (X = 4.31) have experience in teaching online during the COVID-19 pandemic. These teachers are "mostly" (X = 3.45) aware of the

importance of using digital technologies today. However, the participating teachers perceive these technologies as "moderately" (X = 3.28) necessary for academic development. The participating high school teachers "slightly agree" (X = 2.07) that their online lessons during the COVID-19 pandemic were effective, and they believe that Turkey is not yet fully prepared in terms of legal regulations for using digital technologies in education (X = 2.15).

To determine if there are significant differences in the perceptions of high school teachers based on demographic variables regarding the items in Table 3, an independent samples t-test was applied for binary groups. As a result of the test, no significant differences were found in terms of education level and branch; however, statistically significant differences were found in the 1st (t(df=410) = 2.186; p = 0.029) and 3rd (t(df=410) = -4.302; p = 0.000) items based on gender. In the first item, which showed a parametric distribution (Levene F = 1.616; p = 0.214), male teachers (X = 3.69) have higher perceptions regarding the use of digital technologies in education today compared to female teachers (X = 3.17). Similarly, in the third item, which showed a parametric distribution (Levene F = 0.590; p = 0.808), male teachers (X = 3.17) perceive that Turkey is legally ready to use digital technologies for learning purposes, more than female teachers (X = 2.01).

In the ANOVA analysis for homogenous distributions of multiple groups, no significant difference was found in teacher perceptions regarding the variable of taking courses related to digital education. However, regarding seniority, a statistically significant difference was identified in the 1st item (F(df=4-408) = 21.855; p = 0.009). In the first item, which showed a parametric distribution (Levene F = 2.214; p = 0.051), a Scheffe test was performed to determine which groups exhibited the difference. As a result, teachers with 1-5 years of seniority (X = 3.86) had higher perceptions regarding the use of digital technologies in education today compared to those with 21 or more years of seniority (X = 2.05).

High School Teachers' Digital Technology Literacy Self-Efficacy

The data regarding the perceptions of high school teachers participating in the study on digital literacy self-efficacy are presented in Table 4.

Table 4. High school teachers' digital technology literacy self-efficacy

No	Items	Participation	
		x	ss
6	I have the general knowledge required to use digital technologies for learning purposes	3.34	.93
7	I am competent in the pedagogical theories/principles underlying the use of digital technology	2.67	1.12
8	I have sufficient knowledge and skills in classroom management for online courses	2.64	1.04
9	I have sufficient knowledge and skills in attention-grabbing strategies for online courses	3.20	.96
10	I have sufficient knowledge and skills in motivating students in online courses	2.15	.91
11	I have sufficient knowledge and skills in engaging students in online courses	2.60	1.04
12	I have sufficient knowledge and skills in addressing individual differences in online courses	3.13	1.32
13	I am proficient in using appropriate teaching strategies, methods, and techniques for online courses	3.24	.93
14	I have sufficient knowledge and skills in questioning strategies for online courses	3.17	1.03
15	I have sufficient knowledge and skills in preparing and presenting digital stories, wikis, and blogs	3.67	1.03
16	I can prepare course videos using multimedia elements for online courses	4.32	1.95
17	I can create digital teaching materials for online courses	3.72	1.00
18	I have sufficient knowledge and skills to download/install hardware software for online courses from the internet or CD	4.00	.76
19	I can use ready-made educational software to design and implement digital lesson plans	3.68	.99
20	I am proficient in sharing lesson contents as files through wireless networks	4.13	.91
TOTAL		**2.48**	**.97**

When Table 4 is examined, it is observed that the participating high school teachers generally have an "average" (X=2.48) level of digital literacy self-efficacy. When the items in Table 4 are reviewed individually, it is evident that the participants generally consider themselves competent in using digital technologies. Specifically, the participating high school teachers are "mostly" (X=4.32) able to prepare lesson videos, "mostly" (X=4.00) able to download software from the internet, and "mostly" (X=3.68) able to use it. They are also able to create digital teaching materials (X=3.72) and digital stories (X=3.67). However, these same teachers do not consider themselves competent in the pedagogical roles and functions required for online courses. In this regard, the participating high school teachers have "average" self-efficacy in areas such as using digital technologies for learning purposes (X=3.34), knowing the pedagogical principles (X=2.67), online classroom management (X=2.64), attention-grabbing strategies (X=3.20), questioning strategies (X=3.17), addressing

individual differences (X=3.13), and using appropriate methods and techniques for this environment (X=3.24). According to Table 4, the participants have "low" self-efficacy in motivating (X=2.15) and engaging students (X=2.60) in online courses.

It is understood that the teachers have experience in conducting online classes during the Covid-19 pandemic. These teachers are "mostly" (X=3.45) aware of the importance of using digital technologies in education today. However, the participating teachers view these technologies as "moderately" (X=3.28) necessary for academic development. The participating high school teachers "slightly agree" (X=2.07) that their online courses were effective during the Covid-19 pandemic, and they perceive that Turkey is not yet fully ready, in terms of legal regulations, to use digital technologies for educational purposes (X=2.15).

To determine whether there is a significant difference in the teachers' perceptions based on demographic variables, an independent samples "t" test was applied. The test results revealed statistically significant differences between gender and subject areas. Statistically significant differences were found in items 6 (t(df=410)= -2.206; p=0.028) and 17 (t(df=410)=2.177; p=0.030). In the parametric distribution of item 6 (Levene F=2.034; p=0.155), science-math teachers (X=3.49) have higher self-efficacy perceptions regarding the use of digital technologies for learning purposes than language-literature teachers (X=3.03). Similarly, in the parametric distribution of item 17 (Levene F=1.269; p=0.261), science-math teachers (X=3.88) have higher self-efficacy perceptions about creating digital teaching materials for online courses than language-literature teachers (X=3.60).

In the ANOVA test performed for homogenous distributions among multiple groups, no significant difference was found in the perceptions of teachers regarding digital education courses. However, statistically significant differences were found in items 13 (F(df=4-408)=8.329; p=0.029) and 16 (F(df=4-408)=4.646; p=0.003) based on teaching experience. Parametric distributions of items 13 (Levene F=1.014; p=0.101) and 16 (Levene F=0.915; p=0.097) were analyzed using the Scheffé test to determine which groups showed the differences. The test results indicated that the difference in item 13 was between teachers with 11-15 years of experience (X=3.51) and those with 21 years or more of experience (X=2.95) regarding their self-efficacy in using appropriate methods and techniques for online courses. Similarly, the Scheffé test showed that the difference in item 16 was between teachers with 1-5 years of experience (X=4.58) and those with 16-20 years of experience (X=4.05) regarding their self-efficacy in preparing lesson videos for online courses.

Discussion and Conclusion

Digital pedagogy, the core educational paradigm of the Information Age, has significantly transformed the roles of students, curricula, and teachers. For Turkey to adapt effectively, it is crucial to understand and embrace these changes, with teachers' perceptions and attitudes playing a decisive role. Adapting to this paradigm requires teachers to develop digital literacy, defined as the ability to understand and use information accessed via computers and the internet (Gilster, 1997, as cited in Özkaya & Erat, 2022). Martin (2008) emphasizes that digital literacy also includes the awareness, attitude, and skills needed to use digital tools (Özerbaş & Kuralbayeva, 2018). Şahin and Kalkan (2022) further stress that for Turkey's digital transformation, educators must first recognize the importance of digital literacy and acquire the necessary competencies. Based on this requirement, the study examined the perceptions and self-efficacy of high school teachers regarding digital technology literacy. The discussion and conclusions regarding the findings of the study are as follows:

The participating high school teachers generally have "average" perceptions of digital technology literacy (X=3.05). In this regard, male teachers and younger teachers have higher perceptions compared to female teachers and more experienced teachers. In the limited studies conducted in Turkey on this topic, there are both results indicating high digital literacy competence among teachers (Şahin & Kalkan, 2022) and studies showing that teachers' digital literacy competence is not at the desired level (Öztürk, 2017). Considering the general dissatisfaction with remote education, which was experienced during the Covid-19 pandemic and is partly related to digital pedagogy, it can be stated that teachers have not fully internalized the digital pedagogy paradigm. This situation, which could be seen as a significant shortcoming in Turkey's adaptation to the Information Age, can be attributed to several reasons. One possible reason for teachers' insufficient perceptions and competencies in digital technology literacy is the lack of emphasis on digitalization in the teaching policies of the teacher training faculties. Another reason could be the negative perceptions of remote education during the Covid-19 pandemic, which have also negatively affected teachers' perceptions and competencies in digital technology literacy. The third and most important reason is that teachers have not put enough effort into learning about emerging technologies and the corresponding educational paradigms. However, the Ministry of National Education (MEB) in Turkey has prepared a "Digital Literacy Teacher's Guide"

(https://www.meb.gov.tr), which aims to guide teachers in this regard. Teachers' responsibility is to invest in themselves and acquire the information and competencies required by the digital age, such as digital literacy. Considering the relationship between lifelong learning and digital literacy (Gökbulut, 2021), the continuous learning needs of teachers become more evident.

Regarding the perceptions of digital technology literacy among the participating high school teachers, it was understood that they are aware of the technological competencies required but perceive the relationship between this competence and academic development as moderately necessary. Furthermore, they do not perceive Turkey as fully ready for this transition (with female teachers showing more concern). As noted earlier, this situation may be due to teachers' failure to fully internalize digital pedagogy. This may be related to teachers' insufficient knowledge regarding the relationship between education and technology. However, it is stated that the path to adapting to digitalization, often referred to as the Digital Revolution, depends on the ability of society members, particularly teachers, to use digital resources (Onursoy, 2018). Therefore, Turkey's readiness for digitalization in education is of great importance. This is because digitalization, which is already showing signs of affecting education shortly, is expected to significantly influence students' awareness, perceptions, thoughts, attitudes, and behaviors (Turan, 2022: 43). Indeed, a study examining the relationship between the digital literacy levels of primary school teachers and their roles in teacher leadership found that increasing digital literacy positively impacts teacher leadership (Tetik & Özkan, 2023). Similarly, a positive correlation has been identified between teachers' digital literacy levels and their lifelong learning tendencies (Gökbulut, 2021). These findings highlight that internalizing digital pedagogy and enhancing digital literacy skills play a critical role in improving the quality of educational processes.

In Turkey's adaptation to digitalization, the digital technology literacy competence of teachers is of critical importance. In this regard, teachers' perceptions of their self-efficacy regarding this topic are essential as they reflect the current state. In the study, the participating high school teachers' general self-efficacy in digital technology literacy was found to be "moderate" (X=2.48). This finding can be interpreted as indicating that teachers are aware of their insufficient competence in this area (especially among language-literature teachers) and recognize the need for further education in this regard. A closer look at the data reveals that the participating teachers generally possess digital knowledge and skills.

These teachers consider themselves competent in preparing lesson videos (with higher ratings among teachers with 1-5 years of experience), downloading and using software from the internet, and creating digital teaching materials and stories. However, it is notable that these same teachers consider themselves only moderately competent in using digital technologies for learning purposes. A detailed analysis shows that the participating teachers are not fully aware of pedagogical principles related to digitalization and only have "moderate" self-efficacy in areas such as online classroom management, attention-grabbing techniques, questioning, and using appropriate methods and techniques for this environment (with higher ratings among teachers with 11-15 years of experience). This finding suggests that while the participating teachers are generally competent in digital technologies, they are not fully proficient in the relationship between these technologies and education. This finding points to a lack of "techno pedagogical" knowledge and skills among the teachers, which can be expected, given Turkey's teacher training, appointment, and selection processes, which have not adequately emphasized the relationship between education and digital technology. Moreover, despite the widespread use of digital technologies in school management, these technologies are not adequately utilized in the teaching process, even with the presence of smart boards in classrooms. However, the MEB's applications, such as the Educational Informatics Network (EBA) and the FATİH Project, are promising. The FATİH Project, which requires the use of techno pedagogical competencies, is known for its benefits in areas such as effective teaching, deep knowledge, and application, quick access to information, efficient time usage, material diversity, and student-centered education (İncik, 2017). Similarly, EBA has been reported to make significant contributions in areas such as reinforcing lessons, visualizing content, providing review opportunities, and preparing for exams (Aktay & Keskin, 2016). Karabacak and Sezgin (2019) emphasize the need in this area by stating, "there is an urgent need for projects that will rapidly enhance digital literacy competencies for a digital transformation in education." What needs to be done is for universities to include techno pedagogical courses where subject knowledge, pedagogy, and technology intersect (Burmabıyık, 2014:4) in their teacher training programs, and for the Ministry of National Education (MoNE) to take measures that will enable a more intensive and effective use of digital technologies in the teaching process. Another solution could be to train existing teachers who lack sufficient knowledge and skills in this area through in-service training programs. However, the best solution is for teachers

themselves to take the initiative and compensate for their knowledge and skill gaps. After all, Turkey's fate in the Information Age and its digitalization process partly depends on "administrators and teachers who can use these technologies, develop new ones, and act in harmony and cooperation" (Öztaban, 2020).

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Ethical Committee Permission Information

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Author Contribution Statement

Elvan GÖKÇEN: *Conceptualization, methodology, formal analysis, investigation, resources, writing - original draft, writing - review & editing.*

Eyüp İZCİ: *Conceptualization, methodology, formal analysis, data curation, writing - original draft, writing - review & editing.*

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