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Research Article

An Investigation of the Relationships among 21st Century Skills, E-Learning Styles, and Emotional Intelligence Levels of Prospective Mathematics and Science Teachers

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Abstract

This study examines the relationships among prospective teachers' 21st century skills, e-learning styles, and emotional intelligence levels, as well as their variations based on demographic factors. A survey design was utilized, incorporating general survey, causal-comparative, relational survey, and predictive correlational approaches. The sample comprised 296 prospective teachers enrolled in mathematics and science education programs. Data were collected using the 21st Century Skills Scale, E-Learning Styles Scale, Schutte Emotional Intelligence Scale, and a demographic information form. Descriptive statistics, t-tests, ANOVA, Pearson correlation, and multiple linear regression analyses were conducted. Findings revealed significant differences in independent learning by field of study and in entrepreneurship, innovation, verbal, independent, and logical learning by gender. Academic achievement influenced information and technology literacy, critical thinking, and various learning skills. Daily internet use affected information literacy, critical thinking, and active learning. Significant correlations were found between 21st century skills, e-learning styles, and emotional intelligence. Various recommendations have been proposed based on the findings.

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Introduction

The acceleration of globalization and the rapid advancement of technology have profoundly transformed societies, economies, habits, and cultural structures. Advancements in information and communication technologies have diminished geographical boundaries, enhanced international interaction, and intensified the dynamism of the global competitive landscape (Care et al., 2012). This transformation has reshaped not only economic structures but also how individuals access information, learn, and engage socially (Kay, 2010; Voogt &

Roblin, 2012). Digitalization redefines expected competencies, cultural, academic, elevating professional, and personal development to new dimensions (Hollands & Escueta, 2020). The rise of knowledge-based economies and the impact of digital technologies on education, the workforce, and social dynamics have accelerated this shift. As traditional learning models become inadequate, required skills evolve, making 21st century competencies—adaptability, communication, critical thinking, problem-solving, digital literacy, collaboration, information management, and self-directed learning—essential for global competitiveness (European Commission [EC], 2008; International Society for Technology in Education [ISTE], 2016). Technical knowledge alone no longer suffices; adaptability, interdisciplinary thinking, and digital proficiency are now crucial (Colley & Maltby, 2008; Lee et al., 2017). Individuals' ability to align their skills with contemporary demands directly affects their capacity for knowledge production and problem-solving. Maintaining societal competitiveness in this rapidly evolving landscape requires individuals to develop specific competencies. According to Trilling and Fadel (2009), jobs demanding basic cognitive skills are declining, being replaced by professions involving higher-order thinking, complex communication, and specialized domain expertise.

The evolving dynamics of both social life and the business world, along with new knowledge-based conditions, necessitate the growing diversification and enrichment of the skills that individuals must possess. According to Harari (2018), the purpose of education today is not merely to transmit knowledge but to develop individuals' ability to interpret, utilize, differentiate essential from non-essential information, and relate knowledge within a global context. In the past, when access to information was limited, acquiring and memorizing knowledge using basic cognitive skills was deemed sufficient (Cevik & Sentürk, 2019). However, today's rapid expansion of knowledge demands that individuals not only access information but also process and apply it effectively. As a result, providing individuals with new and advanced skills has become essential (Binkley et al., 2012). While these competencies, known as 21st century skills, are defined differently by various researchers and institutions, they are widely acknowledged as a core set of abilities aligned with modern demands (Care et al., 2012; Partnership for 21st Century Learning [P21], 2019). Initially introduced in the scientific literature in the early 1990s, these skills have garnered growing attention in academic research, particularly since 2006 (Ekici et al., 2017).

21st century skills are not limited to knowledge and skills alone but also encompass understanding and performance, making them a comprehensive framework. These skills, which emerge from the integration of knowledge, competencies, attitudes, and values, are essential for individuals' success in both education and social life (Dede, 2010; Organisation for Economic Co-operation and Development [OECD], 2018). The National Research Council classifies these skills into three core domains: cognitive, interpersonal, and intrapersonal skills (NRC, 2011). When examined from a broad perspective in the literature, these skills are considered essential for both personal development and academic and professional success (Ekici et al., 2017). Given that they encompass both cognitive and affective domains, the interplay between them has emerged as a significant focus of scholarly inquiry. This study considers 21st century skills as an overarching framework and provides an in-depth analysis of their relationships with emotional intelligence and e-learning competencies.

Theoretical Background of the Study

21st Century Skills

21st century skills were introduced in the United States through the P21 platform and have since been implemented in 21 states. Supported by 33 institutions and organizations, this platform plays a key role in shaping and expanding the scope of these skills. This framework, which includes diverse components such as proficiency in English and other world languages, artistic skills, mathematical and analytical thinking, economic literacy, historical awareness, management skills, and citizenship, aims not only to enhance individuals' academic success but also to equip them to be effective global citizens (P21, 2019). These skills, which foster integrated knowledge application and support individuals' success in both daily life and professional settings, have been classified through multiple frameworks by various institutions (ISTE, 2016; Kereluik et al., 2013; OECD, 2018) and researchers (Wagner, 2008). According to research compiling articles and reports from these institutions (Ekici et al., 2017), the most emphasized skills include critical thinking, problem-solving, collaborative communication, creativity and innovation, ICT literacy, responsibility, flexibility, and adaptability.

The OECD Skills Framework (2018) highlights that by the 2030s, having expertise in only one field will no longer be sufficient. To succeed in the future, individuals will need to cultivate interdisciplinary thinking and gain expertise across multiple fields. In this context,

the DeSeCo framework defines three key competency domains: creating new values, coping with challenges, and taking responsibility. Furthermore, to adapt to changing conditions, individuals must acquire advanced competencies in metacognitive skills (learning to learn, innovative thinking), emotional-social skills (empathy, self-efficacy, emotional awareness), and practical skills (ICT proficiency). Various frameworks, including ATC21S (Assessment and Teaching of 21st Century Skills), and P21 emphasize skills such as analytical thinking, global competence, reflective judgment, strategic reasoning, technology-mediated reasoning, and career-readiness competencies (Binkley et al., 2012). Collectively, these frameworks aim to foster interdisciplinary competence, adaptability and critical thinking contributing to success in education, professional life, and society.

E-Learning Style

The rapid advancements in information and communication technologies have provided individuals with extensive opportunities to access information. In particular, the widespread adoption of online learning platforms during the COVID-19 pandemic has led to significant changes in the roles of both students and teachers (Yurdakul, 2016). In this new model, teachers take on a guiding role, while students take more responsibility for their own learning journey. This shift has increased the significance of individual differences in learning and allowed students to participate more autonomously in instructional activities within digitally mediated learning environments. According to Nitko (2004), understanding individual differences in this process has become essential for effective instruction. Learning styles refer to individuals' preferences in perceiving, processing, and utilizing information. Küpesiz and Gürpınar (2022) state that the term "learning styles" is used in the plural form since it represents the diverse characteristics and approaches of learners. Since the second half of the 20th century, as the influence of behaviorism has declined, numerous models and approaches to learning styles have emerged (Elçiçek & Erdemci, 2021).

Learning style refers to the methods individuals prefer for acquiring, processing, and utilizing information, which are influenced by personal differences (Dunn, 2000; Kolb & Kolb, 2005). The ways in which students receive, process, and store information determine their learning styles (Felder & Silverman, 1988; Yeşilyurt, 2019; Zain et al., 2019). While different preferences for processing information and learning sequences emerge in educational practices, an individual's learning approach is regarded as a key factor that

directly influences academic achievement and learning efficiency (Willingham et al., 2015). Therefore, how knowledge is acquired and processed is a fundamental aspect of the learning process (Kolb & Kolb, 2005; Ramírez-Correa et al., 2017; Yeşilyurt, 2019). Van Wart et al. (2017) emphasize that e-learning styles determine how students engage in learning activities, use digital learning materials, and communicate on e-learning platforms. These styles are directly linked to individual learning preferences, technological proficiency, and self-regulation skills (Willingham et al., 2015).

Emotional Intelligence

The idea that intelligence is the fundamental ability differentiating individuals has led to the emergence of various definitions. In this context, different perspectives vary regarding the influence of environment and genetics on the development of intelligence. According to the traditional approach, intelligence is perceived as a one-dimensional, fixed, and unchangeable trait (Kuzgun & Deryakulu, 2014). However, Gardner challenged this view by emphasizing both the biological and cultural dimensions of intelligence. He argued that intelligence is not a single entity but rather a combination of multiple cognitive abilities (Murray & Moore, 2012). Gardner's theory, which introduced eight distinct types of intelligence, significantly altered the criteria for academic success, showing that achievement is not solely dependent on academic intelligence (Pursun & Efilti, 2019). According to Goleman (1995), academic intelligence plays a crucial role in success.

Salovey and Mayer (1990), who pioneered the concept of emotional intelligence, define emotions as organized responses that extend beyond physiological, cognitive, motivational, and experiential systems. Emotions arise in response to an internal or external event that carries either positive or negative significance for the individual. Epstein (1998) states that emotions are crucial in processing environmental stimuli and are essential to both learning processes and decision-making mechanisms. Over time, various definitions of emotional intelligence have emerged. Cooper and Sawaf (2003) define emotional intelligence as an individual's ability to manage emotions effectively, whereas Brackett et al. (2004) view it as the ability to use, understand, and regulate emotions to support cognitive processes. Deniz et al. (2013) note that emotional intelligence is generally examined within the framework of the trait and information processing approaches. Similarly, Petrides and Furnham (2000) evaluate emotional intelligence from two distinct perspectives: Trait

emotional intelligence and the information-processing model of emotional intelligence. Accordingly, they conceptualize their model as emotional self-efficacy, while characterizing Mayer and Salovey's (1993) model as emotional cognitive ability.

Literature Review on 21st Century Skills, E-Learning Styles, and Emotional Intelligence

A review of the literature reveals that no comprehensive study integrates students' 21st century skills, e-learning styles, and emotional intelligence levels. Existing research typically addresses these variables individually or in pairs, yet there is a noticeable gap in studies that adopt a holistic approach to these three factors. Baki (2021) investigated the self-perceived competencies in 21st century skills of prospective Turkish language teachers and found that, overall, they considered themselves lacking competence. However, an analysis of sub-dimensions revealed that the highest perceived competency was observed in life and career skills, while the lowest was in information, media, and technology skills. Conversely, Gömleksiz et al. (2019) and Erdoğan and Eker (2020) found that prospective Turkish language teachers rated their 21st century skills highly. Similarly, Aydın and Şişman (2021) reported that prospective English language teachers perceived themselves as competent in learning, renewal, life, career, and intercultural skills. Kan and Murat (2018) found that prospective science teachers demonstrated confidence in creativity, problem-solving, independent work, and original project development. Studies conducted with prospective teachers from different fields have yielded similar findings. Research by Özden et al. (2018), Donmuş-Kaya and Akpunar (2018), and Güler (2019) demonstrated that prospective teachers exhibited strong competencies in life and career skills, learning skills, and information, media, and technology skills.

Numerous studies have explored the relationships between e-learning styles, 21st century skills, emotional intelligence, and other relevant factors. In the literature, research on students' e-learning styles is particularly prominent (Ucar & Yilmaz, 2023). Additionally, studies have examined the relationships between e-learning and thinking styles and problem-solving skills (Carmo et al., 2006; Güner & Erbay, 2021; Kaya et al., 2024), learning styles, educational technology self-efficacy, and academic achievement (Bakaç, 2022; Zain et al., 2019), e-learning styles, attitudes, and self-efficacy perceptions (Ozaydın-Ozkara & Ibili, 2021; Yurdal et al., 2021). The impact of e-learning styles on academic performance has also been widely examined (El Ghouati, 2017; Kia et al., 2009; Kurnaz & Ergün, 2019; Shahabadi &

Uplane, 2015). Studies have also investigated the relationship between emotional intelligence and educator performance (Khassawneh et al., 2022) as well as emotional intelligence and academic performance (Quílez-Robres et al., 2023). However, comprehensive research that simultaneously examines 21st century skills, e-learning styles, and emotional intelligence levels remains limited. Therefore, future studies are expected to contribute to the field by adopting a holistic perspective for investigating the interaction among these three variables.

Purpose of the Study and Research Questions

In today's digital age, individuals' access to information, learning, and problem-solving processes is rapidly evolving. Consequently, there is a growing need for research that provides a holistic examination of the interaction between 21st century skills, e-learning styles, and emotional intelligence levels. In this context, the primary objective of this study is to determine the relationship between 21st century skills, e-learning styles, and emotional intelligence levels in prospective teachers. Also, the 21st century learning skills, e-learning styles, and emotional intelligence levels of prospective mathematics and science teachers are analyzed in relation to different factors. Furthermore, this study aims to contribute to the development of more effective, personalized educational strategies by identifying patterns among these variables. This study seeks to answer the following research questions (RQ):

- RQ1: What are the levels of 21st century skills, e-learning styles, and emotional intelligence among prospective teachers?
- RQ2: Do prospective teachers' 21st century skills, e-learning styles, and emotional intelligence levels significantly differ based on their academic discipline and gender?
- RQ3: Do the 21st century skills, e-learning styles, and emotional intelligence levels of prospective teachers significantly vary based on their academic achievement and daily internet usage duration?
- RQ4: Is there a significant relationship between 21st century skills, e-learning styles, and emotional intelligence levels in prospective teachers?
- RQ5: Do 21st century skills and e-learning styles significantly predict emotional intelligence levels among prospective teachers?

Method

Research Design

This study adopted the survey model within a quantitative research framework to ensure efficient and goal-oriented data collection while meeting the necessary conditions for analysis. This model focuses on describing the current situation without altering it (Karasar, 2018). The research utilized survey-based general, causal-comparative, correlational, and predictive correlational designs to examine key relationships. The general survey design was employed to assess the 21st century skills, e-learning styles, and emotional intelligence levels of prospective mathematics and science teachers. The causal-comparative design explored whether these variables varied based on academic discipline, gender, academic achievement, and daily internet use. The correlational survey design investigated the interrelationships among these three variables, while the predictive correlational design analyzed the extent to which 21st century skills and e-learning styles influence emotional intelligence levels. In this approach, independent variables were identified, and their effects on the dependent variable were analyzed (Büyüköztürk, 2011).

Population and Sample

The population of this study consists of prospective teachers enrolled in an undergraduate program at a public university during the fall semester of the 2023-2024 academic year. The sample was selected from prospective teachers studying in the mathematics and science education departments. A non-random sampling method was employed, specifically, the purposive sampling technique. In this method, the participants' academic disciplines were used as the primary selection criteria. Criterion sampling is a technique used to examine cases that meet predefined criteria (Yıldırım & Şimşek, 2021). These criteria can either be determined by the researcher or chosen based on an existing list (Marshall & Rossman, 2016). A total of 296 voluntary prospective teachers participated in the study. Of the participants, 51.4% (n=152) were mathematics, while 48.6% (n=144) were science teachers.

Data Collection Tools and Procedure

To assess prospective teachers' 21st century skills, the Multidimensional 21st Century Skills Scale, developed by Cevik and Sentürk (2019), was employed. The scale consists of 41

items and five sub-factors: information and technology literacy, critical thinking and problem-solving, entrepreneurship and innovation, social responsibility and leadership, and career awareness. Confirmatory factor analysis (CFA) validated that the five-factor structure fits the dataset [χ^2/df=2.60, RMSEA=.050; SRMR=.058; GFI=.90; NFI=.91; CFI=.95; NNFI=.94]. The Cronbach's alpha internal consistency coefficient was measured at .86, while in this study, it was .87. To determine prospective teachers' learning preferences in digital environments, the E-Learning Styles Scale (ELSS), developed by Gülbahar and Alper (2014), was employed. The scale comprises 38 items and seven sub-factors: independent learning, social learning, visual-auditory learning, active learning, verbal learning, logical learning, and intuitive learning. CFA validated that the seven-factor structure fits the dataset [χ^2(632, N=2344)=5195.95, p<.000; RMSEA=.056; SRMR=.047; GFI=.90; AGFI=.88; NNFI=.97; IFI=.98; CFI=.98]. The Cronbach's alpha internal consistency coefficient was .94 for the overall scale and .82, .87, .86, .83, .86, .77, and .72 for the sub-factors.

In this study, the internal consistency coefficient was measured at .88. To assess prospective teachers' emotional intelligence levels, the Schutte Emotional Intelligence Scale, translated and adapted into Turkish by Tatar et al. (2017), was used. The scale consists of 33 items and follows a single-factor structure. CFA validated that the single-factor structure fits the dataset [χ^2/df=4.79, RMSEA=.04; GFI=.91; AGFI=.89; RMR=.11; CFI=.17]. Cronbach's alpha internal consistency coefficient was reported as .86, and in this study was measured as .87. A personal information form was used to determine prospective teachers' academic discipline, academic achievement, gender, and daily internet use. After receiving approval for the measurement instruments, the study was conducted voluntarily in an electronic format. The scales, designed in a five-point Likert format, ranged from 1 (strongly disagree) to 5 (strongly agree).

Data Analysis Process

Before proceeding with the analyses of prospective mathematics and science teachers' 21st century skills, e-learning styles, and emotional intelligence levels, a missing data analysis was conducted, and no missing values were found. Addressing missing data is a critical step in ensuring the reliability of results obtained (Çokluk et al., 2014). In the next stage, the normality of the dataset was examined. Initially, outliers were investigated, and Mahalanobis, Cook's, and Leverage values were analyzed. In the casewise diagnostics table,

a single outlier with an extreme z-score was identified and subsequently removed from the dataset. Following this adjustment, the analysis continued with 295 data points. The assumption of normal distribution for the subscales of the measurement instruments was assessed by examining skewness and kurtosis values. The results indicated that kurtosis values ranged from 1.47 to -0.65, while skewness values ranged from 0.11 to -0.87. According to Tabachnick and Fidell (2013), skewness and kurtosis values falling within the range of ±1.50 indicate a normal distribution. These findings suggest that the data follow a normal distribution. Descriptive statistical analyses, including median, standard deviation, variance, minimum, and maximum values, along with independent sample t-tests, one-way analysis of variance (ANOVA), Pearson correlation analysis, and multiple linear regression analysis, were conducted to address the research sub-problems. Certain assumptions must be met for multiple linear regression analysis, and accordingly, the variance inflation factor (VIF), tolerance value (TV), and condition index (CI) were examined. VIF values ≥10, TV≤.10, and CI≥30 indicate the presence of multicollinearity (Çokluk et al., 2014). According to the analysis results, the highest correlation value in the dataset was .53, while VIF values ranged from 1.33 to 2.06, CI values ranged from 1.00 to 27.49, and TV values ranged from .48 to .74. Based on these values, no multicollinearity issue was detected among the independent variables, and the findings confirmed that the assumptions of the study were met. Since all required assumptions were satisfied, the analysis proceeded with 295 participants. In the final dataset, 75.9% (n=224) of the participants were female, 24.1% (n=71) were male, 51.5% (n=152) were prospective mathematics teachers, and 48.5% (n=143) were prospective science teachers.

Results

This section presents descriptive statistics for the measurement instruments related to 21st century skills, e-learning styles, and emotional intelligence, including median, variance, standard deviation, minimum, maximum, and mean values. Independent sample t-tests were conducted to analyze these variables based on academic discipline and gender, followed by ANOVA analyses for academic achievement and daily internet use. Next, the relationships among these three variables were examined. Finally, multiple linear regression analysis assessed the predictive power of 21st century skills and e-learning styles on emotional intelligence levels.

Table 1. Descriptive statistics of 21st century skills, e-learning styles, and emotional intelligence

Scales	Dimension	Department	*N*	$\bar{X}$	Median	Variance	Sd.	Min.	Max.
	V_1	Math	152	3.95	3.93	.11	.33	2.80	4.93
		Science	143	3.97	3.93	.14	.38	2.73	5.00
	V_2	Math	152	3.94	4.00	.51	.71	1.67	5.00
		Science	143	4.08	4.17	.53	.73	2.00	5.00
	V_3	Math	152	3.46	3.40	.22	.46	2.30	4.50
21st		Science	143	3.52	3.50	.21	.46	2.10	4.80
Century	V_4	Math	152	3.65	3.75	.35	.59	2.00	5.00
Skills		Science	143	3.70	3.75	.27	.52	2.25	4.75
	V_5	Math	152	4.30	4.33	.20	.45	3.00	5.00
		Science	143	4.22	4.16	.27	.51	2.50	5.00
	General	Math	152	3.86	3.83	.11	.33	3.00	4.63
		Science	143	3.90	3.91	.13	.36	2.87	4.70
	Total		295	3.88	3.90	.12	.34	2.87	4.70
	V_6	Math	152	3.76	3.75	.23	.48	2.13	4.75
		Science	143	3.80	3.87	.31	.55	2.13	4.88
	V_7	Math	152	3.10	3.14	.36	.60	1.57	4.57
		Science	143	3.13	3.14	.38	.61	1.71	4.86
	V_8	Math	152	3.35	3.41	.42	.64	1.83	5.00
		Science	143	3.32	3.33	.54	.73	1.50	5.00
	V_9	Math	152	3.57	3.66	.47	.69	1.83	5.00
E-learning		Science	143	3.66	3.83	.47	.68	1.50	5.00
Style	V_{10}	Math	152	3.95	4.00	.36	.60	2.75	5.00
		Science	143	3.79	4.00	.59	.76	1.50	5.00
	V_{11}	Math	152	3.82	4.00	.58	.76	1.67	5.00
		Science	143	3.90	4.00	.46	.68	2.00	5.00
	V_{12}	Math	152	3.30	3.25	.50	.70	1.75	5.00
		Science	143	3.31	3.25	.52	.72	2.00	5.00
	General	Math	152	3.55	3.55	.17	.41	2.47	4.66
		Science	143	3.56	3.54	.19	.44	2.39	4.69
	Total		295	3.55	3.51	.18	.42	2.39	4.69
Emotional	V_{13}	Math	152	3.90	3.84	.13	.36	2.76	4.70
Intelligence		Science	143	3.89	3.87	.14	.37	2.82	4.82
	Total		295	3.89	3.87	.13	.37	2.76	4.82

Note: In the table above, information on the abbreviations used for measuring instruments are shown below.
Knowledge and technology literacy (V_1), Critical thinking and problem solving (V_2), Entrepreneurship and innovation (V_3), Social responsibility and leadership (V_4), Career consciousness (V_5), Audio-Visual Learning (V_6), Verbal Learning (V_7), Active Learning (V_8), Social Learning (V_9), Independent Learning (V_{10}), Logical Learning (V_{11}), Intuitive Learning (V_{12}), Emotional Intelligence (V_{13})

Table 1 shows that prospective mathematics teachers scored highest in career consciousness ($\bar{X}$=4.30), lowest in entrepreneurship and innovation ($\bar{X}$=3.46) in 21st century skills. Prospective science teachers achieved the highest score in career consciousness ($\bar{X}$=4.22) and the lowest in entrepreneurship and innovation ($\bar{X}$=3.52). For the e-learning styles scale, prospective mathematics teachers achieved the highest score in independent learning ($\bar{X}$=3.95) and the lowest in verbal learning ($\bar{X}$=3.10). Meanwhile, prospective science teachers had the highest score in logical learning ($\bar{X}$=3.90) and the lowest in verbal learning

($\bar{X}$=3.13). According to the emotional intelligence scale, the mean scores of prospective mathematics teachers ($\bar{X}$=3.90) and prospective science teachers ($\bar{X}$=3.89) were closely aligned.

Table 2. T-test results on differences by academic discipline in 21st century skills, e-learning styles, and emotional intelligence

						Levene Test			
Scales	**Dimension**	**Department**	***N***	$\bar{X}$	**Sd.**	***F***	***Sig.***	***t***	***p***
	V_1	Math	152	3.95	.33	2.82	.09	-.47	.63
		Science	143	3.97	.38				
	V_2	Math	152	3.94	.71	.18	.67	-1.59	.11
		Science	143	4.08	.73				
21st Century	V_3	Math	152	3.46	.46	2.84	.09	-1.20	.22
Skills		Science	143	3.52	.46				
	V_4	Math	152	3.65	.59	2.78	.09	-.73	.46
		Science	143	3.70	.52				
	V_5	Math	152	4.30	.45	.69	.40	1.42	.15
		Science	143	4.22	.51				
	V_6	Math	152	3.76	.48	2.89	.09	-.73	.46
		Science	143	3.80	.55				
	V_7	Math	152	3.10	.60	.23	.63	-.41	.67
		Science	143	3.13	.61				
	V_8	Math	152	3.35	.64	3.60	.05	.47	.63
		Science	143	3.32	.73				
E-learning	V_9	Math	152	3.57	.69	.01	.92	-1.18	.23
Style		Science	143	3.66	.68				
	V_{10}	Math	152	3.95	.60	7.62	.00	1.99	.04*
		Science	143	3.79	.76				
	V_{11}	Math	152	3.82	.76	1.19	.27	-.94	.34
		Science	143	3.90	.68				
	V_{12}	Math	152	3.30	.70	.42	.51	-.10	.91
		Science	143	3.31	.72				
Emotional	V_{13}	Math	152	3.90	.36	.00	.92	.31	.75
Intelligence		Science	143	3.89	.37				

*p<.05

Table 2 shows that only the independent learning subdimension of e-learning styles significantly favored prospective mathematics teachers ($t_{(293)}$=1.99, p<.05). The following dimensions showed no significant differences: knowledge and technology literacy ($t_{(293)}$=-.47, p>.05), critical thinking/problem-solving ($t_{(293)}$=-1.59, p>.05), entrepreneurship and innovation ($t_{(293)}$=-1.20, p>.05), social responsibility and leadership ($t_{(293)}$=-.73, p>.05), career consciousness ($t_{(293)}$=1.42, p>.05), audio-visual learning ($t_{(293)}$=-.73, p>.05), verbal learning ($t_{(293)}$=-.41, p>.05), active learning ($t_{(293)}$=.47, p>.05), social learning ($t_{(293)}$=-1.18, p>.05), logical learning ($t_{(293)}$=-.94, p>.05), intuitive learning ($t_{(293)}$=-.10, p>.05), and emotional intelligence ($t_{(293)}$=.31, p>.05).

Table 3. T-test results for gender in 21st century skills, e-learning styles, and emotional intelligence

Scales	Dimension	Department	*N*	$\bar{X}$	Sd.	Levene Test *F*	Levene Test *Sig.*	*t*	*p*
	V_1	Female	224	3.97	.32	5.61	.01	1.29	.19
		Male	71	3.91	.43				
	V_2	Female	224	4.04	.73	.63	.42	1.35	.17
		Male	71	3.91	.69				
21st Century Skills	V_3	Female	224	3.46	.45	.62	.42	-2.16	.03*
		Male	71	3.59	.49				
	V_4	Female	224	3.67	.58	2.80	.09	-.30	.76
		Male	71	3.69	.47				
	V_5	Female	224	4.29	.48	.04	.83	1.84	.06
		Male	71	4.16	.48				
	V_6	Female	224	3.78	.53	1.60	.20	.10	.91
		Male	71	3.77	.47				
	V_7	Female	224	3.05	.60	.07	.78	-3.46	.00**
		Male	71	3.33	.58				
	V_8	Female	224	3.30	.69	.34	.55	-1.60	.11
		Male	71	3.45	.66				
E-learning Style	V_9	Female	224	3.59	.70	2.59	.10	-.92	.35
		Male	71	3.68	.64				
	V_{10}	Female	224	3.83	.71	10.43	.00	-1.83	.04*
		Male	71	4.01	.59				
	V_{11}	Female	224	3.80	.71	1.03	.31	-2.34	.02*
		Male	71	4.03	.73				
	V_{12}	Female	224	3.29	.70	1.30	.25	-.87	.38
		Male	71	3.37	.73				
Emotional Intelligence	V_{13}	Female	224	3.91	.35	1.32	.25	.99	.32
		Male	71	3.86	.42				

*p<.05, **p<.01

Table 3 shows that, by gender, a significant difference was observed in entrepreneurship and innovation within 21st century skills in favor of male prospective teachers ($t_{(293)}$=-2.16, p<.05). Likewise, in the e-learning styles subdimensions, verbal learning ($t_{(293)}$=-3.46, p<.01), independent learning ($t_{(293)}$=-1.83, p<.05), and logical learning ($t_{(293)}$=-2.34, p<.05) favored male prospective teachers. However, the following subdimensions showed no significant differences: knowledge and technology literacy ($t_{(293)}$=1.29, p>.05), critical thinking and problem-solving ($t_{(293)}$=1.35, p>.05), social responsibility and leadership ($t_{(293)}$=-.30, p>.05), career consciousness ($t_{(293)}$=1.84, p>.05), audio-visual learning ($t_{(293)}$=.10, p >.05), active learning ($t_{(293)}$=-1.60, p>.05), social learning ($t_{(293)}$=-.92, p>.05), intuitive learning ($t_{(293)}$=-.87, p>.05), and emotional intelligence ($t_{(293)}$=.99, p>.05).

Table 4. ANOVA results for 21st century skills, e-learning styles, and emotional intelligence levels by academic achievement

Variables	Source of Variance	Sum of Squares	Mean Square	F	*p*	Difference
	Between Groups	1.10	.55	4.41	.01*	2>1
V_1	Within Groups	36.68	.12			3>1
	Total	37.78				
	Between Groups	4.18	2.09	4.04	.01*	2>1
V_2	Within Groups	151.02	.51			
	Total	155.20				
	Between Groups	.20	.09	.44	.63	-
V_3	Within Groups	63.94	.21			
	Total	64.14				
	Between Groups	.06	.03	.09	.90	-
V_4	Within Groups	92.02	.31			
	Total	92.08				
	Between Groups	.45	.22	.93	.39	-
V_5	Within Groups	69.94	.24			
	Total	70.39				
	Between Groups	.30	.14	.54	.58	-
V_6	Within Groups	79.86	.27			
	Total	80.16				
	Between Groups	1.74	.87	2.35	.09	
V_7	Within Groups	108.35	.37			
	Total	110.09				
	Between Groups	4.79	2.39	5.15	.00**	1>3
V_8	Within Groups	135.85	.46			
	Total	140.64				
	Between Groups	2.88	1.44	3.07	.04*	1>3
V_9	Within Groups	136.87	.46			
	Total	139.76				
	Between Groups	.78	.39	.81	.44	-
V_{10}	Within Groups	139.94	.47			
	Total	140.72				
	Between Groups	3.15	1.57	3.04	.04*	2>1
V_{11}	Within Groups	151.44	.51			2>3
	Total	154.59				
	Between Groups	12.05	6.02	12.70	.00***	1>3
V_{12}	Within Groups	138.50	.47			2>3
	Total	150.55				
	Between Groups	.38	.19	1.40	.24	-
V_{13}	Within Groups	39.92	.13			
	Total	40.30				

*p<.05, **p<.01, ***p<.001, [1: 2.00-2.99, 2: 3.00-3.49, 3: 3.50-4.00]

Table 4 shows a significant difference between knowledge and technology literacy ($F_{(2,292)}$=4.41, p<.05) and critical thinking and problem-solving ($F_{(2,292)}$=4.04, p<.05) within 21st century skills. This difference favors prospective teachers with higher academic achievement. Significant differences appeared in the e-learning styles subdimensions of active learning ($F_{(2,292)}$=5.15, p<.01), social learning ($F_{(2,292)}$=3.07, p<.05), logical learning ($F_{(2,292)}$=3.04, p<.05), and

intuitive learning ($F_{(2,292)}$=12.70, p<.001). The differences in active learning and social learning favor prospective teachers with lower academic achievement.

Table 5. ANOVA results for 21st century skills, e-learning styles, and emotional intelligence levels by daily average internet usage duration

Variables	Source of Variance	Sum of Squares	Mean Square	F	p	Difference
	Between Groups	.92	.45	3.62	.02*	1>3
V_1	Within Groups	36.86	.12			
	Total	37.78				
	Between Groups	8.54	4.27	8.50	.00***	1>3
V_2	Within Groups	146.67	.50			2>3
	Total	155.21				
	Between Groups	.40	.20	.92	.39	-
V_3	Within Groups	63.73	.21			
	Total	64.13				
	Between Groups	.32	.15	.50	.60	-
V_4	Within Groups	91.76	.31			
	Total	92.08				
	Between Groups	.18	.09	.38	.68	-
V_5	Within Groups	70.21	.24			
	Total	70.39				
	Between Groups	.01	.00	.02	.98	-
V_6	Within Groups	80.15	.27			
	Total	80.16				
	Between Groups	.96	.48	1.28	.27	-
V_7	Within Groups	109.13	.37			
	Total	110.09				
	Between Groups	3.13	1.56	3.32	.03*	3>1
V_8	Within Groups	137.51	.47			
	Total	140.64				
	Between Groups	.45	.22	.48	.61	-
V_9	Within Groups	139.30	.47			
	Total	139.75				
	Between Groups	.01	.00	.01	.98	-
V_{10}	Within Groups	140.71	.48			
	Total	140.72				
	Between Groups	.12	.06	.11	.89	-
V_{11}	Within Groups	154.47	.52			
	Total	154.59				
	Between Groups	.84	.42	.82	.44	-
V_{12}	Within Groups	149.71	.51			
	Total	150.55				
	Between Groups	.18	.09	.66	.51	-
V_{13}	Within Groups	40.11	.13			
	Total	40.29				

*p<.05, ***p<.001, [1: 1-3 hours, 2: 4-6 hours, 3: 7 hours or more]

Table 5 shows a significant difference between knowledge and technology literacy ($F_{(2,292)}$=3.62, p<.05) and critical thinking and problem-solving ($F_{(2,292)}$=8.50, p<.001) within 21st century skills. This difference favors prospective teachers with less daily internet use.

However, a significant difference appeared in the active learning subdimension of e-learning styles ($F_{(2,292)}$=3.32, p<.05), favoring those with more daily internet use. Table 6 presents the relationship between 21st century skills, e-learning styles, and emotional intelligence levels.

Table 6. Relationship between 21st century skills, e-learning styles, and emotional intelligence

Variables	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}	V_{13}
V_1	1.00	.24**	.53**	.31**	.39**	.38**	.36**	.19**	.35**	.22**	.32**	.07	.47**
V_2		1.00	.01	.22**	.36**	.23**	-.21	-.01	.15**	.09	.18**	-.10	.39**
V_3			1.00	.47**	.36**	.25**	.34**	.27**	.37**	.09	.31**	.18**	.33**
V_4				1.00	.31**	.19**	.19**	.15**	.37**	-.01	.14*	.03	.19**
V_5					1.00	.46**	.09	.18**	.37**	.30**	.20**	-.02	.53**
V_6						1.00	.42**	.39**	.46**	.45**	.40**	.28**	.48**
V_7							1.00	.36**	.37**	.30**	.22**	.24**	.28**
V_8								1.00	.39	.39**	.26**	.34**	.35**
V_9									1.00	.12*	.20**	.14*	.43**
V_{10}										1.00	.36**	.34**	.42**
V_{11}											1.00	.24**	.33**
V_{12}												1.00	.21**
V_{13}													1.00

Table 6 shows significant relationships among the study variables. The highest correlation value among the variables is between knowledge and technology literacy and entrepreneurship and innovation, as well as between career consciousness and emotional intelligence (r=.53, p<.01), whereas the weakest significant correlation appeared between social learning and independent learning (r=.12, p<.05). Also, statistically significant relationships emerged among the criterion variables. The closer the correlation coefficient is to ±1, the stronger the relationship between the variables (Can, 2023). Correlation values are categorized as follows: .00 to ±.29 indicates a weak correlation, ±.30 to ±.59 a moderate correlation, and ±.60 to ±1.00 a strong correlation (Büyüköztürk, 2011). Based on these categories, the relationships mainly fall within the weak to moderate range. Furthermore, the presence of low, non-significant correlations among certain variables is noteworthy, as it suggests potential underlying patterns that may not be immediately apparent. Given that the likelihood of low correlations reaching statistical significance tends to increase with a larger sample size, this result aligns with expected statistical outcomes and does not necessarily indicate the absence of meaningful relationships (Kline, 1994). To assess the predictive power of 21st century skills and e-learning styles on emotional intelligence levels, a multiple linear regression analysis was performed. The model incorporated knowledge and technology literacy, critical thinking and problem-solving, entrepreneurship and innovation, social

responsibility and leadership, career consciousness, audio-visual learning, verbal learning, active learning, social learning, independent learning, logical learning, and intuitive learning as key predictors of prospective teachers' emotional intelligence levels, aiming to examine the extent to which these variables contribute to emotional intelligence development in educational contexts. Table 7 presents the results of the multiple linear regression analysis.

Table 7. Regression results for 21st century skills, e-learning styles, and emotional intelligence

Model	Variables	B	Std. Error	□	*t*	Partial	Part	R	R^2	Adjusted R^2
	Constant	.86	.19		4.34***			.72	.53	.51
	V_1	.17	.05	.16	3.12**	.18	.12			
	V_2	.12	.02	.25	5.33***	.30	.21			
	V_3	.04	.04	.05	.98	.05	.04			
	V_4	-.07	.03	-.10	-2.17*	-.12	-.08			
	V_5	.18	.04	.24	4.30***	.24	.17			
1	V_6	.01	.04	.01	.24	.01	.01			
	V_7	.01	.03	.02	.39	.02	.01			
	V_8	.05	.02	.10	1.99*	.11	.08			
	V_9	.09	.02	.17	3.22**	.18	.13			
	V_{10}	.09	.02	.17	3.18**	.18	.13			
	V_{11}	.01	.02	.02	.57	.03	.02			
	V_{12}	.05	.02	.09	2.03*	.12	.08			
	**p<.05, **p<.01, ***p<.001, [$F_{(12\text{-}282)}$=26.58, p<.001, Durbin-Watson: 1.66]*									

According to the findings in Table 7, when emotional intelligence level is considered as the outcome variable, the multiple regression coefficient indicates that it is a significant factor, considering other predictors [R=.72, R^2=.53, $F_{(12,282)}$=26.58, p<.001]. 21st century skills and e-learning styles together explain approximately 51% of the total variance in emotional intelligence levels. The following variables were found to be significant predictors of emotional intelligence: knowledge and technology literacy (β=.16, $t_{(282)}$=3.12, p<.01), critical thinking and problem-solving (β=.25, $t_{(282)}$=5.33, p<.001), social responsibility and leadership (β=-.10, $t_{(282)}$ = -2.17, p<.05), career consciousness (β=.24, $t_{(282)}$=4.30, p<.001), active learning (β=.10, $t_{(282)}$=1.99, p<.05), social learning (β=.17, $t_{(282)}$=3.22, p<.01), independent learning (β=.17, $t_{(282)}$=3.18, p<.01), and intuitive learning (β=.09, $t_{(282)}$ =2.03, p<.05). On the other hand, entrepreneurship and innovation (β=.05, $t_{(282)}$=.98, p>.05), audio-visual learning (β=.01, $t_{(282)}$=.24, p>.05), verbal learning (β=.02, $t_{(282)}$=.39, p>.05), and logical learning (β=.02, $t_{(282)}$=.57, p>.05) were not significant predictors of emotional intelligence levels. Accordingly, it can be concluded that as knowledge and technology literacy, critical thinking and problem-solving, career consciousness, active learning, social learning, independent learning, and intuitive learning levels increase—while social responsibility and leadership levels decrease—the

emotional intelligence levels of prospective teachers also tend to rise. When examining the semi-partial correlation coefficients of the predictor variables, critical thinking and problem-solving has the highest significant positive correlation (r_p=.21), whereas social responsibility and leadership, active learning, and intuitive learning have the lowest significant positive correlation (r_p=±.08).

Discussion, Conclusion and Limitations

This study examines the relationships between 21st century skills, e-learning styles, and emotional intelligence levels among prospective mathematics and science teachers. Additionally, these variables are analyzed based on various factors. Descriptive findings reveal that both groups exhibit certain differences in their 21st century skills, e-learning styles, and emotional intelligence levels. According to the results of the 21st century skills, career consciousness scored the highest in both groups, while entrepreneurship and innovation scored the lowest. According to the e-learning styles scale, prospective mathematics teachers achieved the highest scores in independent learning, whereas prospective science teachers excelled in logical learning. Both groups showed the lowest mean score in the verbal learning dimension. The emotional intelligence scale results indicate that the average scores of prospective mathematics and science teachers are quite similar. The findings suggest that prospective teachers generally exhibit similar patterns in 21st century skills, e-learning styles, and emotional intelligence levels, with some variations in specific dimensions. Both groups scoring highly in career consciousness but low in entrepreneurship and innovation suggests that prospective teachers have strong career awareness but perceive themselves as less proficient in these areas.

21st century skills enable individuals to adapt to evolving social and technological conditions while fostering high-level cognitive competencies such as critical thinking, problem-solving, and creativity (Binkley et al., 2012; ISTE, 2016; Kay, 2010; OECD, 2018; P21, 2019; Voogt & Roblin, 2012). Therefore, enhancing educational content and programs that foster entrepreneurship and innovation among prospective teachers will strengthen their professional competencies, thus enabling them to provide students with a more effective learning experience. In terms of e-learning styles, prospective mathematics teachers scored higher in independent learning, while prospective science teachers excelled in logical learning, suggesting that both groups develop learning strategies aligned with the cognitive

demands of their respective fields. However, both groups' lower scores in verbal learning suggest a preference for visual and logical learning methods over verbal information. This finding highlights the need for varied instructional strategies that accommodate different learning styles (Bakaç, 2022; Carmo et al., 2006; El Ghouati, 2017; Kaya et al., 2024; Kurnaz & Ergün, 2019; Shahabadi & Uplane, 2015). Similar scores among prospective mathematics and science teachers suggest that both groups share common traits in emotional awareness, self-regulation, and empathy. As emotional intelligence is vital for effective communication, classroom management, and student motivation in teaching, strengthening programs that develop these skills is essential (Brackett et al., 2004; Cooper & Sawaf, 2003; Goleman, 1995; Salovey & Mayer, 1990). Emotional intelligence enables teachers to empathize with students, understand individual differences, and guide learning with sensitivity, while also enhancing their stress management, problem-solving, and conflict resolution skills, fostering a more productive and supportive educational environment (Quílez-Robres, 2023).

The findings show that prospective teachers have similar levels of 21st century skills, e-learning styles, and emotional intelligence, regardless of their academic discipline. However, a significant difference observed only in independent learning, favoring prospective mathematics teachers, suggests that this group prefers autonomous learning. This outcome may be due to the nature of mathematics, which inherently requires problem-solving, abstract thinking, and individual study. Meanwhile, the lack of significant differences in knowledge and technology literacy, critical thinking, entrepreneurship, social responsibility, career consciousness, and emotional intelligence suggests that prospective mathematics and science teachers have similar perceptions of their competencies. The significant overlap in teacher education programs across faculties may explain the similar outcomes in 21st century skills, e-learning styles, and emotional intelligence among prospective teachers from both disciplines. However, prospective mathematics teachers' greater tendency for independent learning highlights possible differences in learning habits and cognitive processes across disciplines. Therefore, diversifying teacher education programs to address discipline-specific learning styles and needs could further strengthen prospective teachers' professional competencies. The literature suggests that students' education level, academic performance, and field of study influence their 21st century skills, e-learning styles, and emotional intelligence (Güner & Erbay, 2021; Kia et al., 2009; Kurnaz & Ergün, 2019; Yurdal et al., 2019; Zain et al., 2019). While some studies highlight the

significant impact of certain variables on these skills (Donmuş-Kaya & Akpunar, 2018; Kaya et al., 2024; Özden et al., 2019), others find no notable differences among students. These conflicting findings suggest that learning processes are shaped by individual and environmental factors, highlighting the need for deeper investigation.

The findings indicate that prospective teachers show gender-based differences in certain dimensions. In 21st century skills, male prospective teachers scored significantly higher in entrepreneurship and innovation. In terms of e-learning styles, male prospective teachers demonstrated a stronger preference for verbal learning, independent learning, and logical learning. However, gender did not significantly affect knowledge and technology literacy, critical thinking and problem-solving, social responsibility and leadership, career consciousness, audio-visual learning, active learning, social learning, intuitive learning, or emotional intelligence. These findings suggest that prospective teachers generally perceive their 21st century skills, e-learning styles, and emotional intelligence in a similar way (Baki, 2022; Erdoğan & Eker, 2020; Gömleksiz et al., 2019; Gülbahar & Alper, 2014; Kan & Murat, 2019). However, male prospective teachers' stronger preference for entrepreneurship and innovation, independent learning, and logical learning underscores the importance of further research on gender's influence on learning strategies and professional skills.

The findings indicate that prospective teachers show significant differences in certain dimensions of 21st century skills and e-learning styles, depending on their academic achievement. Specifically, prospective teachers with higher academic achievement scored significantly higher in knowledge and technology literacy, as well as critical thinking and problem-solving. This suggests that academic success is closely linked to technological literacy or critical thinking skills. The literature supports this connection highlighting the relationship between academic achievement, performance, and problem-solving skills and these variables (El Ghouati, 2017; Güner, 2021; Khassawneh et al., 2022; Kia et al., 2009; Kurnaz & Ergün, 2019; Shahabadi & Uplane, 2015). In terms of e-learning styles, academic achievement levels influenced differences in active learning, social learning, logical learning, and intuitive learning. Prospective teachers with lower academic achievement were more inclined toward active and social learning, while those with moderate academic achievement performed better in logical learning. Additionally, prospective teachers with lower academic achievement showed a stronger preference for intuitive learning. These findings suggest a complex relationship between academic achievement and learning styles, indicating that

prospective teachers adopt distinct approaches based on their achievement levels. Enhancing academic success through technological literacy and critical thinking, along with developing instructional strategies for diverse learning styles, may improve learning efficiency.

The findings suggest that prospective teachers show significant differences in certain dimensions of 21st century skills and e-learning styles, depending on their daily internet usage. Prospective teachers with lower internet usage scored significantly higher in knowledge and technology literacy, as well as critical thinking and problem-solving. This suggests that restricted internet use may foster a more deliberate and goal-oriented development of technological literacy and critical thinking skills. Conversely, prospective teachers with higher internet usage scored significantly higher in active learning. This finding suggests that active learning can be enhanced with digital resources and that internet integration in education may have a positive impact. Overall, the impact of internet usage on 21st century skills and e-learning styles varies across dimensions. While strategic and mindful internet use is essential for developing technological literacy and critical thinking skills, excessive usage may negatively impact certain academic abilities.

The findings reveal significant relationships among the study variables. Knowledge and technology literacy showed the strongest correlation with entrepreneurship and innovation, while social learning had the weakest significant correlation with independent learning. Overall, the correlations among the variables were generally weak to moderate. The study found that 21st century skills and e-learning styles are related to prospective teachers' emotional intelligence. Specifically, knowledge and technology literacy, critical thinking and problem-solving, career consciousness, active learning, social learning, independent learning, and intuitive learning have a significant impact on emotional intelligence. This suggests that individuals with strong critical thinking, independent learning, and social learning skills tend to have higher emotional intelligence. However, the negative correlation between social responsibility and leadership and emotional intelligence suggests that the perception of social responsibility may affect emotional processes differently depending on the context. Additionally, the absence of a significant effect of entrepreneurship and innovation, audio-visual learning, verbal learning, and logical learning on emotional intelligence suggests that these factors do not directly determine emotional intelligence. Critical thinking and problem-solving showed the strongest relationship, suggesting that critical thinking positively impacts emotional intelligence. In contrast, the

weaker correlations of active learning and intuitive learning suggest that their contribution to emotional development may be limited. Overall, to enhance prospective teachers' emotional intelligence growth, education programs emphasizing critical thinking, independent learning, and social learning should be strengthened. Encouraging problem-solving skills and balancing individual and social learning processes could support both the academic and emotional development of prospective teachers.

Limitations and Suggestions for Future Research

This study examined the relationships between 21st century skills, e-learning styles, and emotional intelligence among prospective science and mathematics teachers. However, the study is subject to certain limitations. First, since the sample includes only prospective teachers from a single university, the findings have limited generalizability. Large-scale studies involving individuals from different universities and teacher education programs would enable a more thorough evaluation of the results. Second, the study employed a cross-sectional research design, which may limit establishing causal relationships between variables. Future research could adopt longitudinal designs to explore the development of 21st century skills, e-learning styles, and emotional intelligence in greater detail. Third, the self-report scales used in the study rely on participants' perceptions, which may lead to some subjectivity in responses. Incorporating qualitative data collection methods such as interviews, observations, and journal analyses in future research could offer more in-depth insights into prospective teachers' skills and learning styles. Additionally, the study considered only a few demographic variables (department, gender, academic achievement, internet usage duration). Future research could include socioeconomic status, teaching methods, educational technology usage, and pedagogical competencies for a more thorough analysis. Finally, while the study identified relationships between 21st century skills, e-learning styles, and emotional intelligence, it did not evaluate the impact of educational programs designed to develop these skills. Future research should employ experimental designs to assess the effectiveness of intervention programs aimed at enhancing these competencies, offering valuable contributions to teacher education. In this regard, conducting studies with larger samples, employing diverse research designs, and incorporating a broader range of variables will yield deeper insights into the role of 21st century skills, e-learning styles, and emotional intelligence in teacher education.

Ethical Committee Permission Information

Name of the board that carries out ethical assessment: Nevşehir Hacı Bektaş Veli University Scientific Research and Publication Ethics Board

The date and number of the ethical assessment decision: 13.01.2023/2023.01.05

Author Contribution Statement

Mahmut POLAT: *Conceptualization, literature review and investigation, data curation and analysis, methodology, implementation, original draft, language editing, organization, and writing*

Deniz KAYA: *Conceptualization, literature review, data curation and analysis, methodology, implementation, original draft, language editing, organization, and writing*

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