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PRE-SERVICE SCIENCE TEACHERS' E-LEARNING STYLES

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Abstract. *E-learning is becoming more popular than conventional teaching methods, particularly in science education. The use of e-learning has increased worldwide, especially after the COVID-19 pandemic. Today, students' e-learning styles have gained even more importance. The participants of this survey, which aimed to examine e-learning styles for selected variables, consisted of 401 pre-service science teachers from two public universities in Turkey. The personal information form was used to obtain data on gender, university, personal computer ownership status, type of device used to connect to the internet, grade level, number of social network memberships, internet usage purpose, and duration of social media use. Another tool used in face-to-face data collection was the E-Learning Styles Scale (ESS). As a result of the analysis, it was understood that participants' e-learning style scores were generally on the positive side. In terms of gender, grade level, and duration of social media use variables, there were statistically significant differences in the ESS and some of its sub-dimensions, while differences were found in only some sub-dimensions for the university variables, internet usage purpose, and number of social network memberships. Several suggestions were made in conjunction with the results of the descriptive and inferential analyses.*

Keywords: *descriptive research, e-learning styles, pre-service science teachers, science education*

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Introduction

The usage of information and technology has increased quickly in recent years as a result of the digital age. With the impact of the COVID-19 pandemic process, it is seen that the level of use of information technologies and internet tools has increased even more, and technology-based teaching systems are widely used in education. The internet, media, and other technology options, which have several educational benefits, provide opportunities in a variety of professions. For teachers, activating the education process, supporting it with cooperative learning, creating teacher-student, student-student, and student-content integrity, and increasing interaction can be counted among the most important features of media and technology.

With the pandemic, the concept of e-learning has gained importance with the increasing use of online environments in distance or open learning. With the changes in education, e-learning has turned from being an alternative option to a necessary situation during the COVID-19 pandemic process (Arslan & Bayram, 2022). E-learning is the realization of teaching activities in electronic learning environments by interacting with multimedia applications. It provides access to information through communication technologies and networks such as intranet/internet without depending on time and environment. E-learning can be defined in its simplest form as the development of students' skills by increasing their knowledge with different technological applications, tools, and strategies by providing interactive and rich learning environments with the technology-supported application of teaching methods compatible with the subject content via the internet and computer (Isman et al., 2003). The e-learning model, which eliminates the obligation of the education process to depend on a fixed time and environment and has rich course content in terms of materials used, also offers students a more adaptable and accessible learning environment. It can be said that e-learning has a very important place in education systems with its ease of sharing, storing, and accessing information, its very flexible structure in terms of time, and its relatively rich variety (Yarayan et al., 2022).

The COVID-19 pandemic in the world and in Turkey has significantly affected the education process and teaching techniques. The most widely used type of education in this process has been distance education. In distance

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education, where the learner and the teacher are not in the same environment, learning environments should be arranged in order to ensure effective learning and strengthen the teacher-student relationship. When the literature (Hamada et al., 2011; Kurnaz & Ergun, 2019; Voigt et al., 2021) is examined, it is concluded that determining learning perceptions and providing improvement or regulation in teaching methods increase the efficiency and productivity of students in learning. In this direction, in order to increase students' success and learning quality, they should be enabled to be more active in the learning process by understanding their personal characteristics and experiences. Individual differences emerge as one of the most important factors affecting success in the learning process. The most important issue that teachers or pre-service teachers, who aim to provide both quality and rich education by identifying the learning differences of students who are isolated in online learning environments, can address is learning styles.

Learning styles are one of the most important factors affecting the effectiveness of education (Akcekoce & Bilgin, 2016). Not everyone learns in the same way. Pre-service teachers may prefer to learn in different ways: by seeing, hearing, thinking deeply and in detail, preferring to learn alone, internalizing what they learn with their emotions, reading, doing, socializing, or living. In fact, one can realize effective learning not only in one way but also in multiple ways. Learning styles indicate the distinctive characteristics of pre-service teachers in the execution of learning activities, while e-learning styles are a way to improve the quality of learning, particularly for those who try to learn something through electronic devices (Gulbahar & Alper, 2014). For this reason, it is of great importance to determine the learning styles of students and pre-service teachers, to educate them in accordance with today's needs by considering these styles, and to organize the educational processes accordingly.

When the literature (Atalay, 2019; Kilic, 2022; Ozaydin-Ozkara & Ibili, 2021; Škoda et al., 2016; Yarayan et al., 2022; Yurdal et al., 2021; Zulfiani et al., 2018) is examined, it is seen that the concept of e-learning styles, as well as learning styles, has been established in recent years. It is understood that this concept is directly related to students' attitudes towards their use of media and technology and has become one of the focal points in education during the pandemic period. Because when the information that students will acquire through media and technology is integrated to include learning styles, a diverse and rich teaching process can be generated. In this context, pre-service science teachers should first be aware that different e-learning styles exist. In the technology-supported education system, which is expected to increase further in the future, they are expected to approach the students they will train with this perspective and offer opportunities suitable for their e-learning styles.

Problem

The purpose of the science education program is to train qualified and competent pre-service teachers. As such, pre-service science teachers should have the capacity and skills to educate future generations in line with the needs and requirements of the age, investigate scientific processes and technological solutions by questioning, take their personal development seriously, have high social relations, and care about sports, the arts, communication, and cultural activities. When they are appointed as teachers, they are expected to teach science in grades 5 to 8. The title of this course has changed several times over the years, including science education, life science, science teaching, and science and technology. Throughout their education, pre-service science teachers take various compulsory and elective courses such as out-of-school learning in science teaching, teaching practice, laboratory practices, instructional technologies, out-of-school learning environments, character and value education, scientific reasoning skills, teaching principles and methods, science learning and teaching approaches, technology, and learning. Upon graduation, they can work as science teachers in public or private schools, or in other educational institutions and consulting companies.

In countries like Turkey, which receive frequent immigration, there are students from many different countries, races, or cultures within the education system. Teachers have a lot of work to do in order to provide a common education at a certain level to this cosmopolitan group. In this context, pre-service science teachers who need to be technologically literate should first educate themselves well and then educate their students well in the future. At this point, the learning and e-learning styles of individuals gain importance. Students can concentrate longer and perform better in an environment that matches their specific needs and learning styles. In this regard, it is believed that an education that pays as much attention to students' learning styles as possible in face-to-face or electronic settings will make a positive contribution.

Due to the importance of e-learning styles, there are various studies (Atalay, 2019; Bakac, 2022; Ergun & Adibatmaz, 2020; Hamada et al., 2011; Kaviza, 2019; Kia et al., 2009; Kurnaz & Ergun, 2019; Voigt et al., 2021) on this

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topic in the literature. In addition to the fact that these studies are not considered sufficient, most of them have been conducted only with those who received either face-to-face or online education. With the pandemic affecting, shaping, and changing our lives radically, education has now returned to face-to-face after being online for a long time. However, in pre-service teacher education, online trainings can still continue when needed or when they are thought to be more effective. In this context, it is thought that examining the e-learning styles of pre-service science teachers, who have experienced the COVID-19 process, which is intended to be at peace with technology, will contribute to the relevant field.

Research Aim and Research Questions

In the related literature, there were some studies conducted with pre-service teachers from different departments. Some of these were studies conducted in the distance education process with non-homogeneous participant groups from different faculties or departments. Some of them were correlational studies, and some of them were conducted with teachers. In most of them, the number of participants was limited. In this context, there was no study conducted only with pre-service science teachers. In this study, it was aimed to examine the e-learning styles of pre-service science teachers with a detailed survey study in terms of different variables in which there were at least 30 participants in each category of the selected categorical variables examined, the sample represented the population relatively better, and face-to-face data were collected. Accordingly, the research questions that directed this study were as follows:

1. How do pre-service science teachers' e-learning styles differ based on gender?
2. How do pre-service science teachers' e-learning styles differ based on their university?
3. How do pre-service science teachers' e-learning styles differ depending on their personal computer ownership status?
4. How do pre-service science teachers' e-learning styles differ depending on the type of device used to connect to the internet?
5. How do pre-service science teachers' e-learning styles differ by grade level?
6. How do pre-service science teachers' e-learning styles differ based on the number of social network memberships?
7. How do pre-service science teachers' e-learning styles differ depending on the purpose of their internet use?
8. How do pre-service science teachers' e-learning styles differ depending on the duration of social media use?

Research Methodology

General Background

A quantitative approach was followed in this descriptive research, in which a ready-made questionnaire was re-examined and used. All of the pre-service science teachers who participated in the study were studying at universities in the capital city of Turkey. This group of participants constitutes approximately 5% of the entire similar population in Turkey. In order to conduct a study with this group, in which it was aimed to have at least 30 participants at each level of the analyzed categorical variables, permission was first obtained from the ethics committee. Ethics permission was obtained in October 2021 as a result of the processes that took approximately three months, such as preparing the files for the application to the ethics commission, application procedures, and the announcement of the results. Data collection was carried out in February 2022. As the participants were from two different universities and different grade levels, it was necessary to visit the departments many times to fit in with their convenient hours. Several descriptive and predictive analyses were used to analyze the data obtained as a result of a process lasting approximately one month.

Participants

In determining the sample size for this study, Nunnally's (1978) widely cited minimum 10-to-1 subject-to-item ratio was taken into account. In this context, the participants of this convenience sampling research were 401 pre-

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service teachers studying in the field of science education at two Turkish-medium public universities in Ankara, the capital of Turkey. Of these participants, aged between 18 and 22 years, 338 were female and 63 were male. Nearly half of the pre-service teachers (215 students) were from one university, while the remaining 186 students were from another university. Although most of the pre-service teachers (82.04%) who participated in the study had a personal computer, it was understood that the majority (87.78%) preferred their mobile phone to connect to the internet. One hundred and twenty-three of the participants were in their first year, 108 in their second year, 100 in their third year, and the remaining 70 in their final year. In addition, it was found that 16.46% of the pre-service teachers were members of only one of the social networks (Facebook, Twitter, YouTube, and Instagram), 33.67% of them were members of two, 33.91% of them were members of three, and the remaining 15.96% were members of all of them. It was understood that more than half of the students used the internet for social networking, 86 students for research-homework, 34 students for game-entertainment, and 70 pre-service teachers for more than one purpose. In the context of duration of social media use, it was determined that 39 pre-service teachers used 1 hour or less, 191 students used between 1–3 hours, 122 students used between 3–5 hours, and 49 pre-service teachers used 5 hours or more.

Instrument

In order to collect the data for the categorical variables to be examined, a "Personal Information Form" was formed by the researchers. With this tool, information was obtained about the gender of the pre-service teachers, the universities they attend, the status of having a personal computer, the types of devices they use while connecting to the internet, their grade levels, the number of social network memberships, internet usage purposes, and the duration of social media use.

The E-Learning Styles Scale (ESS) developed by Gulbahar and Alper (2014) was used as another data collection tool. There are 38 items on this scale, all of which are positive. The items in the ESS are 5-point Likert type and can be coded from five to one as I strongly agree, agree, undecided, disagree, and strongly disagree, respectively. Participants can get a minimum of 38 points and a maximum of 190 points from the scale. The Cronbach alpha reliability coefficient was found to be .94 during the development of the ESS. For the seven sub-dimensions determined, these coefficients were calculated as .86 for the "**Au**dio-Visual Learning" dimension (AUD), .86 for the "**Ve**rbal Learning" dimension (VED), .83 for the "**Ac**tive Learning" dimension (ACD), .87 for the "**So**cial Learning" dimension (SOD), .82 for the "**Fr**ee Learning" dimension (FRD), .77 for the "**Lo**gical Learning" dimension (LOD) and .72 for the "**In**tuitive Learning" dimension (IND), respectively. In this study, the reliability value for ESS was calculated as .80. Factor analysis was also performed for construct-validity evidence. By looking at the scree plot with eigenvalues, and examining with varimax and promax rotations, it was found that there were seven sub-dimensions, as in the original study of Gulbahar and Alper (2014). As can be seen from Table 1, which was prepared according to the item numbers of the original scale, the dimensions of six items (1, 9, 11, 16, 21, and 38) in the ESS were found to be different from their places in the original scale.

Table 1
The Original and New Version of the Dimensions of the ESS

Dimension	Original study	This study
AUD	1, 2, 3, 4, 5, 6, 7, 8	2, 3, 4, 5, 6, 7, 8
VED	9, 10, 11, 12, 13, 14, 15	10, 12, 13, 14, 15
ACD	16, 17, 18, 19, 20, 21	11, 17, 18, 19, 20
SOD	22, 23, 24, 25, 26, 27	1, 21, 22, 23, 24, 25, 26, 27
FRD	28, 29, 30, 31	16, 28, 29, 30, 31, 38
LOD	32, 33, 34	32, 33, 34
IND	35, 36, 37, 38	9, 35, 36, 37

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To briefly summarize the e-learning styles in Table 1, AUD is the e-learning style of those who like details while learning, prefer to learn by hearing and seeing, love to listen, and give priority to images such as figures, tables, and videos. VED refers to those who learn abstractly, learn by reading, express themselves better with written and oral expression, have a large vocabulary, and are keen on social studies lessons. Those in ACD have concrete learning characteristics; they like learning by doing and activities such as sports. People in SOD interact with their environment, participate in activities and trainings, like group work, and prefer project work. FRD expresses the style of those who are self-confident, independent, able to take responsibility, and who like to work individually. LOD stands for a realistic e-learning style that works through planning and loves math. IND can be explained as the innovative style that students learn by using their emotions and intuition.

Data Collection

The ethics committee's approval was first obtained before the data collection process. With this permission, this study was carried out with the knowledge of the university and faculty deans where the study will be implemented. Data collection tools appropriate to the problem of the study were determined, and their application to the students was carried out face-to-face by one of the researchers visiting the universities several times and applying the scales to the participants one-to-one. With the questionnaires used in the context of data collection, pre-service teachers were expected to fill out the "Personal Information Form" and the ESS, respectively. After one of the authors gave some general information about the study, the instructions for the scale were briefly explained. It took approximately 30 to 35 minutes to complete the process in each class. Thus, data were obtained from a total of 406 pre-service science teachers who volunteered.

Data Analysis

First, the obtained data was transferred to the computer environment. Then, the necessary tag names were added to the categories of the items. The highest and lowest values were checked by using frequency tables. Accordingly, 11 answers, which were understood to have been entered incorrectly because it was not possible, were rechecked and corrected. Then, the missing data were checked, and no missing answers were found in the data of the personal information form. In the data of the ESS, it was understood that only 40 of 406 pre-service teachers had missing data in 21 items. Only 47 of the 15428 possible answers were found to be empty. Since the percentage values of the missing data in the relevant items were less than 5%, the missing data for female pre-service teachers was given the average of all women in that item, and the missing data for male participants was filled by the average of all men. Boxplot diagrams were drawn separately for all variables, and stem-and-leaf diagrams were examined. The data of five participants, who were found to have extreme outliers for more than one variable, were excluded from the study. For the control of normality, after the kurtosis and skewness values were checked and confirmed that they were between -1 and +1, the boxplot diagrams were examined again. Thus, after the data cleaning process was completed, the analysis of the research continued with the remaining 401 participants.

As a result of the factor analysis for the ESS, the dimensions and related items of the scale were re-examined. By paying attention to these new groupings in Table 1, total scores were calculated separately for the ESS and its seven sub-dimensions. Since the number of items in the sub-dimensions was different from each other, these total scores were divided by the number of items in the relevant dimension. Consequently, standard scores out of 5 were obtained for each dimension separately. The averages of these standard scores were used to descriptively compare pre-service teachers' e-learning styles in terms of eight categorical variables. In addition, the sub-dimension or e-learning style in which each pre-service teacher had the highest average was also identified as a result of these scores. This sub-dimension, with the highest standard score, was accepted as the pre-service teacher's predominant e-learning style. Thus, the number of students in each sub-dimension or e-learning style was determined. These frequencies were examined for significant differences with the non-parametric chi-square test.

Parametric inferential statistical analyses were generally used throughout the study. In this context, 32 independent samples *t*-tests were conducted to examine the e-learning styles of pre-service science teachers according to gender, university, having a personal computer, and the type of device used to connect to the internet. A total of 32 one-way analyses of variance (ANOVA) were used to evaluate students' e-learning styles according to grade level, number of social network memberships, purpose of internet use, and duration of social media use.

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When statistically significant differences were found, a total of 13 Tukey and one Dunnett C tests were conducted to determine between which groups there were significant differences.

Research Results

The results regarding the distribution of e-learning styles determined according to the standard scores calculated out of 5 are given in Table 2. As can be seen from this table, 136 of 401 pre-service teachers had the highest standard scores in LOD. Other high-frequency predominant e-learning styles were FRD and AUD, while the least common were VED and ACD. It was observed that some pre-service teachers got the same highest standard scores in more than one e-learning style. It was found that the rate of these participants, who were determined to have more than one dominant e-learning style, was 9.7%. As a result of the chi-square test conducted for the data in Table 2, it was understood that there was a significant [$\chi^2(7, N = 401) = 317.66, p < .001$] difference between the e-learning styles of the pre-service science teachers.

Table 2
Distribution of Pre-service Science Teachers' E-learning Styles

Dimension	AUD	VED	ACD	SOD	FRD	LOD	IND	Multiple
N	54	5	8	36	107	136	16	39
%	13.5	1.2	2.0	9.0	26.7	33.9	4.0	9.7

In order to compare scores in general, a total of 200 average standardized scores out of 5 were calculated for all 24 categories and all participants by dividing the total scores by the number of items in that dimension, are shown in Table 3. As seen from this table, all data varied between 2.83 and 4.14. Only three of the data were on the slightly negative side, with a value below three. It is noteworthy that all three of these occurred in ACD. There were a total of 10 data with a value of 4 or more. Most of them (six) were formed in FRD. All the remaining data (93.2%) in this table were on the slightly positive side and ranged from four (agree) to three (undecided). When the ESS was analyzed, it was seen that all mean values calculated for both the 24 categories of eight variables and all sub-dimensions of the ESS were on the positive side and ranged between three and four.

Table 3
Descriptive Overview

Variable	Category	ESS	AUD	VED	ACD	SOD	FRD	LOD	IND
Total	All	3.60	3.89	3.25	3.08	3.71	3.89	3.99	3.17
Gender	Female	3.62	3.91	3.26	3.11	3.73	4.00	3.94	3.17
	Male	3.47	3.73	3.21	2.92	3.63	3.68	3.78	3.16
University	A	3.57	3.85	3.24	3.06	3.65	3.97	3.85	3.11
	B	3.63	3.93	3.26	3.10	3.78	3.92	3.98	3.24
Personal computer	Yes	3.60	3.87	3.26	3.08	3.71	3.95	3.92	3.17
	No	3.60	3.97	3.19	3.09	3.70	3.93	3.88	3.18
Type of device used	Computer-tablet	3.62	3.84	3.36	3.12	3.72	3.92	3.98	3.29
	Mobile phone	3.59	3.89	3.23	3.07	3.71	3.95	3.90	3.15
Grade level	1st grade	3.51	3.79	3.12	3.03	3.70	3.81	3.74	3.07
	2nd grade	3.56	3.88	3.19	3.04	3.55	4.03	3.93	3.14
	3rd grade	3.64	3.92	3.31	2.99	3.82	3.99	3.95	3.25
	4th grade	3.75	4.03	3.47	3.35	3.83	4.01	4.14	3.29

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Variable	Category	ESS	AUD	VED	ACD	SOD	FRD	LOD	IND
Social network memberships	One	3.54	3.87	3.19	3.07	3.58	3.84	3.88	3.16
	Two	3.56	3.90	3.18	3.03	3.66	3.93	3.90	3.14
	Three	3.65	3.89	3.33	3.15	3.80	4.04	3.97	3.18
	Four	3.60	3.88	3.29	3.04	3.78	3.90	3.86	3.22
Internet usage purpose	Social network	3.57	3.87	3.17	3.05	3.70	3.96	3.85	3.19
	Game-entertainment	3.62	3.86	3.19	3.40	3.74	3.76	4.05	3.24
	Research-homework	3.62	3.94	3.39	3.06	3.66	4.00	3.96	3.13
	More than one	3.62	3.89	3.34	3.03	3.79	3.93	3.98	3.14
Duration of social media use	1 hour or less	3.63	3.93	3.30	3.22	3.69	3.96	3.74	3.31
	Between 1–3 hours	3.56	3.84	3.25	3.06	3.66	3.91	3.89	3.10
	Between 3–5 hours	3.68	3.97	3.29	3.16	3.84	4.04	4.05	3.20
	5 hours and more	3.49	3.80	3.10	2.83	3.60	3.87	3.81	3.24

When Table 3 was compared on the basis of sub-dimensions, it was understood that the highest values were in FRD (15 out of 24 categories) and LOD (eight categories), and the lowest values were in ACD (22 of them). In terms of the gender variable, it is striking that female pre-service teachers' data in the ESS and all sub-dimensions were higher than that of males. While there were small differences between the values in terms of the university variable, it was understood that the data for the categories of having a personal computer and the type of device used to connect to the internet were not very different. In terms of grade level, purpose of internet use, number of social network memberships, and duration of social media use, there were small differences between the data for the ESS and its sub-dimensions. Especially in terms of the grade level variable, it is noteworthy that the last year's pre-service teachers' averages in the ESS and all sub-dimensions were higher than those in the first grade.

In the context of inferential statistics, the findings of the independent samples *t*-tests conducted to examine the mean scores of the pre-service teachers participating in the study in terms of the ESS and sub-dimensions according to the gender variable are given in Table 4. As can be seen from this table, a statistically significant difference was found between the categories of the gender variable in the analysis performed for the ESS [$t(399) = -3.22$, $p = .001$]. In terms of sub-dimensions, statistically significant (p values < .05) differences in favor of women were found between the categories of the gender variable in the analyses performed for AUD, ACD, and FRD.

Table 4
Independent Samples T-test Findings for the First Research Question

Dimension	Female ($\bar{X}$)	Male ($\bar{X}$)	*t*	*p*
ESS	137.51	131.88	-3.22	.001
AUD	27.40	26.12	-2.54	.013
VED	16.28	16.05	-0.63	.529
ACD	15.54	14.59	-2.03	.043
SOD	29.81	29.05	-1.22	.224
FRD	19.75	17.92	-3.39	.001
LOD	16.04	15.51	-1.53	.126
IND	12.68	12.65	-0.10	.924

The results of the independent samples *t*-tests for the university variable are presented in Table 5. As can be seen from this table, only two of the eight tests for the university variable were significant. In other words, statistically significant differences were found between the categories of the university variable only in SOD [$t(399) = -2.21$, $p = .028$] and IND [$t(399) = -2.03$, $p = .044$]. There were no significant differences between the scores of other sub-dimensions or e-learning styles of pre-service teachers studying at two different universities.

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Table 5
Independent Samples T-test Findings for the Second Research Question

Dimension	University A ($\bar{X}$)	University B ($\bar{X}$)	*t*	*p*
ESS	135.51	137.91	-1.86	.063
AUD	26.94	27.49	-1.63	.103
VED	16.21	16.28	-0.24	.812
ACD	15.32	15.48	-0.46	.643
SOD	29.22	30.23	-2.21	.028
FRD	19.52	19.40	0.76	.445
LOD	15.84	16.09	-1.71	.088
IND	12.45	12.95	-2.03	.044

When the findings for the third and fourth research questions were examined, it was seen that none of the independent samples *t*-tests were significant (*p* values > .05). In other words, it was understood that the pre-service science teachers' scores in the ESS and its sub-dimensions did not change significantly in terms of the categories of having a personal computer and the type of device used to connect to the internet.

The findings of the ANOVAs for the grade level variable are given in Table 6. From this table, it was understood that there was a significant difference between pre-service teachers' ESS scores in terms of the grade level variable [$F(3, 397) = 9.24$, $p < .001$]. In addition, significant differences (*p* values < .05) were found in all sub-dimensions except IND.

Table 6
One-way ANOVA Findings for the Fifth Research Question

Dimension	Sum of Squares (Between Groups)	Sum of Squares (Within Groups)	*F*	*p*
ESS	4345.19	62219.31	9.24	< .001
AUD	136.70	4345.49	4.16	.006
VED	149.88	2699.92	7.35	< .001
ACD	155.80	4575.98	4.51	.004
SOD	317.23	8039.92	5.22	.002
FRD	131.43	4649.57	3.74	.011
LOD	66.30	2015.49	4.35	.005
IND	46.57	2400.93	2.57	.054

Of the seven Tukey analyses conducted to determine which groups the differentiation originated from, only the findings of the one for the ESS are discussed in Table 7. When this table was examined, it was seen that there were statistically significant (*p* values < .05) differences between the 1st and 3rd grade [1–3], 1st and 4th grade [1–4], and 2nd and 4th grade [2–4] categories. Since the differences between the averages were negative, it was understood that these differences were higher in favor of the upper classes. According to the results of the other Tukey tests, whose findings are not given in the tables here, significant differences (*p* values < .05) were found between different categories: one [1–4] for AUD, three [1–3, 1–4, and 2–4] for VED, three [1–4, 2–4, and 3–4] for ACD, two [2–3 and 2–4] for SOD, one [1–2] for FRD, and one [1–4] for LOD.

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Table 7
Tukey Test Findings for the Fifth Research Question

Grade Level		*MD*	*p*
1st grade	2nd grade	-1.98	.627
	3rd grade	-5.03*	.016
	4th grade	-9.30*	< .001
2nd grade	3rd grade	-3.05	.296
	4th grade	-7.32*	.001
3rd grade	4th grade	-4.27	.128

*$p < .05$

The data obtained regarding the ANOVAs conducted to examine the mean score of the ESS and its sub-dimensions in terms of the number of social network memberships variable are given in Table 8. As it can be understood from this table, there was no statistically significant difference in the ESS. Among the eight sub-dimensions, only SOD showed a statistically significant difference [$F(3, 397) = 2.85$, $p = .037$]. However, no significant finding was found as a result of the Tukey test based on the assumption of equal variance, which was performed to determine the groups that differed in this sub-dimension (p value > .05). The Dunnett C test, which does not assume equal variance, revealed a significant (p value < .05) difference in the number of social network memberships between "only one" and "three".

Table 8
One-way ANOVA Findings for the Sixth Research Question

Dimension	Sum of Squares (Between Groups)	Sum of Squares (Within Groups)	*F*	*p*
ESS	1234.36	65330.14	2.50	.059
AUD	1.54	4480.65	0.05	.987
VED	48.24	2801.55	2.28	.079
ACD	27.67	4704.18	0.78	.506
SOD	176.01	8181.13	2.85	.037
FRD	76.90	4704.10	2.16	.092
LOD	5.77	2076.02	0.37	.776
IND	5.32	2442.18	0.29	.834

The findings of the ANOVAs for the internet usage purpose variable are presented in Table 9. As it can be understood from this table, statistically significant differences were found only in VED [$F(3, 397) = 4.68$, $p = .003$] and ACD [$F(3, 397) = 2.72$, $p = .045$] among the ESS and its seven sub-dimensions.

Table 9
One-way ANOVA Findings for the Seventh Research Question

Dimension	Sum of Squares (Between Groups)	Sum of Squares (Within Groups)	*F*	*p*
ESS	275.07	66289.44	0.55	.649
AUD	16.63	4465.56	0.49	.687
VED	97.33	2752.46	4.68	.003
ACD	95.14	4636.64	2.72	.045
SOD	47.00	8310.15	0.75	.524

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Dimension	Sum of Squares (Between Groups)	Sum of Squares (Within Groups)	*F*	*p*
FRD	54.31	4726.70	1.52	.209
LOD	18.33	2063.46	1.18	.319
IND	6.80	2440.71	0.37	.776

The results of the Tukey test for VED, which is one of the two sub-dimensions determined to have significant *p* values in terms of the internet usage purpose variable, are given in Table 10. As can be seen from this table, there was only a significant (*p* value < .05) difference between those who used the internet as a "social network" and those who used it for "research-homework". A statistically significant (*p* value < .05) difference was found only between the "social network" and "game-entertainment" categories for ACD, whose findings are not given in the table here.

Table 10
Tukey Test Findings for the Seventh Research Question

Internet Usage Purpose		*MD*	*p*
Social network	Game-entertainment	-0.10	.997
	Research-homework	-1.13*	.005
	More than one	-0.86	.087
Game-entertainment	Research-homework	-1.03	.216
	More than one	-0.76	.517
Research-homework	More than one	0.27	.916

*$p < .05$

The findings of the ANOVAs for the variable duration of social media use are presented in Table 11. When this table was examined, it was understood that there was a significant [$F(3, 397) = 5.15$, $p = .002$] difference between pre-service teachers' ESS scores in terms of duration of social media use. In addition, significant (*p* values < .05) differences were found in ACD and SOD.

Table 11
One-way ANOVA Findings for the Eighth Research Question

Dimension	Sum of Squares (Between Groups)	Sum of Squares (Within Groups)	*F*	*p*
ESS	2492.20	64072.31	5.15	.002
AUD	86.90	4395.29	2.62	.051
VED	34.65	2815.14	1.63	.182
ACD	112.84	4618.94	3.23	.022
SOD	184.57	8172.58	2.99	.031
FRD	59.63	4721.37	1.67	.173
LOD	37.11	2044.68	2.40	.067
IND	33.81	2413.69	1.85	.137

Of the three Tukey analyses performed, the findings of only the one for the ESS are given in Table 12. As can be seen from this table, there were significant (*p* values < .05) differences between the categories of "between 1–3 hours" and "between 3–5 hours" and the categories of "between 3–5 hours" and "5 hours or more". As a result of other Tukey analyses, significant (*p* values < .05) differences were found between two ["1 hour or less" and "5 hours or more"; "between 3–5 hours" and "5 hours or more"] different categories for ACD and one ["between 1–3 hours" and "between 3–5 hours"] for SOD.

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Table 12
Tukey Test Findings for the Eighth Research Question

Duration of Social Media Use		*MD*	*p*
1 hour or less	Between 1–3 hours	2.50	.678
	Between 3–5 hours	-2.14	.796
	5 hours or more	5.11	.240
Between 1–3 hours	Between 3–5 hours	-4.64*	.009
	5 hours or more	2.61	.574
Between 3–5 hours	5 hours or more	7.26*	.004

*$p < .05$

Discussion

The e-learning styles of pre-service science teachers were first analyzed through frequencies and chi-square analysis. Thus, there was a significant difference in the participants' e-learning styles, with LOD, FRD, and AUD being more common for this group, while VED and ACD were the least common. Senturk and Cigerci (2018), in their study with 213 classroom teachers, determined VED as the e-learning style with the lowest rate. Gulbahar and Alper (2014), on the other hand, found VED to be one of the more common ones in their study with students enrolled in different associate degree and undergraduate completion distance education programs. This difference is thought to be due to the fact that this study was conducted in an earlier year with distance education program students and a non-homogeneous group. In the context of the most common e-learning styles, Dikmen (2020) found the factors of LOD, FRD, and AUD in the same order as in our study in the research they conducted with 148 university students. Senturk and Cigerci (2018), on the other hand, determined the same three styles identified in our study, but in a different order: AUD, LOD, and FRD, as the most common e-learning styles. Although the prevalence rate of AUD was still high in this research, it was thought that the effect of the COVID-19 pandemic process, the fact that they were different branch groups, and that one group was pre-service teachers and the other was teachers, had contributed to its decline to third place. When evaluated in general, it can be said that pre-service teachers like to work in a planned manner, they are self-confident at the point of independent learning, and they prefer to learn through audio-visual.

For the descriptive evaluation of the findings regarding the e-learning styles of the pre-service science teachers, it was concluded that a total of 200 averages belonging to 24 categories of eight variables, which were examined with standard scores out of 5, were moderately positive. Only in ACD, three data were below three and were on the slightly negative side. The fact that all three of them were engaged in active learning has brought to mind the idea that pre-service science teachers, who are generally not very active, have become accustomed to inaction a little more with the COVID-19 pandemic process. It is thought that the COVID-19 pandemic process also contributed to the formation of the six highest averages in the ESS. All of the 24 averages and the seven sub-dimension averages calculated for the ESS were positive and ranged from three (undecided) to four (agree). The mean values found by Gulbahar and Alper (2014) on the basis of factors for the ESS ranged between 3.07 and 3.95. Ozudogru (2022), on the other hand, found averages between 3.09 and 3.93. When the total scores calculated for the sub-dimensions in Kuru's (2018) study with 193 primary school teachers were divided by the number of items in the relevant factor, it was understood that the data on the factor basis were again on the slightly positive side and varied between three and four. While the mean of all participants in the ESS in our study was found to be 3.60, Durnali (2022) reported a very close value of 3.58 for his study with 476 education faculty students.

When the gender variable was examined, it was understood that the averages of female pre-service teachers in the ESS and all sub-dimensions were higher than those of males. Inferential analyses also showed that these differences were statistically significant for ESS, AUD, ACD, and FRD. The means of females and males for the ESS were calculated as 137.51 and 131.88, respectively. Kuru (2018) also determined the means of women and men for the ESS as 137.27 and 130.48, with very similar values, and found statistically significant differences in favor of women in the ESS, SOD, and ACD, and in favor of men in the FRD. The fact that the independent e-learning style was found

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to be against women can be reconciled with the fact that that study was conducted in earlier years with pre-service classroom teachers; the participants were 193 people; and perhaps the COVID-19 process changed something. In this context, Senturk and Cigerci (2018) also found a significant difference in the distribution of classroom teachers' e-learning styles in terms of the gender variable, and it was understood from the relevant tables that female classroom teachers were more in the ESS, AUD, and FRD. Geri (2021) conducted a study with 340 sport sciences students and found significant differences in favor of women in AUD and ACD.

The descriptive values for the university variable differed slightly, but only two of the eight inferential tests were statistically significant. Cohen's d values of .221 and .202 and partial eta squared values of .012 and .010 were calculated in SOD and IND, where significant differences were found. Considering the small effect size values obtained, the convergent descriptive values of the related groups, and the sample size, which could not be counted as a small sample size, it would not be wrong to say that there was no significant difference between the e-learning styles of the pre-service science teachers in terms of the university variable within the scope of this study. In the national or international literature review, no study was found in which pre-service science teachers' e-learning styles could be compared in terms of this variable.

The findings related to the personal computer ownership variable showed that there were no significant differences in the ESS and its sub-dimensions. This is not surprising considering that almost every pre-service science teacher has a smart device. Likewise, it was concluded that the type of device used to connect to the internet did not create significant differences in the e-learning styles of pre-service science teachers. Yetis (2018) also found that e-learning styles did not differ according to the type of device used to connect to the internet. Nowadays, since it is very easy to access the internet with any smart device, it is understood that the important thing is the goal, not the means.

In terms of the grade level variable, differences were observed between the descriptive data for the ESS and its sub-dimensions. The averages of the senior pre-service teachers on the ESS and all its sub-dimensions were higher than those of the first year. In fact, it was understood that the mean scores of pre-service teachers' e-learning styles were consistently higher in parallel with their grade levels in ESS, AUD, VED, LOD, and IND. In this context, statistically significant differences were found in terms of the grade level variable in both the ESS scores and all sub-dimensions except IND. Geri (2021) found statistically significant differences in AUD and SOD, Ibili (2020) in LOD and IND, and Kuru (2018) in ACD, SOD, and FRD in terms of grade level, while Yetis (2018) reported no significant difference. In conclusion, when both the descriptive values of this study and the results of Tukey tests were interpreted together, it was concluded that the highest differentiation between the first and fourth grades occurred in VED, ACD, and LOD. Unlike first graders, it is thought that experiencing the pandemic process during their university education, taking a teaching practice course, and even entering the graduation path may have had an effect on this situation.

As a result of the findings obtained in terms of the number of social network memberships variable, it was understood that there was a significant difference only in SOD. However, no difference was found between the two groups with Tukey analysis, and a significant difference was found between social network membership categories "only one" and "three" as a result of the Dunnett C test. In other words, contrary to our expectations, there were no clear differences in the e-learning styles of those with more social network memberships versus those with fewer memberships, despite the fact that pre-service teachers are thought to be doing more diverse sharing, interaction, learning, or research as a result of their social network memberships. The partial eta squared value for SOD, which was the only significant difference, was calculated as .021. It is thought that this statistically significant difference was not very important in practice as a result of the findings such as the small effect size value, the high sample size, and the fact that the averages were not very different. In this context, it can be said that there was no significant difference between the e-learning styles of pre-service teachers in terms of the social network memberships variable within the scope of this study. On the other hand, when Yetis (2018) compared the e-learning styles of those with and without social network memberships with the independent samples *t*-test, he found significant differences in favor of those with social network memberships in ESS, AUD, ACD, SOD, LOD, and IND.

When an evaluation was made in terms of the internet usage purpose variable, significant differences were observed in fewer factors than expected, only in two sub-dimensions. In particular, it was expected that there would be a difference between those whose purpose of using the internet was "research-homework" and others in SOD and LOD. It is also noteworthy that VED (five students) and ACD (eight students), which were determined to be different, were the two groups with the lowest frequencies in terms of dominant e-learning style distribution, with a total of 13 pre-service science teachers. Moreover, the partial eta squared values calculated for both of them show a small effect size. Significant differences were found between "social network" and "research-homework" in

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VED and between "social network" and "game-entertainment" in ACD. The mean of the "social network" category is lower in both. While Yetis (2018) stated that there was no significant difference in terms of this variable, Dikmen (2020) found that the most common internet usage purpose was "social networking" in his study with medical school students.

In terms of the duration of social media use variable, statistically significant differences were found between its categories in the ESS, ACD, and SOD. Considering the differences in the means, *F* and *p* values, and partial eta squared values, it can be stated that these statistical differences were behind expectations in terms of practical significance. Dikmen (2020) did not find a significant difference when he examined the distribution of students' e-learning styles according to their internet usage time with chi-square analysis. Ibili (2020), on the other hand, in his study conducted with 1989 students attending distance education, found significant differences in VED, ACD, FRD, and LOD, while Kuru (2018) found significant differences only in ACD.

Conclusions and Implications

This descriptive survey revealed that the dominant e-learning styles of approximately 61% of Turkish pre-service science teachers in total were FRD and AUD. The least common e-learning style was VED. Approximately 10% of participants had more than one dominant e-learning style. Almost all of the e-learning style scores of pre-service science teachers calculated for all levels of the eight variables examined in the ESS and all its sub-dimensions were on the positive side. Statistically significant differences were found in ESS and some sub-dimensions in terms of gender, grade level, and duration of social media use variables. Among these, the grade level variable had the highest number of dimensions with significant differences. This was generally due to the difference between seniors and freshmen. For the variables of university, purpose of internet use, and number of social network memberships, there were no significant differences in ESS, but only in some sub-dimensions. It is useful to treat all these conclusions with caution, within the limitations of the study. It should be kept in mind that the results obtained were limited to the data obtained from the 401 participants who participated in this study, and it was assumed that all pre-service science teachers filled out the 38-item ESS with the same sincerity, accuracy, and meticulousness without getting bored.

The nine suggestions are as follows: First, similar studies can be conducted with larger groups in different countries, different cities, or different universities with similar variables only for the e-learning styles of pre-service science teachers. Second, the study can be repeated with variables that are different from those examined in this study. Third, identifying a specific culture's e-learning styles is critical for the education system of the relevant country and should be taken into account when developing educational policies and curricula. Fourth, in order to be able to support their students as much as possible without discrimination, every institution, university, faculty, and perhaps every conscious educator should identify the e-learning styles of their students for their own discipline. Fifth, more categories can be selected to examine the "device type used to connect to the internet" variable, including different types of devices such as mobile phones, desktop computers, laptops, tablets, TVs, and smart phones. Sixth, research can be conducted on the reasons for the differences between the e-learning styles of senior and first-year pre-service science teachers. Seventh, new effective methods, games, applications, and activities can be researched for pre-service teachers who want to use the internet for research and homework purposes other than social use. Eighth, studies can be conducted to see whether the ESS, which was developed in accordance with Turkish culture, works reliably in the same way and with the same factors in other countries, cultures, or ethnic groups. Ninth, the functionality of the ESS used in this study can be compared to pre-existing or newly developed e-learning style scales.

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Declaration of Interest

The authors declare no competing interest.

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References

Akcekoce, A., & Bilgin, K. U. (2016). Leadership styles of school principals and teacher performance. *Journal of Contemporary Management Sciences*, *3*(2), 1–23. https://dergipark.org.tr/en/download/article-file/408119

Arslan, S., & Bayram, A. (2022). Investigation of the relationship between nursing students' attitudes towards e-learning and their learning perceptions during the Covid-19 pandemic process. *Dokuz Eylul University Faculty of Nursing Electronic Journal*, *15*(4), 468–486. https://doi.org/10.46483/deuhfed.946855

Atalay, T. D. (2019). Learning styles and teacher efficacy among prospective teachers based on diverse variables. *International Journal of Evaluation and Research in Education*, *8*(3), 484–494. https://files.eric.ed.gov/fulltext/EJ1232333.pdf

Bakac, E. (2022). Investigation of the relationship between teacher candidates' e-learning styles, academic achievements, and educational technology self-efficiency perceptions. *Cukurova University Faculty of Education Journal*, *51*(1), 148–164. https://dergipark.org.tr/en/download/article-file/1605308

Dikmen, M. (2020). The mediating role of medical students' attitudes towards distance education in the relationship between e-learning styles and academic achievements. *Journal of Educational Issues*, *6*(2), 351–373. https://files.eric.ed.gov/fulltext/EJ1280871.pdf

Durnali, M. (2022). 'Destroying barriers to critical thinking' to surge the effect of self-leadership skills on electronic learning styles. *Thinking Skills and Creativity*, *46*, Article 101130. https://doi.org/10.1016/j.tsc.2022.101130

Ergun, E., & Adibatmaz, F. B. K. (2020). Exploring the predictive role of e-learning readiness and e-learning style on student engagement. *Open Praxis*, *12*(2), 175–189. https://dx.doi.org/10.5944/openpraxis.12.2.1072

Geri, S. (2021). Investigation of physical education and sports school students' e-learning styles in terms of some variables. *African Educational Research Journal*, *9*(1), 51–59. https://files.eric.ed.gov/fulltext/EJ1285150.pdf

Gulbahar, Y., & Alper, A. (2014). Development of e-learning styles scale for electronic environments. *Education and Science*, *39*(171), 421–435. http://eb.ted.org.tr/index.php/EB/article/view/2078/654

Hamada, A. K., Rashad, M. Z., & Darwesh, M. G. (2011). Behavior analysis in a learning environment to identify the suitable learning style. *International Journal of Computer Science & Information Technology*, *3*(2), 48–59. https://airccse.org/journal/jcsit/0411csit04.pdf

Ibili, E. (2020). A comparison of learning style preferences in e-learning environment: A study of health science university students in Turkey. *Osmangazi Journal of Educational Research*, *7*(1), 127–150. https://dergipark.org.tr/en/download/article-file/1180882

Isman, A., Barkan, M., & Demiray, U. (2003). *Online distance education book*. The Turkish Online Journal of Educational Technology-TOJET Press. http://www.tojet.net/e-book/ebook.htm

Kaviza, M. (2019). The relationship between learning styles and history subject achievement: A survey in secondary schools. *Malaysian Journal of Social Sciences and Humanities*, *4*(4), 98–108. https://msocialsciences.com/index.php/mjssh/article/view/246/176

Kia, M. M., Aliapour, A., & Ghaderi, E. (2009). Study of learning styles and their roles in the academic achievement of the students of Payame Noor University. *Turkish Online Journal of Distance Education*, *10*(2), 24–37. https://dergipark.org.tr/en/download/article-file/156177

Kilic, M. Y. (2022). Analysis of teacher candidates' perceptions of computer self-efficiency and attitudes towards e-learning. *Gazi University Journal of Gazi Educational Faculty*, *42*(1), 239–272. https://doi.org/10.17152/gefad.942359

Kurnaz, F. B., & Ergun, E. (2019). Investigation of the relations between e-learning style and academic achievement in e-learning environment. *Journal of Theoretical Educational Science*, *12*(2), 532–549. https://doi.org/10.30831/akukeg.407029

Kuru, O. (2018). Examination of e-learning styles of primary school teachers in terms of various variables. *Kahramanmaras Sutcu Imam University Journal of Social Sciences*, *15*(1), 105–118. https://dergipark.org.tr/tr/download/article-file/473184

Nunnally, J. C. (1978). *Psychometric Theory* (2nd ed.). McGraw Hill.

Ozaydin-Ozkara, B., & Ibili, E. (2021). Analysis of students' e-learning styles and their attitudes and self-efficacy perceptions towards distance education. *International Journal of Technology in Education and Science*, *5*(4), 550–570. https://doi.org/10.46328/ijtes.200

Ozudogru, G. (2022). Preservice teachers' e-learning styles and attitudes toward e-learning. *IE: Inquiry in Education*, *14*(1), 4. https://files.eric.ed.gov/fulltext/EJ1345423.pdf

Senturk, C., & Cigerci, F. M. (2018). Examination of classroom teachers' e-learning styles. *Kahramanmaras Sutcu Imam University Journal of Social Sciences*, *15*(1), 69–88. https://dergipark.org.tr/en/download/article-file/473181

Škoda, J., Doulík, P., Bílek, M., & Šimonová, I. (2016). Learning style as a factor influencing the effectiveness of the inquiry-based science education at lower secondary schools. *Journal of Baltic Science Education*, *15*(5), 588–601. https://doi.org/10.33225/jbse/16.15.588

Voigt, C., Oesterreich, T. D., Hoppe, U., & Teuteberg, F. (2021, September). Understanding e-learning styles in distance learning in times of the covid-19 pandemic–towards a taxonomy. In R. A. Buchmann, A. Polini, B. Johansson, & D. Karagiannis (Eds.), *International Conference on Business Informatics Research* (pp. 19–35). Springer. https://link.springer.com/chapter/10.1007/978-3-030-87205-2_2

Yarayan, Y. E., Fakazli, A. E., & Ilhan, L. (2022). E-learning attitude scale: The university students form validity and reliability study. *Gazi University Journal of Gazi Educational Faculty*, *42*(1), 273–302. https://doi.org/10.17152/gefad.913541

https://doi.org/10.33225/jbse/23.22.167

Yetis, U. (2018). *The relationship between university students' social media use habits and e-learning style* (Publication No. 521613) [Master's thesis, Kahramanmaras Sutcu Imam University]. YOK Thesis Center. https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Yurdal, M. O., Sahin, E. M., Kosan, A. M. A., & Toraman, C. (2021). Development of medical school students' attitudes towards online learning scale and its relationship with e-learning styles. *Turkish Online Journal of Distance Education*, *22*(3), 310–325. https://doi.org/10.17718/tojde.961855

Zulfiani, Z., Suwarna, I. P., & Miranto, S. (2018). Science education adaptive learning system as a computer-based science learning with learning style variations. *Journal of Baltic Science Education*, *17*(4), 711–727. https://doi.org/10.33225/jbse/18.17.711

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