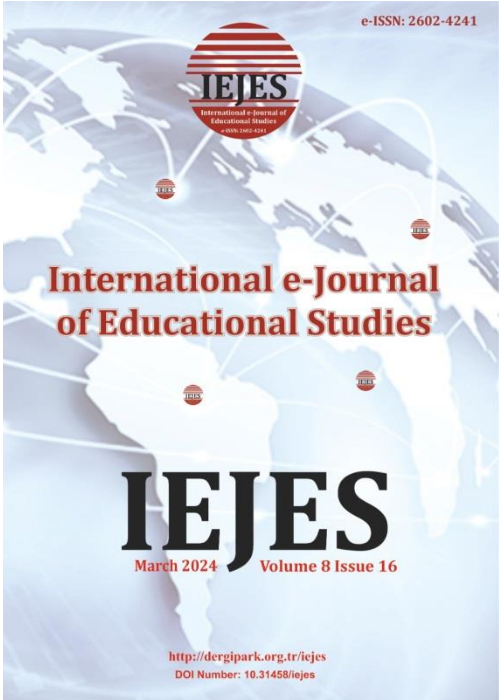

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Abstract

This study aims to determine the relationship between pre-service elementary mathematics teachers' e-learning styles, educational technology self-efficacy perceptions, and problem-solving skills. The sample of the study, in which the relational screening model was used, consists of 150 pre-service teachers studying in a state university's elementary mathematics teaching department. Of the participants, 68% (*n*=102) were female and 32% (*n*=48) were male. Data collection tools, e-learning styles, education technology self-efficacy, and measurement tools consisting of non-routine problems were used to determine problem-solving skills and an information form. Pearson product-moment correlation technique and multiple linear regression analysis were used to analyze the data set. According to the study's findings, significant relationships were determined between the sub-dimensions of e-learning styles, education technology self-efficacy, and problem-solving skills. Predictive variables consisting of sub-dimensions of e-learning styles and education technology self-efficacy explained 36% of the variance of the problem-solving skill. At the same time, audio-visual learning, verbal learning, active learning, logical learning, modeling digital-age work and learning, designing and developing digital-age learning experiences and assessments, and engaging in professional growth and leadership variables were effective in problem-solving. Finally, according to the findings, some suggestions are presented.

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Research Article

Investigation of the Relationships between E-Learning Styles, Educational Technology Self-Efficacy Perceptions and Problem-Solving Skills of Pre-Service Elementary Mathematics Teachers' *

Deniz KAYA [1] **Tamer KUTLUCA** [2] **Gökhan DAĞHAN** [3]

Abstract

This study aims to determine the relationship between pre-service elementary mathematics teachers' e-learning styles, educational technology self-efficacy perceptions, and problem-solving skills. The sample of the study, in which the relational screening model was used, consists of 150 pre-service teachers studying in a state university's elementary mathematics teaching department. Of the participants, 68% (n=102) were female and 32% (n=48) were male. Data collection tools, e-learning styles, education technology self-efficacy, and measurement tools consisting of non-routine problems were used to determine problem-solving skills and an information form. Pearson product-moment correlation technique and multiple linear regression analysis were used to analyze the data set. According to the study's findings, significant relationships were determined between the sub-dimensions of e-learning styles, education technology self-efficacy, and problem-solving skills. Predictive variables consisting of sub-dimensions of e-learning styles and education technology self-efficacy explained 36% of the variance of the problem-solving skill. At the same time, audio-visual learning, verbal learning, active learning, logical learning, modeling digital-age work and learning, designing and developing digital-age learning experiences and assessments, and engaging in professional growth and leadership variables were effective in problem-solving. Finally, according to the findings, some suggestions are presented.

Keywords: Educational technology self-efficacy, e-learning styles, pre-service teacher, problem-solving skill

1. INTRODUCTION

In today's information age, technological tools are a valuable component of educational environments. Information and communication technologies (ICTs) and digital competencies come to the fore more in the academic understanding of 21st-century societies (National Research Council [NRC], 2011). Studies/research for integrating ICTs into learning environments, which are increasingly used in many areas of modern life, continue without slowing down. These dizzying developments force the structure of learning environments to change and differentiate learning strategies and teaching methods (Hollands & Escueta, 2020). Therefore, there is a sharp evolution towards a performance-based understanding of skills. For this purpose, sustainability and versatility gain more importance in nations that want to better prepare their generations for the future (European Commission [EC], 2008). While skill-oriented needs increase with the effect of innovative paradigms, expectations from individuals also differ (International Society for Technology in Education [ISTE], 2016). Although technological tools are widely used in our lives, they also add a different dimension to the view of the concept of education. The concept of change is an inevitable beginning in every age, but it is also frequently mentioned in

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education. The development of the Internet infrastructure and the ease of access to technological devices caused a change in the concept of education (Lee et al., 2017). The increasing diversity of technology and the COVID-19 epidemic, which has recently affected all humanity, are also increasing the interest in space-independent environments. Therefore, it is inevitable for educators at all levels and disciplines to better adapt to situations arising from epidemics and the changes required by age (Yurdal et al., 2021).

The fact that technology has become a critical tool in increasing the quality of teaching requires nations to include more technological tools in their learning environments (Colley & Maltby, 2008). The primary reason for this situation is that with the spread of internet-based technologies, students tend to use applications such as smartphones, tablets, videos, online, and social networks more, and their learning styles change depending on these situations (Pan, 2020). Especially with the increasing prevalence of e-learning, the importance of students' technological competencies is increasing. Because the e-learning process is a process that takes place under the control of students, knowing student skills has become very important (Gülbahar & Alper, 2014). This situation leads researchers to understand students' working processes, concept learning, and understanding styles in learning environments supported by technological tools (Biggs, 1993; Pan, 2020; Rich et al., 2015; Soydaş-Çakır & Akyazı, 2021). Considering individuals' e-learning styles (ELS) and educational technology self-efficacy (ETSE) perceptions during learning practices supported by technological infrastructure opportunities may positively affect the improvement of problem-solving skills. In particular, the developmental impact of educational technology and a learning atmosphere in which ELS will be supported may contribute to students' skills. Drawing attention to this situation, Coffield (2004) stated that knowing learning styles can increase students' self-awareness and metacognition. Transformations in digitalization in the last two decades and changes in learning contexts during the epidemic disease further increase the importance of ELS and ETSE, leading to a significant increase in the number of studies in this direction (Zhang, 2022). The changes in learning style, lifestyle, and communication skills with ICTs will continue to increase the interest in technology-based studies. Therefore, knowing the characteristics of students in learning environments that require technological tools is a precious step.

1.1. E-Learning Styles

Although there are many groups of factors that affect the learning process, there are situations that differ from person to person. Therefore, one of the essential ways to increase the efficiency and quality of learning experiences is to consider individual differences when designing learning processes. One factor that affects individuals' permanent learning is learning style. Learning style refers to the learning path individuals prefer to make their learning more permanent. Therefore, while preferences are at the forefront of learning style, individual differences are the main determinants of learning style (Dunn, 2000; Kolb & Kolb, 2005). Students' preferences in receiving, holding, and processing information constitute their learning styles (Dunn, 2000; Felder & Silverman, 1988). In educational practices, different preferences for processing certain types of information or steps to process information in specific ways are more prominent (Willingham et al., 2015). Because different learning ways preferred by different individuals have a predictive effect on their learning, the learning experiences of individuals differ from each other in many features, so how they acquire and process knowledge affects their learning styles (Kolb & Kolb, 2005; Yeşilyurt, 2019). Some individuals can use theories and theories, reading texts, pictures, experiments, and examples as learning tools (Truong, 2016). Therefore, learning designs considering individuals' learning styles and responding to individual needs offer a different perspective on permanent learning. The functional features of digital technologies help to design and organize learning environments suitable for individuals' learning styles. In this respect, electronic learning environments, which include an innovative approach, facilitate the learning of individuals and contribute to the development of learning skills (Elçiçek & Erdemci, 2021; Gürcan & Özyurt, 2020; Luo et al., 2017; Şeker & Yılmaz, 2011).

In order to make the education of students in learning environments more efficient, the learning styles and preferences of students should be considered because learning styles are seen as one of the most critical factors affecting the quality of education (Felder & Silverman, 1988). Learning style is more prominent in developing the skills acquired from online learning environments where students are usually alone. Because learning style is a crucial factor in designing e-learning environments and affects students' academic success and perspectives on e-learning (Gülbahar & Alper, 2014). Studies on learning styles reveal that individual preferences differ from student to student (Khamparia & Pandey, 2020). Coffield (1988) defines learning style as an "educational experience that motivates the student to choose, participate and perform effectively in a course or educational exercise" (p. 1). Gülbahar and Alper (2014) identified students' e-learning styles: audio-visual, verbal, active, social, independent, logical and intuitive. Seeing and hearing in audio-visual learning, textual reading in verbal learning, feeling and participating in activities in active learning, group work and interaction in social learning, individual study in independent learning, computation, and science applications in logical learning, and intuitive learning emotions and instincts are the prominent learning styles (p. 435). The diversity of learning styles that have the potential to affect the quality of electronic learning environments can be a significant predictor of student's academic performance as well as their perspectives on learning. Therefore, the regulation of students in e-learning environments, taking into account their differences, has an essential effect on increasing both learning quality and learning motivation (Kurnaz & Ergün, 2019; Shahabadi & Uplane, 2015; Sönmez & Korucuk, 2023). Drawing attention to this situation, Cassidy (2004) underlines that learning styles are a concept that contains valuable information about the learning of individuals. The increase in research on e-learning/learning styles, which have become increasingly popular in recent years, reveals that these concepts are directly related to students' behaviors (Pan, 2020; Ucar & Yilmaz, 2023). Therefore, when the information individuals acquire through media, digital and technology, electronic learning style, and educational technology are integrated with the perception of self-efficacy, it can create rich learning content, and environments.

1.2. Educational Technology Self-Efficacy Perceptions

One of the basic judgments known to be highly effective on individuals' learning behaviors is the perception of self-efficacy. Self-efficacy is a person's judgment of his ability to perform a particular task or skill (Bandura, 1997). These judgments reflect the views of individuals about the skills needed to produce desired results (Pajares, 1996). Self-efficacy enables individuals to organize their learning goals by increasing their profitability in achieving the task (Bandura, 2001). Because the personal judgments that individuals adopt about how well they will perform a task are the primary indicator of self-efficacy belief (Huffman et al., 2013). This belief is "superior ability that cognitive, social and behavioral sub-skills need to be organized to serve their numerous purposes" (Bandura, 1982, p. 391). Because individuals' perception of self-efficacy is adequate on cognitive, motivational, emotional, and selective processes and is an essential tool in coping with difficulties (Schunk & Pajares, 2002; Zimmerman, 2000). Therefore, special attention is paid to developing students' self-efficacy perceptions.

While self-efficacy is considered a necessary concept in many learning areas, it has also achieved an increasingly important position in today's technology world due to the transformation of ICTs. So much so that technology self-efficacy is seen as an essential reason for individuals' academic performance and future career choices (Vekiri & Chronaki, 2008). Perception of technological self-efficacy includes the judgments of individuals regarding their ability to use technological tools and sites to achieve the intended learning outcomes (Keengwe, 2007). Individuals' thoughts about whether they have sufficient and correct skills to deal with a technology-related task successfully constitute the perception of technological self-efficacy (McDonald & Siegall, 1992). Individuals' self-efficacy perceptions are associated with technology-related cognitive qualities (Lamb et al., 2014). Technology self-efficacy reflects the representations of integrated beliefs individuals have developed about using technology. For these reasons, judgments developed for technological tools in creating, structuring, interpreting, transferring, and evaluating information obtained from electronic learning environments affect the perception of technological self-efficacy. Stronger bonds between technology and education are established daily, increasing the importance of individuals' feelings and thoughts toward technological tools. Especially during the COVID-19 quarantine, the critical role of educational technology in ensuring the continuity of online teaching has also brought individuals' interaction with technological tools to a different stage (Kaqinari et al., 2022). Therefore, the efficient use of ICTs makes their perceived technological competence important. The findings of many studies in the literature indicate that educational technology self-efficacy has positive effects on individuals' technology use (Asfahani, 2023; Celik & Yesilyurt, 2013; Elçiçek & Erdemci, 2021). In addition, it is stated that there is a positive relationship between the self-efficacy perception regarding the use of digital tools and the use of ICTs for teaching purposes (Hatlevik & Hatlevik, 2018). Therefore, technological self-efficacy also significantly affects individuals' preferences for using technological tools and their perceptions of their usefulness (Mew & Honey, 2010). Drawing attention to this situation, Compeau and Higgins (1995) underline that technology self-efficacy is an essential tool in effectively using and accepting innovative ICTs. In this respect, it can be said that the perception of technology self-efficacy varies. However, this perception of competence includes priority processes in determining the needs of individuals for technology-related tools and selecting and evaluating learning strategies (Pan, 2020). This process helps to confirm appropriate learning outcomes by emphasizing the learners' sense of personal competence regarding their learning goals (Rahman et al., 2023).

1.3. Problem-Solving Skills

Problem-solving skills reflect the basic understanding of mathematics teaching programs. Although this understanding is a complex activity, it is an approach that develops both a mathematical process and other competencies (Cai & Leikin, 2020). Problem-solving skill, the central theme of many curricula, is essential in developing societies (ISTE, 2016; NRC, 2011). The developments in the 21st-century understanding of the information age, changing needs, and innovations in learning approaches also significantly differentiate the expectations of individuals. Problem-solving skills come first among these expectations. Problem-solving is a goal and a tool to establish interdisciplinary connections, develop positive mathematical identity, and develop students' confidence, determination, creativity, flexibility, perseverance, and curiosity (National Council of Teachers of Mathematics [NCTM], 2000, 2020). In this respect, it is considered a central process of learning (Anderson, 1993). When the problem-solving steps created by researchers from the past to the present are examined, emphasis is placed on problem-solving steps with similar characteristics. Also, it is underlined that to reach a solution, it is necessary first to understand the problem (Chen & Cai, 2020; Dewey, 1997; Polya, 1962). In this context, understanding the problem, writing the mathematical equation of the problem, solving the mathematical equation, checking the accuracy of the result, and evaluating the problem are the prominent problem-solving steps (Polya, 1962).

It is stated that in order for a situation or action to be a problem, it must have specific characteristics. First of all, it should make individuals want to solve it; it should be a situation/action that has not been encountered before; it should create confusion, it should have the characteristics to overcome a difficulty; it should contain a purpose and create an internal motivation (Schoenfeld, 1992). In this respect, the concept of problem has a deep content. There are many explanations and definitions in the literature about the concept of a problem. However, according to the widely accepted definition, it is a situation that must be done, a question that causes confusion, or it consciously seeks appropriate actions to reach a definite result (Polya, 1962; Schoenfeld, 1992). When the concept of the problem and its components are examined in terms of mathematics, it is seen that mathematics teaching is one of the main fields of study (NCTM, 2020). The related literature shows that the types of problems are divided into routine (ordinary) and non-routine problems (Güner & Erbay, 2021). Routine problems have "correct, precise, and clear answers, contain all the elements of the problem, depend on the application of customary rules, have a possible solution, and have concepts easily seen and predicted by students" (Jonassen, 1997, p. 68). In non-routine problems, "the meaning is not clearly stated in order to reach a solution the number of unknown elements of the problem may be one or more, there is an inconsistency between concepts and rules, it does not contain only one event, the ways of determining the appropriate method are not clear, students express their personal views on the problem and express this opinion" (Jonassen, 1997, p. 68-69).

1.4. Literature Review on ELS, ETSE and Problem-Solving Skills

The fact that there are a limited number of studies in the relevant literature examining the relationship between students' ELS, ETSE and problem-solving skills indicates the need for this study. However, there are many studies evaluating different types of variables with ELS and ETSE. Among these studies, studies examining students' ELS were mainly conducted (Ucar & Yilmaz, 2023). On the other hand, problem-solving skills with thinking style (Carmo et al., 2006; Güner & Erbay, 2021; Güner, 2021), educational technology self-efficacy, learning style, and academic success (Asfahani, 2023; Bakaç, 2022; Zain et al., 2019), technology self-efficacy and technology acceptance (Holden & Rada, 2011), e-learning and attitude or self-efficacy perception (Ozaydin-Ozkara & Ibili, 2021; Yurdal et al., 2021), ELS and academic success (El Ghouati, 2017; Kia et al., 2009; Kurnaz & Ergün, 2019), perception of self-efficacy with technology (Kaqinari et al., 2022; Kent & Giles, 2017). When the research in the literature is evaluated in general terms, it is seen that there are different levels of relations between ELS, ETSE, and the variables. Kurnaz and Ergün (2019) stated that taking part in online activities, viewing content videos, active learning and independent learning styles predict academic success in online learning courses. As a result of the study conducted by El Ghouati (2017), it was stated that there was no significant relationship between visual learning style, auditory learning style, kinesthetic learning style, read/write learning style and academic success. In the study conducted by Bakaç (2022), the relationship between ELS, ETSE perception, and academic success was examined. The findings of the study indicated that ELS and ETSE were effective on academic success. Visual and intuitive learning styles have been reported to be significant predictor of ETSE perception. The study conducted by Kia et al. (2009) determined that students with social-auditory- verbal learning styles alone were more successful in e-learning environments. In the study conducted by Ozaydin-Ozkara and Ibili (2021), it was determined that there is a positive relationship between ELS and self-efficacy. However, there is no relationship between e-learning and attitude. According to the findings reached by Ucar and Yilmaz (2023), it was reported that the learning style scores of the participants were generally positive and the learning style was important for their participation in the course. The least common learning style was found to be verbal learning. Sentürk and Cigerci (2018) determined that verbal learning was less common, while logical, free, and audio-visual learning styles were used more frequently.

1.5. Statement of the Problem

Developments in science and technology directly affect the scope of information, access to information, and learning styles. Therefore, spreading the digital platforms that will help personalized learning is essential. Numerous studies on e-learning have been carried out to increase the quality of teaching and support permanent learning. These studies are critical to improving students' learning performance (Chang et al., 2009). The fact that there are few studies in the literature on the relationships between ELS, ETSE, and problem-solving skills reveals the necessity of this study. Knowing the relationship between ELS and ETSE with problem-solving skills may provide essential clues for studies to be conducted similarly. Unlike studies in the literature, students' problem-solving skills were used as a variable. With this aspect, it is hoped that it will contribute to the literature by filling the gap in the field. Considering that the prevalence of use of e-learning environments, whose existence we need so much, especially with the COVID-19 epidemic, is increasing day by day and ICTs add a different style to teaching, it also increases the importance of the variables that are assumed to have a direct effect on learning environments. Therefore, it is precious to know the direction of the relationship between individuals' e-learning styles, technology perceptions, and problem-solving skills. Individuals' use of technological tools in daily life increases the need for such studies. Therefore, individuals need to be aware of their learning styles with their e-learning experience, which is different from face-to-face education environments in the classroom. Depending on the use of ICTs, determining the relationship between learning styles, technology self-efficacy perception, and problem-solving skills is an important issue that needs to be investigated.

1.6. Purpose of Study

Many studies are in the literature on students' learning styles, self-efficacy, and problem-solving. These studies generally evaluate self-efficacy perception and learning styles with technology. However, the spread of individualized learning approaches with the developing technology makes it necessary to examine individuals' perceptions towards ELS and ETSE. For these reasons, the main starting point of the study is to determine the relationship between ELS and ETSE perceptions of pre-service elementary mathematics teachers' and their problem-solving skills. Within the scope of the study, answers to the following research questions (RQs) were sought:

RQ 1. What is the level of ELS, ETSE and problem-solving skills of pre-service elementary mathematics teachers?

RQ 2. Is there a significant relationship between the ELS, ESTE, and problem-solving skills of pre-service elementary mathematics teachers?

RQ 3. Are pre-service elementary mathematics teachers' ELS and problem-solving skills a significant predictor of ESTE perceptions?

RQ 4. Are pre-service elementary mathematics teachers' perceptions of ELS and ETSE significant predictors of problem-solving skills?

2. METHOD

2.1. Research Design

This study is a descriptive study in which the relational screening method is used since the relationship between ELS, ETSE perception, and problem-solving skills is examined. The relational survey model tries to understand the existence of the change between two or more variables. In this model, whether the variables change together. If there is a change, it is tried to determine how it happened (Karasar, 2018). For the first model of the study, the independent variables are problem-solving skills with ELS, while the dependent variable is ETSE beliefs. For the second model of the study, the independent variables are ELS and ETSE perception, while the dependent variable is problem-solving ability.

2.2. Sample of the Study

The study sample consists of pre-service teachers studying in the department of elementary mathematics teachers. A non-random sampling method was preferred in the selection of the sample. While choosing the purposeful sampling, the department where the students' study was determined as a criterion. The primary purpose of criterion sampling, which is one of the purposive sampling methods, is to investigate situations that meet specific predetermined criteria (Yıldırım & Şimşek, 2021). The researcher determines the criterion(s), or a pre-created criterion list is used (Marshall & Rossman, 2016). 68% (*n*=102) of the participants were female and 32% (*n*=48) were male.

2.3. Data Collection Tools and Procedure

The ELS scale developed by Gülbahar and Alper (2014) was used to reveal the learning styles of pre-service teachers in online learning environments. The measuring tool consists of 38 items and seven sub-factors. These sub-factors were determined as independent learning (IDL), social learning (SL), audio-visual learning (AVL), active learning (AL), verbal learning (VL), logical learning (LL), and intuitive learning (IL), respectively. Confirmatory factor analysis was performed to test the construct validity of the scale, and it was determined that the seven-factor structure of the scale was compatible with the collected data set [χ^2(632, N=2344)=5195.95 p<.000; RMSEA=.056; SRMR=.047; GFI=.90; AGFI=.88; NNFI=.97; IFI=.98; CFI=.98]. In addition, the total internal consistency coefficient of the measuring tool was tested and calculated as .94. The Cronbach alpha reliability coefficients of the scale factors were determined as IDL .82; SL .87; AVL .86; AL .83; VL .86; LL .77 and IL .72 respectively. The ETSE scale developed by Simsek and Yazar (2016) was used to measure pre-service teachers' perceptions of ETSE. The measuring tool consists of 40 items and five factors. These sub-factors are facilitating students' learning and creativity (FSLC), designing and developing digital-age learning experiences and assessments (DDDALEA), modelling digital age work and learning (MDAWL), promoting and modelling digital citizenship and responsibility (PMDCR), and engaging in professional growth and leadership (EPGL). Confirmatory factor analysis was performed to test the construct validity of the scale, and it was determined that the five-factor structure of the scale was compatible with the collected data set [χ^2(732, N=394)=2362.77 p<.000; RMSEA=.069; SRMR=.059; NNFI=.97; CFI=.97; IFI=.97]. In addition, the total internal consistency coefficient of the scale was tested and calculated as .95. The Cronbach alpha reliability coefficients of the measuring tool factors were determined as .83 for FSLC, .87 for DDDALEA, .77 for MDAWL, .78 for PMDCR, and .85 for EPGL respectively.

Five non-routine problems were used to determine the problem-solving skills of pre-service teachers (Posamentier & Krulik, 2020). The problems were rearranged by developing different solution strategies and adapted to the Turkish culture. While evaluating the solution processes for the problems posed to prospective mathematics teachers, the steps suggested by Polya (1962) for problem-solving processes were used. Four steps were taken into account: (1) understanding the problem, (2) making a plan, (3) implementing the plan, and (4) controlling the problem. Understanding the problem involves reading the problem, developing understanding, and organizing information. The planning step involves developing appropriate principles for solving the problem, considering contextual factors, and clarifying the relationship between what is given and what is wanted. Implementing the plan includes identifying adequate and necessary strategies for the problem, implementing them in the solution, and performing operational processes effectively. The step of checking the problem includes testing the solution's correctness and the results' plausibility. The answer sheets of the pre-service teachers were examined according to the problem-solving steps in the context of insufficient, partially sufficient, and sufficient criteria. According to these criteria, the answer given to each non-routine problem was evaluated over 20 points. The maximum score that can be obtained from the problem-solving skills measurement tool is 100 (5 problem statements x 20 points). An example problem statement is presented below.

Problem Statement: Many employees are assigned to monitor the number of people participating in daily special activities at the town fair. Rozalin's notes showed there were 510 people in the lottery booth from Monday to Saturday. Gülşen noted that there were 392 players at the stand from Monday to Wednesday. Funda noted that there were 220 players on Tuesday and Friday. Adil noted that there were 208 players on Wednesday, Thursday, and Saturday. Finally, Ali noted that there were 118 players in the booth from Thursday to Saturday. Assuming all numbers are correct, how many players are in the lottery booth on Monday?

In addition, a short information form was also used within the scope of the research. The information form includes instructions with necessary explanations and gender information. After obtaining the necessary permissions for the measurement tools, it was applied by the researcher voluntarily for the study. Within the scope of the research, internal consistency coefficient of the measurement tools was also tested. Accordingly, the internal consistency coefficient of the ELS measurement tool was found to be .83 and the internal consistency coefficient of the ETSE measurement tool was found to be .95.

2.4. Data Analysis Process

In this study, the relationship between ELS, ETSE perception and problem-solving skills of the participant group was calculated by Pearson product moments correlation technique. The effects of ELS and ETSE perceptions on problem solving skills were examined by multiple linear regression analysis. Descriptive statistical information about the study's variables is also stated in the findings section of the study. On the other hand, it is essential to meet certain assumptions before performing multivariate analyses. The assumptions to be taken into account can be listed as (*i*) the effects of extreme-values, (*ii*) harmony of the assumptions, (*iii*) multicollinearity issue (Çokluk et al., 2014). In order to determine whether the average distribution assumptions were met, the kurtosis and skewness values of the dimensions of each measurement tool were checked. In this context, the skewness values of the sub-dimensions of the ELS measurement tool were between -1.0 and .42; kurtosis values were determined to vary between -.39 and .75. The skewness values of the sub-dimensions of the ETSE measurement tool were between -.28 and .10; kurtosis values were determined to vary between -.56 and .12. In addition, the kurtosis and skewness values of the measurement tool consisting of five non-routine problems were also examined in order to determine the problem-solving skills of the pre-service teachers. Accordingly, the skewness value of the tool measuring problem-solving skills was calculated as -.25, while the kurtosis value was calculated as -.53 over the total score. Tabachnick and Fidell (2013) emphasized that the distribution usually occurs when the skewness and kurtosis values are between ±1.50. In this respect, it can be said that the data obtained from the measurement tools exhibit a normal distribution.

On the other hand, the mahallobonis value was examined, and it was determined that the values met the normal distribution. It is recommended to check the strong relationships ($r>.90$) between the independent variables to determine the multicollinearity problem among the predictors (Çokluk et al., 2014). In addition, it is recommended to calculate variance increase factors, tolerance values, and condition index (Çokluk et al., 2014). In this study, the highest correlation value between independent variables was .76. The variance increases factors between 1.14-3.53; condition index between 1.00-26.88, and tolerance values between .28-.87. Considering the variance increase factors (≤10), condition index (≤30), and tolerance values (≥.10), it can be said that there is no multicollinearity problem between the independent variables.

3. FINDINGS

In research articles, findings should be given here and the above mentioned principles should be considered. This part of the research includes descriptive findings of measurement tools. In this context, range values, minimum/maximum values, mean, standard deviation, and variance values are included. Afterward, information about the correlation values between the independent and dependent variables was shared. In the regression analysis section, firstly, the predictive of problem-solving skills with ELS on the perception of ETSE was examined. Finally, the effect of the predictive of ELS and ETSE perception on problem-solving skills was examined. Table 1 includes the findings obtained from ELS, ETSE, and problem-solving measurement tools.

Table 1. Descriptive statistical values for ELS, ETSE and problem solving levels

Variables	N	Range Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Deviation Statistic	Variance Statistic
V1	150	2.38	2.63	5.00	3.87	.43	.18
V2	150	3.29	1.57	4.86	3.12	.59	.35
V3	150	3.50	1.50	5.00	3.43	.71	.50
V4	150	3.33	1.67	5.00	3.45	.81	.65
V5	150	2.75	2.25	5.00	4.03	.61	.38
V6	150	4.00	1.00	5.00	3.92	.92	.85
V7	150	3.50	1.25	4.75	2.95	.56	.31
V8	150	2.56	2.44	5.00	4.09	.54	.29
V9	150	2.80	2.20	5.00	3.89	.57	.32
V10	150	2.80	2.20	5.00	3.82	.58	.34
V11	150	2.86	2.14	5.00	3.83	.54	.29
V12	150	2.22	2.78	5.00	3.91	.55	.30
V13	150	65.00	30.00	95.00	73.21	9.53	90.97

Note: In the table above, information on the abbreviations used for measuring instruments are shown below.
ELSS Dimensions: AVL (V1), VL (V2), AL (V3), SL (V4), IDL (V5), LL (V6), IL (V7)
ETSSE Dimensions: FSLC (V8), DDDALEA (V9), MDAWL(V10), PMDCR (V11), EPGL (V12), Problem-Solving Tool (V13)

According to Table 1, the mean value of the sub-dimensions of the ELS measurement tool, from largest to smallest, are IDL ($\bar{x}$=4.03), LL ($\bar{x}$=3.92), AVL ($\bar{x}$=3.87), SL ($\bar{x}$=3.45), AL ($\bar{x}$=3.43), VL ($\bar{x}$=3.12) and IL ($\bar{x}$=2.95). Similarly, the mean value of the sub-dimensions of the ETSE measurement tool, from largest to smallest, are FSLC ($\bar{x}$=4.09), EPGL ($\bar{x}$=3.91), DDDALEA ($\bar{x}$=3.89), PMDCR ($\bar{x}$=3.83), and MDAWL ($\bar{x}$=3.82). On the other hand, the mean value of the problem-solving measurement tool ($\bar{x}$=73.21) was found above the scale's midpoint. The table below shows the level of relations between ELS and ETSE sub-dimensions and problem-solving skills.

Table 2. Correlation values between variables

Variables	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13
V1	1.00	.45**	.36**	.33**	.13	.25**	.19*	.46**	.42**	.45**	.34**	.45**	.38**
V2		1.00	.33**	.43**	.19*	.20*	.20*	.40**	.27**	.30**	.24**	.31**	.40**
V3			1.00	.44**	.10	.20*	.22**	.39**	.31**	.29**	.28**	.35**	.39**
V4				1.00	-.14	.26**	.24**	.34**	.26**	.19*	.24**	.26**	.35**
V5					1.00	.12	-.08	.16*	.09	.20*	.12	.17*	.01
V6						1.00	.00	.17*	.18*	.20*	.17*	.20*	.27**
V7							1.00	.19*	.22**	.16*	.11	.26**	.16
V8								1.00	.76**	.52**	.49**	.57**	.24**
V9									1.00	.68**	.52**	.67**	.09
V10										1.00	.57**	.70**	.21*
V11											1.00	.61**	.14
V12												1.00	.08
V13													1.00

**p<.05, **p<.01, N=150*

When the values in Table 2 are examined, it is seen that there are significant relationships between the variables. The highest relationship between the variables is between FSLC and DDDALEA (r=.76, p<.01). The least significant relationship is between IDL and FSLC; between IL and MDAWL (r=.16, p<.05). While the relationship between problem-solving skills and VL (r=.40, p<.01) is the highest at the level of significance, the relationship between problem-solving skills and MDAWL (r=.21, p<.05) is the lowest at the level of significance. In addition to these, significant relationships are found between each dimension and criterion variables. The closer the correlation coefficient between the variables is to ±1, the stronger the relationship increases (Can, 2023). Generally, it is expressed as a weak correlation between .00 and ±0.29, moderate between ±.30 and ±.59, and strong correlation between ±.60 and ±1.00 (Büyüköztürk, 2011). Accordingly, it is seen that the relations between the variables are generally concentrated at medium and weak levels. On the other hand, there are also low-level correlations between the variables that are not significant. However, there is a possibility that low-level correlation amounts will become significant as the sample increases (Kline, 1994). Multiple linear regression analysis was used to test the dimensions of ELS and the predictive status of problem-solving skills on ETSE. The obtained results are presented in Table 3.

Table 3. The predictive status of problem solving skills with ELS on ETSE beliefs

Model	Variables	B	Std. E.	β	t	sr^2	R	R^2	Adjusted R^2	F
1	**Constant**	1.32	.38	-	3.43**	-				
	V1	.39	.08	.36	4.60**	.30				
	V2	.08	.06	.10	1.20	.08				
	V3	.13	.05	.19	2.47*	.16				
	V4	.05	.04	.08	1.02	.06	.60	.36	.33	10.16**
	V5	.07	.05	.10	1.43	.09				
	V6	.03	.03	.07	1.03	.06				
	V7	.09	.05	.11	1.59	.10				
	V13	-.00	.00	-.15	-1.93	-.13				

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

According to the findings in Table 3, when ETSE is considered as an outcome variable, the multiple regression coefficient of the first model is an important factor when considering other predictors [R=.60, R^2=.36, $F_{(8\text{-}141)}$=10.16, p<.01]. Problem-solving skill with ELS explains about 36% of the total change on ETSE. Accordingly, AVL (β=.36, $t_{(141)}$=4.60, p<.01) and AL (β=.19, $t_{(141)}$=2.47, p<.05) variables predict ETSE significantly. On the other hand, VL (β=.10, $t_{(141)}$=1.20, p>.05), SL (β=.08, $t_{(141)}$=1.02, p>.05), IDL (β=.10, $t_{(141)}$=1.43, p>.05), LL (β=.07, $t_{(141)}$=1.03, p>.05), IL (β=.11, $t_{(141)}$=1.59, p>.05), and problem-solving skills (β=-.15, $t_{(141)}$=-1.93, p>.05) are not a significant predictor of ETSE over the total score. In this context, it can be said that as the levels of AVL and AL increase, the ETSE levels of pre-service elementary mathematics teachers will also increase.

When the semi-partial coefficients for the predictor variables are examined, AVL (sr^2=.30) has the highest positive correlation value. On the other hand, SL and LL (sr^2=.06) have the lowest positive correlation value. In another research step, multiple linear regression analysis tested the predictability of the problem-solving skills of the ELS and ETSE dimensions. The obtained results are presented in Table 4.

Table 4. Predicting problem solving skills of ELS and ETSE perceptions

Model	Variables	B	Std. E.	β	t	sr^2	R	R^2	Adjusted R^2	F
2	**Constant**	36.92	7.86	-	4.69**	-				
	V1	4.29	1.88	.19	2.27*	.15				
	V2	3.03	1.36	.19	2.22*	.15				
	V3	2.98	1.09	.22	2.73**	.18				
	V4	.93	1.02	.08	.91	.06				
	V5	-1.09	1.15	-.07	-.94	-.06				
	V6	1.58	.75	.15	2.11*	.14	.60	.36	.31	6.59**
	V7	1.28	1.24	.07	1.03	.07				
	V8	3.30	2.02	.18	1.63	.11				
	V9	-4.90	2.12	-.29	-2.30*	-.15				
	V10	4.28	1.77	.26	2.41*	.16				
	V11	.17	1.57	.01	.11	.01				
	V12	-5.23	1.91	-.30	-2.72**	-.18				

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

According to the findings in Table 4, when problem-solving skill is evaluated as the outcome variable, the multiple regression coefficient of the second model is an essential factor when other predictors are taken into account [R=.60, R^2= .36, $F_{(12\text{-}137)}$=6.59, p<.01]. ELS and ETSE explain approximately 36% of the total variation in problem-solving skills. According to the findings, AVL (β=.19, $t_{(137)}$=2.27, p<.05), VL (β=.19, $t_{(137)}$=2.22, p<.05), AL (β=.22, $t_{(137)}$=2.73, p<.01), LL (β=.15, $t_{(137)}$=2.11, p<.05), DDDALEA (β=-.29, $t_{(137)}$=-2.30, p<.05), MDAWL (β=.26, $t_{(137)}$=2.41, p<.05), and EPGL (β=-.30, $t_{(137)}$=-2.72, p<.01) variables significantly predict problem solving skills. On the other hand, SL (β=.08, $t_{(137)}$=.91, p>.05), IDL (β=-.07, $t_{(137)}$=-.94, p>.05), IL (β=.07, $t_{(137)}$=1.03, p>.05), FSLC (β=.18, $t_{(137)}$=1.63, p>.05), PMDCR (β=.01, $t_{(137)}$=.11, p>.05) is not a meaningful predictor of problem solving ability. In this context, as the levels of AVL, VL, AL, LL, MDAWL increase, as the levels of DDDALEA and EPGL decrease, it can be said that the problem solving skill levels of pre-service elementary mathematics teachers will also increase. Looking at the semi-partial coefficients for the predictor variables, EPGL (sr^2=-.18) has the highest level of correlation. On the other hand, PMDCR (sr^2=.01) has the lowest level of correlation.

4. DISCUSSION and CONCLUSION

This study tried to determine the relationship between pre-service elementary mathematics teachers' ELS, ETSE perceptions, and problem-solving skills. According to the descriptive findings, it was determined that the participant group had the highest average value for independent learning and the lowest average value for intuitive learning style. According to these findings, pre-service elementary mathematics teachers prefer the IDL style more among the sub-dimensions of e-learning styles. There may be many reasons for this situation, but the effect of the COVID-19 epidemic in recent years can be shown as the primary reason. In addition, it can be shown as another reason that e-learning environments pay more attention to individual characteristics. In order to enable individuals to act independently in e-learning environments, a learning-centered approach is adopted, and an internet-based learning process is given importance (ISTE, 2016). For this reason, students attach importance to working alone, and individualism comes to the fore in their belief in learning. Individuals with this learning style focus on organized verbal materials while achieving their goals (EC, 2008; Yeşilyurt, 2019). The IL style among the ELS sub-dimensions is less preferred. While individuals with this learning style enjoy solving problems, they are patient in complex situations (Yeşilyurt, 2019). In this context, we can say that e-learning environments activate students' intuitive senses less and encourage individual learning more. These findings indicate that students in e-learning environments avoid applied approaches and are distant towards innovative approaches. Individual learners prefer to work independently with guidance and take responsibility for their learning (Gülbahar & Alper, 2014). It can be said that pre-service elementary mathematics teachers are self-confident in their learning ability, while individuality stands out in their e-learning style. Intuitive learners use intuition while solving problems and learn better by associating their emotions (Gülbahar & Alper, 2014; Keengwe, 2007). Accordingly, it can be said that students keep their emotions in the background and do not like different resources and options.

Another finding of the study was obtained from descriptive values for ETSE perception. The descriptive findings determined that the participant group had the highest average value in FSCL and the lowest in MDAWL dimensions in ETSE perception. Pre-service elementary mathematics teachers have a perception of facilitating creativity and learning in the context of educational technology. For this reason, it is seen that educational technology's facilitating and innovative features come to the fore. It is known that ETSE has positive effects on individuals' technology use (Asfahani, 2023; Celik & Yesilyurt, 2013; Elçiçek & Erdemci, 2021). Therefore, it is not surprising that students have a positive self-efficacy perception regarding the benefits of technology. Because of the developing technologies, technology literacy in individuals is increasing daily. This situation is also reflected in the student's learning behaviors and affects the potential use of technology. This way, individuals can determine their needs and move in this direction more easily. On the other hand, it is seen that individuals do not feel self-confident enough in the understanding of working and learning in the digital-age. One of the most important reasons is that pre-service teachers do not see themselves as sufficient in terms of knowledge, skills, and understanding required by their age. As technological advances become both a tool and a goal in increasing the quality of education, the roles expected from individuals undergo a rapid change (Colley & Maltby, 2008; EC, 2008). However, this situation causes difficulties for many individuals, and they do not see themselves sufficiently in understanding learning in the digital age. Therefore, both program makers and instructors have essential responsibilities. Considering this situation, innovative approaches must sustain and support learning environments.

One of the important significant findings was obtained from the relationship between the sub-dimensions of ELS and ETSE perceptions and problem-solving skills. According to the findings, it was determined that there is a strong relationship between FSLC and DDDALEA among the sub-dimensions of ETSE. On the other hand, when the relationship between ELS sub-dimensions and problem-solving is examined, it is seen that the relationship between VL style and problem-solving skills is the highest. There was a moderate and positive significant relationship. In this context, problem-solving skills affect individuals who actively use e-learning environments. The problem-solving process is an essential activity that develops the individual's competencies (Cai & Leikin, 2020). Therefore, the effect of learning styles specific to individuals in learning environments must be considered. Because the primary purpose of e-learning environments is to support individuals' efforts in the process by facilitating their learning (Luo et al., 2017).

When the relationship between the sub-dimensions of ETSE perception and problem-solving skills is examined, it is seen that the relationship between FSLC perception and problem-solving skills is the highest. There was a low and positive significant relationship. In this context, although the perception of facilitating students' learning and revealing creativity was the highest compared to other dimensions, this relationship remained low. Accordingly, although the relations between the sub-dimensions of ETSE perception and problem-solving skills were significant, these relations remained relatively low. It is assumed that this situation arises from the effect of too many variables on individuals' perceptions of technological tools. Students need to keep up with these changes because of the innovative approaches emerging in technological tools.

The last finding of the study was obtained from the predictive power of the determined variables. Accordingly, in the first model, the predictive power of the problem-solving skill with ELS on the perception of ETSE was examined. According to the findings, only AVL and AL variables predicted ETSE significantly. However, VL, SL, IDL, LL, IL, and problem-solving variables do not significantly predict ETSE. In this direction, students' visual materials and auditory structures are effective on ETSE. Drawing attention to this situation, Şeker and Yılmaz (2011) state that the instructional tools used for instructional technologies positively affect the learning of students with visual and auditory learning styles. It is also known that visual and intuitive learning styles are significant predictors of educational technology self-efficacy (Bakaç, 2022).

On the other hand, in the second model, the predictive power of ELS and ETSE perception on problem-solving skills was examined. According to the findings, AVL, VL, LL, DDDALEA, MDAWL, EPGL variables significantly predict problem-solving skills. It can be said that instructors who explain the subject in detail, visuals such as pictures, tables, and graphics, activities that require calculations, and chat, virtual classroom, and whiteboard applications effectively develop students' problem-solving skills. As ELS auditory learners enjoy listening to the experiences of others, visual learners remember visual objects, plans, and situations more easily (Gülbahar & Alper, 2014). In addition, it is crucial to design learning environments and assessment activities suitable for the digital age in the development of individuals' ETSE perceptions and to lead the learning understanding of the digital age (Simsek & Yazar, 2016). These findings also show some similarities with the results of some studies in the related literature. For example, the study conducted by Bakaç (2022) determined that the intuitive learning style predicted the academic success of students with ETSE. Similarly, in the study conducted by Güner (2021), it was determined that there is a relationship between hierarchical and internal thinking styles and academic achievement.

As a result, it is seen that the perception of ELS and ETSE affects students' problem-solving skills. In this context, students' learning styles and self-efficacy perceptions are an issue that should be taken into account in order to become effective problem solvers. The findings of many studies in the literature indicate that learning styles and self-efficacy perceptions are effective in students' academic success, problem-solving skills, attitudes, or interest in technological tools (Asfahani, 2023; Bakaç, 2022; El Ghouati, 2017; Güner, 2021; Gürcan & Özyurt, 2020; Kia et al., 2009; Kurnaz & Ergün, 2019; Ozaydin-Ozkara & Ibili, 2021). Accordingly, instructors must design learning environments by considering the possible variables affecting problem-solving. Because in order for students to perform better, learning environments should be designed according to students' dominant learning styles and developed in this direction (Zain et al., 2019). Coffield (2004) states that knowledge of learning styles is essential in recognizing students' self-awareness and strengths and weaknesses. This situation is an essential issue that educators and curriculum structures should consider in their teaching processes.

4.1. Recommendations

The study's findings indicate that the perception of ELS and ETSE affects students' problem-solving skills. In this context, instructors need to design learning environments by considering this situation. Although many studies in the related literature examine the relationship between achievement, learning styles, and self-efficacy, the number of studies with different variables is negligible. For this reason, in future studies, the relationship with variables such as motivation, attitude, anxiety, self-regulation, time management, learning and goal orientation, career, reflective thinking, and metacognitive awareness can be examined with the help of experimental studies conducted in different environments. At the same time, taking into account different learning styles, the performance effects of individuals can be investigated with the help of qualitative and mixed research methods. Therefore, research designs that prioritize individual characteristics and skills can be developed.

On the other hand, the effects of learning styles and educational technology self-efficacy perceptions can be investigated for students studying mathematics and other disciplines. The effects of technological tools can be considered together with different variables (attitude, anxiety, self-confidence, belief, *etc*.). In addition to all explanations, there are certain limitations of the study. The study's primary limitation is the selection of pre-service elementary mathematics teachers as the study group. The relationship between ELS and ETSE perceptions of students studying in different departments and their problem-solving skills may vary. In addition, the data collection process, which is limited to a single institution, can also be examined on a larger sample. The results of the students who did not take part in the study voluntarily due to the operational process applied according to the principle of volunteering may differ. Students' problem-solving success was limited to the questions in the measurement tool. In this respect, it can be used in variables such as academic success, academic performance, competence, competence, course success, and problem-solving skills.

Ethics Committee Decision

This research was carried out with the permission of Nevşehir Hacı Bektaş Veli University Publication Ethics Board with the decision numbered 13.430 dated 26.12.2022.

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