Predicting Secondary School Students' 21st-Century Skills Through Their Digital Literacy and Problem-Solving Skills

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Abstract

The research aims to determine whether secondary school students' digital literacy and problem-solving skills predict 21st-century skills. It is a correlational survey study. The population of the research is the students studying in secondary schools in formal education institutions in Elazig. The sample of the research is 490 secondary school students determined by the disproportionate cluster sampling method. Data collection tools in the research are demographic information form, digital literacy scale, problem-solving inventory for primary school children, and 21st-century skill scale. The research makes use of parametric tests for the analysis of the data as the data fulfill the normal distribution condition. The results show that while the digital literacy and 21st-century skill levels of secondary school students are not very high, their problem-solving skills are high. The results also show that the problem-solving and 21st-century skill levels of secondary school students differ significantly by gender, and mother and father's education level while there is no significant difference between secondary school students' digital literacy levels by their father's education level. The results of the research also show that there is a positive and moderately significant relationship between the problem-solving skills of secondary school students and their digital literacy levels. The results also indicate that there is a significant relationship between the communication sub-dimension of secondary school students' 21st-century skills and digital literacy levels, and between the "confidence in problem-solving skills" and "avoidance" sub-dimensions of problem-solving skills. While the significant relationships identified are negative in the avoidance sub-dimension, they are positive in other dimensions. The results show that digital literacy and problem-solving skills do not significantly predict secondary school students' 21st-century skill levels. However, secondary school students' 21st-century skill and problem-solving skill levels significantly predict their digital literacy level.

Keywords: secondary school students, digital literacy, problem-solving skills, 21st-century skills

1. Introduction

In parallel with the technological change, educational approaches aim that students to become individuals who can communicate effectively, work productively with others by adapting to various roles and responsibilities, solve the problems they encounter through a critical thinking process, are sensitive to different perspectives, and are digitally equipped (National Research Council [NRC], 2011). In other words, the human quality needed for the future is changing. Today, although there is no obstacle to acquiring and reaching information, it is known that there are deficiencies and problems in skill acquisition (Harari, 2018).

21st-century skills are competencies that can help individuals prepare for the developments in today's world and the future. These skills cover both the learning periods of the individual and the field of lifelong learning. It is believed that these features, which are related to knowledge, skills, working habits, and character, have an important role in increasing success. At the beginning of this century, educators, researchers, and stakeholders began to think about the skills students will need for their future careers and university preparation. Different organizations have made different classifications of 21st-century skills. For example, although the skills listed in the reports identifying and describing 21st-century skills (Preparing for the 21st Century: The Education Imperative, National Academy of Sciences [NAS], 1997) appear to have differences, the central theme is creativity and innovation. P21, one of the most accepted of these organizations, gathered 21st-century skills under three main headings. It is emphasized that it is important for individuals to have these skills, which are gathered under the main headings of learning and innovation skills, knowledge, media and technology skills, and life and career skills (Ataizi & Donmez, 2014; Trilling & Fadel, 2009; Yalcin, 2018).

Learning and innovation skills (Trilling & Fadel, 2009), which form the basis of lifelong learning and creative thinking, consist of critical thinking and problem-solving, creativity and innovative skills, cooperation and communication skills, and are also referred to as the "4Cs" in the literature in recent years (P21, 2019). Many organizations in different countries have created some frameworks for schools as well as researching future competencies. One of the frameworks emphasized as competencies that teachers should teach and students should learn was developed by the National Education Association (NEA) (Pincham & McTague, 2021). Published under the 4C title, this framework has been widely accepted. The 4C framework includes communication, collaboration, critical thinking, and creativity skills. However, there are sub-skills and strategies within each element. Communication as the ability to think outside the box, cooperation as the ability to work together to achieve a common goal, creativity as the ability to convey ideas quickly and clearly, and critical thinking as problem-solving practices constitute the elements of the 4C framework (Pincham & McTague, 2021). Some 21st-century skills are defined together in the frameworks. When looking at all of these basic frameworks, there are common themes (Kyllonen, 2021). It is stated that technology plays a critical role in the acceptance and application of these skills. In addition, it is seen that communication and cooperation skills are emphasized in all frameworks. Creativity, critical thinking, and problem-solving skills are included in most frameworks (eg P21, ATCS, NETS / ISTE) (Voogt & Roblin, 2010). As it is seen, while these skills are emphasized by national and international organizations, it is clear that these skills are important in teaching environments. The primary goal is to improve learning and teaching in schools. In this respect, the student profile in the 21st century requires being active in thinking strategies such as creativity, critical thinking, problem-solving, and working ways such as communication and teamwork (Altınpulluk & Yıldırım, 2021; Education Research and Development Department [EARGED], 2011). Various social skills, including collaboration, critical thinking, and problem-solving, and preparing students for the digital age are of great importance (Kennedy & Sundberg, 2020). In the light of the common denominators of the frameworks in the literature, communication, cooperation, critical thinking, and problem-solving, creativity skills that will be explored in this study will be briefly expressed as "4C skills". Communication skill, one of the 4C skills, is the ability of the individual to express his/her thoughts and ideas in accordance with the situation she/he is in through effective use of verbal and non-verbal communication skills, and to be an active listener (Partnership for 21st Century Learning, 2015; Trilling & Fadel, 2009).

Problem-solving skills and digital literacy, which are related to 21st-century skills, are examined in a relational sense in the context of the research. Relationally, 21st-century skills, digital literacy, and problem-solving skills are considered together and the relationship and impact status between them is determined.

1.1 Purpose of Research

The purpose of the research is to determine whether the digital literacy and problem-solving skills of secondary school students predict 21st-century skills. In addition, the research also aims to determine the level of digital literacy, problem-solving, and 21st-century skills of secondary school students, and to determine whether there is a significant difference between them by gender, and mother and father's education level. Considering the mentioned purposes, the research seeks answers to the following sub-problems:

1)   At what level are secondary school students' digital literacy, problem-solving, and 21st-century skills?

2)   Is there a statistically significant difference between secondary school students' digital literacy, problem-solving, and 21st-century skill levels by gender?

3)   Is there a statistically significant difference between secondary school students' digital literacy, problem-solving, and 21st-century skill levels by their mother's education level?

4)   Is there a statistically significant difference between secondary school students' digital literacy, problem-solving, and 21st-century skill levels by their father's education level?

5)   Is there a statistically significant relationship between secondary school students' digital literacy, problem-solving, and 21st-century skill levels? If yes, at what level and direction?

6)   Do secondary school students' digital literacy and problem-solving skill levels predict 21st-century skills?

2. Literature Review

2.1 Digital Literacy

To adapt to the digital society, qualifications including literacy skills are vital. However, to be a literate individual in the digital age, more comprehensive skills and competencies are needed (Media Smarts, 2016). As a result of the significant effects of the digitalization of daily life on education, discussions have started among schools and educators about preparing students for the digital future. In these discussions, digital literacy has emerged as a key

concept for educators, researchers, and education bureaucrats to help them understand the competitive demands on schools and students in the digital society (Pangrazio, Godhe, & Lopez, 2020).

Cornell University defines digital literacy as the ability to obtain, produce, use, evaluate, and share content over the internet and information technologies (Levin & Tsybulsky, 2017). According to Yeşildal (2018), digital literacy is the awareness and ability of people to identify, access, and use digital tools and resources; manage, integrate, evaluate, and analyze them and create new information and media expressions. Being able to exist as an individual in the digital world is possible by using the internet effectively, sharing, producing, selling, buying, acting ethically, developing skills, as well as being aware of threats and dangers, and being protected from such possibilities. These components can be implemented through the acquisition of digital literacy skills (Sağıroğlu et al., 2020).

2.2 Problem-Solving Skill

Problem-solving is the process of overcoming difficulties to achieve a goal. It can also be defined as the process of finding solutions by using knowledge and adding originality, creativity, or imagination to it (Bingham, 2004). There are four characteristics of problem-solving as defined by Mayer and Wittrock (2006). The first is that problem-solving is cognitive. Second, it involves a process. It is not just about results. It is the whole of the mental processes carried out from the beginning to the end of the problem for the problem solver. Third, problem-solving is guided by the purpose of the problem. Finally, problem-solving is personal. The difficulty or ease of the problem varies according to the person who solves it, her/his knowledge, and experience.

The ability of an individual to find new ways to solve a problem is called "problem-solving skill" (Tatlısu, 2020). Problem-solving skills help the individual to adapt to the environment in which she/he lives. Individuals should learn to solve problems to adapt effectively to the conditions in which they live. Some problems have clear solutions and the right solution can be reached by using certain strategies. However, some problems do not have a definite solution, they have only one correct answer. The solution to these problems requires interdisciplinary knowledge, multidimensional thinking, and creativity (Yazıcı, 2013).

2.3 21st-Century Skills

Along with conveying knowledge, education should also teach people contemporary skills and competencies that will enable them to benefit from new forms of socialization and take an active role in economic development under the developments in society and the economy. These skills and competencies are referred to as 21st-century skills and competencies to indicate that they are more related to today's social and economic development needs rather than interests and needs in the past (Ananiadou & Claro, 2009). Anagün et al (2016). state that in the 21st century, the main skills and high-level thinking skills are necessary for people to adapt to changes, to react, to follow technology, to reach the right information, to analyze and evaluate, to adapt the information to real life, and to produce a product and these skills are called 21st-century skills.

In their study, Voogt and Roblin (2010) conclude that the impact of the development of society and the rapid advancement of technology on the lives of individuals in the 21st century is a common problem in many countries. Since development and change are global, it is not possible for societies and individuals not to be affected. The advancement of technology increases this interaction too. Examining the literature, it is possible to find many studies on 21st-century skills. There are different views on what 21st-century skills are and how students can acquire them. Eryılmaz and Uluyol (2015) emphasize that individuals need to have 21st-century skills to find a place for themselves in social life and economic field in the 21st century and claim that knowledge alone is insufficient. Gökbulut (2020), on the other hand, argues that technological developments affect almost every area and every segment of society.

3. Method

3.1 Model of Research

The research is a correlational survey study. Correlational survey studies aim to determine the relationship between variables in studies with two or more variables and to determine whether the variables affect each other (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz, & Demirel, 2022; Creswell, 2012; Fraenkel, Wallen & Hyun, 2011; Tekbıyık, 2014). Due to the mentioned characteristics of the correlational survey, the relationship between secondary school students' digital literacy, problem-solving, and 21st-century skill levels is determined. In addition, the effects of the variables on each other (prediction) are discussed.

3.2 Population and Sample of Research

The population of the research is students studying at secondary schools in formal education institutions in Elazig.

The sample is determined by the disproportionate cluster sampling method. Due to the nature of the disproportionate cluster sampling, public secondary schools in the city center of Elazığ are initially considered as a cluster (Karasar, 2022). The students in the accepted cluster are determined out of proportion and included in the research. In this context, 490 secondary school students voluntarily participate in the research.

54.3% of the secondary school students constituting the sample are girls (n=266) and 45.7% are boys (n=224); 30.2% of their mothers are secondary school graduates (n=148), 37.6% are high school graduates (n=184), and 32.2% are university graduates (n=158); 21% of their fathers are secondary school graduates (n=103), 36.9% are high school graduates (n=181), and 42% are university graduates (n=206).

3.3 Data Collection Tools

The research makes use of four data collection tools to determine the digital literacy, problem-solving, and 21st-century skill levels of secondary school students and to reveal the statistical differentiation of the determined levels according to various independent demographic variables. These data collection tools are demographic information form, digital literacy scale, problem-solving inventory for primary school children, and 21st-century skill scale. Information on data collection tools is as follows:

3.3.1 Digital Literacy Scale

The research uses a digital literacy scale developed by Pala and Başıbüyük (2020) to determine the digital literacy levels of secondary school students. The scale consists of 21 items and four sub-dimensions: "Information Processing", "Communication", "Security" and "Problem-Solving". The Likert-type inventory is scored as "Always, Often, Sometimes, Rarely, and Never". While Pala and Başıbüyük (2020) calculate the reliability of the original form of the scale as 0.87, the reliability Croanbach coefficient of the scale was 0.95 in the research conducted. According to these data, it is possible to say that the reliability of the digital literacy scale data is high (Tavşancıl, 2005; Büyüköztürk, 2021; Büyüköztürk et al., 2022). It is accepted that the high scores to be obtained from the digital literacy scale indicate the high digital literacy of secondary school students, and the low scores indicate low digital literacy.

3.3.2 Problem-Solving Inventory for Primary School Children

The research makes use of the "Problem-Solving Inventory for Primary School Children" developed by Serin, Bulut Serin, and Saygılı (2010) to determine the problem-solving skill levels of secondary school students. The inventory consists of 24 items and three sub-dimensions: "Confidence in problem-solving skills", "Self-control" and "Avoidance". The Likert-type inventory is scored as "I never act like this, I rarely act like this, I sometimes act like this, I often act like this, I always act like this". While Serin, Bulut Serin, and Saygılı (2010) calculate the reliability of the original form of the scale as 0.80, the Cronbach coefficient of the scale was 0.72 in the research conducted. According to these data, it is possible to say that the reliability of the problem-solving inventory data for primary school children is high (Tavşancıl, 2005; Büyüköztürk, 2021; Büyüköztürk et al., 2022). It is accepted that the high scores to be obtained from the problem-solving inventory indicate that secondary school students have high self-perception about problem-solving, and low scores indicate low self-perception about problem-solving (Serin, Bulut Serin & Saygılı, 2010).

3.3.3 21st-Century Skills Scale

The research uses the 21st-century skill scale developed by Mete (2021) to determine the 21st-century skill levels of secondary school students. The scale has 12 items and a single factor. The Likert-type scale is scored as "Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree". While Mete (2021) calculates the reliability of the original form of the scale as 0.81, the Cronbach coefficient of reliability of the scale is 0.90 in the research conducted. According to these data, it can be said that the reliability of the 21st-century skill scale data is high (Tavşancıl, 2005; Büyüköztürk, 2021; Büyüköztürk et al., 2022). It is accepted that the high scores to be obtained from the 21st-century skill scale indicate the high level of 21st-century skills of secondary school students, and the low score indicates low 21st-century skills.

3.4 Analysis of Data

In the data analysis process of the research, the normal distribution of the Likert-type data collection tools used to determine the digital literacy, problem-solving, and 21st-century skill levels of secondary school students is determined. The skewness and kurtosis values obtained as a result of the analyzes are presented in Table 1.

Table 1. Data on normal distributions of data

Scales	Sub-dimensions	Skewness	Kurtosis
	Information Processing	-.319	-.606
	Communication	-.744	-.386
Digital Literacy	Safety	-.520	-.262
	Problem-Solving	-.302	-.769
	Overall	-.627	-.179
	Confidence in Problem-Solving Skill	.117	-1.042
	Self Control	-.756	1.455
Problem-Solving Skills	Avoidance	.018	-.461
	Overall	.147	-.628
21st Century Skills Overall		.254	.513

According to Table 1, the skewness values of the digital literacy scale data vary in the range of "302-744", and the kurtosis values in the range of ".179-.769"; the skewness values of the problem-solving skills scale range between ".018-.756", the kurtosis values between ".461-1.455"; the skewness value of the 21st-century skills scale is ".254" and the kurtosis value is ".513". It is possible to say that the calculated values show a normal distribution (DeCarlo, 1997; Hopkins and Weeks, 1990; Tabachnick and Fidell, 2013). Parametric tests are used in the analysis of the data since the research data show a normal distribution.

In the research, an unrelated Samples t-Test is used to determine whether there are significant differences between secondary school students' digital literacy, problem-solving, and 21st-century skill levels by gender and One-Way Analysis of Variance (ANOVA) is used to determine whether there is a significant difference by mother and father's education level. In case of significant differences in the ANOVA result, the Tukey HSD test, one of the post hoc multiple comparison tests, is used to determine between which groups the difference is. In addition, Pearson Correlation analysis is used to determine the relationship between secondary school students' digital literacy, problem-solving, and 21st-century skill levels, and Multiple Linear Regression is used to determine the predictive status between these students' digital literacy, problem-solving, and 21st-century skill levels.

4. Findings

The findings obtained as a result of the analysis of the data collected by using the scales related to digital literacy, problem-solving, and 21st-century skills in the research are explained below in the order of the research problems.

4.1 Findings on the Level of Secondary School Students' Digital Literacy, Problem-Solving, and 21st-Century Skills

In the study, the data in Table 2 is reached as a result of analyzing the research data collected to determine secondary school students' level of digital literacy, problem-solving, and 21st-century skills with descriptive statistical methods.

Table 2. Students' level of digital literacy, problem solving, and 21st-century skills

Scales	Sub-dimensions	$\bar{X}$	ss
	Information Processing	3.17	1.003
	Communication	3.54	1.183
Digital Literacy	Safety	3.23	1.046
	Problem-Solving	3.27	1.164
	Overall	3.30	1.011
	Confidence in Problem-Solving Skill	3.57	.392
	Self Control	3.47	.425
Problem-Solving Skills	Avoidance	2.91	.804
	Overall	3.40	.329
21st Century Skills Overall		3.44	.296

According to Table 2, the digital literacy levels of the secondary school students participating in the research are "Sometimes ($\bar{X}$ =3.17)" in the "Information Processing" sub-dimension, "Often ($\bar{X}$ =3.54)" in the "Communication" sub-dimension, and "Sometimes ($\bar{X}$=3.23)" in the "Safety" sub-dimension, "Sometimes

($\bar{X}$=3.27) in the "Problem-Solving" sub-dimension, and "Sometimes ($\bar{X}$=3.30)" in overall for digital literacy levels. Based on these findings, it cannot be said that the digital literacy levels of secondary school students are very high.

According to Table 2, the problem-solving skills of the secondary school students participating in the research are "Often ($\bar{X}$=3.57)" in the "Confidence in Problem-Solving Skills" sub-dimension, "Often ($\bar{X}$=3.47)", in the "Self-Control" sub-dimension, "Sometimes ($\bar{X}$=2.91)" in the "Avoidance" sub-dimension, and "Often ($\bar{X}$=3.40)" in the overall problem-solving skills. According to these findings, it can be said that secondary school students have high problem-solving skills.

Table 2 also shows that the 21st-century skill levels of the secondary school students participating in the research are at the level of "I agree ($\bar{X}$=3.44)". Based on these findings, it can be said that the 21st-century skill levels of secondary school students are not low.

4.2 Findings on Secondary School Students' Digital Literacy, Problem-Solving, and 21st-Century Skills by Gender

In the research, to determine the statistically significant difference between secondary school students' digital literacy, problem-solving, and 21st-century skill levels by gender, the data in Table 3 are obtained as a result of analyzing the unrelated samples t-Test method from parametric inferential statistical methods.

Table 3. Analysis data of students' digital literacy, problem solving, and 21st century skills by gender

Scales	Sub-dimensions	Gender	n	$\bar{X}$	ss	t	p
Digital Literacy	Information Processing	Female	266	2.91	.969	-6.744	.00
		Male	224	3.49	.950		
	Communication	Female	266	3.30	1.204	-4.981	.00
		Male	224	3.82	1.096		
	Safety	Female	266	3.02	1.016	-4.969	.00
		Male	224	3.48	1.028		
	Problem-Solving	Female	266	2.98	1.117	-6.277	.00
		Male	224	3.61	1.126		
	Overall	Female	266	3.05	.985	-6.188	.00
		Male	224	3.59	.961		
Problem-Solving Skills	Confidence in Problem-Solving Skill	Female	266	3.49	.369	-5.263	.00
		Male	224	3.67	.395		
	Self Control	Female	266	3.42	.447	-2.642	.00
		Male	224	3.52	.391		
	Avoidance	Female	266	2.81	.730	-2.904	.00
		Male	224	3.03	.871		
	Overall	Female	266	3.33	.305	-5.642	.00
		Male	224	3.49	.335		
21st Century Skills Overall		Female	266	3.40	.358	3.908	.00
		Male	224	3.49	.188		

Table 3 shows the analysis data showing the significant difference between the 21st-century skills and digital literacy levels of secondary school students and their problem-solving skills by gender. When the analysis data by gender is examined, it is seen that there is a significant difference (p<.05) between the digital literacy levels of secondary school students. The significant difference determined is in favor of male students since the digital literacy of male students is significantly higher than that of female students. In addition, according to the data on digital literacy skills in Table 3, digital literacy levels differ significantly in favor of male students based on sub-dimensions.

Examining Table 3, it is understood that there is a significant difference (p<.05) between the problem-solving skills of secondary school students by gender. The significant difference determined is in favor of male students, since the problem-solving skills of male students are significantly higher than that of female students. In addition, according to the data on problem-solving skills in Table 3, it is understood that there is a significant difference in problem-solving skills in favor of male students based on sub-dimensions.

In Table 3, it is seen that there is a significant difference (p<.05) between the 21st-century skill levels of secondary school students by gender. The significant difference determined is in favor of male secondary school students, since the 21st-century skill levels of male students are significantly higher than female students.

4.3 Findings on Secondary School Students' Digital Literacy, Problem-Solving, and 21st-Century Skills by Their Mothers' Education Level

Within the study, to determine the statistically significant difference between secondary school students' digital literacy, problem-solving, and 21st-century skill levels by their mothers' education level, the data in Table 4 are obtained as a result of the analysis of the collected research data with the one-way analysis of variance method, one of the parametric inferential statistical methods.

Table 4. Analysis data of digital literacy, problem solving, and 21st century skills by mother's education level

Scales	Dimensions	Education Level	n	$\bar{X}$	ss	F	p	Tukey HSD
Digital Literacy	Information Processing	1. Secondary School	148	3.05	1.136	3.165	.04	1-3
		2. High School	184	3.14	.935			
		3. University	158	3.33	.932			
		Total	490	3.17	1.003			
	Communication	1. Secondary School	148	3.21	1.326	10.983	.00	1-2 1-3
		2. High School	184	3.56	1.184			
		3. University	158	3.83	.944			
		Total	490	3.54	1.183			
	Safety	1. Secondary School	148	3.08	1.085	4.715	.00	1-3
		2. High School	184	3.18	1.062			
		3. University	158	3.43	.963			
		Total	490	3.23	1.046			
	Problem-Solving	1. Secondary School	148	3.20	1.278	7.845	.00	1-3 2-3
		2. High School	184	3.07	1.156			
		3. University	158	3.55	1.000			
		Total	490	3.27	1.164			
	Overall	1. Secondary School	148	3.13	1.133	6.683	.00	1-3 2-3
		2. High School	184	3.23	.986			
		3. University	158	3.53	.872			
		Total	490	3.30	1.011			
Problem-Solving Skills	Confidence in Problem-Solving Skill	1. Secondary School	148	3.45	.333	23.311	.00	1-3 2-3
		2. High School	184	3.53	.412			
		3. University	158	3.73	.366			
		Total	490	3.57	.392			
	Self Control	1. Secondary School	148	3.35	.458	8.561	.00	1-2 1-3
		2. High School	184	3.54	.417			
		3. University	158	3.49	.379			
		Total	490	3.47	.425			
	Avoidance	1. Secondary School	148	2.68	.834	8.876	.00	1-2 2-3
		2. High School	184	3.00	.799			
		3. University	158	3.02	.740			
		Total	490	2.91	.804			

Overall	1. Secondary School	148	3.26	.269	25.386	.00	1-2
	2. High School	184	3.42	.331			1-3
	3. University	158	3.52	.332			2-3
	Total	490	3.40	.329			
21st Century Skills	1. Secondary School	148	3.31	.440	22.095	.00	1-2
	2. High School	184	3.48	.164			1-3
	3. University	158	3.51	.195			
	Total	490	3.44	.296			

Table 4 presents the analysis data showing whether the 21st-century skills and digital literacy levels of secondary school students and their problem-solving skills differ significantly according to their mother's education level. In Table 4, it is seen that there is a significant difference (p<.05) between secondary school students' digital literacy levels by their mother's education levels. As a result of the Tukey HSD test, it is seen that the determined significant difference is between the students whose mothers are secondary school graduates and those whose mothers are university graduates in all dimensions. In addition, there are significant differences between the students whose mothers are high school graduates and those whose mothers are university graduates in the overall problem-solving sub-dimension of the digital literacy skills scale, and in the communication sub-dimension of the students whose mothers are secondary school graduates. According to Table 4, while the general average of the digital literacy scale of the secondary school students participating in the research differs significantly, based on the sub-dimensions, the digital literacy of the secondary school students differs significantly according to the mother's education level (p<.05).

Table 4 also shows that there is a significant difference (p<.05) between secondary school students' problem-solving skills and by mother's education level. The significant difference determined as a result of the Tukey HSD test is between students whose mothers are secondary school graduates and those whose mothers are high school or university graduates. There is also a significant difference between students whose mothers are high school graduates and those whose mothers are university graduates. In terms of the overall average of the scale, in Table 4, the problem-solving skills of the secondary school students participating in the research differ significantly, and based on the sub-dimensions, there is a significant difference (p<.05) in secondary school students' problem-solving skills by their mother's education level.

In Table 4, it is clear that there is a significant difference (p<.05) between secondary school students' 21st-century skill levels by their mother's education levels. The significant difference determined according to the Tukey HSD test data is between the students whose mothers are secondary school graduates and those whose mothers are high school or university graduates. Based on these findings, it is possible to say that the 21st-century skill levels of students whose mothers are university graduates are significantly higher.

4.4 Findings on Secondary School Students' Digital Literacy, Problem-Solving, and 21st-Century Skills by Their Fathers' Education Level

Within the study, to determine the statistically significant difference between secondary school students' digital literacy, problem-solving, and 21st-century skill levels by their fathers' education level, the data in Table 5 are obtained as a result of the analysis of the collected research data with the one-way analysis of variance method, one of the parametric inferential statistical methods.

Table 5. Analysis data of digital literacy, problem solving, and 21st century skills by father's education level

Scales	Dimensions	Education Level	n	$\bar{X}$	ss	F	p	Tukey HSD
Digital Literacy	Information Processing	1. Secondary School	103	3.15	1.220	.209	.81	-
		2. High School	181	3.15	.879			
		3. University	206	3.21	.990			
		Total	490	3.17	1.003			
	Communication	1. Secondary School	103	3.30	1.441	3.060	.04	1-2

		2. High School	181	3.66	1.131		
		3. University	206	3.55	1.068		
		Total	490	3.54	1.183		
	Safety	1. Secondary School	103	3.25	1.284	.327	.72	-
		2. High School	181	3.18	.886		
		3. University	206	3.26	1.048		
		Total	490	3.23	1.046		
	Problem-Solving	1. Secondary School	103	3.16	1.326	.891	.41	-
		2. High School	181	3.25	1.125		
		3. University	206	3.34	1.111		
		Total	490	3.27	1.164		
	Overall	1. Secondary School	103	3.22	1.274	.485	.61	-
		2. High School	181	3.30	.878		
		3. University	206	3.34	.973		
		Total	490	3.30	1.011		
Problem-Solving Skills	Confidence in Problem-Solving Skill	1. Secondary School	103	3.48	.355	7.275	.00	1-3 2-3
		2. High School	181	3.54	.393		
		3. University	206	3.65	.397		
		Total	490	3.57	.392		
	Self Control	1. Secondary School	103	3.38	.446	4.100	.01	1-3
		2. High School	181	3.46	.401		
		3. University	206	3.52	.428		
		Total	490	3.47	.425		
	Avoidance	1. Secondary School	103	2.99	.942	.822	.44	-
		2. High School	181	2.87	.752		
		3. University	206	2.91	.774		
		Total	490	2.91	.804		
	Overall	1. Secondary School	103	3.35	.289	4.781	.00	1-3 2-3
		2. High School	181	3.38	.307		
		3. University	206	3.46	.359		
		Total	490	3.40	.329		
21st Century Skills		1. Secondary School	103	3.30	.497	17.160	.00	1-3 1-3
		2. High School	181	3.44	.224		
		3. University	206	3.51	.170		
		Total	490	3.44	.296		

Table 5 shows the analysis data showing the significant difference between secondary school students' 21st-century skills and digital literacy levels and their problem-solving skills by their fathers' education level. It also shows that there is no significant difference (p>.05) between secondary school students' digital literacy levels by their fathers' education levels. While Table 5 shows that the secondary school students participating in the research do not differ significantly in terms of the overall average of the digital literacy scale, there is a significant difference between the students whose fathers are secondary school graduates and those whose fathers are university graduates in the "Communication" sub-dimension based on sub-dimensions.

Table 5 also shows that there is a significant difference (p<.05) between secondary school students' problem-solving skills by their fathers' education level. The significant difference determined, as a result of the Tukey HSD test, is between the students whose fathers are secondary school graduates and those whose fathers are

high school or university graduates. There is also a significant difference between students whose fathers are high school graduates and those whose fathers are university graduates. According to these findings, the problem-solving skills of the students whose fathers are university graduates are significantly higher. This situation reveals that the problem-solving skills of the secondary school students participating in the research do not show similarity according to their fathers' education level. Table 5 also shows that while the problem-solving skills of the secondary school students participating in the research differ significantly in terms of the overall average of the scale (p<.05), the problem-solving skills of the secondary school students do not differ significantly according to the education level of their fathers only in the avoidance sub-dimension based on the sub-dimensions (p>.05).

In addition, Table 5 shows that there is a significant difference (p<.05) between secondary school students' 21st-century skill levels by their mother's education levels. The significant difference determined, as a result of the Tukey HSD test, is between the students whose fathers are secondary school graduates and those whose fathers are high school or university graduates. According to these findings, the 21st-century skill levels of students whose fathers are university graduates are significantly higher.

4.5 Findings on the Relationship Between Secondary School Students' Digital Literacy, Problem-Solving, and 21st-Century Skills

Within the research, the data collected to determine the relationship between secondary school students' digital literacy, problem-solving, and 21st-century skill levels are analyzed via the Pearson correlation analysis method, which is one of the parametric inferential statistical methods, and the data in Table 6 are obtained.

Table 6. Analysis data of the relationship between 21st century skills and digital literacy levels and problem-solving skills

		1	2	3	4	5	6	7	8	9	10
1	r	1	.806**	.761**	.799**	.905**	.416**	.305**	.035	.380**	.049
	p		.000	.000	.000	.000	.000	.000	.442	.000	.280
2	r	.806**	1	.808**	.792**	.925**	.488**	.292**	.025	.413**	.099*
	p	.000		.000	.000	.000	.000	.000	.576	.000	.029
3	r	.761**	.808**	1	.822**	.926**	.438**	.351**	-.022	.381**	.021
	p	.000	.000		.000	.000	.000	.000	.622	.000	.645
4	r	.799**	.792**	.822**	1	.927**	.425**	.295**	-.063	.332**	.025
	p	.000	.000	.000		.000	.000	.000	.166	.000	.588
5	r	.905**	.925**	.926**	.927**	1	.481**	.338**	-.008	.409**	.052
	p	.000	.000	.000	.000		.000	.000	.851	.000	.251
6	r	.416**	.488**	.438**	.425**	.481**	1	.396**	.090*	.790**	.123**
	p	.000	.000	.000	.000	.000		.000	.046	.000	.006
7	r	.305**	.292**	.351**	.295**	.338**	.396**	1	.037	.631**	.045
	p	.000	.000	.000	.000	.000	.000		.420	.000	.318
8	r	.035	.025	-.022	-.063	-.008	.090*	.037	1	.576**	-.107*
	p	.442	.576	.622	.166	.851	.046	.420		.000	.017
9	r	.380**	.413**	.381**	.332**	.409**	.790**	.631**	.576**	1	.036
	p	.000	.000	.000	.000	.000	.000	.000	.000		.428
10	r	.049	.099*	.021	.025	.052	.123**	.045	-.107*	.036	1
	p	.280	.029	.645	.588	.251	.006	.318	.017	.428	

Note. 1. Information Processing; 2. Communication; 3. Safety; 4. Problem-Solving; 5. Digital Literacy Overall; 6. Confidence in Problem-Solving Skills; 7. Self Control; 8. Avoidance; 9. Problem-Solving Overall; 10. 21st Century Skills.

According to Table 6, the data on the relationship between 21st-century skills and digital literacy levels and problem-solving skills show a significant relationship (p<.05) between secondary school students' problem-solving skills and digital literacy levels. The determined relationship is positive and moderate (r=409; .30<r<.70). According to this finding, it is possible to say that as secondary school students' problem-solving skills increase, their digital literacy levels increase. It is also clear in Table 7 that there is a significant relationship (p<.05) between secondary school students' 21st-century skills and digital literacy levels in

the communication sub-dimension, and between the "confidence in problem-solving skills" and "avoidance" sub-dimensions of problem-solving skills. However, the significant relationship determined in the avoidance sub-dimension is negative.

4.6 Findings of Secondary School Students' Digital Literacy, Problem-Solving, and 21st-Century Skills Predicting Each Other

Within the study, the data in Table 7 and Table 8 are obtained by analyzing the data collected in the research with the multiple linear regression analysis, one of the inferential statistical methods, to determine the predictive status of the digital literacy and problem-solving skill levels of the secondary school students and the 21st-century skill levels.

Table 7. Multiple linear regression analysis data on the predictive role of digital literacy and problem-solving skills on 21st-century skill levels

Dependent Variable	Independent Variables	B	Std. Error	β	t	p
21st-century skill	Fixed	3.348	.140		23.872	.000
	Problem-Solving Skill	.016	.045	.018	.355	.723
	Digital Literacy	.013	.015	.045	.903	.367
	r=.054; r²=.003; F=.723; p=.486					

According to Table 7, digital literacy and problem-solving skills do not significantly predict the 21st-century skill levels of secondary school students (p>.05).

Table 8. Multiple linear regression analysis data on the predictive role of problem-solving skills and 21st century skill levels on digital literacy

Dependent Variable	Independent Variables	B	Std. Error	β	t	p
Digital Literacy	Fixed	-1.398	.640		-2.185	.029
	Problem-Solving Skill	1.250	.127	.408	9.856	.000
	Digital Literacy	.127	.141	.037	.903	.367
	r=.411; r²=.169; F=49.363; p=.000					

Looking at Table 8, the cause-effect relationship between secondary school students' "21st-century", "problem-solving" and "digital literacy" skills is significant (F = 49.363; p =.00). Table 9 shows that secondary school students' 21st-century and problem-solving skills significantly predict their digital literacy levels by 16.9% (r2=.169; p<.05). Problem-solving skill, which is among the independent variables, affects digital literacy as moderately positive (β=.408).

5. Results and Discussion

According to the research results, secondary school students' digital literacy levels are "Sometimes" in the "Information Processing" sub-dimension, "Often" in the "Communication" sub-dimension, "Sometimes" in the "Safety" sub-dimension, "Sometimes" in the "Problem-Solving" sub-dimension, and "Sometimes" in overall. According to this result, it cannot be said that secondary school students' digital literacy levels are very high.

According to the results, secondary school students' problem-solving skills are "Often" in the "Confidence in Problem-Solving Skills" sub-dimension, "Often" in the "Self-Control" sub-dimension, "Sometimes" in the "Avoidance" sub-dimension, and "Often" in the overall problem-solving skills. Based on this result, it can be said that secondary school students have high problem-solving skills. Similarly, Arkan (2011), Baysal, Arkan, and Demirbaş (2011), and Çağlar (2022) determined in their research that students have high problem-solving skills.

According to the results, secondary school students' 21st-century skill levels are at the "I agree" level. According to this result, it can be said that the 21st-century skill levels of secondary school students are not low.

The research results indicate that there is a significant difference between secondary school students' digital literacy, problem-solving, and 21st-century skill levels. The significant difference identified can be seen in favor of male students, since their digital literacy, problem-solving, and 21st-century skill levels are significantly higher than female students'. This result can be interpreted as secondary school students' digital literacy, problem-solving, and 21st-century skill levels are not similar by gender, or it can be said that gender affects

secondary school students' digital literacy, problem-solving, and 21st-century skill levels. Similarly, Ferah (2000), Bozkurt, Serin, and Emran (2004), Serin and Derin (2008), Tüysüz (2013), Kontaş, Ünişen, and Sürücü (2016), Çağlar (2022), Kaya Öztürk (2022) determine that there is a significant difference between the problem-solving skills of the students by gender. In addition, there are many studies in the literature that overlap with this result, that is, support that there is a significant difference between the problem-solving skills of students by gender (Saracoğlu, Yenice, & Karasakaloğlu, 2009; Dündar, 2009; Arslan, 2010; Sezen & Paliç, 2011; Yıldırım, Hacıhasanoğlu, Karakurt, & Türkleş. , 2011; Çetinkaya, 2013; Kuloğlu & Arı, 2014; Karaca, Akyol, Karaca, & Can Yaşar, 2016; Gözcü Reyhan, 2018; Akyüz & Hardalaç, 2021). It can be said that the significant difference in gender variable is due to the difference in the cognitive and affective development processes of female and male students (Bilgiç & Bilgin, 2016). There are also research results in the literature that show parallelism with the results of the significant difference determined by gender within 21st-century skills. In this regard, Karakaş (2015), Sümen and Çalışıcı (2017), Asalıoğlu (2022) determine that there is a significant difference between the 21st-century skill levels of the participants by gender.

Based on the results of the research, the 21st-century skills, digital literacy levels and problem-solving skills of secondary school students differ significantly according to the educational status of their mothers. It can be said that the significant difference determined according to mothers' education level is between the students whose mothers are secondary school graduates and those whose mothers are university graduates, and the difference is in favor of the students whose mothers are university graduates. According to these results, it can be said that the mother's education level affects secondary school students' digital literacy.

The research reveals that secondary school students' problem-solving skill levels differ significantly by their mothers' education level. The significant difference determined according to the mother's education level is between the students whose mothers are high school graduates and those whose mothers are university graduates. Based on these results, it is possible to say that the problem-solving skills of the students whose mothers are university graduates are significantly higher. According to these results, it can be said that the problem-solving skills of secondary school students are not similar according to their mothers' education level. Likewise, Ünüvar (2003) determines in her research that there is a significant difference between the problem-solving skills of the students according to mothers' education level.

The research reveals that students whose mothers have high education have higher problem-solving skills. There are studies in the literature showing that students whose mothers have a high education level also have high problem-solving skills. Kaya Öztürk (2022), in her research on this subject, determines that the problem-solving skills of students whose mothers are university graduates are higher.

The research determines that there is a significant difference between secondary school students' 21st-century skill levels by their mothers' education levels. The significant difference determined according to the mother's education level is between the students whose mothers are secondary school graduates and those whose mothers are high school and university graduates. According to these results, the 21st-century skills of students whose mothers are university graduates are significantly higher.

The research differs in three main variables according to the mother's education level. Examining the significant differences identified, it is seen that mothers' education level and the 21st-century skills, problem-solving skills, and digital literacy of the students increase in parallel.

In the research, secondary school students' 21st-century skills, digital literacy levels, and problem-solving skills are significantly different according to their father's education level. According to the findings, there is no significant difference between secondary school students' digital literacy levels according to their father's education level. According to this result, it can be said that secondary school students' digital literacy is similar in terms of the father's education level, and it can be said that the father's education level does not affect the digital literacy of the students.

Based on the sub-dimensions of the research, it is concluded that there is a significant difference between the students whose fathers are secondary school graduates and those whose fathers are university graduates in the "Communication" sub-dimension of the digital literacy scale of secondary school students. In addition, the secondary school students' digital literacy does not differ significantly, except for the communication sub-dimension, according to the father's education level. Similarly, Serin and Derin (2008) and Kaya Öztürk (2022) state in their research that there is no significant difference between students' problem-solving skills according to their father's education level. In line with the result that there is no significant difference in the sub-dimension of self-control, Çağlar (2022) also states that there is no significant difference.

In the study, there are significant differences between secondary school students' problem-solving skill levels

according to their fathers' education level. Significant differences determined by the father's education level are between students whose fathers are secondary school graduates and those whose fathers are high school or university graduates. There are also significant differences between students whose fathers are high school graduates and those whose fathers are university graduates. According to these results, it can be said that the problem-solving skills of the students whose fathers are university graduates are significantly higher. In addition, it can be said that secondary school students' problem-solving skills are not similar according to their fathers' education level and that their fathers' education level affects students' problem-solving skills.

The research reveals that there is a significant difference between secondary school students' 21st-century skill levels - according to their fathers' education level. Significant differences determined according to the father's education level are between the students whose fathers are secondary school graduates and those whose fathers are high school and university graduates. According to these results, the 21st-century skills of students whose fathers are university graduates are significantly higher.

The three main variables of the research differ according to the father's education level. Examining the significant differences identified, it can be said that fathers' high education levels provide an increase in the 21st century and problem-solving skills of the students as well as an increase in their digital literacy.

According to research results, there is a positive and moderately significant relationship between secondary school students' problem-solving skills and their digital literacy levels. This result can be interpreted as secondary school students' digital literacy levels increase as their problem-solving skills increase. In another way, this result can be interpreted as a decrease in digital literacy levels as secondary school students' problem-solving skills decrease.

The research shows that there is a significant relationship between secondary school students' 21st-century skills and digital literacy levels in the communication sub-dimension, and between the "confidence in problem-solving skills" and "avoidance" sub-dimensions of problem-solving skills. While the significant relationships identified are negative in the avoidance sub-dimension, they are positive in other dimensions. These results show that as secondary school students' 21st-century skill levels increase, their problem-solving avoidance behaviors will decrease.

The research reflects that digital literacy and problem-solving skills do not significantly predict secondary school students' 21st-century skill levels. However, secondary school students' 21st-century skill level and problem-solving skill level significantly predict the digital literacy level. According to the research, problem-solving skill, which is among the independent variables, affects digital literacy positively at a moderate level, and according to this result, secondary school students' problem-solving skill level increases the level of digital literacy.

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