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The Relationship Between Students' 21st-Century Skills and Academic Performance in Science and Mathematics

Mehmet Akif BİRCAN[1]
Sivas Cumhuriyet University
Emrah AKMAN[2]
Ordu University

Abstract

This study aimed to reveal a relationship between high school students' 21st-century skills and academic performance in mathematics and science courses. The research was designed in a relational survey model. In the study group, there were 596 students. Descriptive statistics, the one-way analysis of variance, the Pearson correlation test, and simple partial regression analyzed the research data. As a result of the research, it was concluded that the 21st-century skills of high school students are above the intermediate level. It is also revealed that there is no significant difference between the dimensions other than critical thinking and problem-solving of 21st-century skills scores according to the type of high school. According to high school type, a difference was found in the dimension of critical thinking and problem-solving. It has been concluded that there is a significant relationship between the 21st-century skills scores of high school students and their academic performances in science and mathematics courses. Information and technology literacy, critical thinking and problem-solving, entrepreneurship and innovation skills, and 21st-century skills overall scores could be used to predict academic performances in science and mathematics courses. The other variables like social responsibility and career awareness cannot predict academic performances in science and mathematics courses concerning this study.

Keywords: High school students, 21st-century skills, math, science, academic performance

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[1]Assist. Prof., Faculty of Education, Sivas Cumhuriyet University, Sivas, Turkey, ORCID: 0000-0003-2442-0600
Correspondence: mehmetakifbircan@cumhuriyet.edu.tr
[2] Assist. Prof., Faculty of Education, Ordu University, Ordu, Turkey, ORCID: 0000-0003-0637-919X,
Email: emrahakman@outlook.com.tr

Introduction

Today, there are changes and developments in science and technology globally at a dizzying speed. In this process of change and development, it is a matter of debate which skills individuals should have to adapt to professional and social life. For this reason, many studies are carried out, and reports are published on what these skills are in the international arena (Cansoy, 2018; Topçu & Çiftçi, 2018).

The skills that individuals need to adapt to the society and era we live in are 21st-century skills (Belet-Boyacı & Güner-Özer, 2019). The mentioned skills are classified and defined by many different institutions and organizations (Hilliker & Loranc, 2022). For example, 21st-century skills are defined as ten different skills in four categories. These skills are categorized as (Scardamalia, Bransford, Kozma, & Quellmalz, 2012):

- Ways of thinking; creativity and innovation, critical thinking, problem-solving and decision making, leadership and metacognition for learning.
- Working tools; information and communication technology literacy, information literacy.
- Ways of working; communication and cooperation.
- Life skills; local and global citizenship, life and career, personal and social responsibility.

Among these, the classification made by the Partnership for 21st-Century Skill (P21) is the most used and valid (Cansoy, 2018). 21st-century skills are grouped as learning and innovation skills, information, media and technology skills, and life and career skills by P21 (Öğretir-Özçelik, 2018). These skills were tabularized by Bal (2018), as in Table 1.

Table 1. 21st-century skills

Main Skills	Sub-Skills
Learning and Regeneration Skills	Creativity and regeneration Critical thinking Problem-solving
Information, Media, and Technology Skills	Information literacy Media literacy Information and communication technology literacy
Life and Profession Skills	Flexibility and harmony Entrepreneurship Self-orientation Social skills Intercultural skills Productivity and responsibility Leadership and responsibility

Apart from the classifications presented above, 21st-century skills EnGauge (The Metiri Group and The Learning Point Associates), NETS/ISTE (National Educational Technology Standards/International Society for Technology in Education), EU (European Union), OECD

(Organization for Economic Cooperation and Development) has been defined (Erten, 2020). However, communication, cooperation, problem-solving, creativity, critical thinking, and information communication technologies literacy are skills included in various definitions (Siddiq, Hatlevik, Olsen, Throndsen & Scherer, 2017).

In the 21st-century, individuals need to have special skills to succeed in business and social life. For this reason, education systems should be structured in such a way as to enable individuals to participate actively in today's business and social life and to gain these skills so that they can lead a prosperous life (Abdullah & Osman, 2010). Individuals who will take place in the business world of the 21st-century should know science and mathematics, creativity, problem-solving skills, and use information and communication technologies (Business-Higher Education Forum, 2005). Therefore, education systems must be transformed to provide students with 21st-century skills. In order to achieve this, it is necessary to establish a link between economic development and the reform of education systems (National Academy of Science, 2006).

The most crucial responsibility in bringing 21st-century skills to individuals falls on the education system and institutions. In this respect, today's curricula must provide students with creativity, problem-solving, critical thinking, effective communication, and cooperation (Gülen, 2013). In addition, since 21st-century skills have been designed with a lifelong learning approach, these skills are expected to be included in teaching environments, and students are expected to graduate with these competencies (Kurudayıoğlu & Soysal, 2019). For future students to overcome the problems they will encounter, it should be ensured that they learn 21st-century skills throughout their entire education life, starting from the pre-school period (Çetin & Çetin, 2021). For this reason, activities that will teach and gain students 21st-century skills should be included in each stage and element of the education process. 21st-century skills have been included with the updates made in the education system and curriculum in Turkey. In the Turkish Qualifications Framework, which was created in line with the European Qualifications Framework, the principles regarding all competencies to be acquired through vocational, general and academic education programs covering primary, secondary, and higher education were determined, and the "Regulation on the Procedures and Principles Regarding the Implementation of the Turkish Qualifications Framework" was put into effect by being published in the Official Gazette dated 9 November 2015 and numbered 29537, with the decision of the Council of Ministers numbered 2015/8213 (Official Gazette, 2015). In this direction, raising individuals who have acquired the basic skills and competencies determined in the Turkish Qualifications Framework has been included in the updated curricula. In these programs, the aim of raising individuals who can think critically, solve problems, are entrepreneurs, and have communication skills has also been put forward (MoNE, 2018). Based on the information in question, it can be stated that the latest education programs aim to raise individuals with 21st-century skills.

Since 2003, Turkey has been participating in PISA exams consisting of three areas; science literacy, mathematical literacy, and literacy skills, which measure the ability of students in the age group of fifteen to use the information they learned at school in daily life (Çepni & Ormancı, 2017). According to Batur, Ulutaş, and Beyret (2019), the PISA application raises individuals with 21st-century skills. The results of Turkey's PISA exams are not promising. For instance, the last PISA 2018 application it participated in ranked 42nd among 79 countries in mathematical literacy and 39th in science literacy (MoNE, 2019). In addition, in Turkey, students take an LGS exam to be placed in high schools after primary education. The purpose of LGS is determined "to enable students to use the information given at school in daily life" (Batur, Ulutaş & Beyret, 2019). In this respect, it can be said that the questions in this exam will be similar to the questions in the PISA exams and will measure the 21st-century skill levels of the students. Students' mathematics and science course scores in Turkey are deficient in the said exam. In LGS in 2021, the average number of correct answers of students on a 20-question math test is 4,20, and the net average of correct answers in science tests is 8,04 (MoNE, 2021). In the light of this information, it can be stated that students studying in Turkey cannot acquire 21st-century skills during their primary education, and their academic performance in mathematics and science courses is deficient. However, program-specific skills are included in the science curriculum, and 21st-century skills are included in the mathematics curriculum, in the particular objectives section of the curriculum (MoNE, 2018). For this reason, it is expected that students who have completed primary education will graduate with these skills and have high academic performance in science and mathematics courses.

When the national and international literature on 21st-century skills is examined, it is seen that there are many studies. Karakaş (2015) in order to measure the 21st-century skill levels of secondary school eighth grade students for science lessons; Engin and Korucuk (2021) in order to examine the 21st-century skills of university students in terms of various variables; Nacaroğlu (2020) in order to measure the 21st-century skills of gifted and typically developing students; Diker Akman (2020) in order to determine the relationship between eighth grade students' TIMSS science results and 21st-century skills; Zeybek (2019) in order to determine the 21st-century learning skill usage levels of high school students; Sukor, Osman, and Abdullah (2010) in order to examine students' 21st-century skills in chemistry; Soh, Arsad, and Osman (2010) in order to determine the relationship between students' 21st-century skills and their perceptions and attitudes towards physics; Woods-Groves, Choi, and Balint-Langel (2021) conducted studies to determine the relationship between students' 21st-century skills and academic achievement.

It can be stated that students who are successful in mathematics and science courses will have higher 21st-century skills. It is essential to conduct scientific studies that test the accuracy of this hypothesis. Determining the development levels of students' 21st-century skills, conducting research

to facilitate the development of these skills, and assessing the extent to which students' demographic factors affect the development of these skills are of paramount importance. Also, it is crucial to conduct studies to reveal the impact of students' 21st-century skills development levels on their academic success. However, when the body of literature is examined, no research has been found examining the relationship between students' 21st-century skills and academic performance in science and mathematics courses. For this reason, it is thought that the study will contribute to the field. Based on this information, the research questions were determined as follows:

- What is the level of 21st-century skills do high school students have?
- Do high school students' 21st-century skills differ according to the type of high school they study?
- Is there a relationship between the 21st-century skills of high school students and their academic performances in science and mathematics courses?
- Do 21st-century skills predict academic performances in science and mathematics courses?

Method

Research Design

This study revealed the relationship between high school students' 21st-century skills and academic performances in science and mathematics courses. The research was designed in a relational survey model. In the relational survey model, a questionnaire or scale is applied to reveal specific characteristics of a group, and the relationships with the descriptive variables obtained are examined (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz, & Demirel, 2014; Karasar, 2012).

Sampling

The convenience sampling method was used to determine the sample. In this sense, students included in the sample have the same probability of being selected. The research study group consists of 617 students studying in the first year of high school or preparatory class in nine different public schools in the city center of Tokat, in the Republic of Turkey. Descriptive statistics of the gender and grades of the students in the research group are presented in Table 2.

Table 2. Distribution of students by gender and grade level

Gender	Frequency	Percent	Grade	Frequency	Percent
Male	387	64.9	Preparatory	109	18.3
Female	209	35.1	9th grade	487	81.7
Total	596	100.0	Total	596	100.0

The study includes 387 (64.9%) male and 209 (35.1%) female students. There were 109 (18,3%) students in preparatory class and 487 (81,7%) students in 9th grade.

Table 3. Distribution of students by high school type

High school type	Frequency	Percent
Science High School	199	33.4
Social Sciences High School	73	12.2
Anatolian High School	231	38.8
Vocational and Technical Anatolian High School	58	9.7
Fine Arts & Sports High School	35	5.9
Total	596	100.0

The number of students included the following: 199 (33.4%) of the students in science high school, 73 (12.2%) in social sciences high school, 231 (38.8%) in Anatolian high schools, 58 (9.7%) in vocational and technical Anatolian high school, and 35 (5.9%) of them in fine arts and sports high school which accepts students with talent exam.

Data Collection Tools

LGS academic performances

In the research, LGS science and mathematics course nets attended in 2021 were used to determine students' academic performance in mathematics and science courses. It was stated that the internal consistency (reliability) coefficient for the subtests was 0.84 for science and 0.76 for mathematics.

Multidimensional 21st-century skills scale

In order to determine the 21st-century skills of the students, the Multidimensional 21st-Century Skills scale developed by Çevik and Şentürk (2019) was used. The scale comprises five sub-dimensions. These dimensions are as follows: Information and technology literacy skills (15 items), critical thinking and problem-solving skills (6 items), entrepreneurship and innovation skills (10 items), social responsibility and leadership skills (4 items), and career awareness (6 items). The scale is in a 5-point Likert type, graded between "Strongly agree" and "Strongly disagree." The scale can be applied to people between 15-25. It was stated that the scale's Cronbach's alpha internal reliability coefficient was 0.86. In this study, Cronbach's alpha coefficient was found to be 0.90. Therefore, it can be said that the scale has an acceptable internal reliability coefficient.

Data Collection Process

Research data were collected through Google Forms from students who have just started high school according to their scores in the 2021 LGS in the 2020-2021 academic year fall semester.

Data Analysis

Research data were analyzed using the IBM SPSS software. While analyzing the quantitative data in the research, normality status was determined by looking at the descriptive statistics of the scores obtained from the scales.

Table 4. Test of normality

Variable	Skewness	Kurtosis
Academic performance in mathematics (APM)	0.043	-1.070
Academic performance in science (APS)	-1.257	1.220
Information and technology literacy	-0.027	-0.315
Critical thinking and problem-solving	-0.389	-0.333
Entrepreneurship and innovation skills	0.102	-0.108
Social responsibility and leadership	-0.167	-0.270
Career awareness	-0.616	-0.321
21st-century skills overall	0.054	-0.099

The skewness and kurtosis coefficient values obtained from the 21st-Century Skills Scale, mathematics, and science course academic performance data are in the range of -2, +2. Therefore, it can be stated that the data obtained from the scales show normal distribution characteristics (George & Mallery, 2010). In line with this information, parametric tests were used to analyze the data in the research.

Findings

Descriptive statistics about 21st-century skills and sub-dimensions of high school students participating in the research are presented in Table 5.

Table 5. Descriptive statistics of 21st-century skills of high school students

21st-century skills	N		Sd
Information and technology literacy	596	4.09	0.42
Critical thinking and problem-solving	596	4.05	0.58
Entrepreneurship and innovation skills	596	3.53	0.59
Social responsibility and leadership	596	3.70	0.62
Career awareness	596	4.43	0.48
21st-century skills overall	596	3.96	0.39

When Table 5 is examined, it is seen that the 21st-century skills of high school students are close to the level of agree (=3.96). In addition, when the 21st-century skills of high school students are examined in terms of sub-dimensions, it is seen that the highest score (=4.43) and the lowest score (=3.53) from *career awareness* are obtained from *entrepreneurship and innovation skills.*

One-way ANOVA tests were conducted to reveal whether the 21st-century skills of high school students differ according to the type of high school. One-way ANOVA results are presented in Table 6.

Table 6. One-way ANOVA test results by type of high school in terms of 21st-century skills

21st-century skills	Component of Variance	Sum of Squares	df	Mean Square	F	p	Scheffe
Information and technology literacy	Between Groups	0.641	4	0.160	0.897	0.465	
	Within Groups	105.483	591	0.178			
	Total	106.123	595				
Critical thinking and problem-solving	Between Groups	6.277	4	1.569	4.790*	0.001	a>e
	Within Groups	193.601	591	0.328			b>e
	Total	199.877	595				
Entrepreneurship and innovation skills	Between Groups	0.346	4	0.087	0.250	0.910	
	Within Groups	204.728	591	0.346			
	Total	205.074	595				
Social responsibility and leadership	Between Groups	0.708	4	0.177	0.461	0.764	
	Within Groups	226.891	591	0.384			
	Total	227.598	595				
Career awareness	Between Groups	1.282	4	0.320	1.422	0.225	
	Within Groups	133.133	591	0.225			
	Total	134.415	595				
21st-century skills overall	Between Groups	0.255	4	0.064	0.417	0.796	
	Within Groups	90.242	591	0.153			
	Total	90.497	595				

*. The mean difference is significant at the 0.05 level. a= Science High School, b= Social Sciences High School, e= Fine Arts & Sports High School.

When Table 6 is examined, it is seen that the *critical thinking and problem-solving* in 21st-century skills of high school students differ significantly by the type of high school they study ($F=4.79$, $p>0.05$). The other dimensions in 21st-century skills of high school students do not differ significantly according to the type of high school they study ($p>0.05$). The post-hoc test was conducted to understand better the difference seen in the *critical thinking and problem-solving* dimensions of 21st-century skills. Students at science high school differ significantly in terms of their *critical thinking and problem-solving* when compared to students at fine arts or sports high school (Mean difference=0.39419, $p<0.05$). Moreover, students at social science high school differ significantly in terms of their *critical thinking and problem-solving* when compared to students at fine arts or sports high school (Mean difference =0.38004, $p<0.05$).

One-way ANOVA tests were conducted to reveal whether the academic performance in science and mathematics courses of high school students differ according to the type of high school. One-way ANOVA results are presented in Table 7.

Table 7. One-way ANOVA test results by type of high school in terms of academic performance

Academic Performance	Component of Variance	Sum of Squares	df	Mean Square	F	p	Scheffe
Science course	Between Groups	3974.634	4	993.659	92.908	0.000	a>b, c, d, e
	Within Groups	6320.807	591	10.695			b>c, d, e
	Total	10295.441	595				c>e
							d>e
Mathematics course	Between Groups	8863.017	4	2215.754	228.331	0.000	a>b, c, d, e
	Within Groups	5735.144	591	9.704			b>e
	Total	14598.161	595				c>e

*. The mean difference is significant at the 0.05 level. a= Science High School, b= Social Sciences High School, c= Anatolian High School, d= Vocational and Technical Anatolian High School, e= Fine Arts & Sports High School.

In Table 7, it is seen that academic performance in both science ($F=92.908$, $p>0.05$) and mathematics ($F=228.331$, $p>0.05$) courses of high school students differs significantly by the type of high school they study. The post-hoc test was conducted to understand better the difference seen in academic performances. Students at science high school differ significantly in terms of their academic performance in science course when compared to students at social sciences high school (Mean difference=2.797, $p<0.05$), Anatolian high school (Mean difference=4.519, $p<0.05$), vocational and technical Anatolian high school (Mean difference=5.599, $p<0.05$) and fine arts and sports high school (Mean difference=9.03, $p<0.05$). Students at social science high school differ significantly in terms of their academic performance in science course when compared to students at Anatolian high school (Mean difference=1.722, $p<0.05$), vocational and technical Anatolian high school (Mean difference=2.802, $p<0.05$), and fine arts and sports high school (Mean difference=6.233, $p<0.05$). Students at Anatolian high school differ significantly in terms of their academic performance in science course compared to fine arts and sports high school (Mean difference=4.511, $p<0.05$). Furthermore, students at vocational and technical Anatolian high school differ significantly in terms of their academic performance in science course compared to fine arts and sports high school (Mean difference=3.431, $p<0.05$).

Students at science high school differ significantly in terms of their academic performance in mathematics when compared to students at social sciences high school (Mean difference=7.846, $p<0.05$), Anatolian high school (Mean difference=7.652, $p<0.05$), vocational and technical Anatolian high school (Mean difference=8.759, $p<0.05$) and fine arts and sports high school (Mean difference=10.175, $p<0.05$). Students at social science high school differ significantly in terms of their academic performance in mathematics compared to students at fine arts and sports high school (Mean difference=2.328, $p<0.05$). Moreover, students at Anatolian high school differ significantly in terms of their academic performance in mathematics compared to fine arts and sports high school (Mean difference=2.523, $p<0.05$). As understood, academic performance in both courses differs significantly according to the type of high school graduate.

Correlation analysis was conducted to determine whether there is a relationship between high school students' 21st-century skills and their academic performances in science courses, and the results are shown in Table 8.

Table 8. Correlations of 21st-century skills and APS variables

	1	2	3	4	5	6	7
1. Academic performance in Science Course	-	-	-	-	-	-	-
2. Information and technology literacy	0.166**	-	-	-	-	-	-
3. Critical thinking and problem-solving	0.241**	0.337**	-	-	-	-	-
4. Entrepreneurship and innovation skills	0.074	0.684**	0.240**	-	-	-	-
5. Social responsibility and leadership	0.050	0.496**	0.282**	0.522**	-	-	-
6. Career awareness	-0.025	0.510**	0.253**	0.451**	0.362**	-	-
7. 21st-century skills overall	0.148**	0.888**	0.528**	0.852**	0.669**	0.657**	-

**p<0.01 (2-tailed).

There is a low, positive, and significant relationship between high school students' overall 21st-century skills scores and academic performance in science courses (r=0.148, p<0.05). In addition, when the relationship between 21st-century skills and academic performance of the students in science courses is examined in terms of sub-dimensions, it is seen that there is a significant relationship in terms of *information and technology literacy* (r=0.166, p<0.01), *critical thinking and problem-solving* (r=0.241, p<0.01).

The regression analysis results performed to see whether the 21st-century skills of the students are significant predictors of the academic performance in science course are given in Table 9.

Table 9. Linear regressions between dimensions of 21st-century and APS

Independent Variables (Predictors)	APS (Academic performance in science course)							
	R	R^2	F	B	SE	β	t	p
Information and technology literacy	0.166	0.027	16.771	1.632	0.399	0.166	4.095	0.000
Critical thinking and problem-solving	0.241	0.058	36.495	1.727	0.286	0.241	6.041	0.000
Entrepreneurship and innovation skills	0.074	0.005	3.248	0.522	0.290	0.074	1.802	0.072
Social responsibility and leadership	0.050	0.003	1.500	0.338	0.276	0.050	1.225	0.221
Career awareness	-0.025	0.001	0.376	-0.220	0.359	-0.025	-0.614	0.540
21st-century skills overall	0.148	0.022	13.362	1.582	0.433	0.148	3.655	0.000

From the results in Table 9, information and technology literacy (B=1.632, t=4.095; p<0.05), critical thinking and problem-solving (B=1.727, t=6.041; p<0.05), entrepreneurship and innovation skills (B=0.522, t=1.802; p<0.05) and 21st-century skills overall scores (B=1.582, t=3.655; p<0.05) could be used to predict academic performance in science course. The other variables like social responsibility and career awareness cannot predict academic performance in science course.

Correlation analysis was conducted to determine whether there is a relationship between high school students' 21st-century skills and their academic performances in mathematics, and the results are given in Table 10.

Table 10. 21st-century skills and APM variables correlations

	1	2	3	4	5	6	7
1. Academic performance in Mathematics Course	-	-	-	-	-	-	-
2. Information and technology literacy	0.084*	-	-	-	-	-	-
3. Critical thinking and problem-solving	0.151**	0.337**	-	-	-	-	-
4. Entrepreneurship and innovation skills	0.082*	0.684**	0.240**	-	-	-	-
5. Social responsibility and leadership	0.023	0.496**	0.282**	0.522**	-	-	-
6. Career awareness	-0.071	0.510**	0.253**	0.451**	0.362**	-	-
7. 21st-century skills overall	0.087*	0.888**	0.528**	0.852**	0.669**	0.657**	-

** p<0.01 (2-tailed), * p<0.05 (2-tailed).

When Table 10 is examined, it is seen that there is no significant relationship between high school students' overall 21st-century skills scores and their academic performance in mathematics (r=0.087, p>0.05). However, when the relationship between students' 21st-century skills and mathematics course academic performance is examined in terms of sub-dimensions, it is seen that there is a significant relationship between *mathematics course academic performance* and *information and technology literacy* (r=0.084, p<0.05), *critical thinking and problem-solving* (r=0.151, p<0.01) and *entrepreneurship and innovation skills* (r=0.082, p<0.05).

The regression analysis results performed to see whether the 21st-century skills of the students are significant predictors of academic performance in mathematics are given in Table 11.

Table 11. Linear regressions between dimensions of 21st-century and APM

Independent Variables (Predictors)	APM (Academic performance in mathematics course)							
	R	R^2	F	B	SE	β	t	p
Information and technology literacy	0.084	0.007	4.222	0.985	0.480	0.084	2.055	0.040
Critical thinking and problem-solving	0.151	0.023	13.811	1.288	0.347	0.151	3.716	0.000
Entrepreneurship and innovation skills	0.082	0.007	4.012	0.691	0.345	0.082	2.003	0.046
Social responsibility and leadership	0.023	0.001	0.323	0.187	0.329	0.023	0.568	0.570
Career awareness	-0.071	0.005	2.981	-0.736	0.427	-0.071	-1.727	0.085
21st-century skills overall	0.087	0.008	4.545	1.107	0.519	0.087	2.132	0.033

From the results in Table 11, information and technology literacy (B=0.985, t=2.055; p<0.05), critical thinking and problem-solving (B=1.288, t=3.716; p<0.05), entrepreneurship and innovation skills (B=0.691, t=2.003; p<0.05) and 21st-century skills overall scores (B=1.107, t=2.132; p<0.05)

could be used to predict academic performance in mathematics. The other variables like social responsibility and career awareness cannot predict academic performance in mathematics.

Discussion, Conclusion, and Suggestions

This study revealed the relationship between high school students' 21st-century skills and academic performances in science and mathematics course. As a result of the research data analysis were interpreted in the context of the total scores obtained from the scale, it was concluded that there was a positive and significant relationship between the 21st-century skills of high school students and their academic performances in both science and mathematics courses. The study examined the relationship between the type of high school in which high school students' study and their 21st-century skills. It was concluded that the 21st-century skills of the students differed according to the high school type in terms of some sub-dimensions. Students at science high school and social science high school differ significantly in terms of their critical thinking and problem-solving compared to students at fine arts and sports high school. However, according to the overall scores of 21st-century skills, 21st-century skills of students did not differ according to high school type. However, academic performance in science and mathematics courses differs significantly by type of high school graduate. There are other research results in the literature that support this finding. For instance, Aydın and Duman (2020) found that the 21st-century skills of university preparatory class students showed a significant difference in favor of those studying in associate degree programs. Considering that the academic performance of students placed in undergraduate programs is higher than those placed in associate degree programs, the thesis that there is a significant relationship between 21st-century skills and academic performance can be strengthened. In the study conducted by Göktepe-Yıldız (2020), it was found that there is a low level of positive correlation between the academic performance levels of high school students and their 21st-century skills. It is expected and desired that students possess high levels of 21st-century skills. In the current 21st-century information age, students at all levels are expected to have developed 21st-century skills. They have access to various technological tools such as tablets, mobile phones, laptops, smart boards, 3D printers, and projectors that can enhance their 21st-century skills, and they utilize these tools constantly, whether they are at home, at school, or elsewhere. Although academic achievement levels may vary across different types of high schools, the fact that 21st century skills do not differ suggests that students may be engaging in activities outside of their academic life that contribute to the development of these skills. A new research topic could be the extent to which activities students engage in throughout the day impact their 21st century skills.

When the findings obtained in the research are examined in terms of the sub-dimensions of 21st-century skills, it is found that there is a significant positive relationship between information technology literacy, critical thinking and problem-solving, and academic performance in science

courses. It is also found that there is a significant positive relationship between information and technology literacy, critical thinking and problem-solving, entrepreneurship and innovation skills, and academic performance in mathematics courses. Akbıyık and Seferoğlu (2006) state that students with high critical thinking skills are more successful in science courses. There are other research results in the literature that support this statement. For instance, Jacob's (2012) research with university students found a significant relationship between critical thinking skill scores and mathematics final exam grades. Also, it was concluded in the study conducted by Özcan (2017) that critical thinking skill is an essential predictor of mathematics achievement. Study results also reveal the significant relationship between problem-solving, another 21st-century skill, and academic performance in science and mathematics courses. Kumlu and Doğan (2018) determined that there is a positive relationship between problem-solving skills and science literacy, according to PISA 2015 results. Özsoy (2005) also found in his study that there is a significant relationship between students' mathematics achievement and their problem-solving skills. Another study has also reported that 21st-century skills have a positive effect on academic achievement in general (Engin & Korucuk, 2021). The internet is considered the most influential factor in the development of students' 21st-century skills. Through the internet, students can acquire information and learn various ways of obtaining information. For example, in a learning environment with robotics activities, students can better understand and develop their 21st-century skills. It has been observed that the learning environments created by robotics activities have an impact on the creativity, problem-solving, critical thinking, communication, and collaboration skills of teacher candidates, which are among the 21st-century skills (Erdoğan, 2019).

In the PISA 2003 study, students' science proficiency was examined for various variables. One of these variables is the level of students' use of information and communication technologies. As a result of this research, a significant relationship was found between information and communication technologies and students' science proficiency (Balım, Evrekli, İnel & Denis, 2009). According to the research findings, it was concluded that there is a significant relationship between academic performance in science courses and entrepreneurship and innovation skills. Upon conducting a comprehensive literature review, no prior research was discovered that established a significant relationship between the two variables under investigation. Nevertheless, subsequent research findings indicated that there exists a positive correlation between critical thinking skills and entrepreneurship skills. Öztürk, Önder, and Güven-Yıldırım (2019) determined that there is a positive and significant relationship between these two skills. A link can be established between entrepreneurship skills and academic performance in line with this finding. In summary, in the light of these findings, it can be stated that developing students' information technology literacy, critical thinking and problem-solving literacy, and entrepreneurship and innovation skills can increase

academic performance in science courses. Also, it can be stated that improving critical thinking and problem-solving skills can increase academic performance in mathematics courses.

In the research, the 21st-century skills of high school students were examined. As a result of the analysis of the research data, it was concluded that the 21st-century skills of high school students are close to the acceptable level. In line with this finding, it can be stated that high school students have high 21st-century skills. Research results find the 21st-century skills of high school students above the average (Zeybek, 2019; Göktepe-Yıldız, 2020). When the scores obtained from the 21st-century skills scale are examined in terms of sub-dimensions, it is seen that the students get the highest score from career awareness and the lowest score from entrepreneurship and innovation skills. Aydın and Duman (2020) obtained similar results in their research with university students and stated that their decision-making skills regarding the profession they want to do in the future are high in line with this finding. Although the scores of the students in the sub-dimension of entrepreneurship and innovation skills are low, it can be stated that they are inclined to develop new ideas and products because they are above the medium level.

As a result, there is a low-level significant positive correlation between high school students' 21st-century skills and academic performance in science course; it was found that there was no significant relationship with academic performance in mathematics courses. In addition, it has been determined that high school students have high 21st-century skills. In line with these findings, the following recommendations can be made:

1- The research was conducted with high school students in a small region. New research can be carried out with high school students across the country.

2- The relationship between high school students' 21st-century skills and their academic performance in mathematics and science courses was examined in the research. In future studies, the relationship between all course achievements can be examined.

3- The research sample can be changed from high to primary or secondary schools.

Policy Implications

In the 21st century, it is expected that individuals will be able to use knowledge by grasping it instead of memorizing it. For this reason, the skills that individuals should have also changed in this century. These skills are defined and categorized as 21st century skills. Educational institutions have the most important role in acquiring these skills to individuals. For this reason, updates are made in education policies in the world and in Turkey, and education policies are prepared in such a way that individuals gain these skills. The basis of 2023 Vision Education Document, curriculum updates and Turkish Qualifications Framework studies is to create the necessary infrastructure for individuals to gain these skills (Hamarat, 2019). 21st century skills have also been reflected in the curriculum with

these policy studies and have taken their place as skills that should be acquired by students. In addition to these skills, in order to have a good profession in Turkey, it is necessary to be successful in disciplines such as science and mathematics. In this study, academic success in science and mathematics courses and 21st century skills of students studying at different high schools were examined; It has been tried to reveal the predictive power of 21st century skills in science and mathematics course academic success. For these reasons, it is thought that the research will contribute to educational policy makers in revealing and guiding the relationship between course content and 21st century skills.

Conflict of Interest

The corresponding author states that there is no conflict of interest on behalf of all authors.

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