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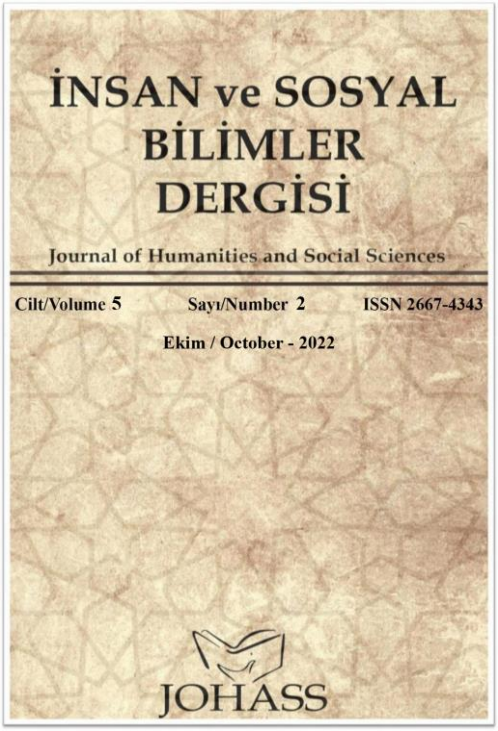

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Developing Secondary School Students' 21st Century Skills Through Online Science Education with Web 2.0 Tools *

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Abstract

In this study, the effect of using Web 2.0 tools in online science lessons on middle school students' 21st century skills was examined. The sample of the research consists of 14 students (8 girls, 6 boys) studying in the 7th grade. In the study, unit topics were handled online using web 2.0 tools. The study lasted for a total of 6 weeks and a different Web 2.0 tool was introduced and applied to the students every week in practice. The model of the research is a mixed model in which quantitative and qualitative methods are combined. In this direction, as a quantitative data collection tool in the research, "21. Century Learning Skills Level Inventory" and "21st Century Skills Open Ended Questionnaire" and "Classroom Observation Form" developed by the researcher were applied as qualitative data collection tools. SPSS program was used in the analysis of quantitative data, and content analysis was used in the analysis of qualitative data. As a result of the research, it was determined that there was a significant difference in favor of the post-test as a result of the pre-test and post-test for 21st century skills. It has been determined that students show positive developments in 21st century learning and innovation skills, leadership and responsibility, problem solving, media and technology literacy, communication, cooperation, entrepreneurship and productivity themes.

Keywords: Web 2.0 tools, 21st century skills, online science education, secondary school students

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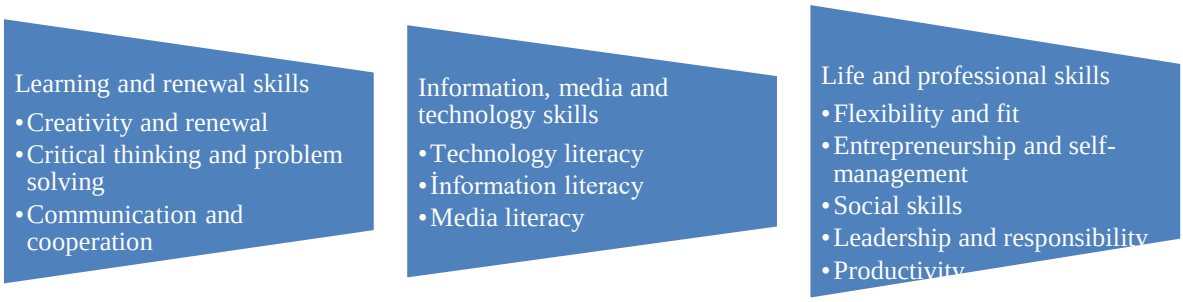
Introduction

The 21st century we live in represents a technology-dependent and information-saturated global world. Contrary to the past, access to information has become much easier today, and therefore, a pile of unnecessary and incorrect information is formed (Vosoughi et al., 2018). Individuals are dealing with extracting the correct information they need from this information stack and evaluating it in daily life. Today, individuals who can associate and use information in the right place and with daily life, and approach the events around them with a critical perspective, can overcome the problems of the age such as knowledge, thought and literacy (Kuhlthau et al., 2007). For this, individuals need to have certain skills and competencies. These high-level skills needed in our age are named as 21st century skills (Majid et al., 2012).

21st century skills are the skills that individuals should have in today's information and technology age. 21st century skills include skills and competencies such as creative thinking, critical thinking and problem solving, active learning, learning to learn, decision making, communication and cooperation, leadership, entrepreneurship, information-media and technology literacy (Trilling & Fadel, 2009). It is generally examined under the headings of "learning and renewal skills", "information, media and technology skills" and "life and professional skills" (The Partnership for 21st Century Skills, 2013). On the other hand, 21st century skills can be divided into categories such as employability skills, survival skills, key competences, deep learning skills and necessary skills (Wagner, 2008).

Figure 1.
Classification of 21st Century Skills by P21 (Partnership For 21 Century Skills)



The education system has a great role in helping individuals acquire 21st century skills. With the education given to individuals, individuals with the necessary competence to meet the expectations of the 21st century from individuals can be raised. Accordingly, the education system aims to raise individuals who produce and share information, find solutions to problems and think critically, are entrepreneurs, have communication skills, and contribute to society in order to keep up with our age (Ahmad, 2018).

Theoretical framework

Web 2.0 tools

In education, the use of environments and tools in which individuals can become more active and develop themselves has become widespread so that they can acquire contemporary skills. With the use of Web 2.0, one of these tools, in online education, individuals are prevented from being passive individuals who only acquire information, activating them and preparing a social learning environment. The use of web 2.0 in online learning environments facilitates collaborative learning among students and with the teacher, thus providing active learning. In addition, it provides progress in learning by providing a flexible learning environment (O'Reilly, 2007). Web 2.0 tools are second generation web environments that allow individuals to produce and share information and content interactively and collaboratively (Chiou, 2012). In addition, the Web 2.0 environment is defined as the platforms where information is acquired, but also produced, shared and organized (Ajjan & Hartshorne, 2008).

Web 2.0 technologies provide a fun learning environment and allow teamwork and collaboration. In addition, these tools increase the motivation of students towards the lesson with their up-to-date content. Thus, it provides active participation and efficient learning. It enables the learning and teaching process to continue in extraordinary situations such as epidemics or disasters (Franklin and van Harmelen, 2007; Bryne, 2009; Bonk, 2009). In a study by Grosseck (2009), it was stated the topics covered are to identify potential benefits of web 2.0 technologies, to introduce the theoretical aspects of its use in higher education, to integrate it into the learning-teaching and evaluation process, and to identify possible obstacles. As a result of the research, it was stated that new generation web 2.0 technologies are spreading rapidly and web 2.0 tools should be used carefully and collaboratively.

In another study by Chawinga & Zinn (2016), university students' awareness of the use of web 2.0 technologies, the purpose for which they use web 2.0 applications, and the factors affecting the use of web 2.0 technologies were examined. 186 undergraduate students participated in the study. A questionnaire was applied to the students as a data collection tool. As a result of the research, it has been determined that students use web 2.0 technologies to access information, communicate with academicians, send homework, and stay in touch with their friends during their academic studies. Also, it has been revealed that Web 2.0 technologies are very effective on undergraduate students and academicians, it is frequently used for social networks, and there is a need for more and more qualified education to raise awareness.

Huang et al. (2013), university students' views on using web 2.0 technologies were examined. A questionnaire was implemented to 423 university students who participated in the study. As a result of the research, students stated that it had a positive effect on their learning, provided interaction between student-student and student-school, increased their level of satisfaction with the lessons, and contributed to their writing skills related to web 2.0 tools.

In a study conducted by Grosseck (2009), the issues of identifying the potential benefits of web 2.0 technologies, introducing the theoretical aspects of their use in higher education, integrating them into the learning-teaching and evaluation process, and identifying the obstacles that may arise were discussed. As a result of the research, it was stated that new generation web 2.0 technologies are spreading rapidly and web 2.0 tools should be used carefully and collaboratively.

Literature review

In another study by Aramide (2022), the contributions of digital and media literacy to information sharing were investigated. In the study, a questionnaire was applied to 190 school library personnel. As a result of the study, it was found that the participants' high level of digital and media literacy skills were effective in sharing information.

Korukluoglu et al. (2022), a curriculum supported by Web 2.0 tools for critical thinking, one of the 21st century skills, was designed, implemented and evaluated for secondary school students. Before the study, a needs analysis was carried out and the application was made for 8 weeks. As a result of the study, a significant difference was found in favor of the post-test in students' critical thinking skills.

In a study conducted by Uçar & Şaka (2022), Web 2.0 tools were used in teaching socioscientific issues. 24 science teacher candidates participated in the study. The pre-service teachers who participated in the study stated that the use of Web 2.0 tools supports effective and permanent learning and they will use them when they become teachers.

Zain et al. (2022), it was aimed to improve pre-service teachers' high-level thinking skills by using the flipped learning model supported by Web 2.0 tools. It was found that 17 pre-service teachers who participated in the study had a meaningful learning experience through active and collaborative learning activities and developed their high-level thinking skills in terms of creativity, cooperation, critical thinking and communication.

In a study by Artiningsih and Nurohman (2019), the effect of Web 2.0 tools on middle school students' 21st century skills was examined. The study is a quasi-experimental study and 127 secondary school students participated. Pre-test-post-test was applied to the students. As a result of the study, it was found that there was a significant increase in students' research skills.

Frisch et al. (2013) examined the effect of Web 2.0 tools on students' critical thinking skills, which is one of the 21st century skills. The model of the study conducted with high school students is mixed method. According to the results obtained from the tests and interviews, it was found that the experimental class experienced an increase in reasoning, systematic thinking, decision making and problem solving.

When the literature is examined, it has been found that Web 2.0 tools and 21st century skills are generally handled separately (Gonzales & Louis, 2008; Scaramozzino, 2008; Pombo et al., 2011; Vaughan et al., 2011; Alvarez, 2014; Mukhlis et al. , 2018). The research problem of this study is "How is the effect of online education applications supported by Web 2.0 tools on students' 21st century skills?" and in this direction, it is an integrated study that combines 21st century skills with web 2.0 tools. With this aspect of the study, it is expected to fill the gap in the literature and contribute to it. In the study, it is thought that online education applications supported by web 2.0 tools focused on 21st century skills of secondary school students are guiding both teachers and researchers.

Method

Model

The model of the study is mixed model. In mixed models, data is obtained, analyzed and interpreted using both qualitative and quantitative methods (Fraenkel et al., 2012). Throughout this study, qualitative and quantitative data were collected simultaneously, analyzed separately and interpreted by correlating the findings obtained at the end of the process. In this direction, the complementarity of the mixed method was used to increase the interpretability, significance and validity of the data (Creswell, 2003).

Sample and Population

The sample of the research consists of 14 (8 girls, 6 boys) students studying in the 7th grade. While determining the research sample, convenience sampling method was used. In convenience sampling, the researcher selects a sufficient number of people as a sample from among existing individuals, situations or situations. (Sedgwick, 2013). Students selected for study are students who have the opportunity to attend online classes at a private school.

Data Collection Tools

Both quantitative and qualitative data collection tools were used in the study. Developed by Gülen & Çakır (2013) as a quantitative data collection tool, "21st Century Learning Skills Level Inventory" was used. Developed by Gülen & Çakır (2013), "21st Century Learning Skills Level Inventory" is an inventory prepared to measure 21st century skills of students. The inventory consists of 33 items in 5-likert type. It was applied to 612 people in total and the Cronbach Alpha reliability coefficient was calculated as 0.81. The inventory is valid and reliable. The inventory was administered to the students before and after the implementation. As qualitative data collection tools, "21st Century Skills Open Ended Questionnaire and Classroom Observation Form" were applied. Prepared by Külegel and Umdu Topsakal (2020), "21. Century Skills Perceptions Form" by the researcher "21. Century Skills Open-Ended Question Form" and the draft form was rearranged in line with the opinions of 5 experts and took its final form. The form was applied to determine the 21st century skills of 7th grade students that emerged during the activities made with web 2.0 tools. The form consists of 12 questions. The open-ended question form was applied to the students before and after the application. The "Classroom Observation Form" developed by Atalay and Boyacı (2015) was used to identify the deficiencies in the application during the activities made with web 2.0 tools, to determine the changes in students' feelings and thoughts about the process and 21st century skills.

Collection of Data and Analysis

Wilcoxon signed-rank test, which is one of the non-parametric tests in the SPSS program, was used in the analysis of the data obtained from the quantitative data collection tool. The purpose of using the Wilcoxon signed-rank test is to compare two related measures. Therefore, in this study, Wilcoxon signed-rank test was preferred to evaluate whether there is a significant difference between pre-test and post-test scores (Trawinski et al., 2012). Content analysis was applied in the analysis of the data obtained from the qualitative data collection tool in the research. Qualitative data obtained in content analysis are converted into various themes, categories and codes (Stemler, 2000). The qualitative data obtained in this study were analyzed by two researchers using open coding. As a result of the analysis, various codes, themes and categories were reached. In order to increase the reliability and validity of the research data, student responses are given under the tables. In the content analysis, internal consistency, which is defined as the similarity, which is defined as the consensus among the coders, and the determination of the reliability, was tried to be achieved. In this study, internal consistency was taken into account and the general agreement between researchers was found to be 0.85. The reliability coefficient calculated for the qualitative data collection tools is higher than 80%, and its reliability is considered sufficient.

Findings

The quantitative and qualitative findings obtained in the study are given under separate headings.

Quantitative Findings

The quantitative findings obtained from the study are as follows:

Table 1.

Descriptive Statistics of Students' Level of Use of 21st Century Learning Skills

Group	N	X	S
Pre-test	14	3,6061	0,69479
Post-test	14	4,0606	0,53973

According to Table 1, the pretest mean score of the study group was X=3,6061; its standard deviation is S=0.69. The post-test mean score of the study group was X=4.06; its standard deviation is S=0.54.

Table 2.

Study Group 21st Century Learning Skills Level Inventory Pre-Test-Post-Test Scores Comparison with Wilcoxon Signed Ranks

Ranks	N	Rank average	Rank sum	Z	p
Negative Rank	2	5,25	10,50		
Positive Rank	12	7,88	94,50	-2,639	,008
Equally Rank	-				

According to Table 2, as a result of the analysis of the data in the research, a positive (Z=-2.639) and significant (p=.008<.05) result was obtained in terms of the level of 21st century skills.

Qualitative Findings

The qualitative findings obtained from the study are as follows:

Table 3.

Students' Answers to the Question of "What do you think should be the characteristics of a person with 21st century skills?"

			Frequency	
Theme	**Category**	**Codes**	**Before**	**After**
21. Yüzyıl Becerisine Sahip Birey	Özellikleri	Ambitious	1	4
		Very smart	1	3
		Researching	2	3
		Creative	1	3
		Open to new ideas	1	2
		Able to use technology well	-	2

	Using the internet correctly	2	1
	Using their knowledge correctly	2	1
	Curious	2	1
	Hard working	2	1
	Self-developing	1	1
	Critic	-	1
	Problem solving	-	1
	Strong communication	-	1
	Questioner	-	1
	Good observer	-	1
	Honest	-	1
	Capable of teamwork	-	1
	Self-confident	-	1
	Successful	-	1
	Entrepreneur	-	1
	Freely thinking	-	1
	Versatile thinker	-	1
	Social	1	-
	Thinking logically	1	-
	Organised	1	-
	Disciplined	1	-
	No idea	3	-

According to Table 3, it was seen that the most common answer given before the implementation in the "Characteristics" category under the theme of "Individual with 21st Century Skills" was "I don't know", and the most common answer given after the implementation was the "Ambitious" code. Considering the frequencies before and after the implementation, it was seen that the students gave more code and frequency output with a significant difference after the implementation.

Table 4.

Students' Answers to the Question of "What should be the characteristics of a leader person? Which of these traits do you have?"

			Frequency	
Theme	**Category**	**Codes**	**Before**	**After**

Leadership and Responsibility	Properties	Forward thinking	-	3
		Brave	1	3
		Self-confident	2	3
		Fair	2	2
		Hard working	1	2
		Intelligent	3	2
		Good router	4	1
		Honest	2	1
		Trustworthy	1	1
		Problem solver	1	1
		High persuasive power	1	1
		Democratic	1	1
		Open to innovation	-	1
		Adaptable to the times	-	1
		Quick decision making	-	1
		Able to motivate	-	1
		Open to criticism	-	1
		Entrepreneur	-	1
		Positive thinking	-	1
		Solution oriented	-	1
		Planned	-	1
		Leading spirit	-	1
		Educated	-	1
		Good listener	3	-
		Open minded	1	-
		Researching	2	-
		Take the initiative	2	-
		Disciplined	1	-

According to Table 4, the most common response given before the application in the "Characteristics" category under the "Leadership and Responsibility" theme was the "Good Router" code, and the most common answer given after the implementation was the " Forward thinking", "Brave" and "Self-confident" codes. Considering the frequencies before

and after the implementation, it was seen that the students gave more code and frequency output with a significant difference after the implentation. It was determined that the students made more self-evaluation after the application than before the implementation.

Table 5.

Students' Answers to the Question of "When you encounter a complex problem, what do you do to solve it?"

			Frequency	
Theme	**Category**	**Codes**	**Before**	**After**
Problem Solving	Thoughts	Trying to find the most suitable solution	6	7
		Reviewing the possibilities	1	4
		Search for the cause	5	3
		Data collection	1	1
		Trying to simplify the problem	1	1
		Do your best	1	1
		Benefit from experienced people	-	1
		Trying to solve from easy to difficult	-	1
		Looking online	-	1
		Be calm	-	1
		Consult someone with an idea	2	-
		Asking the family	1	-
		Do the first thing on your mind	1	-
		Asking the teacher	1	-
		Making hasty decisions	1	-

According to Table 5, the most common answer given before and after the implementation in the "Thoughts" category under the "Problem Solving" theme is " Trying to find the most suitable solution" code has been found. While it was observed that the students consulted others to solve problems before the implementation, it was determined that they tried to solve it on their own after the implementation.

Table 6.

Students' Answers to the Question of "Do you think you can come up with original ideas and come up with a new product? Can you explain?"

Theme	**Category**	**Codes**	**Before**	**After**
Creativity and Renewal	Yes	I produce	6	9
	No	I can't produce	6	3

	Other	I'm undecided	2	2
Total			14	14

According to Table 6, the most common answer given before and after the application in the "Yes" category under the "Creativity and Renewal" theme was the "Production" code. It was seen that the most common answer given before and after the application in the "No" category was the "I cannot produce" code.

Table 7.
Explain of Original Ideas or Products

			Frequency	
Theme	**Category**	**Codes**	**Before**	**After**
Creativity and Renewal	Positive	Making products that benefit humanity	1	4
		Designing heat-resistant shuttles to approach the sun	-	1
		Genetically altering plants to produce oxygen gas on Mars	-	1
		Making a car project with gas and pedal system	-	1
		Making a solar panel lamp	-	1
		Making a vacuum cleaner	-	1
		Discovering bacteria and plant species and finding solutions to diseases	-	1
		Developing ideas and products to solve transportation problems	-	1
		Generating new ideas about the growth, development, care and habitat improvement of animals	-	1
		Converting discarded items	1	-
		Achievement with imagination and ideas	1	-
		Ability to present new ideas	1	-
		Inventing a machine that records dreams	1	-
	Negative	I can't do it	1	1
		I don't think	6	3
		I do not trust myself	-	1
	Other	I can do it if the right conditions are met.	-	1

	If the imagination is strong	1	-

According to Table 7, under the theme of "Creativity and Renewal", there was no common code given before the implementation in the "Positive" category, and the most common answer given after the implementation was " Making products that benefit humanity." code has been found. It was seen that the most common answer given before and after the implementation in the "Negative" category was the "I don't think" code. Considering the frequencies before and after the implementation, it was seen that the students gave more code and frequency output with a significant difference after the implementation.

Table 8.

Students' Answers to the Question of "What do you know about science, science, the environment?"

			Frequency	
Theme	**Category**	**Codes**	**Before**	**After**
İnformation Literacy	Science	It's getting better every day	1	1
		Science covers science and the environment	-	1
		Scientific information depending on experiment and observation	-	1
		I like to do scientific research	1	-
		Science is an art	1	-
		Connected with science	1	-
		Diseases can be cured	1	-
		No idea	5	1
	Science	My favorite lesson	2	2
		I am interested in astronomy	2	1
		The collective name given to the sciences of physics, chemistry, biology	-	1
		Examines living and non-living things	-	1
		Explains the cause of events happening around us	-	1
		Is a science	-	1
		My most studied course	-	1
		No idea	5	1
	Environment	Our living space that we must protect	1	1

		everything around us	-	1
		our nature	-	1
		A place where living and non-living things coexist	-	1
		Polluted by industrialization	1	-
		No idea	5	1
	Other	I know as much as taught in school		1
		Environment = Nature	1	-
		Natural Phenomena and force covers most things in our life	1	-

According to Table 8, the most common answer given before the implementation in the "Science" category under the "Information Literacy" theme was "I have no idea." code, after the implementation, " No idea" code is decreasing, "Science covers science and the environment" and "Scientific information depending on experiment and observation". It has been seen that there are "I Have No Idea." code the most common response before the implementation was in the "Science" category. It was seen that the most common answer given after the implementation was the "Favorite Lesson" code. Considering the frequencies before and after the implementation, it was seen that the students gave more code output in the "Environment" category after the implementation.

Table 9.

Students' Answers to the Question of "What do you think about studies using mass media such as computers"

			Frequency	
Theme	**Category**	**Codes**	**Before**	**After**
Media Literacy	Positive	Beneficial	5	6
		Making our life easier	-	4
		Allows us to access information quickly	-	3
		Constantly evolving	-	3
		We can do research online.	-	2
		We can take a virtual tour with google maps	-	1
		Easier research than an encyclopedia	-	1
		Ability to follow technological developments easily	-	1

		Accessing information with a single call button	-	1
		Research from digital devices	-	1
		Ability to teach during the pandemic process	-	1
		Research what we're wondering	3	-
		It will be very important in our life	2	-
		Allows to communicate	1	-
		Virtual execution of many operations	1	-
		Doing good work for humanity	1	-
		Quick access to the work done	1	-
	Negative	I don't think	3	2
		No idea	1	-
	Other	The world is getting virtual	1	-
		More work is needed	-	1
		Not every information we get is correct.	1	1

In Table 9, under the "Media Literacy" theme, the most common answer given before and after the implementation in the "Positive" category was the "Beneficial" code. It was seen that the most common answer given before and after the implementation in the "Negative" category was the "I don't think" code.

Table 10.

Students' Answers to the Question of "Have you done research on mass media such as computers, television, newspapers? What would be the benefit of doing research from such sources?"

			Frequency	
Theme	**Category**	**Codes**	**Before**	**After**
Technology Literacy	Thoughts	Easy access to new information	-	5
		Quick access to information	2	5
		Find out what I'm curious about	-	2
		Research effortlessly	1	1
		Learning what I don't know	3	1
		Quick access to information	-	1

Keeping up with developing technology	-	1
Learning new information	4	-
learn more	2	-
Find out what I'm curious about	1	-
Preparing for the lesson	1	-

According to Table 10, the most common answer given before the implementation in the "Thoughts" category is “Easy access to new information” and “Quick access to information” codes the most common response after the application under the "Technology Literacy" theme. It has been determined that while the students thought of the benefit of doing research from mass media as being able to learn new information only before the implementation, they thought that they could obtain the information in a short time and quickly after the implementation.

Table 11.

Students' Answers to the Question of "Do you think you will create a more effective product when working on your own or collaborating with your friends? Why?"

			Frequency	
Theme	**Categories**	**Codes**	**Before**	**After**
Communication and Collaboration	Individual	By myself	7	5
	Teamwork	With my friends	4	7
	Other	Depends on the subject	3	2
Total			14	14

According to Table 11, the most common answer given before and after the implementation in the "Individual" category under the "Communication and cooperation" theme was the "By myself" code. It was seen that the most common answer given before and after the implementation in the "Teamwork" category was the "With My Friends" code. It was seen that the most common answer given before and after the implementation in the "Other" category was the “Depends on the subject” code.

Table 12.

Creating Effective Product While Working Individually or Collaboratively

			Frequency	
Theme	**Category**	**Codes**	**Before**	**After**
Communication and Collaboration	Individual	I'm not good at teamwork	1	1
		I'm afraid of setbacks in teamwork	-	2
		I'm afraid that my opinions will be ignored	-	1

	Teamwork gets complicated	-	1
	I like to answer questions myself	-	1
	I can use my time more efficiently	-	1
	Ability to focus on one thing in silence	-	1
	Feeling more comfortable on my own	2	-
	Inability to be fair in group work	1	-
	Not having to obey my friends' commands	1	-
	Finding it wrong to get ideas from someone else for my own product	1	-
	Developing myself by thinking about my ideas	1	-
	Inability to focus when working with my friends	1	-
	Being able to finish my work quickly	1	-
Teamwork	Complementing each other by combining our ideas	-	4
	Easier and faster progress of the process	2	2
	Together we will be stronger	1	1
	I don't like working alone	1	-
	Being able to notice and discuss the deficiencies of my ideas with my friends	1	-
Other	Depends on the subject studied	2	2
	I can cooperate if I think it will be difficult	-	1
	Individual study is more efficient when studying with a group on project assignments	1	-

According to Table 12, the most common answer given before the implementation in the "Individual" category under the "Communication and Collaboration" theme was " Feeling more comfortable on my own" code. After the implementation, " I'm afraid of setbacks in teamwork" was the most common answer. In the “Teamwork” category, the most common answer given before the implementation was “Easier and faster progress of the process” code, the most common answer after the implementation “Complementing each other by combining our ideas” code. In the “Other” category, the most common answer given before and after the implementation is “Depends on the subject studied” code.

Table 13.

Students' Answers to the Question of "Can you study in harmony with your teammates in a team effort?"

			Frequency	
Theme	**Category**	**Codes**	**Before**	**After**
Flexibility and Adaptation	Yes	I can study	5	8
	No	I can not study	6	3
	Other	Maybe	3	3
Total			14	14

According to Table 13, the most common answer given before and after the implementation in the "Yes" category under the "Flexibility and Adaptation" theme was the "I can study" code. It was seen that the most common answer given before and after the implementation in the "No" category was the code "I can not study". It was seen that the most common answer given before and after the implementation in the "Other" category was the "Maybe" code.

Table 14.

Answers to the Question of "Do you strive to produce a product that benefits humanity? What would this product be about?"

			Frequency	
Theme	**Category**	**Codes**	**Before**	**After**
Productivity	Yes	I can try	12	10
	No	I can not try	2	2
	Other	I'm undecided	-	2
Total			14	14

According to Table 14, the most common answer given before and after the implementation in the "Yes" category under the "Productivity" theme was the "I can try" code. It was seen that the most common answer given before and after the implementation in the "No" category was the "I can not try" code. It was seen that the most common answer given before and after the implementation in the "Other" category was the "I am undecided" code.

Table 15.

The Subject of the Product Designed for the Benefit of Humanity

			Frequency	
Theme	**Category**	**Codes**	**Before**	**After**
Productivity	Subject Area	Health	4	2

	Astronomy	1	2
	Environmental pollution	3	1
	Transport	1	1
	Car	-	1
	Purifier	-	1
	Food	1	-
	Robot	1	-
	Art	1	-
Other	I don't know	2	2
	Automatic pen	1	-

According to Table 15, the most common answer given before the implementation in the "Subject Area" category under the "Productivity" theme was the "Health" code, and the most common answer given after the implementation was the "Health" and "Astronomy" codes. It was seen that the most common answer given before and after the implementation in the "Other" category was the "I don't know" code.

Table 16.

Students' Answers to the Question of "Do you have any initiative to promote, disseminate and market the product you produce or will produce? How?"

			Frequency	
Theme	**Category**	**Codes**	**Before**	**After**
Entrepreneurship and Self-Management	Yes	It's possible	7	9
	No	Impossible	5	5
	Other	Maybe	2	-
Total			14	14

According to Table 16, the most common answer given before and after the implementation in the "Yes" category under the "Entrepreneurship and Self-Management" theme was the "It's possible" code. It was seen that the most common answer given before and after the implementation in the "No" category was the "Impossible" code. It was seen that the most common answer given before the implementation in the "Other" category was the "Maybe" code.

Table 17.

Students' Answers the Question of "Taking initiative to promote, disseminate and market the product to be produced"

		Frequency

Theme	Category	Codes	Before	After
Entrepreneurship and Self-Management	Product Promotion and Dissemination	Billboard	-	3
		Mass media	-	2
		Social media	2	1
		Web site	2	1
		Acquaintances	-	1
		Street lamps	-	1
		Trash can	-	1
		Public network	-	1
		Advertisement	1	-
		Magazine	1	-
	Marketing the Product	Social media phenomena	1	1
		Exhibition	-	1
		Sponsor	-	1
	Other	I don’t	8	5

According to Table 17, under the theme of "Entrepreneurship and Self-Management", in the category of "Product Promotion and Dissemination", the most common answer given before the implementation was "Social Media" and "Web site" codes, and the most common answer given after the implementation was the "Billboard" code. It was seen that the most common answer given before and after the implementation in the "Marketing the Product" category was the "Social Media Phenomenon" code. It was seen that the most common answer given before and after the implementation in the "Other" category was the "I don't" code.

Table 18.

Students’ Answers to the Question of “Is group work for a purpose suitable for you? Why? How is your mutual communication with the group members while designing a product as a group?

Theme	Category	Codes	Before	After
Social and Intercultural Skills	Teamwork	Appropriate	9	7
		Not appropriate	3	2
		Depends on person	2	2
		Depends on the purpose of the study	1	3

Communication	It is good	10	7
	I have no idea	1	3

According to Table 18, the most common answer given before and after the implementation in the "Teamwork" category under the theme of "Social and Intercultural Skills" was the code "Appropritate". It was seen that the most common answer given before and after the implementation in the "Communication" category was the "It is good" code.

Findings from the observation form

Theme : 21st century learning and renewal skills

According to the researcher's observation, under the theme of "21st century learning and renewal skills", findings were obtained in the categories of "creativity and renewal skills", "critical thinking and problem solving skills" and "cooperation and communication skills".

Category 1: creativity and renewal skills: After the application, it was found that the students gave answers to curiosity about the subject, reading and researching, producing solutions, developing original proposals, producing original products, and dreaming in the category of "creativity and renewal skills".

Category 2: critical thinking and problem solving skills: After the application, in the category of "critical thinking and problem solving skills" of the students, comparison, giving examples, making similarities, summarizing the subject, making inferences, connecting information, associating with daily life, estimating the solution, It has been reached that they gave answers to giving examples, comparison, inference, making similarity, and self-criticism.

Category 3: cooperation and communication skills: After the application, it was found that the students gave answers to asking questions and sharing information in the classroom, communicating with their friends, friendly competition, listening to ideas and criticizing performance, helping and supporting in the categories of "cooperation and communication skills".

Accordingly, it was observed that there was a positive change in the students' theme of "21st century learning and renewal skills" after the application.

Result and Discussion

In this study, the effects of online education applications supported by Web 2.0 tools on the 21st century skills of 7th grade students were examined. As a result of the study, it was concluded that online education applications supported by web 2.0 tools developed students' 21st century skills. It was found that students gave more code and frequency outputs with a significant difference after the application in the themes of 21st century learning and renewal skills, leadership and responsibility, problem solving, media and technology literacy, communication, cooperation, entrepreneurship and productivity.

Similarly, in a study conducted by Alsuwida (2022), it was found that Web 2.0 tools had a significant and positive effect on 21st century skills. In the study conducted by Korukluoğlu et al. (2022), it was found that Web 2.0 tools had a positive effect on the critical thinking skills of the participants. Zain et al. (2022), it was found that teaching supported by Web 2.0 tools improved the participants' high-level thinking skills, which is one of the 21st century skills.

In a study conducted by Jose (2021), it was concluded that participation in communication, cooperation, critical thinking and creativity activities carried out through web 2.0 tools can gain participants' curiosity, patience, harmony and sociocultural awareness.

In a study by Artiningsih and Nurohman (2019), it was found that Web 2.0 tools provided a significant increase in secondary school students' research skills, which is one of the 21st century skills. Frisch et al. (2013), it was found that Web 2.0 tools provided a positive development in students' critical thinking skills, which is one of the 21st century skills. Other studies in the literature are also supportive (Banister, 2008; Tucker, 2014).

Recommendations

In this study, the subject of "reproduction, growth and development in living things" was chosen in the science lesson and Web 2.0 tools were applied and a positive result was obtained. Accordingly, it may be beneficial to implement web 2.0 tools in other educational levels. In addition, Web 2.0 tools can be used in online lessons and classroom activities, as in this study. In this study, online training activities were carried out using the web 2.0 tools Canva, Padlet, Quizizz, Nearpod, Wordwall, Kahoot, Storyboard That and Bubbl Us. It may be beneficial to provide online education by using different web 2.0 tools according to the needs of the course, the teacher and the students. On the other hand, in order to generalize the study, it may be beneficial to practice with more students and for a longer period of time.

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