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STEAM from Soil to Table

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ABSTRACT

Food literacy/nutrition and sustainable agriculture, which are among the most important issues of our time, have started to have a significant place in education along with many other fields in recent years. In this regard, the aim of this study is to determine the effect of the 'From Soil to Table STEAM' project, which includes STEAM-supported applications to raise secondary school students' awareness of where the food on our tables comes from, how it is produced and about green and sustainable agriculture. The participants consisted of 20 6th, 7th and 8th grade immigrant and disadvantaged students (children of martyrs, orphans, earthquake victims) determined according to purposive criterion sampling. The research was carried out as a case study, which is one of the qualitative research methods. The forms 'Where Does Our Food Come From?' and "Let's Draw Our Meals in 2050" created by the researchers were used as data collection tools. The forms were applied at the beginning and the end of the project. As a result of the content analysis, it was seen that the students' knowledge about the sources of nutrients was good in the pre-treatment and some students, although few, corrected their mistakes on this subject. Also, after the training, it was observed that some students became aware of the production methods of healthy foods and tended to prefer healthy nutrition. In addition, it was observed that students were provided with both knowledge and hope for the sustainability of healthy meals for the future.

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1. Introduction

Today, factors such as the effects of climate change, especially on the living ecosystems and indirectly on agricultural production, international migration, the dizzying impact of technology on all areas of life such as production, consumption, science, communication and education, and the global Covid-19 outbreak cause worldwide economic crises and disruption of economic balance. Many reports emphasize that natural resources are under threat due to population growth, which will increase from 7.7 billion to 9.7 billion by 2050, and human activities. In the report published by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES] (2019), it was emphasized that one million species are at risk of extinction and warned that this situation will have catastrophic effects on people and nature. The International Panel on Climate Change [IPCC] (2017) has recommended

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rapid, far-reaching changes in all areas of society to keep the temperature rising to 1.5°C by the end of this century (Vardy et al., 2017) In this context, it is suggested that not only environmental problems should be addressed, but also complex social and economic issues, such as inequality, that are intertwined with the cause and effect of these problems. The Sustainable Development Goals (Global Goals) came into force in 2015 with the unanimous consent of the 193 member states of the United Nations. In this context, the main objectives to be achieved by the end of 2030 are to end poverty and combat inequality and injustice by evaluating solutions to limit and reduce human-induced greenhouse gas emissions together with global problems. The member states of the United Nations (UN) are committed to achieving these goals and targets by 2030 (Sustainable Development Goals Report, 2019). The European Union (EU) announced its green transformation targets with the European Green Deal on 11 December 2019 (https://errin.eu/tags/european-green-deal), aiming to become the first carbon neutral continent by 2050. Following this announcement, other countries have also accelerated their policies to combat climate change and announced their goals for green transformation. For example, countries such as Sweden, Norway and Canada have declared zero emission targets. In line with these developments in other countries, studies have been initiated in our country, which is among the countries most affected by climate change, to adapt to the targeted policy changes. A working group was formed with the participation of relevant ministries on February 4, 2020, under the coordination of The Ministry of Commerce, and an action plan was prepared. Within the scope of this plan, issues regarding developing policies and taking measures to combat climate change and adaptation were included under the title of "Livable Cities, Sustainable Environment" (Report of the Working Group on Sustainable Management of Environment and Natural Resources, 2019).

For these reasons, facts and concepts such as climate change, biodiversity, health literacy, food literacy, agricultural literacy come to the fore both in national development plans and international targets for the future. In this context, it has been observed that these facts have been added to the education programs of countries, and they have been determined as essential objectives of research projects (Burnett & Pain, 2023). In the 11th Development Plan of our country, issues such as climate change, increasing food demand, urbanization, a decrease in soil and water resources, protection of environment and biodiversity, increase in demand for healthy, organic and good agricultural products were highlighted and it was emphasized that *'Education systems that provide analytical, critical, creative and computational thinking skills for solving real-life problems with an approach that emphasizes science, technology, engineering and mathematics disciplines in an integrated manner are gaining importance.'* (p.16). In this context, sustainable agriculture awareness and food literacy have also found a place in prominent educational processes. The implementation places of project were selected in Çanakkale region with its fertile lands and diverse climatic conditions, supports a wide range of agricultural production, including cheese, tomatoes, grapes, cherries, and peaches. The historical and cultural heritage of Çanakkale, combined with the traditional agricultural knowledge of its local population, plays a significant role in the establishment of sustainable food systems. In this context, studies on sustainable agriculture and food literacy in the region contribute both to strengthening the local economy and to fostering healthy eating habits within the community.

Food literacy is a set of interrelated knowledge, skills, attitudes, values and behaviors that include the planning, management, selection, preparation and consumption stages of nutritional intake to meet the energy needs required for an individual to survive" (Bahar & Yılmaz, 2021, p.95). At the same time, it is the ability to make decisions that will ensure individual health and access to a sustainable food system, considering environmental, social, cultural, economic and political components (Cullen, et al., 2015). In line with this definition, sustainable food education plays an important role in the development of food and nutrition literacy. For an individual to have a healthy diet, he/she should have sufficient knowledge and skills about nutrients and be able to transform this knowledge and skills into behavior (Zoellner et al., 2009). It is necessary to have skills such as purchasing food and beverages, growing crops, selecting, preparing, cooking and serving food and considering various criteria (Benn, 2014). The increase in disease outbreaks and the resulting poor eating habits of individuals shows the need for food and nutrition education (Gussow & Contento, 1984; Perez-Rodrigo & Aranceta, 2001). Interest in

providing knowledge and skills regarding food and nutrition in school education has increased recently (Kam & Gopinathan, 1999; Kuurala & Rauma, 2008). The reason for this increase is due to improvement in students' eating habits with the acquisition of knowledge and skills in food and nutrition (Brooks & Begley, 2014; Markow, 2012; Nelson et al., 2013). In the project carried out by Scazzocchio and his colleagues in Italy in 2021 with 15,800 students between the ages of 6 and 13, 600 teachers took part in the food and health literacy education model study to evaluate the training module in online and face-to-face lessons, farm visits and cooking activities with the participation of families. Firstly, the students received information about fruits and vegetables, how they are grown and what they should pay attention to when choosing foods during farm visits, and then interactive cooking trainings were carried out. As a result of the study, it was determined that in addition to the increase in students' food and health literacy knowledge, the training module could be implemented in the Italian education system and in other countries. In a study conducted to measure the food literacy of university students in Romania, it was determined that the participants received an average score of 56 and women obtained higher scores. While it is stated in the research that food and health literacy should be an important part of education programs, another dimension is that teachers' level of knowledge about food, agriculture and health affects students' knowledge regarding these subjects. For example, Wang and Knobloch (2018) found that teachers who were asked to make STEM lesson plans including problems from daily life on agriculture, food and natural resources could not make connections between the problems and STEM fields, while in a different study conducted with 929 students and their teachers, it was found that students' agricultural literacy level was affected by the fact that the teachers had agricultural, flora and natural sciences knowledge (Jeong & Choi, 2020). According to results of the qualitative data analyses of a field-to-plate study conducted by Amin et alia in 2018, that focused on food knowledge, food systems, cooking and gardening, conducted with a sample of 31 students between the ages of 9 and 13 in 2018, the step of food processing in the factory and the processes that apple sauce, potatoes and milk samples went through until they reached the plate was omitted in the questions about the source of the food .When buying food, it was important to pay attention to the expiry date, however, the food bought directly from the field was fresh, and the gardening and cooking activities they experienced with their families were more effective when it comes to their food literacy than school education. Therefore, they suggested that gardening and cooking activities should be included in the curriculum for food literacy education. Another study found a positive correlation between food literacy and eating behaviors and between cooking skills and food knowledge in adolescents (Vaitkeviciute et.al., 2015).

Since the STEM approach is based on real-world problems, various studies have been conducted internationally linking agriculture and food with STEM disciplines. This association was evaluated by analyzing 52 studies conducted between 2010 and 2017, and it was determined that these studies were carried out at various levels from primary school to postgraduate education, science and mathematics disciplines were well represented/reflected, while engineering and technology disciplines were inadequately represented. In these studies, the teaching approaches used to determine how learning occurs were also evaluated and it was found that the problem-based learning approach was used in a way that was most consistent with the STEM approach. In addition, it was determined that studies focusing on integrating agriculture and food fields with STEM education have started to attract more and more attention (Scherer et al., 2019). Studies emphasize that school-based agriculture, food and natural resources education play an important role in STEM. It is emphasized that school-based agricultural education carried out using the STEM approach for middle and high school students is student-centered (Robinson et al., 2018) and provides advantages such as gaining knowledge about agriculture, food and natural resources, creating career awareness (Knobloch & Wang, 2024), as well as preparing students for the 21st century workforce (Charoenmuang et al., 2024) and acquiring qualities such as using science and mathematics to solve complex problems (Dym et al., 2005), and acquiring 21st century skills such as problem solving and critical thinking (Robinson et al., 2018). In addition to these benefits, school-based agriculture, food and natural resources education in which the STEM approach is integrated enables students to learn about food security, energy, ecosystem, biodiversity, climate

change and environmental sustainability (Burrows, 2021) and provides interdisciplinary learning by recognizing the interactions of different disciplines in the solution process of problems related to these issues (Robinson et al., 2018), increasing their motivation and participation in the course (Vallera & Bodzin, 2020). However, in a study evaluating research conducted between 2009 and 2024 emphasis was placed on STEM education which integrates high quality agriculture, food and natural resources and highlighted the need for pre-service and in-service teacher training to design, deliver and evaluate learning experiences for this type of education (Knobloch & Wang, 2024).

There are studies conducted on agriculture and food literacy at the secondary school level in our country, undertaken by various institutions. In addition to project-based initiatives aimed at enhancing students' agricultural literacy levels (https://muglaarge.meb.gov.tr), there are also studies that explore the characteristics of agriculturally literate individuals and propose methods for fostering the development of such individuals. Haşıloğlu et al. (2011) they emphasized that with the increasing role of technology in daily life, traditional agricultural education has become less functional and therefore there is a need to develop more comprehensive agricultural education programs for primary school students, teaching materials and in-service training should be provided to teachers to improve agricultural education in Turkey. In a study aiming to determine the awareness levels of secondary school students on selected current concepts related to agriculture, it was found that they had low levels of knowledge on genetically modified seeds, medicinal and aromatic plants and agroecology. The general results of the study emphasize the necessity of teaching agriculture as a course in secondary schools or including these subjects in the content of science courses (Çalışır & Gücüm, 2023).

One important study for food literacy was prepared as the National Strategy and Action Plan for Food Literacy in Turkey within the scope of the 'Capacity Building on Food Literacy' project in cooperation with the Ministry of Agriculture and Forestry and FAO in 2021 to expand and increase the effectiveness of the studies on this subject. The Ministry of National Education, the Ministry of Health and the Ministry of Agriculture have jointly conducted a program on healthy nutrition in schools. A food literacy course program was planned by the General Directorate of Lifelong Learning of MoNE (FAO, 2023, p 2-10). With the aim of increasing food literacy in schools and creating a healthy eating culture, the 'I Eat Healthy in My School Program' project was implemented in pilot schools (https://sagliklibesleniyorum.meb.gov.tr/). However, a study examining whether the curricula of various courses included components of food literacy, found that the Life Sciences Curriculum was more comprehensive than others in terms of the dimensions and components of food literacy, and that in general the curricula did not include components aimed at raising food literate individuals at a sufficient level (Bahar & Yılmaz, 2021).

When literature is examined, it is seen that the number of national studies in which STEM approach is integrated into agricultural literacy and food literacy is limited. In a study implemented as STEM+A (Science Technology Engineering Mathematics Agriculture) for 6th grade students, an agricultural activity was carried out in the garden for 14 weeks through STEM. As a result of the study, it was determined that students' 21st century skills, STEM career awareness and environmental awareness were positively affected (Çevik & Azkin, 2018). A project study carried out with the integration of healthy nutrition with STEM, aimed to help students gain knowledge and skills by evaluating problems such as balanced and healthy nutrition, obesity, oral and dental health from an interdisciplinary perspective (https://school-education.ec.europa.eu/). The 'From Nature to Table' project, organized as the Horizon European Researchers' Night, was carried out during 2022-2023. Throughout the project, whose primary target group was children, activities were carried out to emphasize the importance of science in the story of consumed products until they reach our table, and efforts were made to raise awareness on the effective use, conservation and sustainability of our natural resources (https://scinurture.atauni.edu.tr/ekibimiz/).

This study includes some of the outputs of the 'From Soil to Table STEAM' project carried out within the scope of TUBITAK Nature Education and Science Schools Support Programme in accordance with the recommendations of the development plan and considering the contents of the green consensus.

The main aim of the project is to raise secondary school students' awareness regarding green and sustainable agriculture through STEAM (science, technology, engineering, art, mathematics) activities. The sub-objectives of the research are to create awareness regarding healthy food production and consumption, wastewater treatment and use, biodiversity, biological control, renewable energy production and energy conservation, production and protection of our agricultural wealth, recycling food waste and organic agriculture production in STEAM learning model.

This study was carried out in out-of-school and in-school environments using STEAM activities in which students were directly active. In this study, students were actively involved in STEAM activities in out-of-school environments. STEAM is an approach that covers different disciplines. STEAM is an acronym that stands for Science, Technology, Engineering, Art and Mathematics (Yıldırım, 2021). It was formed by adding art to STEM disciplines with the idea that art is the field in which individuals' inherent creativity skills are best reflected (Sağat, 2019). This approach associates four basic disciplines (science, technology, engineering and mathematics) with art to solve real-life problems. The STEAM education model has become a contemporary and multidimensional education model included in the literature to provide individuals with the employability skills (e.g., teamwork, cooperation, communication, adaptability) necessary for career and economic advancement by combining art with STEM subjects (Hetland & Winner, 2004; Liao, 2016; NAEA, 2016; Root-Bernstein, 2015) in order to improve student integration, innovation, problem-solving skills and other cognitive benefits, especially creativity (Colucci-Gray et al., 2017). Therefore, the main purpose of the STEAM-based education model is to increase the creativity levels of young people and to enable them to produce both aesthetic and functional products. In this project, STEAM applications were preferred to identify food sources, to produce healthy foods naturally, free of pesticides and hormones, to solve our current problems for healthy nutrition and sustainable food production and consumption, and to ensure that product production is carried out with the direct involvement of students. Also, since the participants consisted of disadvantaged students, art was added to the practices for the integration of the group. How food and agricultural literacy is integrated into STEAM activities can be examined in detail in the attached annex 'my local soup' activity plan.

Studies have emphasized that the deterioration of environmental factors in disadvantaged areas is related to the lack of education, economic situation and local governments (Ghiurca et al., 2012). People living in disadvantaged areas have a greater connection with nature due to their poor socio-economic status (Gupta, 2018). They benefit more from nature to meet their needs. Therefore, it is important for them to develop sustainable agriculture awareness. They need to have knowledge about sustainable agricultural techniques, renewable energy, water use, biological control, and healthy food production. Since many of the agricultural workers in Çanakkale region are migrant workers, migrant children were purposively selected in the research group so that they pass on what they have learned to their families and for the sustainability of the project.

This study aimed to create awareness of green and sustainable agriculture among students to ensure the sustainability of our planet. Students who gain awareness will embrace the sustainability mindset and will take actions that will affect society. In this respect, the training given on the subjects determined in the project is important for the survival of future generations, their equal utilization of the available resources and the welfare of society.

This study includes the evaluation of the data obtained from the "STEAM From Soil to Table" project outputs regarding the sources of the food that we consume and the sustainability of our meals in the future. In this direction, the problems of this research were determined as.

- How did it contribute to the students' knowledge regarding the process that food goes through until it reaches our tables?
- What are the students' thoughts before and after the project regarding the sustainability of our meals in the future?

2. Method

The research was conducted as a qualitative case study. Yin (2017) defines a case study as an empirical inquiry into a current phenomenon in the context of its reality, especially when the boundaries between phenomenon and context are not very clear, and states that at least three points offer opportunities for the application of this research model. One of these points is the fact that it indicates a descriptive question such as 'What is happening or what happened?' or an explanatory question such as 'How or why did something happen? The second is to investigate a phenomenon in the context of the real world. The third point is that it enables evaluation. In this research, within the scope of a project, educational training was designed for disadvantaged secondary school students by addressing the sustainability of our meals within a STEAM-based context. Since it was aimed to explore how this training was carried out and the level of awareness generated by the process in the students, it was deemed appropriate to plan it as a case study.

2.1. Research Group

The research group consisted of 20 immigrant and disadvantaged students (children of martyrs, orphans, orphans, earthquake victims) attending 6th, 7th and 8th grades during 2022-2023 academic year in Çanakkale. The target group was selected according to the criterion sampling method from purposive sampling types. A purposive sampling approach was used to ensure the accessibility of the students and the voluntariness of the institutions (Palinkas et al.,2015), the diversity of demographic data that will ensure the realization of the targeted outcomes of the project (Patton, 2002). This research group was selected to help disadvantaged (immigrant, refugee, disabled, gifted, etc.) students integrate into school, class and society (NGSS, 2013). In the selection of the research group, the educational level of the family, socio-economic status and disadvantages of being a model were taken into consideration to prove that solutions could be produced with the help of engineering activities, experiments, trips, observations and instructors. The families of the students who participated in the study work in the agriculture sector in Çanakkale and its towns. Many of these families, including those of Syrian and Afghan students, work as land workers or rent land for farming. This research group was selected to let students share what they learned with their families. Another goal is to help these students, and their families become science-based, conscious producers in the future. Also, recognizing and learning about cultural differences through art within STEAM activities and facilitating adaptation to the society in which they live was one of the reasons for the selection of the research group. Since most of the project activities would take place in the natural (apiculture, tomato growing, wheat growing, Ayazma Park) and cultural (Troy Museum) areas of Çanakkale province's towns, it was also aimed to enable immigrant students to discover the region they live in and its characteristics.

2.2. Data Collection Tools

To find answers to the research questions, the forms 'Where Does Our Food Come From?' and 'Let's Draw Our Meals in 2050' were used as qualitative data collection tools. The scales evaluated changes in students' knowledge and awareness regarding food sources and their methods of acquisition.

2.2.1. The Form 'Where Does Our Food Come From?'

The form, 'Where Does Our Food Come From?' was developed by the researchers. While creating the form, the researchers first discussed which foods should be included. The food list was created primarily by considering the foods students use daily. In addition, the form was created by determining the foods the students encounter and use almost every day to avoid getting bored during the answering process. The researchers created the forms. All four researchers have expertise in the field of science education. In the form, the source of 15 foods is questioned. While selecting the foods, it was ensured that they were foods consumed by the students regularly. Students were first asked to choose whether the source of the food was of plant, animal or non-living organisms' origin, and then to write and/or draw a picture of the processes and stages that the food went through until it reached our table. Honey, cheese, yoghurt, eggs and meatballs were selected as foods of animal origin; sugar, bread, vinegar,

chips, tomato paste, fruit juice and olive oil were selected as foods of plant origin; salt, water and mineral water were selected as foods obtained from non-living organisms' sources. At the beginning of the form, the stages of obtaining chocolate are given as an example (Figure 1).

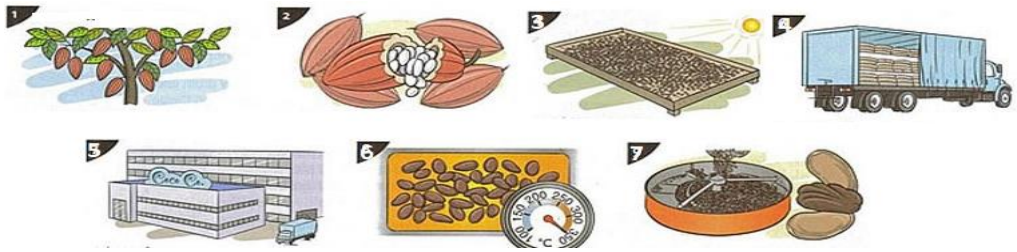
<table>
<tr><td rowspan="3"> 
Chocolate</td><td>√</td><td>It is obtained from plants.</td></tr>
<tr><td></td><td>It is obtained from animals.</td></tr>
<tr><td></td><td>It is obtained from non-living organisms.</td></tr>
<tr><td colspan="3"> 
Chocolate is made from cocoa beans that are obtained from the fruits of the cocoa tree. The cocoa beans are separated from the shells, roasted and then grinded in a machine to obtain cocoa powder.</td></tr>
</table>

Figure 1. Example given in the form 'where does our food come from?'

The form was applied individually at the beginning and at the end of the project after the activities were completed.

2.2.2.'Let's Draw Our Meal' Form

The form 'Let's Draw Our Meal' was developed by researchers and the students were asked to imagine and draw a meal thinking that they were in the year 2050. Then, the following questions were asked about the meal they drew:

- What did you think /imagine while creating your meal?
- Why did you set such a table?
- Write down the name of the ingredients the food in your drawing is obtained from.

The form was applied individually at the beginning and at the end of the project after the activities were completed.

2.3. Data Analysis

Qualitative data were evaluated with content analysis, and codes were created from the participants' drawings and statements through open coding, and then categories were created from these codes to reach the claims. The following steps were taken in this process:

- In line with the sub-problems, the data were analyzed and categorized in terms of which data sources would answer which sub-problems. All researchers decided upon this process.
- The researchers separately examined and coded the data set under these classifications.
- The first coding versions were compared when the researchers came together. A consensus was reached on the codes that did not match.
- The data set was reviewed again using the agreed codes.

- The researchers came together and decided on quotations illuminating the coding. quotations from students' written and visual data sources were included in the presentation of the findings. Since the researchers did not adopt a post-positivist approach, the coefficient of concordance was not calculated.

2.4. Application Process

All project activities were carried out between 12 and 17 of June 2023. At the beginning of the activities, the forms titled *'Where Does Our Food Come From?'* and *'Let's Draw Our Meal'*, created by the researchers, were administered as a pre-treatment. Table 1 includes the names and purposes of the activities carried out within the scope of the project. During the six-day project, the activities started at 9 am and were completed at 18 pm. The activities were carried out for 1.5 hours to 2 hours depending on the content. Between 6 and 8 activities were carried out per day. The activities were carried out in a student-centered manner by expert instructors. At the end of the activities, the forms titled 'Where Does Our Food Come From?' and 'Let's Draw Our Meal' were administered again as post treatment.

Table 1. Activities carried out during the project and their aims

Activity Name	Purpose	Activity Name	Purpose
What is STEAM? Engineering Design Process Application	Theoretical and practical application of the steps of the engineering design process	Troy Museum Trip - My Ancient Period Cafe	Creating a list of healthy meals following historical food processing methods
My Cat Who Doesn't Get Cold Meets Art	Heat Insulation	My Trojan Horse is on Mars	Possible consequences of climate change in technology integration
Glass Painting-Yoghurt Bowl	Recycling and art integration	My Bread from Ancestral Seeds	The importance of local seeds and biodiversity
Natural Dye: Textile workshop	Different areas of use of natural resources	My Local Soup	A healthy diet which incorporates local products
Collect Sun for Your Greenhouse	Using renewable energy sources to prevent air pollution	Biodiversity Field Study	Discovering endemic species and their importance
Design is My Job-3D design	Arduino, 3D exploration of nature	Compost production	The importance of recycling practices for the protection of nature
Automatic Drip Irrigation System	Water saving	Purify My Water	Fighting drought
My Green Town Web 2-animation project	Energy saving, recycling technology integration	I Produce My Own Healthy Fruit Yoghurt	Biotechnology-healthy nutrition-life integration
Which Honey is Natural?	Getting to know bees and their importance, honey production processes, distinction between natural and artificial honey	I Produce My Local Cheese	Production processes of local products

My Sour Apple Turned Sweet: Grafting	Grafting, the importance of breeding studies	Natural vinegar production	Production processes for recycling and healthy nutrition
Biological Control: Field work	The importance of biological control for the environment through natural means without using chemicals	My vitamin-rich fruit juice	Analyzing the nutritional value of natural fruit juice

Image 1-2. Photo examples from the activity 'Which honey is natural?'

Image 3. 'My Sour Apple Turned Sweet': Photo example from the grafting activity

Image 4. Photo example from 'I Produce My Own Healthy Fruit Yoghurt' activity

Image 5. Photo example from' An automatic drip irrigation' activity

Image 6. Photo example from 'My vitamin-rich fruit juice 'activity

Figure 2. Photo examples from the activities

3. Findings

The findings obtained from the forms used to collect data on the sources and sustainability of our food are included in this section. The tests were applied on the first and last days of the project, and the students who could not participate due to various reasons (family issues, missing the school bus and travelling by their own means, distribution of report cards, etc.) were not included in the evaluation. For this reason, the data of 12 students who participated in the pre and post treatments of the form 'Where Does Our Food Come From?' and 15 students who participated in the pre and post treatments of the form 'Let's Draw Our Meal' were evaluated and the findings were presented under two headings.

3.1. Students' Opinions on the Processes that Our Food Goes through until It Reaches Our Tables

Under this heading, which seeks answers to the first sub-problem, the data obtained from the form 'Where Does Our Food Come From?' were evaluated. The evaluations regarding the foods obtained from plants, animals and non-living organisms in the form are presented separately. Table 2 shows the results obtained after analyzing students' answers regarding the sources of animal-derived foods.

Tablo 2. Data obtained from the form 'Where Does Our Food Come From?' (Foods of Animal Origin)

	Honey		Cheese		Yoghurt		Eggs		Meatballs	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
M1	√	√	√	√	√	√	√	√	√	√
M2	√	√	√	√	√	√	√	√	√	√
M3	√	√	√	√	√	√	-	√	-	√
M4	X	X	√	√	√	√	-	√	√	√
M5	√	√	√	√	√	√	√	√	√	√
M6	√	√	√	√	√	√	√	√	√	√
M7	√	√	X	√	X	√	√	√	√	√
F1	√	X	√	√	√	√	√	√	√	√
F2	X	X	√	√	√	√	√	√	√	√
F3	√	√	√	√	√	√	√	√	√	√
F4	√	√	√	√	√	√	√	√	√	√
F5	√	√	√	√	√	√	√	√	√	√

Note: √: Correct answer, X: Incorrect answer, -: Blank

When Table 2 is analyzed, the students generally made correct inferences, both in the pre-test and post treatment, about the origin of the foods given to them. Regarding honey, M4 and F2 did not rectify their misconceptions about their source and the process it follows until it reaches our table, while F1 answered incorrectly in the post treatment.

F2 stated that honey is both a plant and an animal product in both the pre- and post-treatments and gave the following explanations: Bees collect pollen from flowers and make honey in honeycombs in the hive (pre-treatment).' and 'Bees make honey by collecting pollen (post treatment).' M4 also named plants and animals as the source of honey in the pre-test but changed his statement to plant in the post treatment. In both of his statements, he emphasized that the bee is an intermediary: *Bees produce honey from pollen until it reaches our table, in short, honey consists of flower pollen (pre-treatment), bees collect honey from flowers until honey reaches our table (post treatment).'*

F1 explained the processes that honey goes through until it reaches our table by drawing pictures. Although there is no difference in the drawings, it is seen that the markings change from animal origin in the pre-treatment to plant origin in the post treatment. The students' drawings are shown below:

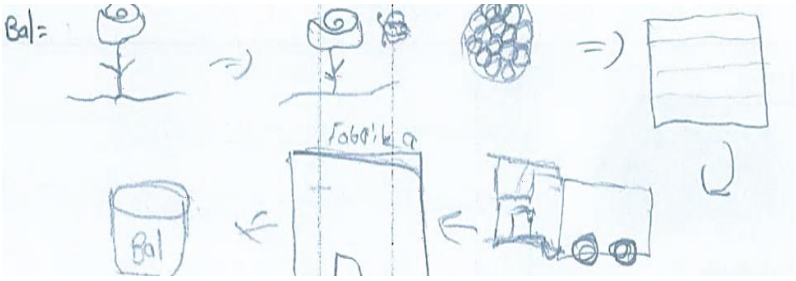


Figure 3. Pre-test drawing of student F1

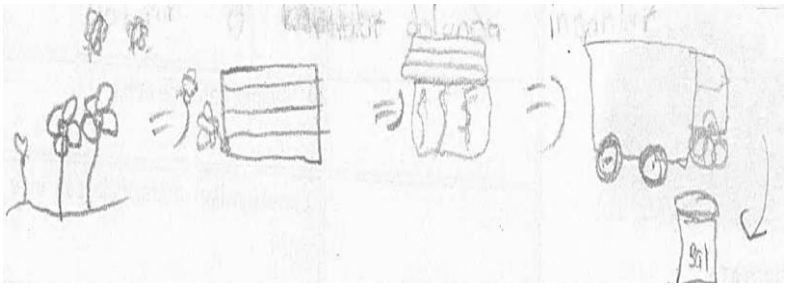


Figure 4. Post treatment drawing of student F2

The rest of the students made correct inferences regarding the source of honey both in the pre- and post-treatments. It was observed that the students, except for M7, answered correctly the questions regarding the source of cheese both in the pre- and post-treatments. As seen in the answer given below, M7 marked that cheese was made from plants and non-living organisms in the pre-treatment. Judging by his explanation and after the interview with him, it is understood that he deemed yeast as a non-living organism. In the post treatment, M7 corrected this mistake.

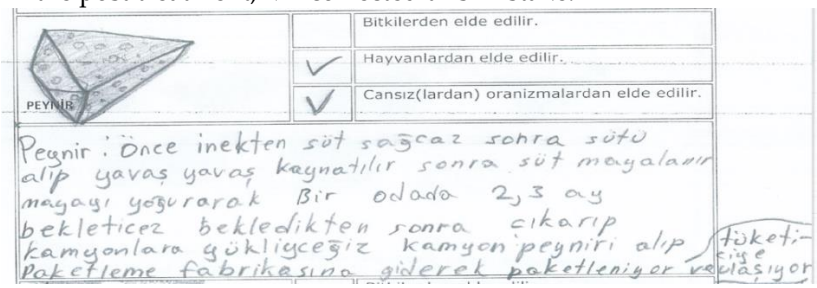


Figure 5. Pre-treatment drawing of student M7

Regarding yoghurt and cheese, M7 stated that they are obtained from animal and non-living organisms' sources but corrected this mistake in the post treatment.

When the answers of the students regarding eggs were analyzed, it was found that M3 and M4 did not answer the question about the source of eggs at the beginning, but in the post treatment, they pointed out that eggs are animal products and stated that we obtain them from chicken.

Regarding the last animal product, meatballs, M3 did not give any answer in the pre-treatment, but in the post treatment, he stated that it is a product of animal origin, but did not give a detailed explanation.

In addition to correcting the mistakes mentioned above, it was observed that the students who gave correct answers in the pre-treatment also gave more detailed explanations in the post treatment. The answers of M1, M6, F1, F4 regarding the cheese and yoghurt process follow until they reach our tables were more detailed in the post treatment and the same thing was observed when analyzing the answers of M7 regarding cheese. For example, M1 explained the process cheese goes through until it reaches our table as follows '*Cheese is produced by heating the milk obtained from animals, cows for example*' in the post

treatment, while in the post treatment he made the following statement '*Cheese is obtained from cow's milk, and it is made by boiling the milk until reaches a certain temperature, adding rennet in it and waiting*'. While M6 stated that cheese was made only from milk in the pre-treatment, he added rennet to the process in the post treatment. Similarly, while F1 did not mention rennet at all in the pre-treatment, she mentioned rennet in her explanation : '*Cheese = Milk is taken from the cow, then it is sent to the factory, turned into cheese in the factory and sold*', and in the post treatment she made the following statement: '*The milk taken from the cows is first heated, then rennet is added and it is gently mixed and left for a few hours without shaking it, then when it rises to the top, the water in it is removed by pouring it on a cloth and it is offered for sale.*' While F4 stated that yoghurt was made only from milk in the pre-treatment, she expanded her explanation in the post treatment and said, '*We take the milk from the cow, put it in a container, add yoghurt starter, mix it and put it in the fridge*'.

Table 3 shows the results obtained after analyzing students' answers regarding the sources of plant-based foods

Table 3. Data obtained from the form 'Where Does Our Food Come From?' (Plant based foods)

	Sugar		Bread		Vinegar		Chips		Tomato Paste		Fruit Juice		Olive Oil	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
M1	√	√	√	√	√	√	√	√	√	√	√	√	√	√
M2	√	X	√	√	√	√	√	√	√	√	√	√	√	√
M3	-	√	√	√	√	√	√	√	-	√	√	√	-	√
M4	-	√	√	√	-	√	-	-	√	√	√	√	-	√
M5	√	X	√	√	-	√	√	√	-	-	√	√	√	√
M6	√	√	√	√	X	√	√	√	√	√	√	√	√	√
M7	√	√	√	√	√	√	√	√	√	√	√	√	√	√
F1	√	√	X	√	√	√	√	√	√	√	√	√	√	√
F2	√	√	√	√	√	√	X	√	√	√	√	√	√	√
F3	√	√	√	√	√	√	√	√	-	√	√	√	√	√
F4	√	√	√	√	√	√	√	√	√	√	√	√	√	√
F5	√	√	√	√	√	√	√	√	√	√	√	√	√	√

Note: √: Correct answer, X: Incorrect answer, -: Blank

As seen in Table 3, although two students (M2 and M5) initially said that sugar was plant-based, in the post test they stated that sugar was obtained from non-living organisms. It is thought that the students confused sugar with salt. Of the remaining students, M3 and M4 had no knowledge regarding the sources of sugar, F1 about bread, M4, M5 and M6 about vinegar, F2 about chips, M3 and F3 about tomato paste, M3 and M4 about olive oil in the pre-treatment, but in the post treatment, they correctly stated the sources of foods. Especially for vinegar, even if it was stated that it was plant-based in the pre-treatment, none of the students explained how it was obtained, but in the post treatment, they explained the process, and F1, F4, M2, M7 gave detailed explanations.

It was observed that among the students who correctly marked these foods as plant-based in the pre-treatment, there were ones who deepened their explanations in the post treatment. It was observed that

the explanations of M1, M4, M6, M7, F3, F4, F5 about bread, M1, F4 and F5 about chips, M4, M6 and F1 about fruit juice, F3 about olive oil and K4 about tomato paste were elaborated and deepened in the last application. In Table 4, a sample statement related to each food is given

Table 4. Students' explanations regarding the process food goes through until it reaches our tables

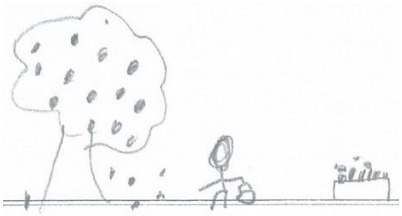
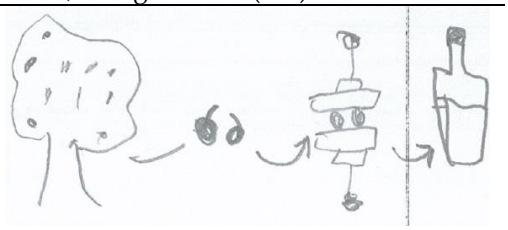
	Pre-treatment	Post- test
Bread	'First the wheat is ground, then it becomes dough, then it is shaped and put in the oven.' (F4)	'We collect the wheat and ground it into flour. We add yeast and hot water into the flour, leave the dough in a warm place for two hours, the dough rises, we shape it and put it in the oven.' (F4)
Vinegar	'?' (F1) The student put a question mark in the explanation section.	Vinegar is made by putting apples or any fruit in a jar or a container, then adding yeast and a little malt or sugar, then adding water and waiting until the apples are at the bottom of the jar and afterwards it is ready to be sold. (F1)
Chips	"Potatoes" (F5)	'Potatoes are cut and fried in oil.' (F5)
Tomato Paste	"From tomatoes" (F4)	'We pick tomatoes from the field, boil them and put them in containers.' (F4)
Fruit Juice	'Fruit juice is made of fruits.' (M4)	'It is made of apples, oranges, cherries, tangerines, mango fruits.' (M4)
Olive Oil	 (F3)	 (F3)

Table 5 shows the data regarding salt, water and mineral water, which were categorized as nutrients obtained from non-living organisms in the form 'Where Does Our Food Come From?'

Table 5. Data obtained from the form 'where does our food come from?' (nutrients obtained from non-living organisms)

	Salt		Water		Mineral Water	
	Pre	Post	Pre	Post	Pre	Post
M1	√	√	√	√	√	√
M2	X	√	√	√	-	√
M3	√	√	-	√	-	√
M4	-	√	-	√	-	√
M5	-	√	√	√	√	√
M6	√	-	√	√	√	√
M7	√	√	√	√	√	√
F1	√	√	√	√	√	√
F2	√	√	√	√	√	√
F3	X	√	-	√	-	√
F4	√	√	√	√	√	√
F5	√	√	√	√	√	√

Salt, water and mineral water were categorized as nutrients obtained from non-living organisms. While M2, M4, M5 and F3 had wrong or no information about the source of salt, M3, M4 and F3 about

the source of water, M2, M3, M4 and F3 about the source of mineral water in the pre-treatment, they got the right information in the post treatment. The explanations gave by the students regarding this category were vaguer compared to the previous two categories. For example, F4 stated that the source of salt was non-living organisms in the pre-treatment, but did not give any explanation. In the post treatment, he stated that he did not have enough information. She stated the following: It is obtained from rock salt, but I don't know the rest.' Similarly, F1 gave a limited explanation, as it follows: 'It is obtained from rocks and sea water' in the post treatment. Water-related explanations were also lacking. Some students wrote that it was formed by a reaction of hydrogen and oxygen (M2, M7), and other students stated that it was formed from rainwater (F3), but no students mentioned where and how we obtain and treat water in the post treatment. Similar findings apply to mineral water. While no information was given about the process that mineral water goes through until it reaches our table in the pre-treatment, M7 said *'It is extracted from the mine. It is obtained from natural spring water.'* in the post treatment.

3.2. Students' Thoughts on the Sustainability of Our Meals in the Future

In the form used to obtain students' thoughts on the sustainability of our meals in the future, they were asked to imagine and draw our meals in 2050, and then they were asked to express their thoughts on why they set such a table and what they imagined. The foods and elements in the students' drawings in the pre- and post-treatments are given in Table 6.

Table 6. Foods in Students' Drawings of Our Meals in 2050

Students	Pre-treatment	Post- Test
M1	Foods like medicine tablets	Eggs, tomatoes, cucumbers, cheese, yoghurt, bread
M2	Bread, apples	Cheese, bread, yoghurt, bulgur, flour
M3	Mulberries, pears, tomatoes, tea, water, pizza, meat	Olives, cucumbers, tomatoes, apples, eggs, cheese, peppers
M 4	Hamburgers, sausages, fish, meatballs, bread, apples, tomatoes	Hamburgers, simit, apples, tomatoes, sausages
M 5	Tomatoes, plums, melons, watermelons, cherries, strawberries	Tomatoes, plums, apples, oranges
M 6	Pizza, dolma, sarma, ayran, chicken	Cheese, yoghurt, tarhana, bread, bulgur, chickpeas, olives, apricots
M 7	Strawberries with hormones	Apricots, peaches, olives, cheese, bread
K1	Chocolate, hamburgers, pizza, meat, carbonated drinks, satiety inducing pills	Fruit, tarhana soup, honey, bread
K2	Hamburgers, apples, fish, bread	Hamburgers, fish, apples
K3	Sujuk, eggs, tomatoes, cucumbers, orange juice, cheese, tea, sugar	Sujuk, eggs, tomatoes, cucumbers, orange juice, cheese, tea, sugar, yoghurt, soup, olives, bread
K4	Fruit with hormones: Apples, cherries, strawberries	Apples in boxes, pasta, bread, water
K5	Pineapples, watermelons, cherries, apples	Tarhana soup, honeycomb, olives
K6	Aubergines, potatoes, zucchini, meat	Cucumbers, salad, soup, peppers
K7	Salad, pasta	Bread, olives, tomatoes, cherries, yoghurt
K8	French fries, tea, phyllo dough rolls, bread, börek, drinks, sugar, strawberry jam, eggs with sujuk	Cheese, tomatoes, olives, börek, cookies

When Table 6 is analyzed, there are no significant differences in the drawings of M4, M5, F2, F6 and F8 in the pre- and post-treatments. It was observed that two of these students (M5, F6) planned healthy meals in both pre and post treatment, M4 and F2 planned mixed healthy and unhealthy meals, and F8 planned unhealthy meals. For example, M5 was one of the two students who planned healthy meals in both tests. When asked why he included these foods, he stated that he included his favorite foods and that the source of these foods was seeds. On the other hand, in the pre-treatment, he emphasized that even though he planned such a meal these vegetables and fruits will not be produced in 2050. In the post treatment, the statement '*I thought about the fruits that could be in the future.*' can be accepted as an indicator that his hopes increased after the project. F2, who planned a meal consisting of healthy and unhealthy foods, maintained her explanations as well as her food choices in the pre- and post-treatments. She emphasized that food would change over time with the statement '*The hamburger of today and the hamburger of 2050 will be different.*' F8, who included unhealthy foods in both of her drawings, gave no explanation for her drawings.

Among the remaining students, three patterns were observed: the students corrected their misconceptions (M1, M6, M7, F1, F3, F5, F7), the students made correct statements in both pre- and post-treatment (M2, M3), the students did not correct their misconceptions(F4). M1, who drew a meal consisting of pills instead of food in the pre-treatment regarding our meals in 2050, said '*People consume pills instead of food and live on pills. I chose pills because I think in 2050, we will take pills, and I think my stomach will be full. Because in 2050, technology will be more advanced, and people will miniaturize food and transform it into pills.*' In the post treatment, he stated that he drew the things he wanted to eat and that he preferred these foods because they were healthy. F1, who had misconceptions at the beginning, was among those who changed their mind. In the pre-treatment, F1 explained why she preferred the foods included in her meal by saying the following '*I planned this type of meal because I thought that people would eat ready-to-eat and unhealthy food in the future. I wanted to explain that people eat poorly as time passes*.' In the post treatment, she manifested a hopeful attitude '*I think that the amount of waste will increase in the future due to population growth, but people will develop trees that can produce several types of fruit at the same time to save money, bake healthy bread, use plant species to preserve fruits, dye clothes at home using vegetables and fruits, and protect agriculture and the environment by using solar energy and irrigation systems. I planned this meal thinking that similar innovations will spread in the future with the development of technology.*' Trace of the activities carried out in the project can be seen in F1's statements. The remarkable statements of F5 can be given as a final example regarding the positive effects of the project. F5 included only fruits in the imaginary meal she created in the pre-treatment and pointed out the fact that fruits are always healthy as a reason for her choice. She also made a complaint and said, '*Let's end the practice of using chemicals to make fruits grow faster.*' In the post treatment, F5, who included the foods we mentioned throughout the project in her drawing, supported this with following statement '*I think that animals and plants will not be harmed in the future.*' and made a wish: '*I hope that nature will not be destroyed*.'

Although there was a change in their opinions, M2 and M3, who had a positive outlook both in the pre-treatment and in the post treatment, stated that they drew the foods they like and deem healthy. Regarding these two students the difference observed in the post treatment was that they named more foods that were mentioned in the project compared to the pre-treatment.

Finally, the drawings of F4, whose negative views persisted in the pre- and post-treatments, are shown below:

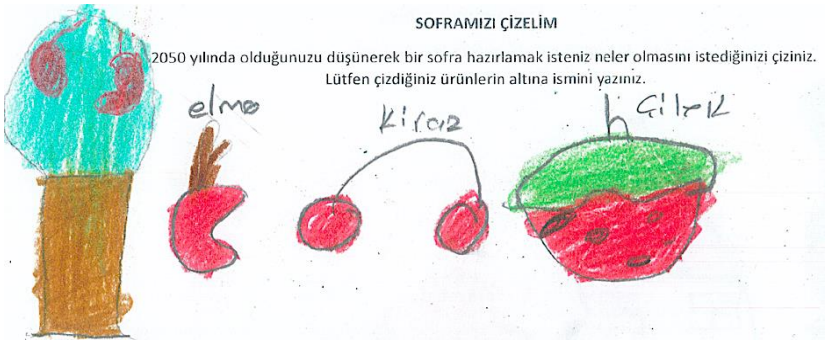


Figure 6. Pre-test of student F4

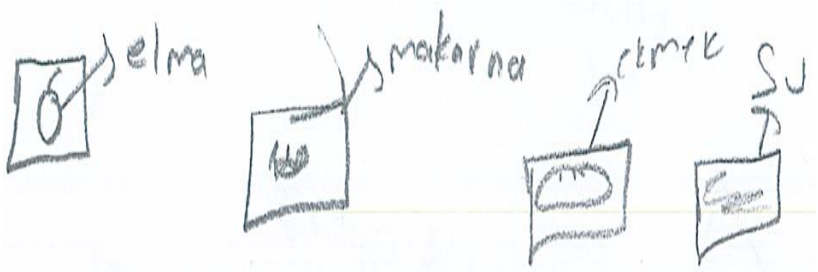


Figure 7. Post test of student F4

In the pre-treatment, F4 justified her drawing with the following statement '*I included hormones in my drawing because they are used a lot. I think everything will contain hormones in the future.*' In the post treatment, she stated that the food will be produced using technological devices and pointed to foods that are not produced naturally by saying *'I think that we will always eat in boxes like chargers in the future while setting the table.'*

To summarize the findings: students learned about the sources of food on our tables and addressed the scientific gaps in the production processes of products such as honey, yogurt, and cheese. By incorporating vegetables and fruits into their table drawings, they demonstrated an awareness of food literacy. They highlighted concerns about the use of harmful substances like pesticides and hormones that damage agricultural lands, animals such as bees, and plants, emphasizing the potential challenges of food scarcity in the future. Moreover, the students proposed solutions for sustainable food and agricultural production by underscoring the importance of technologies such as solar energy panels and drip irrigation systems.

4. Conclusion and Discussion

The results and implications have been concluded with literature into two main parts. Educational reflections and public health reflections

4.1. Educational Reflections

The most notable outcome of the findings of this study, which reflects a part of the outputs of the TUBITAK 4004 project named 'From Soil to Table', is that the students explained the production steps of foods such as cheese, yoghurt, vinegar, tomato paste in detail in the post treatments. Also, although the students had substantial prior knowledge about animal and plant-based foods, they learnt that salt, mineral water and water are obtained from non-living organisms, chips are produced from potato and vinegar are produced by microorganisms the same as cheese and yoghurt. It can be said that these results reflect the fact that the students directly produced the food themselves according to the criteria required in STEAM activities. Similarly, Scazzocchio et al., (2021) reported that students with cooking and gardening experience had higher levels of food literacy and knowledge about nutrients. In this project, both seeing the food production process in the field and performing the food production process

had a positive effect on the results. As suggested in the study of Amin et al., (2018) or as achieved in the practices carried out in Eco Schools in Portland, Oregon, students experiencing the food production and food preparation processes in school gardens or out-of-school learning environments or family integration are effective for students to gain food literacy and healthy eating habits. Another result that supports this conclusion is that two students that took part in the study drew meals consisting of healthy foods in both the first and last drawings. Seven students substituted unhealthy foods with healthy foods, two students decreased the number of unhealthy foods in the last drawings, and it can be said that they learnt about healthy nutrition through the activities carried out. In the introduction and exploration part of this study, in which STEAM teaching model was applied, a study like the practices of exploring the contents of foods, their sources, how they are produced, whether they are healthy or not was carried out in the field and laboratories by Woodruff et al., (2020) in Canada with 287 students through 42 lesson plans. Likewise, the lessons were associated with science, mathematics, art, drama, language, health and physical education. As a result, it was observed that the students learnt what they should pay attention to when buying fruits and vegetables and that the number of students who opted for fruits and vegetables in their meals increased. However, in the same study, no change was observed in the portion size. In this study, the fact that two students labeled their unhealthy food choices as 'foods we like' in both the pre and post drawings can be explained by the fact that behavioral changes can occur in a long process. As a matter of fact, a 10-week study conducted by Ülker et al., (2024) involving 75 experimental and 83 primary school students, revealed that students need to receive long-term education for behavioral change in food and nutrition literacy to change students' food preferences and promote cardiovascular health. When the results of the research regarding the sustainability of our meals were evaluated, it was determined that the activities carried out helped students gain knowledge about how problems related to food sustainability and agriculture could be solved. This conclusion was drawn based on the students' explanations, such as "plants and animals should not be harmed, pesticides should not be used on fruits and vegetables, hormones should not be used to grow bigger plants, technological applications such as solar energy and drip systems will ensure the sustainability of food production". It can be said that the feature of STEAM education in providing problem solving skills is effective (Hetland & Winner, 2004; Liao, 2016; Root-Bernstein, 2015). When these answers are evaluated from another framework, we can say that in addition to food and nutrition knowledge, attitude, food preparation and cooking skills, action-intention, action-strategies, which are the dimensions of sustainable food literacy (Haznedar & Aktaş, 2022), in this study food literacy is used to teach environmentally friendly nutrition behavior and knowledge to students.

4.2. Public Health Reflections

According to the results of TUIK (2024) reports the highest death rates in our country are related to cardiovascular diseases with 35.8% in 2022 and 33.4% in 2023 and tumors with 15% in 2022 and 15% in 2023. It is recommended that out-of-school learning or in school environment applied trainings for food literacy and environmentally friendly nutrition behaviors should be carried out in education programs at an early age and families should be included into these trainings. There is also a need to include academic studies on food literacy in the literature, especially practical samples, to develop scales specific to our country in this field, and to develop awareness and attitudes towards sustainable healthy food production and consumption.

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Makale Bilgi Formu

Yazarın Katkıları	Makale dört yazarlıdır. Sorumlu yazar proje yürütücüsü Ganime Aydın literatür, uygulama ve makale yazımında Hikmet Sürmeli literatür, uygulama ve sonuç tartışma kısmından, Mehpare Saka Melen ve Aysun Öztuna Kaplan ise ölçeklerin hazırlanması, verilerin analizi ve bulgulardan sorumludur.
Çıkar Çatışması Bildirimi	Yazar tarafından potansiyel çıkar çatışması bildirilmemiştir.
Destek/Destekleyen Kuruluşlar	Bu araştırma TUBİTAK 4004 122B585 numaralı Topraktan Sofraya STEAM projenin kısmı bir çıktısıdır.
Etik Onay ve Katılımcı Rızası	"Topraktan sofraya STEAM" başlıklı çalışma Çanakkale Onsekiz Mart Üniversitesi 17.02.2022 tarih ve 04/37 sayılı karar ile etik kurul onayı alınmıştır.

ANNEX 1

STEAM ACTIVITY PLAN: MY LOCAL SOUP

Duration:

- 2 hours for soup preparation
- 2 hours for ceramic soup bowl creation

Objectives:

a. **Science:**

- Gain conceptual knowledge about proteins and vitamins by selecting ingredients rich in these nutrients for the soup.

b. **Art & Science:**

- Enhance creativity by designing a ceramic soup bowl that retains heat for longer periods.
- Develop visual aesthetic skills in the presentation of the soup.

c. **Technology:**

- Develop digital literacy skills by utilizing digital tools to calculate the nutritional value of the soup.
- **Make A Soup Bowl in Tinker cad | 3D Modeling**
- Use digital tools to design the ceramic soup bowl.

d. **Mathematics:**

- Apply mathematical knowledge in real life by calculating the cost of raw materials and adjusting ingredient quantities according to portions.

e. **Food Engineering:**

- Evaluate and improve the soup's taste, texture, color, and aroma.
- Learn to make economic, healthy, and sustainable ingredient choices.
- Foster awareness of using local products and methods to prevent waste in cooking.

Criteria:

1. The appearance, aroma, consistency, and taste of the soup must receive at least 7 points (out of 10) from a jury consisting of up to 5 members (teachers, students, or parents).
2. The protein and vitamin content of the soup must meet at least **60%** of the recommended nutritional value.
3. The evaluation of the soup bowl design will be conducted using a rubric filled out by students outside the group, and it must achieve a minimum of **50 points**.

Constraints:

- The materials used must be local and economical.
- Aside from flour, salt, spices, and oil, **three additional ingredients** can be selected.
- Soup preparation time is **60 minutes**.
- The amount of waste produced must be no more than **250 grams**.
- Each group can purchase soup ingredients with a maximum budget of ……. TL.
- All tasks must be completed within the given time frame.

Materials:

- **Local Products:** Vegetables, legumes, spices, flour, oil, salt.
- **Kitchen Tools:** Measuring cups, scales, pots, electric stoves, gloves, masks, goggles, wooden cutting boards, knives, graters, and other kitchen equipment.
- **For Ceramic Bowls:** Ceramic clay and paints.

Implementation:

1. A short presentation on local and seasonal products will be given. Information about preventing waste and making economic purchases is shared with students. Groups are provided with a list of local products and their budget allocation.

Design:

- Groups prepare a shopping list based on the allocated budget.
- They research which protein and vitamin sources to use (e.g., lentils, chickpeas, chicken broth).
- They choose vitamins-rich vegetables (e.g., carrots, spinach, zucchini).
- Nutritional value calculations are performed.
- The measurements of solid and liquid ingredients are determined, and the soup formula is developed.
- The digital tools for nutritional calculations and ceramic bowl design are identified.

Application (Kitchen and Workshop):

- Groups design and paint their ceramic soup bowls in the ceramic workshop.
- They then prepare the soup according to their recipe.

Sharing:

- Groups present their soups in their ceramic bowls to their classmates.

Evaluation:

- The soup is evaluated based on taste, presentation, and nutritional value.
- Ceramic bowl designs are also evaluated.
- Compliance with the criteria and constraints is assessed.