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Making Yogurt: A Practical Study to Develop an Understanding of Useful Bacteria

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ABSTRACT This study aims for students to comprehend the beneficial functions of bacteria with the traditional home yogurt leavening activity. Also, it aims to identify alternative concepts related to leavening and contribute to students' home yogurt consumption habits. The study is a case study. The study was conducted with 29 fifth-grade students studying at a public school in Istanbul in the 2019-2020 academic year and their parents. Questionnaire forms and student observation forms developed by the researchers were used as data collection tools.The obtained data were described by content analysis. Before the application, the participant students were given these three statements; microbes as a sample of microscopic creatures, yeast fungi caused yogurt formation, and yogurt is healthy because it was a dairy product. While after the application, participant students changed their statements to these three; the term microbe was not used as a sample of microscopic creatures, bacteria took part in the formation of yogurt, and yogurt is healthy because it contains microscopic creatures beneficial for the digestive system. The educational activities integrated into daily lifecontribute to students' conceptual learning.

Keywords Science Education, Conceptual Learning, Learning Microorganisms, Life-based Learning

1. INTRODUCTION

Microorganisms are creatures that appeared billions of years ago. These creatures have been playing critical roles in the life cycles on earth. The survival of many advanced life forms depends on the activities of microorganisms. Even the oxygen we breathe results from the activities performed by microorganisms billions of years ago. Prokaryotic microorganisms such as bacteria, archaea, and eukaryotic microorganisms such as fungi are widespread worldwide. Although they have many species, very few microorganisms have a pathogenic effect (Madigan, Martinko, Stahl, & Clark, 2015). However, this pathogenic effect and spoilage factors in foods cause microorganisms to be perceived as bad by individuals, especially children. Verran, Redfern, Moravey, and Adebola (2018) aimed to correct this misperception through microorganisms involved in forming fermented food products in their study targeting families and adults. They determined that this societal perception could change with five different family activities they performed. In the studies of Dreyfus (1995), Gillen and Williams (1993), Jones and Rua (2006), Simonneaux (2000), and Williams and Gillen (1991), it was revealed that students emphasized mainly the harmful effects of microscopic organisms.

Moreover, the studies found that children defined *microorganisms* as pathogens (Simonneaux, 2000). Byrne's (2011) study about how children between the ages of 7-14 perceive microorganisms found that microorganisms are mostly perceived as microbes. In this study, the term microbe was defined as a creature that cannot be seen by the naked eye and has a pathogenic effect. In the same study, children were determined to have believed that microorganisms live in dirty places and on dirty hands. Inour country, every child who starts school is introduced to the term microbe while learning the hygiene rules and attributes many things that can be harmful to health to microorganisms (Bozdemir Yüzbaşıoğlu & Sarıkaya, 2019). However, children learn the characteristics of microorganisms within the scope of the unit 'classifying living things' at the fifth grade level in more detail. Therefore, it is thought that it is essential for children to be

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taught that microorganisms are not harmful at all times by good management of the education process and teaching by experience. Lago et al. (2017) argued that primary-school-age children could learn about creatures such as yeast and bacteria through experimental methods. Similarly, Mafra, Lima, and Carvalho (2015) emphasized that teaching the subject of microscopic creatures through experimental methods is more effective. In this sense, it is crucial to learn that bacteria, as a living thing, engage in forming yogurt, a healthy food.

This study aimed to understand the function of bacteria in yogurt making. Thus, students can comprehend that microorganisms are not always harmful. However, when the teachers who teach this subject were interviewed, their experiences and observations showed another issue. The teachers stated that most of their students stated that the creatures forming yogurtwere yeast fungus. This situation is thought to be caused by two reasons. The first reason is that all bacteria are harmful, preventing students from thinking that bacteria function in forming yogurt, which is healthy food. Bozdemir Yüzbaşıoğlu and Sarıkaya (2019) determined in their study that students emphasize the term microbes as a pathogenic agent in daily life and mostly identified the term microbe with bacteria. It was found that students classified bacteria as harmful for this reason. Schwarz, André, and Sevegnani (2012) also state that children have difficulty classifying microorganisms. The second reason is that making yogurt is defined as "to leaven yogurt" in everyday life in Turkey. Therefore, the term yeast here creates a different perception in students.

Yeast is traditionally and widely used in making bakery products at home. It is thought that children who have heard verbal statements such as "I leavened dough" and "I leavened yogurt" from an early age may have developed a perception that these two leavening processes are the same. It is knownthat the language we use daily creates alternative perceptions about some concepts. For example, in the past, the concept of fish has been given as a name to many different aquatic creatures, such as jellyfish, cuttlefish, starfish, crayfish, and shellfish, which were not acceptedas fish species scientifically. In the sixteenth century, naturalists classified whales, dolphins, seals, crocodiles, hippopotamuses, and other invertebrate aquatic creatures as fish (Hickman, Roberts, Keen, Eisenhour, & I'Anson, 2014). Similar to the fact that some invertebrate aquatic creatures are called fish, dough yeast and yogurt yeast, widelyused in our culture, can be conceptually confused. This classification may create some alternative concepts in the minds of children. Therefore, this study, which discusses the leavening process of yogurt as a function of bacteria, was thought to allow children to rearrange the concept of yeast formed in their minds.

Understanding the formation process of fermented foods such as yogurt contributes to understanding the functions of bacteria and the importance of recognizing the place of these foods in people's diets. Generally, people's relations with their environment and other living things are perceived in a macro dimension regarding ecology. The students defined the examples they could see with the naked eye. However, ecological relations at the micro-level are often unnoticed. The role of fermented foods is significant in understanding micro-level creatures and humans' relationships with these creatures.

Today, societies' nutrition mostly depends on fermented foods and, therefore, microscopic creatures that provide the production of these foods (Scott & Sullivan, 2008). Fermentation is a natural process in creating food sources. One of the two realms that provide fermentation is fungi and bacteria. Fermented foods are generally obtained from the mixtures of plant or animal products with fungi or bacteria (Madigan et al., 2015). Yogurt, the subject of this study, is a nutrient-rich bacterial culture. The bacterial cells that form most yogurt are *Lactobacillus*, a bacterium adapted to live on milk sugar (lactose). Yogurt is the product of the milk sugar (lactose) ferment formed by two types of bacteria, *Lactobacillusbulgaricus* and *Streptococcus thermophilus* (Madigan et al., 2015; Nelson & Cox, 2008). The enzymes in the bacteria we use today convert lactose into lactic acid. Yogurt is acidic and lasts longer than milk. Historically, *Lactobacillus* has been used in many parts of the world bypeople wi t h lactose deficiency, an enzyme that breaks down lactose. Many Middle Eastern and African cultures use yogurt, which is easier to digest, in their diets instead of milk (Vodopich & Moore, 2017; Enger & Ross, 2008). *Lactobacillus* species areindispensable for the food and dairy industry. These species have been used in producing fermented vegetables (e.g., pickled cabbage, pickles), sourdough bread, Swiss and other hard cheese, yogurt, and fermented sausages. *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subspecies *bulgaricus* are used to obtain this product. Thermophilic fermentations are carried out at a temperature of around 45°C. Today, many commercial yogurts contain strains of probiotic bacteria, but they do not contribute to the fermentation process. Fruit or fruit flavors are pasteurized separately and then combined with yogurt. Newly prepared yogurt contains about 109 bacteria per gram (Willey, Linda, Sherwood, & Woolverton, 2014).

1.1 Purpose

This study, which focuses on integrating yogurt making from milk into the course process, mainly aims to understand the beneficial functions of bacteria. At this point, it is thought that the study will contribute to correcting the misconception that yogurt is formed of yeast fungus caused by daily language use in society. Besides, understandingthat yogurt is healthy food is also considered an implicit goal.

2. METHOD

2.1 Study Design

In this study, traditional homemade yogurt production from milk was carried out as a life-based activity for understanding the functions of bacteria. Before the activity, the students' preliminary knowledge about bacteria, healthy food, balanced nutrition understandings, and the milk transformation into yogurt were determined. After the activity, the students were asked to experience the in-class application at home to include it in their lives.Parents were also included in this process. After all the applications were completed, the final knowledge of the students about healthy food understandings and the transformation process of milk into yogurt was determined through open-ended questions. In addition, parents' opinions about the process were taken. Of the qualitative research designs, a case study was used to implement a life-based application and examine the results of this application.

2.2 Study Group

The study group of the research consists of 29 students studying in the fifth grade of a state secondary school in Beykoz District of Istanbul Province in the 2019-2020 academic year and their parents (N=25). 75.8% (N=22) of the participating students are females, and 24.2% (N=7) are males. 65.5% (N=19) of the participating students in the study (N=29) stated that their parents made their yogurt at home, and 34.5% (N=10) of them stated that they consumed commercial yogurt. None of the students stated that they had made yogurt before.

2.3 Application Process

This study aims to conduct a life-based application to understand the functions of microscopiccreatures in the "Let's Classify Living Creatures" unit in the fifth-grade Science course. For this, the knowledge which will be learned was first performed experimentally. Later, itaimed to realize meaningful learning by applying the knowledge acquired by students experimentally at home. Parents' support was also received for students to transfer their knowledge to daily life. The applications conducted within the scope of the research are given as a model in Figure 1.

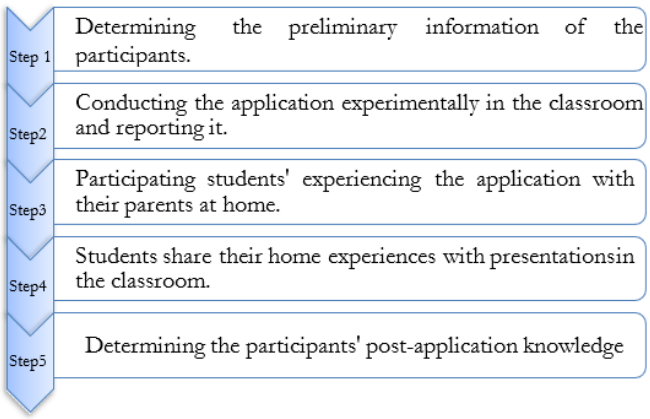

Figure 1 Determining the preliminary information of the participants

The preliminary information of the participants about healthy foods, balanced nutrition, microscopic creatures, how yogurt is made, and whether yogurt is a healthy food were determined. In this context, open-ended questions that the researchers prepared were asked to the students. The obtained data were then evaluated by content analysis.

Experimental Conducting of the Application and Students' Home Experiences

After taking safety precautions in the classroom, the following guidelines for traditional homemade yogurt production were followed.

1. 750 milliliters of farmers' cow milk was placed in a suitable container.
2. Milk was placed on the fire and boiled for 3-5 minutes (Figure-2).

Figure 2 Farmers' cow milk was being boiled on the fire

3. The milk was divided into three identical glass jars.
4. One of the jars was placed in the fridge to cool down to 1°C. The second one was kept out until it became 42-45°C, and the third one was kept in the cooker so that the temperature remained at 96°C.
5. After the three jars of milk were brought to the desired temperature, a half tablespoon of yogurt taken from the yogurt kept at room temperature was added using separate spoonsand mixed.
6. The caps of the jars were closed. The milk temperature inside was written on the labels and stuck on the jars. The jars were placed in three

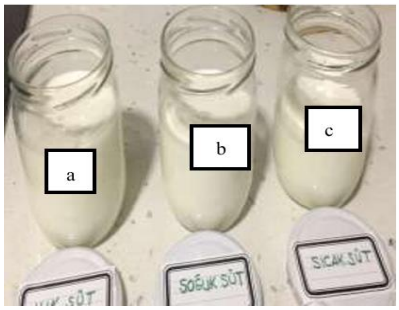

Figure 3 Milk samples at different temperatures (a: 45°c; b: 1°c; c: 96 °c)

Yogurt did not form fromboiled milk (96 °C).

Yogurt did not form from coldmilk (1°C).

Yogurt was formed from warm milk (45°C).

Figure 4 Milk at different temperatures in which yogurt was added and kept for five hours, and the results were observed

separate environments to maintain the same temperature (Figure-3).

7. After five hours, the jars were removed from where they were, and the observations were made (Figure-4).
8. The students were asked in which of these jars the milk formed into yogurt.
9. The jar in which yogurt formed was kept in a cold environment for fifteen minutes.
10. The students were asked to eat this yogurt by putting it on their plates. Then they were asked to note the smell and taste of the yogurt.
11. Students were asked, "Why do you think that only one jar of milk formed into yogurt, not the others?" The question was answered verbally in the classroom, and the students were asked to write this question and their answers in the experiment results section while preparing the experiment report.
12. After taking some yogurt on a microscope slide and dropping a drop of water, a cover glass was covered. Then, the prepared slide was placed on the microscope, and the appropriate magnification was done as in Figure-5 (First 10x40, then 10x100).

Figure 5 A sample of yogurt made by students was being examined under the microscope, and bacteria in motion were being observed

13. Students were asked to examine what they saw, define its shape, draw it on their notebooks with a pencil, or draw it in the air with their hand signs.
14. After the students' opinions and definitions were taken about what they saw under the microscope, the teacher told them that those creatures were a kind of bacteria transforming milk into yogurt. Then the students were asked what they thought of these bacteria.The question was answered verbally in the classroom first. Then, the students were asked to write this question and its answer in their notebooks in the conclusion part of the experiment report section.
15. Then it was asked again why the milk kept at temperatures of 1°C and 96°C could notform into yogurt. First, the answers were shared verbally in the classroom, and then the students were asked to write them in the conclusion part of the experiment report.
16. A worksheet regarding the process resulting in yogurt formation was distributed to students. The students were assigned to explain making yogurt to their parents and making yogurt at home with them. They were asked to monitor this process and present their images in the classroom (Figure-6).

2.4 Data Collection and Analysis

Data Collection Tools

In order to collect data, three different data collection tools were used in this study. First, a questionnaire form was developed by researchers to understand the cognitive structures of the students, an observation form for their psychomotor skills, and parental questionnaires to understand their effective structures. The model in Figure 7 was used for data collection tools. The model in Figure 7 was used for data collection tools.

Before the application, the students were asked their opinions about bacteria and healthy food, how yogurt is produced, and whether yogurt is healthy. A questionnaire form (Annex-1) consisting of four open-ended questions

Figure 6 Activities performed by a few students for the experimental yogurt-making homework

Figure 7 Data collection tools

developed by the researchers was prepared with this aim. With this questionnaire form, student views were also taken after the application. It aimed to determine whether the students' prior knowledge changed after applying.

Since the study's purpose is to transform theoretical knowledge into a meaningful pattern by practicing, this knowledge was expected to be transferred into daily life. Therefore, the students were asked to carry out the application at home. Students were asked to record their practices at home with a camera or photograph them. Applications made by the students werepresented in the classroom. The teacher watched each student's presentation and gave feedbackto the students about their practices. The teacher marked the participation status of thestudents according to the observation form (Annex-2) developed by the researchers. The scorevalue was given to the observation results with the rubric evaluation created based on these markings. The level of participation was determined according to the interval determined for the total score achieved by each student. Accordingly, the 20-25 score range shows a high level of participation; the 14-19 score range shows a medium level of participation; the 7-13 score range shows a low level of participation. The 0-6 score range shows that the application has not been implemented.

After this subject was taught in the course and the implementation was applied, the questionnaire (Annex-I) was conducted again. A questionnaire was also conducted for the parents of those students. The volunteer parents were determined first to select the parents to participate in the questionnaire. Then, a questionnaire consisting of three open-endedquestions, developed by the researchers, was applied to the parents who affirmed that they would voluntarily participate in the study (Annex-III).

2.5 Data Analysis

The data, which consists of open-ended questions, were evaluated by content analysis. *Content analysis* is the systematic coding of quantitative or qualitative data within the framework of specific themes and classifications (Cohen, Manion, & Morrison,2007; Fraenkel, Wallen, & Hyun, 2012). The student answers given by writing the questionnaire forms were coded by two researchers independently, and then the consistency of these codes was controlled. The formula of (Reliability = Consensus/All opinions) introduced by Miles and Huberman (2015) was applied to determine whether there was a consistency between researchers. The reliability value of the two encoders was calculated as .85. Parent questionnaire forms were also included in the content analysis. Two researchers read and coded these questionnaires independently, then controlled the consistency ofthese codes. When the Miles and Huberman formula is applied, the reliability value of the two encoders was calculated as 90%. The teacher marked the observation form and observed the application directly. The observation form is a criterion to determine how much the students were involved in the application.

3. FINDINGS

3.1 Findings Regarding the Preliminary Opinions of the Participants

In the research, it was firstly aimed to determine students' prior opinions/knowledge about healthy food. In this context, the question "What is healthy food?" was asked. The findings obtained are given in Table 1. When the findings in Table 1 are examined, it is seen that students defined healthy foods as foods protecting us from illnesses (f=9), natural homemade products (f=6), foods containing vitamins (f=3), and foods that provide growth and development (f=2) and microscopic creatures containing (probiotic) products (f=2). In addition, it was determined that the students (f=7) gave some examples while defining healthy food, and they mostly used macro-level foods (fruits, vegetables, etc.) in these examples.

Table 1 Student opinions about healthy foods

Codes	f	Sample Student Statements
Foods protecting us from illnesses	9	*S-2: Healthy foods keep us healthy and provide immunity to our bodies. S-17: Healthy food is the food we need to consume for our health, protecting usfrom harmful things. For example, vegetables and fruits.
Explaining withsamples	7	S-1: Fruits and Vegetables, egg, olives, milk, yogurt, *ayran* S-28: Cheese, milk, watermelon, etc.
Natural and homemade products	6	S-10: Healthy foods are foods we do not buy as ready-made but make at home. S-25: Vegetables and homemade natural foods, fruits and vegetables, banana, cauliflower, jam, molasses.
Vitamin-containingfoods	3	S-8: Healthy foods are foods that contain vitamins, such as fruits and vegetables. S-18: It is a food that has enough of each vitamin.
Foods that enable us to grow up and develop our body	2	S-7: Healthy food helps our body to develop in a healthy way. Broccoli, spinach, cheese, tomato, cucumber, fish, egg, lettuce, carrot, milk, cauliflower, cabbage.
Products containing microscopic creatures (probiotic)	2	S-22: Healthy foods are foods that have useful microscopic creatures and are clean. S-29: Healthy foods are foods that contain healthy bacteria and are good for us.

Table 2 Preliminary opinions/knowledge of students regarding microscopic creatures

Codes	f	Sample Student Statements
Bacteria	19	S-6: There are creatures that cannot be seen by the naked eye. Like bacteria. S-9: Yes, there are bacteria, ……These creatures can only be seen by a microscope.
Microscopic Creatures	11	S-1: There are creatures invisible to the eye. For example, microscopic creatures. S-7: Yes there is. We call them microscopic creatures.
Protista Samples	8	S-5: Bacteria, Paramecium, Ameba and Euglena are creatures that cannot be seen with the naked eye. S-12: Yes, there is. Like amoeba, euglena. For example, ameba can live in water.
Virus	6	S-11:… microscopic creatures such as viruses and coronavirus. S-8: There are creatures that cannot be seen with the naked eye. For instance, ……, viruses.
Microbe	5	S-28: Microbes S-2: Yes, there is. Microbes …… ..… These are invisible creatures and there is more.
Fungus	3	S-2: Yes, there are …….. like yeast fungus …… These are invisible creatures and there is more. S-24: There is. Microscopic creatures are the examples of these…… , like yeast fungus.

In order to determine the students' prior opinions/knowledge about microscopic creatures in the study, the question "Are there any creatures we cannot see by the naked eye? If yes, can you give examples of these creatures?" was asked. The findings obtained are given in Table 2. When the findings in Table 2 are examined, it can be seen that the students (f=29) accepted the existence of creatures that cannot be seen with the naked eye. The students are seen to have classified invisible creatures as bacteria (f=19), microscopic creatures (f=11), Protista samples (f=8), virus (f=6), microbe (f=5) and fungus (f=3).

In the study, the question "How is yogurt produced?" was asked. The findings obtained are given in Table 3. When the findings in Table 3 are examined, it is seen that the students have preliminary information/knowledge that yogurt is made of milk (f = 24), leavening (f = 11), yeast fungus (f = 8), and by microscopic creatures (f = 4). Furthermore, students (f = 24) stated that yogurt is a dairy product. Regarding the milk's transformation into yogurt, the concept of leavening, that is, fermented food, has been tried to be defined. However, it was found that the students' preliminary knowledge of this subject was incomplete and insufficient.

In the research, to determine students' prior opinions/knowledge about whether yogurt is a healthy food, the question "Is yogurt a healthy food? Why?" was asked. The findings obtained are given in Table 4. When the findings in Table 4 are examined, it is seen that the students defined yogurt as healthy food because they believe that yogurt protects against diseases (f=9), contains vitamins or minerals (f=8), contains milk (f=7), is made it at home (f=4) and an alternative food for those who cannot consume milk (f=1).

Table 3 Preliminary opinions/knowledge of students regarding yogurt production

Codes	f	Sample Student Statements
Yogurt is made of milk	24	S-1: Yogurt is produced from milk. S-2: We can make yogurt by boiling the milk.
By leavening	11	S-18: Yogurt is made by leavening milk. S-27: It is made by adding some leaven or yogurt into the milk.
Yeast fungus	8	S-15: When the milk from the cow is mixed with yeast fungus, we get yogurt. S-25: It is formed by leavening the yeast fungus.
Virus	6	S-11:… microscopic creatures such as viruses and coronavirus. S-8: There are creatures that cannot be seen with the naked eye. For instance, ……, viruses.
Microscopic creatures	4	S-17: Milk is boiled and kept waiting. Some microscopic creatures cause the milk to leaven and turn into yogurt. S-20: Yogurt is made by leavening milk. Because there are microscopic creatures in yogurt production.

Table 4 Students' preliminary opinions/knowledge regarding yogurt being a healthy food

Codes	f	Sample Student Statements
It protects us against diseases	9	S-15: Yes, it is healthy, because it contributes to our bone development by giving calcium, it makes us strong, we do not get sick thanks to it. S-24: It is healthy because it protects us from diseases and gives us health.
It contains vitamins or minerals	8	S-3: Yes, because it contains all the vitamins. S-9: Yogurt is healthy because it contains calcium and vitamins; it helps us to be healthy and our bones to develop.
It has milk in it	7	S-1: Yogurt is a healthy food because it contains milk. S-7: It is a healthy food. Because yogurt contains milk and milk is healthy.
Homemade products are healthy	4	S-16: Handmade yogurt is healthy, supermarket sold yogurt is not as healthy as handmade. S-25: Homemade foods are healthy because they do not contain additives.
It is an alternative food for the ones who cannot drink milk	1	S-2: Yes, when we are little kids, we drink milk. Milk causes nausea and pain in the stomach for adults. So, when we grow up, if we cannot drink milk, we should eat yogurt.

3.2 Findings of Application and Afterwards

This section includes students' involvement in the process of conducting the experiment and students' opinions about the concept of healthy food, the existence of creatures that cannot be seen with the naked eye, how milk turns into yogurt, whether milk is a healthy food, and why it is healthy if it is healthy food. In addition, this section also includes the parents' opinions about the extent to which the students reflect the knowledge they have learned through the yogurt-making activity into their daily lives.

Participation of Students in the Process of Conducting Experiment

The results of the observation form for students' level of making yogurt individually at home areseen in Table 5. Accordingly, all of the participating students were highly involved in the process of experimenting.

Student Opinions

After the implementation, it was aimed to determine the students' opinions about healthy food. In this context, the question "What is healthy food?" was asked. It was determined that the participants gave answers that could be included in the two different coding groups. Therefore, 32 code sentences were determined for 29 students. The findings obtained aregiven in Table 6. When the findings in Table 6 are examined, it is seen that the students defined healthy food as products containing bacteria (f=16), foods

Table 6 Students' opinions about healthy foods

Codes	f	Sample Student Statements
Products containing bacteria	16	S-16: Foods including beneficial bacteria, such as yogurt, are healthy.
Vitamin-containing foods	10	S-7: Healthy food contains many types of nutrients such as vitamins and minerals.
Foods that protect from diseases	6	S-11: Healthy foods support our body's immunity and make us stronger against diseases.
Natural and handmade products	6	S-23: Natural and homemade foods are healthier than packaged foods in grocery stores.

Table 5 Participation levels of students making yogurt individually at home

Criteria	Student Number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Experiment instruction were followed.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
The experiment was carried out with care.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Findings justified.	4	5	4	4	4	5	4	4	5	4	4	4	4	4	4
Experiment result is interpreted.	4	5	4	4	4	5	4	4	5	4	4	4	4	4	4
Each stage of experiment was included in the presentation.	5	5	4	4	4	5	4	5	5	4	4	5	4	4	5
Total	23	25	22	22	22	25	22	23	25	22	22	23	22	22	23

Criteria	Student Number													
	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Experiment instruction were followed.	5	5	5	5	5	5	5	5	5	5	5	5	5	5
The experiment was carried out with care.	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Findings justified.	5	4	4	4	4	4	4	4	4	5	4	4	5	5
Experiment result is interpreted.	5	4	4	4	4	4	4	4	4	5	4	4	5	5
Each stage of experiment was included in the presentation.	5	4	4	5	5	5	4	5	5	5	5	4	5	5
Total	25	22	22	23	23	23	22	23	22	25	23	22	25	25

Table 7 Students' opinions about microscopic creatures

Codes	f	Sample Student Statements
Bacteria	16	S-8: As in yogurt, there are bacteria that we cannot see directly, but see by a microscope. S-17: Bacteria are creatures that we cannot see by our eyes and that we see by a microscope.
Microscopic creatures	6	S-11: There are microscopic creatures that we can only see by a microscope. S-21: Living creatures that cannot be seen with the eye are microscopic creatures.
Protista samples	4	S-7: Paramecium, Amoeba and Euglena are creatures that cannot be seen with the naked eye. S-9: .....Amoeba who can live in water is an example to this, as well.
Fungus	3	S-20: Yes, there is. For example, yeast fungus. S-6: ……. fungus, yeast fungi, ……..

containing vitamins (f=10), foods that protect against diseases (f=6), and natural and handmade products (f=6).

After the implementations, to determine the students' opinions about microscopic creatures, the question "Are there any creatures we cannot see with the naked eye? If so,can you give examples of these creatures?" was asked. The findings obtained are given in Table 7. When the findings in Table 7 are examined, it is seen that the students classified the creatures invisible to the naked eye as bacteria (f = 16), microscopic creatures (f=6), Protista samples (f=4), and fungi (f=3).

After the implementations, to determine the students' opinions about yogurt making, the question "How is yogurt made?" was asked. The findings obtained are given in Table 8. When the findings in Table 8 are examined, it is seen that the students (f=22) stated that bacteria transformed milk into yogurt by explaining the stages of the transformation process of milk into yogurt. In addition, some students (f =5) stated that milk turned into yogurt by leavening, while others (f =2) stated that the yeast fungus made the leavening.

After the implementations, the question "Is yogurt a healthy food? Why?" was asked to determine students' opinions about whether yogurt is healthy food. The

Table 8 Students' opinions about yogurt production

Codes	f	Sample Student Statements
Bacteria	22	S-2: First, milk is boiled, then, is waited until it is cool. Some yogurt is put in it, the jar is closed and kept. The bacteria in yogurt that is put into milk turns the milk into yogurt.
By leavening	5	S- 17: Milk is boiled and then it is waited until it gets cool. Yogurt is produced by putting yogurt, or yeast, into warm milk.
Yeast fungus	2	S-15: Yeast fungus is added into warm milk and leavened.

Table 9 Students' opinions about whether yogurt is a healthy food or not

Codes	f	Sample Student Statements
It contains bacteria that are beneficial for our digestive system.	22	S-1: Yogurt is a healthy food. The bacteria contained in it help our organs such as the stomach and intestines to function healthier. S-4: Yogurt is a healthy food. Because the yeast we use to ferment yogurt contains bacteria, which are healthy for our body. S-12: ……. In addition, the bacteria contained in it are very important for our digestive system and intestinal flora.
It contains vitamins or minerals.	14	S-10: It is a healthy food. It contains calcium minerals that strengthens our bones as well as beneficial bacteria for our body. There are also many other types of vitamins and minerals. S-12: Yogurt is a healthy food, because protein strengthens not only our bones and teeth with its calcium, but also our muscle activities with magnesium and potassium in it…
It protects from diseases/strengthens immunity.	7	S-11: It is healthy because it contains beneficial bacteria. These bacteria strengthen our immunity. S-14: It is a healthy food, the bacteria in it enable us to be healthier. S-21: It is a healthy food because it strengthens our health.
Homemade products are healthy	2	S-25: Yogurt is healthy because of the vitamins and minerals it contains. These are important for the development of our bones and the immunity of our bodies. However, homemade yogurt is much healthier, because yogurt sold in supermarkets goes through many processes. During these processes, it loses vitamins and minerals in it.

findings obtained are given in Table 9. When the findings in Table 9 are examined, the students defined yogurt as healthy because it has bacteria that are useful for our digestive system (f=22), it has vitamins or minerals (f =14), it protects us from diseases/strengthens our immunity (f=7), and it is made at home (f=2).

Parent Opinions

After the activity was conducted within the scope of the research, parents were askedthe question, "How would you describe your child's behaviors about making yogurt at home and consuming yogurt after performing the yogurt activity in the Science course?" to determine the changes in students' behaviors regarding yogurt making and consuming. The findings obtained are given in Table 10. When the findings in Table 10 are examined, it isseen that the parents (f =25) stated that the students had not consumed homemade yogurt or preferred to consume less before the activity. However, their habits of consuming homemadeyogurt increased after the activity.

Within the scope of the research, to determine the contribution of the yogurt-makingactivity to the students, the parents were asked, "How did the yogurt-making activity we performed in the Science course contribute to your child's life?" The findings are given in Table 11. When the findings in Table 11 are examined, it is seen that the parents stated that yogurt-making activity contributed to the students' lives in terms of self-confidence (f=10), breaking their prejudices (f=10), and providing permanent knowledge that microorganisms could be beneficial (f=5).

Within the scope of the research, the question "How did the yogurt-making activity that we performed in the Science course contribute to the nutritional habits of your child?"was asked to determine the effect of yogurt-making activity on students' nutritional habits. The findings obtained are given in Table 12. When the findings in Table 12 are examined, it is seen that parents stated that homemade yogurt and *ayran* consumption of the students (f=25) increased after the yogurt-making activity. In addition, parents stated that after the activity, students' desire to consume healthy foods that had not been consumed before increased (f=2).

Table 10 Parents' opinions about students' post-activity behaviors

Codes	f	Sample Parent Statements
Homemade yogurt consumption increased.	25	* P-5: He did not use to eat homemade yogurt because it has clotted cream on it and tastes different. When he made it on his own, he got used to eating it. He started drinking *ayran* as well. P-12: We used to have a problem with eating homemade yogurt at home. He did not like the taste and did not consume other than ready-made yogurt. After making yogurt on his own at home, he started consuming homemade yogurt. P-1: I am a working mother, sometimes I cannot find the opportunity to make homemade yogurt. After this activity, my daughter became more insistent on making yogurt at home. Now we make homemade yogurt every week. P- 23: Homemade yogurt is consumed in our home. We buy milk and make yogurt every week. My son was also used to eating homemade yogurt. While eating homemade yogurt after the activity, he started to explain to his brother why this yogurt is healthy. I like this very much.

Table 11 Parents' opinions about the contribution of yogurt-making to students' lives

Codes	f	Sample Parent Statements
Self confidence	10	P-7: She realized that she could do something, and became more interested in doing kitchen work. P-10: She went into the kitchen at home and carried out an experiment on her own. She was very eager to do this. She divided the milk into jars and added some yogurt in it. After waiting for a while, she constantly checked the jars. Six hours did not pass for her. When the yogurt finally formed, she got incredibly proud of herself. While serving it to us, she said this is the yogurt I made.
It broke down to prejudices	10	P-7: He did not use to consume homemade yogurt at all, as he did not like the taste of homemade yogurt and the clotted cream on it. He had a prejudice on this issue. This activity broke down his prejudice by showing him how yogurt is actually made, enabling him to produce a product with his own effort, and making him observe that it is a healthy food through experiments. P-14: He refused to eat homemade yogurt because it tasted a little sour. Now he consumes homemade yogurt.
It provided permanent knowledge that microorganisms could be beneficial.	5	P-21: I have always told her that yogurt contains microorganisms that are beneficial for our intestines. This activity gave her the opportunity to see th is in detail. P-18: He kept telling about the bacteria living in yogurt at home. We now learned about the bacteria in yogurt including their shapes.

Table 12 Parents' opinions about the effect of yogurt-making activity on students' nutritional habits

Codes	f	Sample Parent Statements
Homemade yogurt and *ayran* consumption increased	25	P-19: My child started to prefer *ayran* instead of instant drinks. P-28: When we say homemade yogurt, he did not used to eat it, so we used to show him the package we bought from the supermarket. Now he does not refuse it any more.
The desire to consume healthy foods that s/he had not previously consumed increased.	2	P-9: He learned that yogurt protects our stomach and intestines through its beneficial bacteria. In this way, he said that he wanted to learn about the benefits of other beneficial foods for our body and immune system, and that he would try foods that he did not want to taste. P-27: Now he is so eager to eat organic products. He began to consume organic eggs, cheese and butter other than homemade yogurt and pay attention.

4. DISCUSSION

All the student participants successfully realized this application, where yogurt, a fermented food type, was made step by step, with high participation. Before the application, the healthy food definitions of the students were determined as vitamin-containing foods at the macro-

level (fruit, vegetable, etc.). When the literature is examined, it is seen that there are studies showing similarities with the results of the study. For instance, in the study of Ocak, Duban, and Yağcı (2016), in which they examined primary school students' opinions about personal care, hygiene, and nutrition, students gave examples of consuming more vegetables and fruits for a balanced and healthy diet and did not state any concept about nutritional contents. However, within the scope of the research, healthy food has changed after the application refers to fermented foods that support immunity, contain many nutrients, and contain microscopic organisms. It is thought that this change in the participants' healthy food definitions was because they carried out the fermentation process step by step. Ruiz-Gallardo and Panos (2017) support this view by claiming that hands-on experimental activities enable meaningful learning for primary and upper primary school students in the concrete operational stage.

The study results indicated that the students defended creatures that cannot be seen with the naked eye before and after the application. Before the application, the students mostly defined the creatures invisible to the naked eye as bacteria and microscopic creatures. They also gave examples of living creatures from fungi, microbes, and the Protista kingdom. It is thought that the reason for students' mentioning the concept of microbes before the application is their naming of microscopic creatures that cause diseases in daily life as microbes. In the literature, it is stated that especially primary and secondary school-age children define microbes and microscopic creatures as harmful (Bozdemir Yüzbaşıoğlu & Sarıkaya, 2019; Işık, Çetin, & Özarslan, 2017; Ruiz-Gallardo & Panos, 2017, Jones & Rua, 2006; Piko & Bak, 2006; Simmonneaux, 2000). For example, the study by Simmonneaux (2000) determined that the students used the term microbes to describe pathogenic microorganisms. Additionally, in the studies conducted by Işık et al. (2017), Ruiz-Gallardo and Panos (2017) Bozdemir Yüzbaşıoğlu and Sarıkaya (2019), and Morel, Peruzzo, Juele, & Amarelle (2019) found that students associated the microbe with the concept of disease in their definitions. After the application, the students gave examples from bacteria, fungi, and the Protista kingdom while defining microscopic creatures that are not visible to the naked eye. Inaddition, students were determined not to have used the microbe concept after the application. It is thought that the students did not include the concept of microbes after the application because they learned that microscopic organisms are involved in the production of food products beneficial for health during the activities. In addition, it is thought that the reason students exemplify bacteria and microscopic organisms are the emphasis on these concepts in the curricula. When the Science curriculum is examined, it is seen that students are introduced to the concept of microscopic creatures in the fifth grade, and only plants and animals are focused on the classifications of creatures in lower grades (Ministry of National Education [MoNE], 2018a). In addition, in the Social Sciences course, which is taught separately from the Science course, the theme of healthy life is taught, emphasizing the students' hygiene and invisible microbes that cause infectious diseases (Ministry of National Education [MoNE], 2018b). For this reason, it can be said that before the application, the students' conceptual knowledge about microscopic creatures was mainly focused on thedisease-causing effect of those creatures.

Before the application, the students stated that yogurt was made from milk. Additionally, it was found that some students used the concept of fermentation. Some of the students stated that yeast fungi were used depending on the concept of fermentation. After the application,the students stated that the warm milk in which yogurt was mixed transformed into yogurt, carried out by the bacteria in the yogurt. In addition, thefermentation was described differently from its use before the application. It is thought that students' making yogurt themselves and observing bacteria in yogurt by examining the yogurt they made under a microscope changed their cognitive structure. Lago et al. (2017) stated that practical activities in the laboratory made it easier for the 9-10 age group to learn about other microscopic creatures. Similarly, Mafra et al. (2015), in their study with primary school fourth-graders about oral health, concluded that when students examined the microscopic creatures that affect dental health under the microscope, they understood this issue better. Scalas et al. (2017), in their study within the scope of the microbiological@mind project, revealed that 9-10 age group students conceptually learned the microscopic creatures as a result of the microscopic examinations and activities they actively participated in.

Before the application, it was determined that most students stated that yogurt was a healthy food due to its being a dairy product regarding whether yogurt is healthy food. In addition, it was also determined that yogurt is healthy because it protects from diseases and contains vitamins. After the application, it was determined that the students defined yogurtas healthy because it contains beneficial bacteria for the digestive system. Additionally, the students stated that they found yogurt healthy because it contains vitamins and minerals, strengthens immunity, and protects against diseases.

The parents of the students who participated in the study stated that yogurt consumption of the participant students increased after the activity. As a result of the study, it was stated that students' prejudices about homemade yogurt were broken down, and their self-confidence increased because they made yogurt on their own. In addition, they showed a positive attitude towards consuming other healthy homemade foods (pickles, etc.) besides yogurt. Verran et al. (2018) held activities with the

families using traditional menus created with fermented foods. As a result of the activities, it was stated that the participants and their relatives developed a positive attitude towards fermented food consumption.

CONCLUSION

As a consequence of the study, the students have actively participated in the application. They could transfer the benefits of bacteria from the cognitive dimension to the behavioral dimension with a life-based activity associated with the curriculum. Learning about living things that cannot be seen with the naked eye is one of the complex subjects in science and biology education. Although the use of cartoons on this subject has come to the fore in recent years (Scavone et al., 2019; Morel et al., 2019; de Fraga, 2018), their effects on primary school students have not been investigated in depth. However, like this study, hands-on experimental studies are known to be effective in this age group (Verran et al., 2018; Lago et al., 2017; Scalas et al., 2017). The increasing number of educational activity studies are based on experience to overcome the view that microorganisms are harmful in primary and secondary schools (Simard, 2021).

Therefore, the subjects included in the Science course should be prepared in a life-based andapplication-oriented manner. Additionally, it was determined that the activity increased the consumption of yogurt, a fermented food product that supports the immuneand digestive systems. It is thought that organizing this activity as a student-parent activity within the scope of a healthy nutrition program in schools will positively affect students' healthy food preferences.

DISCLOSURE STATEMENT

The authors reported no potential conflict of interest.

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