

## Facilitating 7th Grade Students' Food Literacy through Science Activities: A Qualitative Study

Sevil Kurt<sup>1\*</sup>, Nagihan Yildirim<sup>1</sup>, Bahar Aksu Sandıkç<sup>2</sup>

<sup>1</sup>Department of Mathematics and Science Education, Faculty of Education, Recep Tayyip Erdogan University, Rize, Turkey

<sup>2</sup>Science Teacher and Job Advisor in Employment Institution, Ümraniye, İstanbul, Turkey

\*Corresponding Author. [sevilkurt@erdogan.edu.tr](mailto:sevilkurt@erdogan.edu.tr)

**ABSTRACT** This study aims to discuss the development of secondary 7th-grade students' opinions on food literacy within the scope of a series of teaching activities. Through a case study, the study sample comprised 14 grade seven students in a state secondary school in the province of Rize in Türkiye. The data was collected through semi-structured interviews before and after the implementation and the reflective diaries written by the students during the implementation. The collected data were analyzed using content analysis and descriptive analysis techniques. As a result, it was found out that the students' knowledge structures and understandings of food literacy changed positively in many aspects during the implementation. Besides, it was seen that the implementation helped the students improve their knowledge and behaviors of food literacy. In the study, it was suggested to organize similar intervention studies for different age groups and to conduct studies in which parents are participants.

**Keywords** Food literacy, 7th-grade students, Science activities, Qualitative

### 1. INTRODUCTION

The changing life conditions and comprehensive options offered by technological developments have gradually transformed humans' eating habits (Keser & Çıracıoğlu, 2015; Steils & Obaidalaha, 2020). Today, many foodstuffs which consume for nutrition have become less natural in terms of ingredients and become more complex (Çalışır & Çalışkan, 2003). The leaping sector of convenience food has particularly accelerated this process. Convenience food is foods that undergo industrial processes for preparation, cooking, and packaging, containing food additives for various purposes and usually sold after being packaged. During the production processes of such foods, many food additives are added to extend shelf life, give flavor and color, increase consistency, regulate acidity, prevent clumping, sweeten, and prevent oxidation. The primary purpose of using additives in functional food seems to increase consumer preferences and preferences for products. However, conventional foods' benefits and risks for human health should consider as an essential criterion as well as physical properties of convenience food such as color, odor, consistency, flavor, and durability (Akbulut, 2011; Çalışır & Çalışkan, 2003; Durmaz & Keser, 2018).

Researches suggest that specific health problems in our age, such as heart diseases, diabetes, cancer, obesity, autism, hyperactivity, attention deficit disorder, and allergic diseases, may be related to environmental factors, and the most important of these factors are poor eating habits and food additives (Erişik, 2012; Malik et al., 2010; Pepino, 2015; Roberts, 2015; Ustaahmetoğlu & Toklu, 2015). In this respect, the foods consumed and the food ingredients deserve as much attention as the amount of food consumed daily. Among all, convenience food targeting growing children as an essential audience group shows due diligence.

Childhood is a period when individuals' psychological, cognitive and physical structures start to be built. Thus, it becomes even more crucial to consume healthy and safe food during this period (Black, 2018; Mattei & Pietrobelli, 2019; Şanlıer & Ersoy, 2005). School-age, in which parental control is reduced, and access to individual preferences becomes easier, is particularly important in this respect. In this connection, it would be helpful to teach individuals and children mainly food ingredients, food additives, food preparation methods, and food selection and consumption

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with a scientific approach rather than through common everyday knowledge for the ultimate aim of establishing reasonable and sustainable nutrition attitudes (Doustmohammadian, Omidvar & Shakibazadeh, 2020; Truman et al., 2017).

The mentioned concepts translate into food and nutrition literacy in the literature. These concepts cannot be clearly distinguished in the literature as they have a lot in common. Bellotti (2010) states that food and nutrition literacy is a concept that covers three main areas of knowledge, which are food, nutrition, and health; agriculture, environment, and ecology; and social development and equality. Vidgen & Gallegos (2014) define food literacy by emphasizing the interaction of knowledge, skills, and behaviors in strengthening dietary resilience by maintaining healthy nutrition, planning, managing, choosing, and preparing food intake. On the other hand, Pendergast & Dewhurst (2012) argue that the concept concerns various components, including sustainable environment, global food system, health-related behaviors, and food and beverage culture and skills. Zoellner, Connell, Bounds, Crook, & Yadrick (2009) define nutritional literacy as the capacity of an individual to reach, process, and understand basic nutritional information. Cimbaro (2008) defines nutrition literacy as generating information about the relationship between food systems and biological, social, and ecological systems using the language and conveying this knowledge to society. Aktaş and Özdoğan (2016) put forward a definition that emphasizes the shared properties of nutrition and food literacy and addresses both terms together. This definition addresses food and nutrition literacy more comprehensively by including access to, analyzing, evaluating the information on food and nutrition literacy and making and applying right decisions; developing and maintaining healthy nutrition, selecting and consuming an appropriate amount of healthy foods, evaluating the functioning of food the food system; and a combination of willingness, knowledge, skills, attitudes, skills, and behaviors to ensure food security.

Due to its suitability with the nature of the study, this study focused on the concept of food literacy as the ability to understand the nature of food, how important it is for individuals to obtain information about food, the ability to process, analyze, and use food. Food literacy is often discussed with its components as, access; planning and management; selection; knowing where food comes from; preparation; eating; nutrition, and language (Vidgen & Gallegos, 2014). These components are also in harmony with the main elements in this study.

In this context, it suggests that individuals are aware of the importance of food in their diet for themselves, care about where the food comes from, have skills in preparing, cooking, preserving food, and have an opinion on food and nutrition issues. They can analyze and use the information

on food labels such as calories and ingredients and interpret written. Visual messages in food and nutrition guides to act appropriately for a healthy diet. In parallel with the importance of the matter, and awareness on food and nutrition has started to develop, and the number of researches on food and nutrition literacy has increased in recent years (Büyükkoyuncu, 2010; Esmailpour, Hanzee, Mansouriani & Khounsiavash, 2018; Folkvord, Anschutz, & Buijzen, 2016; Günlü, & Derin, 2012; İncedal-Sonkaya, Balci & Ayar, 2018; Kurt & Altun, 2014; Malan et al., 2020; Rhea, Cater, McCarter & Tuuri 2020; Ünver & Ünüsan, 2004; Watson, Kwon, Nichols & Rew 2009; Velardo, 2015; Vidgen & Gallegos, 2012). However, the literature presents only a few studies examining how individuals accurately use certain concepts such as food additives, organic foods, natural foods, genetically modified foods, and additive-free foods. To what extent are they aware of this, and their buying and consumption behavior is guided by this (Bekar, 2013; Arica, Güreş & Arslan, 2016; Çalık & Bayçelebi, 2020; Ustaahmetoğlu & Toklu, 2015; Yurtbakan, Çalık & Güler, 2020).

Most of the related literature is descriptive studies that expose the current situation concerning individuals' behaviors, opinions, attitudes, and food awareness in purchasing food (Bekar, 2013; Dalan, 2010; Demir Özdenk & Özcebe, 2018; Demirezen & Cosansu, 2005; Günlü & Derin, 2012; Kılınc & Çağdaş, 2012; Lee, Jin & Kim, 2013; Raiha, Tossavainen, Turunen, Enkenberg & Halonen, 2006; Sezek, Kaya & Doğan, 2008; Thomas, 2005). It has been reported that the participants lack adequate knowledge and skills of food and nutrition, and the importance of training has been stressed for overcoming such deficiency. It has also been reported that such training should be planned by determining the objectives, acting based on scientific theories, approaches, and models, using appropriate teaching methods, and monitoring and evaluating activities. As another common finding of the previous studies, the researchers argue that should teach knowledge and skills about nutrition and foods early. In this respect, attention has been paid to the importance of increasing the number and continuity of applied studies aimed at creating social awareness about the matter in question (Ronto, Ball, Pendergast & Harris, 2016; van Lippevelde et al., 2016).

Likewise, only a few national studies investigate student-centered teaching materials on the subject, implementing these materials, and the individual results. Çalık & Bayçelebi (2020) developed prediction-observation-explanation (POE) worksheets of healthy foods, and they investigated their effects on grade 3 students' conceptions. They found that POE worksheets, which engaged the students in hands-on and minds-on activities, seem to have enhanced their learning capacities of healthy foods and supported students' conceptual understanding/conceptual growth. Yurtbakan, Çalık, and

Güler (2020) researched the impact of the standard knowledge construction model (CKCM)-oriented instructional treatment on the fourth-grade students' conceptual growth of organic and non-organic foods. They utilized a word association test (WAT) and worksheets to collect data. Their study determined a significant difference between mean scores of the pre and post-WAT in favor of the post-WAT scores, and they concluded that CKCM-oriented instructional treatment had facilitated students' conceptual growth of the organic and non-organic foods.

However, secondary school intervention studies are scarce, and the topic has little coverage in the secondary school science curriculum (Bulut, Nalbant & Çokar, 2002; MEB, 2018; Vergi, 2018). Particularly, adolescence, which overlaps with the onset of puberty, is accepted as a transition period when rapid physical and mental changes occur, environmental factors are influential, risky behaviors are likely, psychosocial needs exist, and various health problems come to the fore (Adams, 1997; Ayer, 2018). Children become more willing to make their own decisions on various matters during this developmental stage by getting away from parental control. Nutrition is one of these fragile subjects (van Lippevelde et al., 2016). Due to the reasons mentioned above, it looks significant to growingly maintain secondary schoolers' knowledge levels, attitudes, and awareness about nutrition and foods, to design and implement comprehensive and applied education activities to this end, and to evaluate the results for bringing up food and nutrition literate individuals and attaining a sustainable healthy society.

This study aimed to implement science activities to improve the food literacy levels of 7th-grade students and assess their developmental levels.

## 2. METHOD

This study followed a case study (sample case study) to sincerely handle the results within a particular situation. Qualitative case studies allow in-depth study of the factors comprising a specific case with a holistic approach, focusing on how they affect the relevant case and how they are affected by the same (Yıldırım & Şimşek, 2008). Therefore, the method of the present study is labeled as a qualitative case study as it attempts to reveal in-depth the opinions of 7th-grade students regarding the activities implemented for food literacy over a specific period.

In line with the research objectives, five teaching materials were prepared to develop healthy diets, functional foods, natural foods, organic foods, genetically modified foods, food preservation methods, food additives and varieties, food additives, and the concept of E-coding. The study lasted for five weeks, 4 hours a week. The constructivist learning approach prepared the materials. The activities enrich various teaching strategies and techniques such as collaborative teaching strategy, group work, argumentation, experiment, observation, out-of-school learning, and inquiry-based learning methods. In addition, three worksheets develop to supplement the implementation of some activities. Teaching materials (activities, worksheets, and lesson plans) examine two chemistry educators, a science educator, and two science teachers in detail. Some revisions were suggested to improve their readability, understandability, and instructional effectiveness. Also, a pilot study was made for activities. After experts' reviewing and pilot the study, some revisions were made. For example, some phrases were made more explicit in worksheets, some steps were rearranged in activities to better implementation, and some

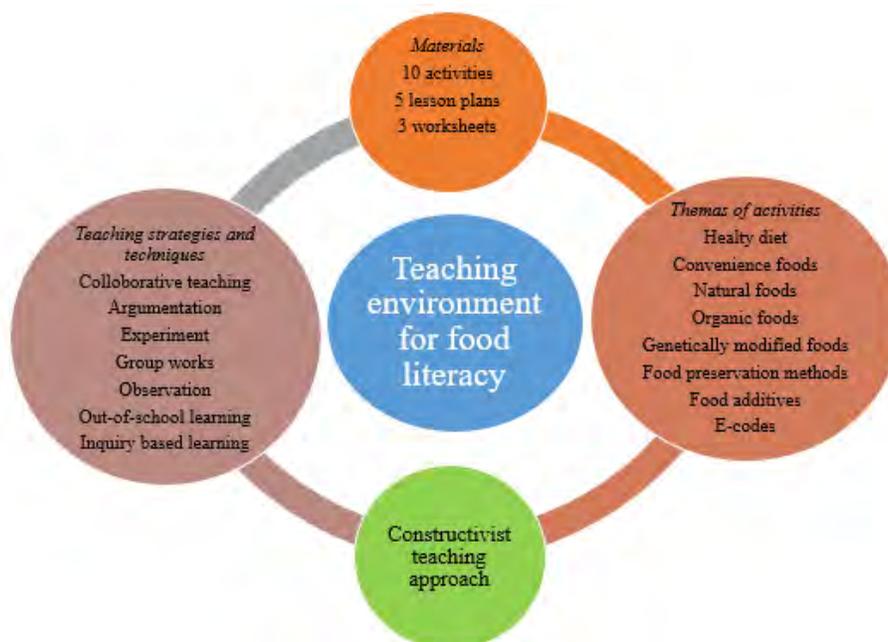


Figure 1 Summary of teaching environment

images change in worksheets. Also, a video and an animation were shortened by taking experts' suggestions into account. In this way, the teaching environment and materials have been finalized. In figure 1 teaching environment was summarized.

### 2.1. Participants

The sample was chosen using the convenience sampling method as it speeds up research and brings in practicality. In this method, the researcher picks up a specific case nearby and is easy to access. Convenience sampling is often preferred when other sampling methods are not reasonable or available.

This study consisted of 14 female students enrolled in one section of the 7th grade in a vocational secondary school in Rize.

### 2.2. Data Collection Tools

The data were collected by using semi-structured interviews conducted with students and reflective diaries kept by the students. A set of questions was used to describe students' opinions about the concept of food literacy before and after implementing the activity. The semi-structured interviews were completed by addressing six basic questions. In addition, seven questions were included in determining students' thoughts about the activities and the overall implementation of this study. After each teaching material was applied, students filled out a reflective diary to express their opinion about the implementation under several headings. Headings to be included in reflective diaries and interview questions were examined by a chemistry educator, a science educator, and a science teacher. A total of 70 reflective diary recordings were obtained, five from each of the 14 students.

### 2.3. Data Analysis

The data obtained through interviews and diaries were both subjected to content analysis. In the analysis of the interview data, the students' remarks were first tape-recorded with their permission and were played back several times and transcribed. Once transcribing was

completed, content analysis was applied to the scripts. The point of content analysis is to reach the concepts and relationships that can explain the collected data and to organize them logically (Yıldırım & Şimşek, 2013). Since this procedure requires a more in-depth study of the data, the transcribed data is reread several times to elicit study codes and the resulting themes. The themes were then tabulated after being placed under specific categories.

The reflective diaries of the students were also analyzed to derive categories and themes. The analysis showed that the same themes could be applied to all of the diary results. Therefore, the findings obtained from the diaries were presented in one single table by excluding the codes to ensure integrity and save space. Apart from this, the activities referred to by the students were given in a column titled "activity codes". Finally, the codes, categories, and themes obtained from the interview and reflective diary data analysis were examined and evaluated by two researchers and analyzed in line with common opinions. In this way, it contributed to the reliability of the data obtained.

The suitability was performed considering the research problems, descriptive analysis on the data interview data regarding the teaching activities and the overall implementation process. First of all, the data recorded in digital media were put into writing. Meaningless phrases or parts that are irrelevant to the research questions were omitted to simplify the data. Next, explanations made by respondents to the interview questions were grouped on a similar basis to obtain a table. Direct quotations from the respondents were also included in the table.

In the current study, data triangulation was exploited to ensure reliability and validity of the data collection tools (pre and post-conceptual interviews, interviews of implementation process, and reflective diaries). Thus, it is aimed to gain a deeper understanding of students' food literacy development.

**Table 1** Students' opinions on food selection criteria in the purchasing process in pre and post-interview

Pre-interview				Post-interview			
Theme	Category	Code	f	Theme	Category	Code	f
Food properties	Label information	Expiry date	11	Food properties	Label information	Food additives	10
		TSE label	4			Ingredients	9
		Ingredients	4			Expiry date	9
		Food additives	3			E-coding	5
		Production place	1			TSE label	4
	Label information	1	Organic food certificate emblem		1		
Unmodified food	Packaging elements	(Foods) Being natural or not	1	Health		(Fruit and vegetables) Being in their season	2
		Package	1			(Foods) Containing hormones or not	1
		Price	1			(Foods) Being rotten or not	1
Physical properties		Appearance	1	Packaging elements		Appearance	1
		Pleasing to eyes	4			Price	3

### 3. RESULT AND DISCUSSION

#### 3.1 Results from the Pre and Post-Interview regarding the Concept of Food Literacy

In this section, firstly, the findings obtained from the interviews conducted using the same questions before and after the activities to identify the students' opinions of the concepts of food literacy are presented in combined tables. This was done to make sure that readers can evaluate the findings from the two interviews with ease.

Table 1 shows the pre and post-interview results regarding what factors students pay attention to when buying any food product. The respondents paid the most attention to label information such as expiry date, TSE label and ingredients, and physical properties such as good eyes while buying food in the pre-interview. Other studies reported that consumers often observe the production and expiry date among the details on the package (Gözener, Büyükbay & Sayılı, 2009; Grunert & Wills, 2007; İncedal-Sonkaya, Balcı & Ayar, 2018; Karabiber & Hazer, 2010; Özgül & Aksulu, 2006).

After the implementation process was completed, the students were addressed the same questions, and their responses were analyzed. The majority stated that they read

the label information while purchasing a foodstuff. In addition to the physical properties of price and appearance referred to during the pre-interview, the respondents introduced a new type of label information, organic food certification emblem, in post-interview. However, students frequently mentioned other label information such as food additives, expiry date, ingredients, and E-coding in the final interview. They also implied a new property of foods, which is "health", by particularly relating it to (fruit and vegetables) being in their season and (food's) containing hormones or not.

It is understood that students pay more attention to a more significant number of criteria for food selection due to the implementation process. That implies that this implementation could help students select food consciously, which is an essential component of food literacy. Food literacy is interpreted as the ability to understand the nature of the food and how important it is to learn about the food and process, analyze and use such information. This definition requires conscious selection of food and knowing its source (Velardo, 2015).

**Table 2** Students' opinions on definition and examples of food additives in pre and post-interviews

Pre-interview				Post-interview					
Theme	Category	Code	f	Theme	Category	Code	F		
Definition	Food additive	Substances added to food	5	Definition	Food additive	Substances added to food	8		
		Harmful things added to food	2			Substances added as a colorant	1		
		Substances added as a sweetener	1			Substances added as a sweetener	1		
		Substances added as a colorant	1			Substances that should not be in food	1		
		Auxiliary food substances	1			Substances added to extend shelf life	1		
		I don't know	No idea			4	Substances added for durability	1	
	Purpose	Shelf life	Foods' not going bad		1	Purpose	Shelf life	Foods' not going bad	3
		Physical properties	Sweeteners		7		Food preservatives	3	
			Colorants		2		Physical properties	Sweeteners	7
			Changing food's appearance		1		Flavor Enhancer	2	
Pleasing to eyes			2	Colorants	4				
Making foods look beautiful			1	Changing food's appearance	5				
Changing food's shape	1	To make it look beautiful	3						
Example	I don't know	No idea	1	Example	Sweeteners	Glucose syrup	11		
	Sweeteners	Glucose syrup	3		Aspartame	3			
		Paraffin	1		Colorants	Food dyes	1		
	Colorants	Food dyes	3		Tartrazine	3			
	I don't know	No idea	9		Trans fats	Trans fats	5		
					Flavor enhancers	Chinese Salt (MSG)	6		
			Flavor enhancers	Flavor enhancers	1				
			Flavors	Flavors	2				
			Preservatives	Paraffin	7				
				Sodium benzoate	2				

**Table 3** Students' opinions about convenience food in pre and post- interviews

Pre-interview				Post-interview				
Theme	Category	Code	f	Theme	Category	Code	f	
Definition	Processed foods	Foods produced in factories	4	Definition	Foods passing through the food industry process	Food processed in factories	8	
		Packaged foods	2			Foods with additives	4	
	Foods that are not made at home	Foods produced with machines	2			Foods that are not used as obtained from the source	Packaged foods	4
		Foods with additives	1				Ready-to-eat foods	2
		Foods we buy ready to eat	2				Unnatural foods	2
		Foods we buy effortlessly	1				Grocery food	2
		Foods that are not made at home	1					
		Foods we don't make ourselves	1					

**Table 4** Students' opinions about natural food in pre and post- interviews

Pre-interview				Post-interview			
Theme	Category	Code	f	Theme	Category	Code	f
Definition	Unprocessed foods	Foods without food additives	5	Definition	Foods used as obtained from the source	Foods without food additives	12
		Healthy	1			Self-growing foods	2
		Foods used as obtained from the source	4			Nature-grown foods	1
		Foods we grow gardens ourselves	2			Fruit and vegetables picked from the branch	1
		Self-growing foods	1			Foods picked from the garden	1
		Fruit picked from the tree	1			Foods we grow ourselves	1
		Foods are grown in nature	1				
		Foods picked from source	1				

During the interviews, the students were asked to describe and exemplify food additives. Findings on this subject are given in Table 2

Table 2 shows that some students defined food additives as substances added to food, harmful things added to food, auxiliary food substances, sweeteners, and substances added as a colorant in the pre-interview. In contrast, some students had no idea at all about what a food additive is. Regarding the purpose of using such chemicals, the students mentioned physical properties at the highest frequency. However, when it comes to examples of food additives, it was seen that the majority of the respondents did not have an idea. At the same time, only a tiny number mentioned glucose syrup, food dyes, and paraffin. In this case, the participants knew that food additive is added to foods, but they could not explain its purpose or examples. This finding is in line with studies in the literature reporting

that children have poor food literacy (Adams, 1997; Ronto, Ball, Pendergast & Harris, 2016).

After the implementation, as seen in Table 2, all of the students described food additives. In addition, to substances, similar opinions were noted in the post-interview with increased frequency this time. Again, the post-interview revealed that the majority of the students exemplified food additives like sweeteners, preservatives, and flavor enhancers with the addition of colorants, trans fats, and flavorings. The most frequently mentioned food additives were glucose syrup, paraffin, and monosodium glutamate, also known as Chinese salt, in the post-interview.

Contrarily, the fact that almost all of the students who could not adequately explain what food additives are could give explanations and examples in the post-interview is an indicator that the student's level of knowledge on food contents improved. Therefore, this subject is essential in

**Table 5** Students' opinions about organic food and GM food in pre and post- interviews.

Pre-interview				Post-interview			
Theme	Category	Code	f	Theme	Category	Code	f
Definition of organic food	Food is grown without chemicals	Additive-free foods	2	Definition of organic food	Production process	Foods grew with organic fertilizers	5
		Unprocessed foods	1			Foods without food additives	4
		Foods that do not contain pesticides	1			Certificate	Foods with organic food certificate emblem
		Hormone-free foods	1		Production place		Foods grew on-field themselves
	Unprocessed foods	Foods harvested from the field	1			Foods are grown in the garden	1
		Foods obtained from animals we raise ourselves	2			Food is grown in the village	1
Definition of GM food	I don't know	Foods are grown in villages	2	Definition of GM food	Intervention to genetics	Genetically modified	12
		No idea	4			Genes modified	2
	I don't know	No idea	14				

acquiring food and nutrition literacy (Aktaş & Özdoğan, 2016; Ayer, 2018).

Food literacy necessitates students' ability to read and analyze the label and packaging information on foods, question the source of the food, and make the right food choice by judging all these at once (Vidgen & Gallegos, 2014).

Next, findings were reached regarding the students' understanding of convenience food before and after the implementation. The findings are given in Table 3.

It was seen in the pre-interview that the students defined convenience food by relating with "processed foods" and "foods that are not made at home". In this connection, they considered packaged foods, foods produced in factories, or foods produced with machines as convenience food. In the post-interview, most students were found to define convenience food as food processed in factories, packaged foods, and foods with additives. In other words, they referred to foods passing through the food industry process to define convenience food. It determines that a small number of them made statements indicating the source of the food.

Table 4 shows the findings on what participants understand from the concept of natural food in the pre and post- interviews. It sees in Table 4 that the students described natural food in categories of "unprocessed food", "foods used as obtained from the source", and "healthy". In this connection, the most frequently stated natural foods were "foods without food additives," "food obtained from animals raised in the village," and "foods we grow ourselves in gardens". After the interview, all respondents described natural food as food obtained from the source and used without food additives. Another point of consideration in the interviews was what the students

know about organic food and genetically modified (G.M.) food. Findings revealing the students' opinions on this subject are given in Table 5.

In the pre-interview, it was seen that the students defined organic food as foods grown without chemicals and unprocessed foods, and some others held no idea about the concept. Those who could provide a definition explained the concept as "additive-free foods", "unprocessed foods", "foods that do not contain pesticides", "foods harvested from the field", "foods grown in villages", "foods obtained from animals we raise ourselves", and "hormone-free foods". It was found that none of the students had an idea in the pre-interviews about genetically modified foods.

In the post-interview results, it was found out that the majority of the students described organic food about the certificate, production process, and production place. The most frequent codes appeared as "foods with organic food certificate emblem", "foods grown with organic fertilizers," and "foods without food additives". According to Table 5, a large number of the participants defined G.M. food in the post-interview by using the term "genetically modified" or "genes modified".

When examined together with the findings in Tables 3, 4, and 5, it can be said that students were confused about the concepts of convenience food, natural food, organic food before the implementation process. While defining natural food, the students mostly used remarks like "foods used as obtained from the source", and they explained "the source" with "village", "garden", or "field". A few of them mentioned the unprocessed quality of food. When the students were asked for the definition of organic food, most of the students used expressions similar to those used to describe natural food. These concepts are related to

**Table 6** Students' opinions about food preservation methods in pre and post-interviews

Pre-interview			Post-interview					
Theme	Category	Code	f	Theme	Category	Code	f	
Food preservation methods	Physical preservation methods	Putting in the fridge	7	Food preservation methods	Physical preservation methods	Canning	10	
		Putting in cold storage	1			Drying	10	
		Put in the freezer	1			Salting	2	
		Put in cool places	1			Heating up	1	
		Putting in Tupperware boxes	1		Chemical preservation methods	Pickling	14	
		Put in warm places	1			Fermenting	3	
		Put in storeroom	1			Brining	1	
			Chemical preservation methods		Fermenting	1		

knowing the food source and, of course, food literacy components (Aktaş & Özdoğan, 2016; Vidgen & Gallegos, 2014).

In the final interviews on the concepts, most students could accurately define convenience food and natural food and explain their respective properties. In addition, most of the students could explain the production process and certification issues regarding organic food. Finally, most of them talked about the presence of an organic food certificate emblem.

However, none of the students could explain G.M.'s food in the first interviews, whereas all of them could define G.M.'s food as genetically modified food in the last interviews (Table 5). Demir & Düzleyen (2012) also interviewed students who did not know anything about genetically modified organisms.

Thus, it can be argued that the activity implementation process proved effective in which the students collaboratively learned the topic through group work.

The literature also reports the positive impact of learning environments where learners' ideas are questioned and shared collaboratively, and they help each other (Sun, Looi & Xie, 2017).

An activity based on small group argumentation was conducted on hormones and genetically modified organisms used in foods. It can thus be claimed that the activity was beneficial in understanding and learning the importance of the topic. Many studies show that activities based on small group arguments are influential and should be used primarily in teaching socio-scientific matters. The teaching process based on small group argumentation exposes students' thinking methods and improves their reasoning mechanisms (Duschl & Osborne, 2002; Kelly & Takao, 2002). The benefits of argumentation activities for students include understanding science concepts, participating in discussions, changing their views on

science, and improving decision-making skills on socio-scientific matters (Chinn & Clark, 2013; Herawati & Ardianto, 2017).

The interviews also searched what ideas students have for naturally increasing the durability of foods without using additives. Their suggestions before and after the implementation are summarized in Table 6. The students mentioned several preservation methods which can be grouped as physical and chemical methods in the first and last interviews. In the pre-interview, they referred to putting (foods) in the fridge, putting in cold storage, putting in the freezer, putting in cool places, putting in Tupperware boxes, putting in warm places, and putting in the storeroom, which means physical methods. Among others, "putting in the fridge" was seen to match the highest frequency. At the other end, "fermenting" was matched with the lowest frequency (1) as a chemical preservation method. It can be said that before the implementation, students' knowledge and experiences concerning food preservation ways were limited levels. The most frequently mentioned methods were physical methods such as putting in the fridge or putting in cold places. In reality, storing food in the fridge can prevent spoilage, but it is not a long-term and economical preservation method. However, traditional methods such as fermenting, canning, salting, pickling, and drying have been practiced from past to present; thanks to these, foods are kept for a long time without going wrong in an economical way and also provide health benefits with prebiotics and probiotics (Amit, Uddin, Rizwanur Rahman, Islam & Khan, 2017; Kumar, 2019).

In the post-interview, it was found that most of the respondents listed both physical and chemical preservation methods. It can be inferred from Table 6 that the students regarded canning, drying, salting, and heating up to be physical methods, whereas everybody saw pickling as a

**Table 7** Students' opinions about E-coding in pre and post-interviews

Pre-interview				Post-interview			
Theme	Category	Code	f	Theme	Category	Code	f
Definition	I don't know	No idea	14		E-coding	Numbers are given to food additives	8
Example	I don't know	No idea	14	Definition		An international figure	4
						Closed representation of food additives	2
						A scientific number	1
				Example	Colorant	E102	8
					Preservative	E221	4
					Sweetener	E951	2
						E924	2
					Flavor enhancer	E621	4

**Table 8** Students' opinions obtained from reflective diaries

Theme	Category	Activity codes	Frequency
Learnt concepts	Food selection	1	14
	Food additives	2	14
	Food additive usage purposes	2	6
	GM food	3	14
	Foods grew with hormones	3	14
	E-coding	4	14
	E-coding examples	4	14
	Things to consider in food shopping	4	14
	Food preservation methods	5	14
Aspects different from other lessons	Collaborative learning	1,2,3,4	35
	Taking an active role	1,2,3,4	37
	Out-of-school activity	4	14
	Design work	5	14
Challenging parts of the activity	None	1,2,3,4,5	14
Pleasing parts of the activity	Collaborative learning	1,2,3,5	26
	Taking an active role	1,2,3,5	42
	Learning food preservation methods	5	14
	Out-of-school activity	4	14
Things to add to the activity	None	1,2,3,4,5	67
	Various activities	1	3

chemical preservation method. In those interviews, two other chemical methods were also put up, fermenting and brining namely. In this context, it can be said that the students' knowledge about food preservation methods has improved in the implementation process. Before the implementation stage ended, the students examined natural (no food additives) preservation methods and learned one of them by experiencing it in person. Likewise, previous studies noted that students learn by being active, cooperating, doing, and experiencing make more sense to them and contribute to permanent learning (Chinn & Clark, 2013; Chiu ve Cheng, 2017; Ünal & Ergin, 2006).

Lastly, findings were obtained on students' knowledge about E-coding on food packages according to pre and post-interviews, as seen in Table 7. It was found out that

while none of the students had an idea or example about the topic in the pre-interview, all of them could describe E-coding in the post-interview. Of those, 8 explained E-coding as numbers are given to food additives, and four thought it was an international figure. Also, in the last interview, the students could exemplify E-codings for food additives used as colorants, preservatives, sweeteners, and flavor enhancers. It was observed that most of the students gave specific examples such as 'E102', a colorant, 'E221', a preservative, and 'E21', a flavor enhancer.

As a part of this study, the students made a supermarket trip, an out-of-school teaching activity. In this way, they learn about what to pay attention to when buying groceries and understand what food labels mean, place and experience. It can thus be suggested that this active learning

**Table 9** Students' opinions about the implementation process

Opinion		Students' direct remarks
Overall judgment	Fun	I think it was enjoyable. We went grocery shopping, watched videos, and did many food activities. (Ö14)
	Instructive	The activities were instructive. I learned a lot. I learned E-coding, I learned food additives, I learned GM food. I learned the health hazards of glucose syrup and trans fats. (Ö5) It went beautifully. We learned things that we did not know (before), I learned which additives are in foods. We learned what to consider while shopping. We learned healthy and balanced eating. (Ö8)
Benefits	Consciousness-raising	Yes. For example, we just ate food. We were not paying attention to the ingredients. Now I pay attention to the expiry date, whether additives are used or not. (Ö3)
	It helps to associate with everyday life	Yes, there were. We learned new things. It was instrumental because I will apply it in daily life. (Ö10) We went grocery shopping, bought food after examining it in detail, bought food, and to apply it in daily life. (Ö14)
	Awareness-increasing	Yes. For example, we just ate food. We were not paying attention to the ingredients. Now I pay attention to the expiry date, whether additives are used or not. (Ö3) Yes. We made pickles, we were going to store them, and now I know why we put salt and vinegar. (Ö4) For example, I became more aware of E-coding; I pay attention when buying, and I will continue to do so. (Ö6) I pay attention not to eat junk food and try not to consume unhealthy products that contain food additives. (Ö8) For example, when I go shopping, I look at its appearance, expiry date, and whether or not food additives are used. (Ö3)
	Behavior-changing	I was buying it without knowing what glucose syrup is. I will not buy anymore. I will consume fruit and vegetables in the season. I will store foods after canning, salting, or drying. (Ö5) For example, when I go to the supermarket, I no longer buy because the price is low. I look at the ingredients. I look at the E-codings. (Ö4) I didn't use to look at the ingredients, but now I read the ingredients, look at the E-coding, and did not use to pay attention because I did not know food additives. (Ö13)

process outside of school improved students' opinions on foodstuffs and E-coding (Chin, 2004). In addition, the literature also reports several favorable effects of out-of-school learning environments such as drawing students' attention, being fun and more motivating and encouraging meaningful and lasting learning (Bakioğlu & Karamustafaoğlu, 2014; Balkan Kıyıcı, 2011).

### 3. 2. Results from the Reflective Diaries

The results obtained from the reflective diaries kept by the students during the experimental stage were summarized in a single table by leaving the study codes outside to maintain the semantic integrity and use the space sparingly. For this reason, the frequency figures in the relevant table indicate the total frequency of the thoughts of 14 students in 5 diaries. In addition, student activities in the diary are entered into a table with the name "activity code".

According to Table 8, all students stated that they learned about food selection, food additives, G.M. food, foods grown with hormones, E-coding, E-coding examples, things to consider in food shopping, and food preservation methods thanks to the carrying out of the activities. It was seen that the students listed aspects of the practical activities different from other lessons, such as taking an active role, collaborative learning, out-of-school activity, and design work. The students stated that they

faced no challenging situations during the five activities they took part in.

As for the good parts of the activities, the students said that they enjoyed collaborative learning, taking an active role, learning food preservation methods, and out-of-school activity in decreasing order of frequency. It was understood from Table 8 that there were no points the students wanted to add or revise in the teaching activities. Only three students stated that different activities such as origami, doing sports activities, and watching videos could be added to Activity 1.

In the results obtained from the students' reflective diaries, the categories of collaborative learning and taking an active role emerged as extraordinary aspects compared to other lessons about all of the activities. At the same time, cooperative learning and taking an active role emerged as two distinct categories under the theme of aspects liked. It can be said that students enjoy the collaborative learning method and being active in the process. The researcher also shows that during collaborative group work, students can experience extraordinary learning experiences such as asking questions, criticizing different thoughts, expressing ideas, and providing examples thanks to interactions with their peers which are not possible when they study alone. (Slavin, 1991; Zimmerman ve Gallagher, 2006).

**Table 9** Students' opinions about the implementation process (*Continued*)

Opinion	Students' direct remarks
Aspects liked	Videos watched Activities carried out Extracurricular learning (grocery shopping) Watching movies Worksheets T-shirt designing activity
Aspects disliked	-
Favorite activity	Pickle making Creating slogans and designing t-shirts Grocery shopping
Thoughts on group work	Joint decision making Sharing ideas Helping each other Versatile thinking Correcting mistakes
Reflections of the activities on students' daily lives	Stopping to consume a type of convenience food consumed before Starting to read the product packaging information in more detail during the purchasing process Adding criteria for product selection that was not considered before
Challenges faced	-

### 3.3. Results from the Interviews regarding the Implementation Process

This section is devoted to the findings obtained from the descriptive analysis of the interviews about the student's opinions on the implementation. The findings are displayed in Table 9. Students stated that the learning

process was fun, instructive, and consciousness-raising. They stated the benefits of the implementation process as it helps to associate with everyday life, awareness-increasing, behavior-changing. Students explained aspects as videos watched, activities carried out, extracurricular learning (grocery shopping), watching movies, worksheets,

and t-shirt designing activities. Their favorite activities were pickle making, creating slogans and designing their t-shirts, grocery shopping. Also, students stated thoughts on group work as joint decision making, sharing ideas, helping each other, versatile thinking, and correcting mistakes.

On the whole, the students disliked no particular thing or found it challenging at the implementation stage. However, a significant result is taken from the study is reflections of the activities on students' daily lives. They explained these issues as stopping to consume a type of convenience food consumed before, starting to read the product packaging information in more detail during the purchasing process, and adding criteria for product selection that was not considered before.

Students' improvement in the implementation process is revealed once again by the conceptual interview findings and the findings related to the theme "learned concepts" in the reflective diaries and the findings obtained from interviews about the teaching activities. Furthermore, the students' remarks suggest that the intended improvement was achieved in behavior beyond perception.

The experimental stage was carried out with five teaching materials based on the constructivist teaching approach. Various teaching methods, techniques, and materials were used in those materials such as argumentation, out-of-school learning, inquiry-based learning, experimentation, producing slogans, watching videos and movies, story, t-shirt design, which are suitable for modern learning approaches and attract students' attention (Ünal & Ergin, 2006; Erdem, 2018). In this context, according to the participants in the present study, those activities were distinguished from other lessons for several reasons, as reported in the interviews and diaries.

The students' positive thoughts might be accounted for by the probability that many rich learning experiences were offered by the teaching materials developed in line with their needs to teach a topic closely related to their real-life (Jack & Lin, 2017).

And another reason may be the opportunity to experience and observe the topic on-site by moving the teaching process out of the familiar classroom environment. Additionally, the students learned by doing these activities and had the chance to reveal their creativity. In the literature, that such activities are practical for actively engaging students in learning and bringing them meaningful learning (Bakioğlu & Karamustafaoğlu, 2014; Balkan Kıyıcı, 2011).

#### 4. CONCLUSION

The current study aimed to discuss the development of 7th-grade students' opinions on food literacy within the scope of a series of teaching activities. The findings showed that the student's knowledge and experience about the subject were very limited before the implementation. The students' limited knowledge about food literacy shows that the current science curriculum is insufficient to improve

food literacy. However, after implementation, the students' opinions on food selection and consumption particulars such as convenience food, natural food, organic food, food additives, hormones, GM food, E-coding and food preservation methods developed significantly. Improvement after implementation indicates that the intervention is effective in facilitating students' learning. Also it can be concluded that the intervention was raised students' awareness. In this context, the following suggestions can be made.

It is pivotal to bring up school-age children as food literate individuals for a healthy society. Therefore, food literacy subjects such as healthy foods, additives, choosing and consuming safe food items, nutritional content, and food label reading must be wider in the science curriculum. Therefore, the number of learning outcomes and the course hours included in the curriculum should be increased. In the current study, the components of food literacy such as food selection, knowing where food comes from, food prevention, and preparation were handled together and tried to be improved by hands-on learning activities by a qualitative approach. Different components of food literacy such as planning, management, and consumption can also be included in the study and examined by experimental design. Because eating habits are inculcated at young ages within the family, the current study can adapt to contexts involving parents as participants. Also, considering that the teaching materials and methods developed and applied in this study were effective in learning food literacy and were liked by the students in many senses, they can be adjusted to other grade levels.

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