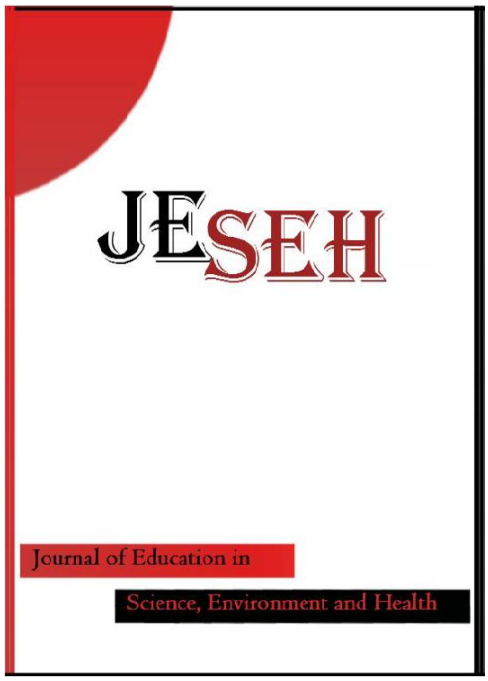

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Promoting Preschool Pre-service Teachers' Understanding of Food Additives Using the Debate Method

Ganime Aydin[1], Deniz Saribas[2]
[1]Canakkale Onsekiz Mart University
[2] İstanbul Aydin University

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Abstract

The aim of this research is to investigate the development of preschool education pre-service teachers' (PST) understanding and evaluation of a socio-scientific topic, namely food additives by using debate as a teaching technique. Qualitative research was designed in a case study model with purposeful sampling in which sixty PST attended Mother and Child Nutrition course. We used qualitative data instruments including pre- and post-reflective forms (RF), assignment papers and video recordings. Data were analyzed using open coding and cross coding. The results indicated that PST's opinions about food additives may change with the use of debate and scientific articles. The findings also showed that it can be possible to improve their understanding of scientific knowledge about food additives, sources of information, evaluation of sources of information with the help of well-designed debate applications. The evaluation of the components of evidence, sources of evidence, arguments, and expert judgment as well as inclusion of these components in teacher education programs are recommended for further research.

Introduction

Scientific literacy has been on the agenda of science education for decades and seven aspects have been defined within the scope of scientific literacy including foundational literacies, content knowledge, understanding of scientific practices, epistemic knowledge, identifying and judging scientific expertise, cultural understanding of science, and dispositions and habits of mind (National Research Council [NRC], 2011, p.32). Scientific literacy is described as the "ability to engage with science-related issues, and with the ideas of science, as a reflective citizen" (Organization for Economic Co-operation and Development [OECD], 2013, p. 7). A scientifically literate individual can explain phenomena scientifically, evaluate and design scientific enquiry, and interpret data and evidence scientifically (OECD, 2013). Furthermore, OECD (2011) stressed the importance of helping students acquire the skills of critical thinking, decision-making, communication, and collaboration included in 21st century skills. In a nutshell, to create scientifically literate individuals who are socially responsible and have a democratic worldview, educators should encourage learners to solve problems by evaluating them critically in a discourse environment. Upahi, Gbadamosi and Bonifaci (2017) suggested making deliberate efforts to relate objectives and contents of curriculum to explain the natural world and how scientific and technological enterprise relates societal issues and problems. To fulfil this requirement, this study examined the influence of debate, which is a teaching technique that enables the acquisition of skills, on PST's understanding and evaluation of a socio-scientific topic, namely food additives.

Health literacy, technology literacy, financial literacy, digital literacy, and other domain literacies closely interconnect and overlap with scientific literacy. Consumers' knowledge and awareness of food is crucial in this sense. However, nutrition is one of the topics that have been rarely studied in science education (Zeidler & Nichols, 2009). Therefore, we aimed to investigate PST's understanding and evaluation of this issue as they create future citizens. Food additives, such as sweeteners and food coloring are often considered by consumers as unnatural, unhealthy, or even hazardous for public health. However, these perceptions are mostly influenced by consumers' knowledge of regulation, their trust in regulators, and their preference for natural products (Bearth, Cousin & Siegrist, 2014). Fake news has been a growing concern for some industrial sectors including food industry. Disinformation and misinformation about food and agriculture spread rapidly in online platforms and jeopardize not only industrial sectors, but also scientific experts, research institutions, research institutions and the whole society (Demestichas, Remoundou, & Adamopoulou, 2020).

PST should have sufficient knowledge about nutrition to help children develop healthy eating habits, good health and prevent malnutrition and disorders. However, PST have generally a lack of knowledge about nutrition (Øvrebø, 2017). From this perspective, we selected food additives as the context of this study to promote PST's both understanding and evaluation of a socio-scientific issue, namely food additives.

Theoretical Framework

Food Additives as a Socio-scientific Issue

At the beginning of the 21st century the definition of socio-scientific issue (SSI) has been established and was considered in science education programs mainly to develop the scientific literacy of students in different grade levels by relating their knowledge to social problems. SSI are defined as issues that are "based on scientific concepts or problems, controversial in nature, discussed in public areas and mostly subjected to political and ethical effects" (Sadler & Zeidler, 2005, p. 113). Studies on SSI implementations in the classroom reported results of increased understanding of science subjects (Barker & Millar, 1996; Dori et al., 2003; Klosterman & Sadler, 2010; Sadler, Barab & Scott, 2007;Yager, 2006), promotion of decision-making processes (Sadler & Zeidler, 2005; Topcu, 2010), improved evidence-based thinking (Wu &Tsaib, 2007) and critical thinking skills (Altuntas, Yılmaz & Turan, 2017) of students in various grades ranging from middle school to undergraduate levels by practices presented with various perspectives.

SSIs are science-related and social issues that are interdisciplinary in nature and inherently include socio-ethical dilemmas (Kolstø, 2001, Ratcliffe & Grace, 2003, Sadler & Zeidler, 2004). Food additives is also a SSI that includes socio-ethical dilemmas and has been accompanied by disinformation and misinformation among public. Contemporary scientific literacy requires individuals' competency to critically evaluate and debate about SSIs (Tsai, 2018). Considering preschool teachers' influence on children in very early ages, it is especially important to foster their scientific literacy by focusing on their understanding and evaluation of a controversial issue about food, namely food additives.

Although there has been much research about SSI, there isn't enough practice of SSI in classroom settings and lecture plans nor enough sources of SSI activities in the classrooms for teachers (Kara, 2012; Lee, Abd-El-Khalick & Choi, 2006; Peel, Zangori, Friedrichsen, Hayes, & Sadler**,** 2019; Sadler, Foulk & Friedrichsen, 2017). Kılınc et al. (2014) argued that contrary to other topics, teaching SSI requires evaluating evidence, coping with uncertainties, defending arguments, and increasing moral and ethical sensitivity. From this point of view, researchers suggest employing argumentation and debate in classroom (e.g. Sadler, 2018); Torres & Cristancho, 2018; Zeidler and Nichols, 2009). Santos (2014) examined debate for global warming as an SSI and suggested the usage of debate for socio-scientific practices. However, there are not enough studies specifically focusing on PST's understanding and evaluation of a topic about food. The influence of debate on PST's understanding and evaluation is also rarely found. Therefore, in this research we applied debate as a teaching technique to provide a deeper understanding by enhancing meaningful learning, applying analysis and evaluation skills of the student, motivating them to hold logical, clear, and error-free discussions (Omelicheva & Avdeyeva, 2008) instead of presenting students information directly. Other teaching methods and techniques included laboratory practices based on inquiry, dilemma cards, concept cartoons, problem scenarios etc. Debate,as a teaching technique based on the literature, requires the discussion of ideas and evidence-based argumentations to make meaning of the topic to be taught and encourages the students to critically evaluate the source of knowledge.

Debate as Teaching Technique

Debate is a teaching technique applied in the form of discussion between the two groups of people who have opposite opinions to defend their own thoughts in front of an audience (Freeley & Steinberg, 2013, Taspinar, 2012). It is considered as an active learning (Bonwell & Eison; 1991) where students take the responsibility for their own learning in which they determine their duties (Bell, 1996). It is based on Socratic dialogue in which students research and analyze a subject or a problem deeply by critically evaluating information based on evidence in an argumentative discourse environment, (Bozer &Kurnaz, 2016; Paul & Elder, 1998; Saban, 2013). It is a teaching technique that provides student's opportunities to share their opinions on the subject, enhance their practice of analysis, evidence-based argumentation and promotes evaluation skills (Omelicheva & Avdeyeva, 2008). In this context, debate includes research and argumentation processes to support or refute an

idea based on scientific evidence, which in turn contributes to students' improvement of critical thinking and their scientific literacy.

Debate applications in class have many benefits for students including promotion of critical thinking, empathy, and communication skills (Hall, 2011; Kennedy, 2009, Shamsudin, Othman, Jahedi & Aralas, 2017), improvement of the ability of persuading others and communication skills (Oros, 2007), development of the ability to work collaboratively (Gervey, 2009), increase in the learning of content knowledge (Vo & Morris, 2006), and enhancement of representation and defense of ideas by discussing with others (Bellon, 2000) as well as elimination of bias and increase in motivation (Kedraka & Kourkoutas, 2018; Schroeder & Ebert, 1983). Critical thinking was indicated as the main output of debate by many academicians for many years but the benefits of debate for students can be divided into four themes.

a-cognitive domain (critical thinking and understanding subject) (Candela, Michael, & Mitchell, 2003; Garrett, Schoener, & Hood, 1996; Oros, 2007)
b-skills (collaborative working, communication (listening, speaking), effective usage of language) (Darby, 2007; Kennedy, 2009; Omelicheva, 2007)
c-attitudes (motivation to lecture and other social and political problems) (Hanna et al., 2014; Kennedy, 2009; Omelicheva & Avdeyeva, 2008).
d- democratic citizens (reducing prejudices and discrimination being scientifically literate) (Jager,2013; Omelicheva, 2007).

Besides the advantages of debate, some researchers focused on the limitation of its implementation. For instance, whether the students agree and disagree or have no idea about the discussed issue, their opinions or ideas may be oriented to their assigned positions after the debate instead of having their own opinions (Lily, 2012). Other disadvantages have been listed, such as misleading students and strengthening their existing views as well as causing conflict, tension, alienation, and anxiety within students (Omelicheva, 2007). Students need advanced research skills like scanning, skimming and critical reading to help them select relevant, useful, and trustworthy sources of information to defend their arguments as well as improving their listening and writing skills (Zare & Othman; 2013). Roy and Macchiette (2005) and Oros (2007) highlighted the importance of assessment and the feedback processes for the successful application of the debate technique. Based on this background, one can infer that critical reading by questioning the trustworthiness of the sources as well as a feedback process is necessary during implementation of debate.

Najafi, Motaghi, Nasrabadi and Heshi (2016) imply that students need to be taught how to think freely and positively, and there is need to increase their self-confidence. Goodwin's (2013) students criticized debate applications while they enjoyed it in that listening to the debates was passive and uninformative. Generally, most argued views about debate interventions are that all of the students are not active, it is difficult in a crowded classroom, it leads students to competitiveness students cannot produce their own ideas, and instructors have problems with classroom management and planning of debate applications, as well as requirement of post-debate feedback and integration of curriculum into debate applications. Therefore, Oros (2007) advises indicating details of a structured classroom debate model in which clear evaluation criteria, appropriate debate questions, management of groups, a well-planned debate format, the practice and evaluation of the debate by way of written and spoken assessment and student self-evaluation with suggestions was outlined with examples. In this research, debate was used as a teaching technique in a structured way including 60 PST's written and oral discussions.

The Purpose of the Study

The aim of this study was to see the improvement of scientific literacy skills of PST by understanding and evaluation of a socio-scientific topic, food additives, by using debate as a teaching technique.

Research Problems

1-Does the debate improve PST's understanding of the contents of the socio-scientific topic, food additives?
2-Do the sources of information that PST use change after the debate?
3-How do PST evaluate the trustworthiness of the sources they use about food additives before and after the debate?
4-Do PST'a opinions of usage of food additives change after the debate?

Significance of the Study

It is essential to promote PST's understanding of nutrition since they have impact on their students' good eating habits and health. It is also significant to create scientific literate preschool teachers who critically evaluate information about food and health in general. To achieve this goal, the study presented here aimed to improve their understanding and evaluation of a socio-scientific topic, namely food additives. The topic of food additives is selected as a context for this study to eliminate the impact of disinformation and misinformation about this topic on PST's. The debate method was chosen with the aim of improving their understanding and evaluation of this topic since it provides students with opportunities to support their argumentation with evidence and it improves their evaluation skills. The results of this study will be a well structed debate in science education and it will bring new light to designing preschool teacher education programs and further research investigating PST's understanding and evaluation of SSIs.

Method

Research Design

The study was designed as a case study using qualitative data. Yin (2009) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." (p.18). The current study uses the case study research to examine PST's understanding and evaluation of food additives. Food additives as an example of SSI were used for real life context to understand the effects of debate on PST's understanding and evaluation of food additives. According to Yin (2014) what differentiates case study research from experimental research is that the case study is investigated in context, examined in its "real world setting" (p.16). This research is an explanatory case study consisting of more than one outcome and examples of casual relationships (Fisher & Ziviani, 2004). In the present study, in which debate as a teaching technique may change PST's understanding and evaluation of food additives, we examined the multiple outcomes of the case and tried to understand and emphasize the complexity and uniqueness of that case (Stake, 1995). Besides, the other feature of explanatory case study is that the usage of multiple sources of qualitative data may bring a deep understanding of a case and provides intrinsic knowledge and details regarding a problem or issues of interest to a researcher (Stake, 1995). In this study, we used reflective form (RF) as pre- and post-reflective forms, assignment papers as homework for the entire sample group and video recordings during the debate activity to answer the research questions. We organized the intervention based on the steps that Oros determined for debate (2007). We examined PST's understanding and evaluation of food additives and the sources they used about this topic. The first author was the instructor of this course. She is an experienced instructor who was familiar with the characteristics of the participants.

Participants

The research sample group represented in table 1 consisted of 60 PST attending a preschool teacher education program who enrolled in a Mother and Child Nutrition course during the fall semester of 2018-2019 academic year in a private university in Turkey and all of the participants were female. Before this course, they only attended anatomy and physiology course related with scientific concepts and most of them graduated from vocational schools that had a limited number of science courses only in 9^{th} grade. They entered the preschool education program by answering literacy and mathematic questions in the university entrance exam. Therefore, purposeful sampling was preferred for the senior level of PST's who were suitable for the research purpose because SSI units related with nutrition are included in the curriculum of this course. In addition, the opportunity of the sample group to communicate experiences and opinions in an articulate, expressive, and reflective manner and willingness to participate purposeful sampling was contributed (Bernard, 2002; Spradley, 1979). The only limitations of the sample group were their gender and their department (Palinkas, Horwitz, Green, Wisdom & Hoagwood, 2015). The participants signed a consent form for the use of data and video recordings in the research.

Table 1. The characteristics of pre-school education pre-service teachers'(PST)

Number of PST	Gender	Grade	Course (application of research)
60	All are female	Senior	Mother and child nutrition

Data Sources

In terms of transferability, Merriam (1998) indicated that the findings of a qualitative study should be applied to other or broader areas. Debate is a teaching technique used in many areas of education and this study tried to show the effective usage of it in science education reduces the negative assumptions of crowded classrooms. The aim of systematically gathering qualitative data was to discover a theory on completion of the research (Glaser & Strauss, 1967). Therefore, we gathered data from various sources including the reflective forms (RF) and assignment papers and video recordings obtained during the debate activity. The researchers of this study analyzed the data independently.

Reflective Test

The RF was applied before and after the debate interventions as a pre- and post-reflective form. The questions in RF were created by researchers to understand the influence of debate intervention. A professor from the Nutrition Department of Health Science Faculty checked the reflective test questions and assignment papers to ensure the validity of the questions. The researchers of this study constructed categories based on the participants' writings, then coded their explanations in approximately one month depending on these categories independently. First, they discussed the categories and after reaching a consensus they began to code the participants' writings. The initial agreement between researchers in coding was 80%. The researchers discussed these conflicts until they reached complete agreement on these codes. The questions in these forms were as follows:

- How can you define food additives?
- Do you think that you are consuming food additives? Provide some examples.
- What are the effects of food additives on human health?
- Which sources do you use to collect information about food additives?
- Do you think your sources of information are scientifically trustworthy or not?

Assignment Papers

Aiming to engage all the students in the debate and inform them about the content, 4 assignment papers were given to meet the requirements of the evaluation criteria that Oros suggested (2017). We distributed four articles to all participants, two of which explained the benefits and the other two mentioned the negative effects of food additives and asked them to read and to answer the questions related to each article. The articles and texts were regulated by omitting unknown concepts and they were shortened for the purpose of comprehension. The researchers of this study again created categories based on the participants' writings, then coded their explanations depending on these categories independently. They coded the participants' writings independently after discussing and deciding on the categories. The initial agreement between their coding was 80% and finally they reached complete consensus on the codes after discussing these concerns.

The questions of the assignments are listed below.

- What did you learn about food additives from the texts? Give a brief information.
- Is there any information in the text that food additives are beneficial or harmful?
- Do you agree with the information in the text? Why/Why not?

Video Recordings

Video recordings began to be used after the development of technology, for data collection, assessment, and distance educations. Gulek (1999) indicated that videos provide teachers an opportunity to critically review their teaching methods and students to observe their own actions due to its capability to reveal insights into the classroom from a different perspective (p.8). In this research during the debate application in the class, video recordings were used to identify and to obtain detailed outcomes of research questions and different outcomes rather than research questions to argue debate as a teaching technique. The video recordings made during the debate activity were used as a data source to understand the scientific knowledge about food additives, change of habits, evaluation and trustworthiness of the sources used by the participants.

Data Collection Process

In this research, six different units which were food additives, functional foods, childhood nutrition, and supplements during pregnancy, genetically modified foods, and diet programs were used to see the effects of debate applications on 60 PST. But in this working paper only the results of the debate about food additives were used. Before the debate application, we distributed four articles two of which explained the negative effects of food additives and the other two explained the necessity and benefits of their usage. When they were reading the articles, they should answer the questions on an assignment paper as homework to allow all the participants to engage in debate and to reduce the limitation of debate based by Goldwin (2013) in which other than debate group lay groups discussed the given information with their group mates and drew a conclusion in their assignment. Also, the pre-reflective form related to food additives, mentioned above, was applied to all sample groups before the debate application. The debate group's members were assigned randomly by drawing names from the whole study group. Five students were assigned to the role of defending the argument that 'foods containing food additives shouldn't be used in nutrition', and the other five of them were responsible for arguing that 'foods containing food additives can be used in nutrition'. The groups had two weeks for preparation and for answering the assignment papers, which were collected at the beginning of debate application from all the PRSET. The format of the debate could change however, the important thing was to ensure that the argumentation process in the class served discussion of bias within the claims (Bonwell & Eison; 1997). We therefore gave structured guidelines, that was given below, before the debate to guide their research and to underline the contents of the debate. We also gave the rubric which was used for the evaluation of the debate groups concerning 60 participants.

Debate Structured Guidelines

Divide the assignments between your teammates and take the following into consideration:
1. Define food additives and their history (when and how they were found, produced, developed)
2. Why is the given topic important for society?
3. What did the society do to prevent the production or to restrict the usage of food additives?
4. What are the positive or negative effects of the given subject regarding human health, psychology, ethics, and moral values?
5. Indicate your references when you provide evidence to support your claims. You can use given articles or texts.
6. You can use many different techniques like videos of your research, experiments, drama, your questionnaire results etc.

Also, the debate steps were mentioned for the participants who didn't take place in any debate activity. The steps generally were structured from Oros (2017) but adapted for 4-5 students in each debate group. The debate activity was completed in two course hours, approximately 90 minutes.

Debate steps:

1a- Team One presents the supporting arguments—10 minutes
. The argument (s) is introduced.
. Evidence is submitted to support the argument.
1b- Team Two presents the opposing arguments—10 minutes.
. The argument is introduced.
. Evidence is submitted to support the argument.
. No direct response is given to Team One.
2a- Team One reintroduces the supporting arguments—5 minutes.
. Secondary arguments are introduced.
. More evidence is submitted.
. The opposing team's evidence and arguments are rebutted.
2b- Team Two reintroduces the opposing arguments—5 minutes.
. Secondary arguments are introduced.
. More evidence is submitted.
. The supporting team's evidence and arguments are rebutted.
3a- Team One rebuttal—5 minutes
. Respond directly to opposing team's arguments.
. Sum up key points of your team's position.

3b- Team Two rebuttal—5 minutes

. Respond directly to opposing team's arguments.

. Sum up key points of your team's position.

4a- b: team one and two will respond the three questions of the instructor, jury member and their friends with evidence.

In the debate, in addition to using the exact first three steps of Oros (2007), the fourth step was added. Finally, the average score of the jury, consisting of a researcher and four other students, was calculated and the score and the reasons for the score of each group were explained. The rubric was composed of three main parts: research, presentation, and group work. The rules of the debate and the results of the evaluation of the rubric forms were also announced. Each group member got the same grade.

Data Analysis

According to Marshall & Rossman (2011), credibility, transferability and dependability are the main issues to determine the trustworthiness of a qualitative study. To ensure the trustworthiness of this study data was analyzed using open coding and cross coding by two researchers depending on the research questions. All data groups were managed using the Miles and Huberman reliability formula (1994) formula:

Reliability = amount of agreements / number of agreements + disagreements

The initial percentage agreement of the researchers was 80%. The researchers discussed their conflicts until they reach 100% agreement to assure the reliability of the results. Depending on the analysis of reflective tests, assignment papers and video recordings during the debate period in class, all codes were grouped under the four themes in the light of the research questions. The themes were: the understanding of scientific knowledge about food additives, source of information, evaluation of sources of information and change in PST' opinion about consumption of food additives. Codes and sub-codes were given in the table 2 below. The results of RF test and assignment papers were given separately and data from video recordings were used to explain each theme results in detail.

Table 2. Themes, codes and used data sources in research analysis.

Themes	Codes	Sub-codes	Used data sources
Understanding of scientific knowledge about food additives	Scientific knowledge	Definition of food additives (Durability –examples of foods, shelf-life color, odor, taste & appearance	Pre-RF test Post –RF test Assignment papers Video recordings
	Effect on health	Harmful, not harmful, diseases	Pre-RF test Post –RF test Assignment papers Video recordings
Source of information	Types of sources		Pre-RF test Post –RF test Video recordings
Trustworthiness of information	Not trustworthy	- explaining why the sources are not trustworthy	
	Trustworthy	- explaining why the sources are trustworthy	Pre-RF test Post –RF test Assignment papers Video recordings
Change in their opinion about consumption of food additives	Harmful	-Why harmful with or without evidence	Pre-RF test Post –RF test Assignment papers Video recordings
	Not harmful	-Why not harmful with or without evidence	Pre-RF test Post –RF test Assignment papers Video recordings

Results

This study analyzed PST's understanding of a socio-scientific topic, food additives and their evaluations of sources of information about this topic before and after the debate in the classroom. To make this analysis we inspected their pre- and post-RF as well as their assignment papers and video recordings. Subsequent sections include the findings of PST's understanding of scientific knowledge about food additives, change in their habit, evaluation of the sources of information they used for this topic and finally, the criteria used to decide the trustworthiness of the sources of information provided in the texts they read.

Understanding of Scientific Knowledge about Food Additives

In this section we present the results of PST's responses in RFs and assignments. First, we present their definitions of food additives, whether they consume these additives and how these additives affect human health in RFs. Table 3 illustrates the results obtained after analyzing the answers of the participants to the first, second and third question of the pre-and post- RF.

Table 3. Frequency of the reference to scientific knowledge

Scientific knowledge (%)					Effect on health (%)				
	Durability	Shelf-life	Color, odor, taste & appearance	Personal consumption	Harmful	Not harmful	Not harmful within pre-determined limits	Both benefits and dangers	No idea
Pre-	25.71	20	42.86	100	94.29	0	0	0	5.71
Post-	31.43	42.86	51.43	100	42.86	2.86	37.14	31.43	0

As shown in Table 3, nearly half of the PST's knew that food additives are the substances added to food to preserve its flavor or improve its odor, taste, appearance, and other properties. Some of them also knew that these substances increase the endurance durability and shelf-life of food. Besides this, all of them thought that they consume food that contains additives before and after the debate. Statements such as one participant wrote, "They are not organic" or another participant, "They are used for the purpose of decreasing costs" are not mentioned in the post-RF. Another explanation in pre-RF was as follows: "They are added to cause the least harm to people." This explanation can be interpreted as the participant's thought that additives are already harmful, but they are added in determined limits. Except for her no other participants made this type of explanation. However, after the debate a considerable number of participants thought that food additives are not harmful in pre-determined limits. It is interesting to note that nearly all the PST believed that these additives are harmful and listed several risks including allergies, digestive problems, obesity, cancer, etc. in their pre-reflections. Two of the participants had no idea about food additives before the debate, while only one participant argued that they are harmless after the debate.

In the assignment papers the answers to the question "What did you learn about food additives from the texts and are the food additives harmful or beneficial?" were used to analyze scientific learning about food additives. Depending on the results an attempt to analyze some of the learned concepts about food additives was made. Different then their pre-RF test new disorders were determined like hyperactivity within 8 % ratio and digestive system problems with 6% and the ratio of allergies in answers increased to 14%. They defined food additives as being unnatural with 9% in pre-test but instead of that they preferred to use *'they have both benefits and dangers', 'no harm in predetermined limits / amounts'*. Even though they used the words; readymade foods, candy, juices, chocolate, take-away foods, ketchup-mayonnaise, and tomato sauces in their pre-RF test. In their assignment papers, the names of new foods like soup and meat products were obtained.

In video recordings taken during the debate application disorders caused by food additives come to prominence such as allergic reactions, hyperactivity, cancer, skin disorders, and insomnia, asthma, gastrointestinal problems. Therefore, when we compared pre-test results and video recordings, the number and the names of disorders caused by food additives were increased. Furthermore, the examples of food additives given during the debate activity changed; examples such as soup, chips, jam, cake, salami, sausage, and gum are given instead of candy, fruit juice, and ketchup-mayonnaise and tomato sauces. PST's descriptions and explanations about food

additives in their assignments and video recordings also revealed their understanding and evaluations of food additives.

All the PST's were able to describe and explain the information presented in the text. The other discussion about the harmful effect of food additives. Their biased perception about the dangers of food additives seems to have changed and they began to argue this topic using more evidence-based ideas after the debate. Although the number of participants who were against using food additives reduced after the debate, nearly half of the participants still thought that these substances were harmful and should not be used. This result supports Sadler and Zeidler's (2005) findings that understanding content knowledge is related to the quality of informal reasoning with regards to SSIs. We argue here that the understanding of content knowledge depends not only on individuals' informal reasoning but also on the sources that they used to obtain information about food additives. Therefore, we analyzed participants' responses to the fourth and fifth questions in RFs and examined whether the sources they use may have an impact on their content knowledge. The subsequent section presents the findings of these questions.

Sources of Information

The fourth question of pre- and post-RF asked participants which sources they utilized. The answers to this question indicated the sources they used to get information on this topic. Before and after debating food additives in the classroom, PST listed the following sources of information used to obtain information about food additives and the frequency of each source is given in the table 4 below.

Table 4. Comparison of source of information between pre-RF and post-RF tests

Sources of Information	Pre- RF %	Post-RF %
Experts in the field	0	14.29
The websites of foundations and universities	0	11.43
TV/newspapers/media	42.86	31.43
Internet	40	17.14
Social media	11.43	0
Books/textbooks	20	14.29
Lecture	8.57	54.29
Journals	8.57	5.71
Articles	2.86	65.71
Peers and people around	17.14	5.71
Various readings	2.86	0
Ingredients written on the package	2.86	0
No source	2.86	0

Table 5. Frequency of the reference to trustworthy sources in RFs

Trustworthy (54.29% in pre-RF, 82,9% in post-RF)								
	News (%)	Academic/ scientific articles (%)	Experts/ professors (%)	Based on evidence / research /data (%)	Based on arguments and counterarguments in the debate (%)	Instructor and friends (%)	Foundations (%)	Various sources (%)
Pre-	2.86	2.86	14.29	0	0	0	0	5.71
Post-	0	8.57	14.29	48.57	2.86	8.57	8.57	2.86

The sources listed above indicate that PST mostly depended on TV, newspapers, or other media, including social media sources to get information about foods additives before debating on this topic in the classroom. Ingredients written on the package and social media seem to be sources of information before the debate, while one participant wrote that she used none of the sources listed above to collect information about food additives. Another significant result is that only three participants stated that they got information about food additives

throughout the lecture while most of the participants did not mention it as a source of information before the debate. After reading related texts and debating on this topic, nearly half of the participants said that they acquired information about this topic in the classroom and from the texts they read. There were also some participants who mentioned expert opinion in post-RF, while none of them mentioned expert judgment in pre-RF.

Evaluation of Sources of Information

The fourth question in the RF asked whether they think these sources are trustworthy and the fourth question of the A asked them whether they think the information presented in the texts are trustworthy. The fifth question in the A asked which source(s) about food additives is/are most trustworthy. The answers that PST gave to these questions in their pre- and post-RF revealed their evaluations of sources of information. Table 5 indicates the frequency of the PST who thought that the sources of information they generally apply are trustworthy and Table 6 shows the frequency of the PST who thought that the sources of information they applied are not trustworthy in RFs. The frequency of the reason they asserted when deciding the trustworthiness of these sources is also presented in these tables.

Table 6. Frequency of reference to untrustworthy sources in RFs

Not trustworthy (14% in pre-RF, 9% in post-RF)					
	Fake news (%)	Not experts/ professors (%)	Contradicting information (%)	Knowledge is tentative (%)	Not scientific (%)
Pre-	0	2.86	0	2.86	2.86
Post-	2.86	0	2.86	2.86	0

As illustrated in Table 5 and 6, PST are more likely to trust the sources of information they get about food additives. The participants who trust their sources also tend to offer more reasons for why they trust them.The findings revealed that PST mostly trust expert judgements before and after debate. Readings on food additives and debating on them seems to have been effective in enabling PST to appreciate evidence and research data. Only one of them mentioned the significance of argument and counterargument during the debate in post-RF. This result may be promising for letting at least one PST to discuss argument and counterargument.

The participants who thought that their sources were not trustworthy listed only five reasons in total. It is important to note that different participants listed all these reasons. Even those who mentioned the tentativeness in pre- and post-RF were different participants. This tentativeness argument seems problematic here. We provided PST texts which addressing both the benefits and harms of the food additives, and this situation seem to have led them to conclude that knowledge is tentative instead of searching the scientific view.

After examining the results of their assignment papers (Table 7) dealing with the trustworthiness of sources like scientific research, foundations and information provided by an instructor, similar results were obtained. But in the assignment paper they mentioned the trustworthiness of research that was done in a laboratory by a scientist or professor and, they explained why they found their teacher to be a trustworthy source.

Table 7. The frequency of sources which were found trustworthy by PST

n= 42	%	Sources	Examples
8	19	Foundations	Ministry of Health, Ministry of Agriculture, World Health Organization (WHO), Food agriculture organization (FAO)
19	45	Expert	Doctors, food engineers, engineers
27	64,5	Scientific research and article	The results of experiments conducted in a laboratory by a scientist and professor.
5	12	Media	TV, social media, media
4	9,5	Internet	Web pages including results of scientific research.
5	12	Books	Course books, scientific books
3	7,1	Course instructor	Our teacher mentioned new research.

Beside PST's positions about using food additives, we also examined the trustworthiness evaluations of each article and sources in general. Table 8 illustrates the frequency of the PST who evaluated trustworthiness of the given texts.

Table 8. The frequency of the PST who evaluated trustworthiness of the given articles.

Not trustworthy	%	Students' examples sentences
Explanation without providing any evidence.	4	"Because I believe that it is not trustworthy."
Emphasis on evidence	16	"The text doesn't provide enough evidence for the given information" "This information does not depend on research findings."
Emphasis on the author	8	"The author of this text is unknown."
Questioning the internet	8	"This text is retrieved from the internet. We cannot trust any source found on the internet."
Emphasis on research	8	"Further research is needed in order to claim that food additives are harmful. The information presented here is not satisfactory." "There is not enough information to draw a conclusion on this subject."
Trustworthy		**Students' examples sentences**
Explanation without providing any evidence.	16	"I think this text is trustworthy. I learned a lot." "Yes, it is trustworthy because it is very instructive." "If it weren't trustworthy, it would not have been published."
Emphasis on evidence	72	"This text provides evidence for the information it gives." "The information given here depends on research data."
Emphasis on expertise	24	"The given information is based on experts' findings." "Experts in this field drew these conclusions."
Emphasis on references	12	"There is a reference section, and it is possible to access these sources." "The references seem sufficient to me."
Emphasis on foundations	4	"Worldwide organizations such as World Health Organization (WHO), Food and Agriculture Organization (FAO), Joint FAO/WHO Expert Committee on Food Additives (JECFA), etc. are referred to in the text."

Again, there are PST who do not provide any evidence for their judgment that the texts are trustworthy or not. However, the discussions of evidence, references, and expertise especially while arguing the trustworthiness of the text seems promising. However, it is not clear what PSTs mean by the term 'evidence.' Furthermore, the number of PST who mentioned the need to include references seems quite low. Another interesting point is that the notion of expertise seems misleading here, especially considering that two participants who mentioned the name of a public figure whose explanations are based on non-scientific evidence. These PST might have seen her on TV and other types of media channels and just because she is a cardiologist, they assume her advice on the topic of food is correct. In other words, her expertise is not on food. The analyses of the trustworthiness of information in general revealed nine criteria. These criteria and their frequency were given in Table 9.

Table 9. The criteria used to evaluate trustworthiness of the given articles by the PST

Criteria used to evaluate trustworthiness of the given articles	%
Experts in the field	64
Scientific articles	56
Research, experiments, scientific studies	52
Foundations and organizations	28
Books	24
Media	16
Course instructor	8
Websites that make scientific explanations	4
Libraries	4

It is promising to have PST include expertise commonly in these criteria as well as scientific articles. They also seem to have appreciated the significance of research, experiments, and scientific articles. They again mentioned foundations and organizations and books as trustworthy sources of information. Among the trustworthy sources of information they mentioned, the participants listed the word "expert". In their assignment papers the participants explained who qualifies as an expert according to them. He/she is a doctor, food engineer or an engineer. In other words, they back up the research results with evidence and explain the results of laboratory experiments.

Also, during the debate process (from the analysis of video recording), they tried to prove their assertions by using a given article, the articles they used for research or reports of World Health Organization [WHO], Ministry of Health, and the results of medical research studies and they indicated the source of the references as "*this information was taken from many articles, news reports and research studies, ……. was explained many years ago by Paracelsus, …… Dr Selman Turker affirmed that the consumption of a legally permitted amount of food additives is not harmful, at the same time in this research the allergic reaction on children who eat…….increase*.

Table 10. The frequency of PST's positions on the usage of food additives

Categories	%	Students' sentences
Harmful		
Explanation without providing any evidence	48	"It makes sense to me." "Because I believe that they are harmful." "I don't believe that they are harmless even in pre-determined limits." "This text gives us sufficient information about their dangers''
Emphasis on evidence	16	"The texts/readings provide enough evidence of the danger."
Emphasis on the responsibility of consumers	8	"The consumers need to read the list of ingredients written on the food label." "The consumers should search and get information about what they eat."
Pointing out prohibited additives	8	"Prohibited substances shouldn't be added to food."
Trust in natural substances	8	"Food additives are harmful because they are not natural."
Emphasis on research	8	"Further research is needed in order to say that they are beneficial because knowledge may change over time." "One day the experts say that a substance is beneficial, then another day they find out that it is harmful. Unless findings of lots of research provides evidence that they are not harmful they shouldn't be used as food additives."
Distrust of the inspection system	12	"I don't trust the food inspection system." "Sometimes human health is ignored by just taking shelf-life into consideration."
Overdose	12	"These substances may be harmful above pre-determined doses."
Beneficial		
Explanation without providing any evidence.	4	"I know that they are beneficial. They protect food."
Emphasis on evidence	24	"This text mentions the hazards of these substances by providing evidence." "There is not enough evidence of the danger."
Persuasion	24	"I was against the use of food additives, but I am convinced of the need of using them after reading this text." "I learned from the text that there are also natural substances that are used as food additives."
Limit of usage	20	"There is no harm in using food additives in pre-determined limits." "The amount of these additives shouldn't exceed the particular limits."
Emphasis on foundations	4	"Worldwide organizations such as World Health Organization (WHO), Food and Agriculture Organization (FAO), Joint FAO/WHO Expert Committee on Food Additives (JECFA), etc. support these findings."

Change in their Opinion about Consumption of Food Additives

Fifty-five PST out of 60 reflected on the readings that we assigned to them. We examined their explanations in two parts. In the first part we created themes for those who were opponent and proponent of using food additives and in the second part we investigated their trustworthiness evaluations of each text they were assigned to read. Table 10 shows the frequency of PST who questioned whether food additives were harmful or

beneficial after reading the texts about these substances. It is interesting to note that the number of PST who explain that they are against using these substances without providing evidence is by far higher than the number of those who propose to use them without making any evidence-based explanations. One can infer from this result that the participants who concluded that food additives are beneficial decided their positions based on evidence, while those who concluded they are harmful based their opinion mostly on their intuitions and beliefs. Very few of the participants emphasized that consumers need to be well-informed about food additives and again very few of them pointed out that there are substances prohibited to use as food additives. Emphasis on the need of a high amount of research seems to be promising, but this seems to have led participants think that we cannot trust these substances because in the future the experts may oppose what they say now. Although the number of PST who don't trust the food inspection system is very low, this result may predict their position on the usage of food additives.

Distrust of natural additives is another interesting point of view. Twenty-four percent of PST seem to have a change of mind after reading related texts and learning that there are also natural substances that are used as food additives; however, some of them still seem to believe that food additives are harmful because they are not natural even after they have read the same texts. The emphasis on foundations to support using food additives and the limit of using them are also promising. These results show that PST rely on various criteria to decide whether it is appropriate to use additives or not. Therefore, as Zare & Othman (2013) explained, PST need advance research skills to select relevant, useful, and trustworthy sources of information to defend their arguments.

According to the video recording, the group who proved that food additives are harmful used their own collected data. They asked people in a market whether food additives are harmful or not and presented their answers in a video during their debates. The majority of the respondents said "*food additives are harmful*" but they cannot explain why they are harmful. The other group refuted the argument like this.

> "*We didn't choose this debate topic and at the beginning we believed that food additives are harmful and we afraid of its proof. But when we researched, read given articles, reports, other research papers, our ideas started to change, we learned that when we consume a limited amount of food additives, they are not harmful. ……we are not saying they are harmful or not, we just explained their risks and beneficial properties in the light of research results, you can read and decide according to the best of your knowledge or ideas." "The consumption of food additives in a limited amount is not harmful.*"

These sentences were repeated many times during the debate by the group with opposing viewpoints. The most important result of the debate is this sentence. *"Due to this debate we learned that we believe whatever we hear, in fact we should seek information from various sources and then we should decide whether they are beneficial or harmful and also we should teach this to at least 15 people around us."* In the above example a PST tried to explain the characteristics of scientifically literate people.

Discussion and Conclusion

In this research, we tried to practice with PST improving properties of scientifically literate people with debate technique by using food additives being the SSI. Therefore, we checked their knowledge about food additives, the types of information sources they used and the criteria they utilized in choosing these sources and the change in their opinions about the consumption of food additives. Based on the results, debate and course readings seem to have had a positive impact on PST's scientific knowledge about SSI concepts. It is hard to change a learner's opinion on a subject even if they are provided with evidence that contradicts their opinion. Topcu, Sadler and Yilmaz-Tuzun (2010) noted that Turkish pre-service teachers benefit from their own learning experiences that support their own informal learning practices. The findings of this study support this discovery by providing insights into PST's reflections about understanding and evaluation of food additives before implementing the debate. However, when we pointed out related scientific sources including results based on scientific evidence to help them prepare for the debate it seemed to have a positive impact on both the learning contents of SSI issue and it helped to change their idea about the usage of food additives like Gervey (2009) and Lilly (2012). The results of this study revealed that reading articles and researching further sources about food additives in preparation for the debate facilitated active learning during the classroom activities (Barker & Millar, 1996; Dori et al., 2003; Klosterman & Sadler, 2010; Sadler, Barab & Scott, 2007; Yager, 2006); thus, understanding of content knowledge increased throughout the debate activity. The articles given to the whole class, introducing the rules of the debate, the usage of an assessment rubric and other students and researchers asking questions to the debate participants, were effective tools to improve argumention during the debate (Goodwin ,2013). In

addition to Roy and Macchiette (2005) and Oros (2007) suggestion of assessment, selecting critical reading articles for all students and detailing research rules to debate groups is effective as stated by Zare & Othman (2013).

Apart from the given articles, the debate groups used many other sources to support their ideas, in other words whichever group had more scientific evidence to refute the opposing ideas seem to have influenced the whole sample group to change their positions about the usage of food additives. In their post-test most of them explained their ideas about usage of food additives as *"suitable for consumption in a limited amount that is scientifically determined."* Therefore, the quality of the research done by the debate groups and their evidence-based argumentation abilities contributed to the decisions of the whole group. The group which had ample resources consisting of scientifically evidence-based conclusions had a chance to alter the ideas of most of the participants. In short, reading articles and debating in the classroom seem to have increased PST's understanding and evaluation of food additives. Therefore, it can be inferred that PST appreciated the importance of evidence on the decisions of society in SSI problems.

To improve PST's appreciation of research and evidence, it is necessary to integrate the discussions of what constitutes evidence and the relationship between evidence and argument seem crucial because PST use the term 'evidence' in their RFs and assignments in an ambiguous way. We can say that the evidence-based reading articles presenting opposing opinions helped PST to make informed decisions. Therefore, the guidance provided by the instructor with the sources of related research articles or given articles to PST is very important for understanding which sources are scientifically evidence-based and which are not. The PST acquired the ability to select evidence-based sources during preparation for the debate (NRC, 2001; OECD, 2013) to read and to search through practice. When questioned about the trustworthiness of their sources, they explained that they learned SSCI units from their teacher. Later on, in their post-test, they mentioned the reason for relying on their teacher as a trustworthy source of information as follows: "when our teacher is mentioning SSCI units she is using some research data". It is evident from this result that this participant seems to have appreciated the credibility of evidence.

The results of the current study also showed that PST misinterpreted the expertise. They need to be informed about the meaning of field expertise and under which circumstances and depending on which criteria it needs to be applied to make decisions based on expertise. For example, does an expert who we used to see in the media very often make his/her explanations based on research findings or his/her own opinions? PST need to be able to distinguish between evidence-based explanations and opinion-based evidence even when considering an expert. Deliberate efforts in teacher education programs should be made to facilitate such kind of distinction. PST also seem to have overestimated the media.

To facilitate argumentation and debate, SSIs should be integrated more often in teacher education programs. Fake news and evidence-based news need to be included during discussions of these issues. As Omlicheva (2017) explained the contribution of debate improves student's attitudes towards political problems. The students who formed the debate groups in this research suggested producing organic food, restricting the use of insecticide and plant hormones to be able to eat unadulterated food. However, the participants outside the debate group denoted the inaccuracy of the country's agricultural policies and economical power of population to buy organic foods. Here, apart from the debate on SSI, there are two important outcomes. One is the increase in PST's scientific knowledge and the other is their awareness about agricultural policies and the relation between agriculture and economy. This result demonstrates that they interconnected an SSI with other fields, and it also helped the students to make research and be informed on the topic, and show interest in these fields (politics, agriculture, economy). Therefore, as Erduran & Jimenez-Aleixandre (2007) stated, debate helps students become knowledgeable and future intellectual citizens, who can construct evidence-based arguments and make decisions based on evidence. In short, encouraging PST to make research, instructor guidance, and competition through debate improved the understanding the topic and communication skills of the participants.

Recommendations

The following implementations are recommended for further research on PST's understanding and evaluation of SSIs based on the findings of this study:

- Implications of debate specifically focusing on the discussions of what counts as evidence and the connection between the evidence and argument.

- Implications of debate specifically focusing on the discussions of expertise and profession by pointing out the significance of expert judgment and its impact on the disinformation and misinformation on SSIs.
- Implications of debate specifically focusing on the evaluation of the credibility of media and other sources of information on SSIs.
- Preschool teacher education programs should encourage PST to design and implement discussions in early childhood activities.

Scientific Ethics Declaration

In this article the rules of scientific research and publication ethics specified in the Higher Education Institute (YOK) Scientific Research and Ethics Regulation were followed.

The author declares that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the author.

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Author(s) Information

Ganime Aydin
Çanakkale Onsekiz Mart University
Anafartalar cad. Çanakkale, Turkey
Contact e-mail: ganime31@gmail.com
ORCID iD:0000-00016112-5243

Deniz Saribas
Istanbul Aydin University
Beşyol, İnönü Cd. No:38, 34295 Küçükçekmece/İstanbul, Turkey
ORCID iD: 0000-0002-4839-7858