



Developing and implementing prediction-observation-explanation worksheets of healthy foods¹

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Abstract. The aim of this study was to develop prediction-observation-explanation (POE) worksheets of healthy foods and to investigate their effects on grade 3 students' conceptions. The sample of the study consisted of 10 grade 3 students at a primary school in the city of Bayburt. Within a pre-experimental research design, data were collected throughout a word association test (WAT), a conceptual understanding test (CUT) and POE worksheets. The results showed that even though the number of the response words in post-WAT ($f=256$) was higher than in pre-WAT ($f=212$), there was no statistically significant difference between the students' scores of pre- and post-WAT. However, a large Hedge's g value and statistically positive change in scores of pre- and post-CUT pointed that the POE worksheets resulted in better conceptual understanding. In brief, the POE worksheets were effective at improving the students' conceptions and awareness of healthy foods. In light of the results, the current study suggests using the POE worksheets for science teaching in primary schools.

Keywords: Grade 3 students, healthy foods, prediction-observation-explanation strategy, science education, worksheet

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INTRODUCTION

The problem of obesity in adulthood mostly points to eating habits/behaviors at childhood (Gürel and İnan, 2001; Zitsman, Inge and Reichard, 2014). Thus, eating habits/behaviors should be gained from an early age by considering the proverb 'You cannot teach an old dog new tricks.' In fact, this calls for equipping students with adequate and balanced eating habits (Lamanauskas and Augienė, 2019; Lytle, 2002; Stang and Bayerl, 2003). Therefore, schools should make students aware of their eating habits and healthy nutrition (Contento, 2008; Tzeng, 2008) to support their economic, psychologic and social development (Dalan, 2010).

Given the idea 'children considerably improve their lifelong sustainable behaviors and habits in primary schools' (Bilici and Köksal, 2013), an effective science education may afford them to gain healthy nutrition habits (Merdol, 1999). Because a significant amount of childhood and youth years is lived at schools, schools play a crucial role in evolving and developing proper health education (Bulut, Nalbant and Çokar, 2002; Soyluoğlu, 2003; WHO/UNESCO/UNICEF, 1992; Young and Williams, 1989). For example, the Ministry of National Education in Turkey has especially emphasized 'Nutrition and Health' learning domain at related curricula (e.g., science of life and science education) to acquire healthy nutrition skills/habits/behaviors. Further, mass media frequently airs varied public service adds to informally make students and parents conscious of healthy nutrition and relevant habits/behaviors. However, more instructional materials and treatments are needed to formally transform their awareness of healthy nutrition into practices. This issue emerges the need of the current study.

The related literature of healthy nutrition has focused on such research topics as: nutrition bag (Şimşek, Yabancı and Turan, 2009), the effect of ads on nutrition (Günlü and Derin, 2012; Kurt and Altun 2014), and eating habits (Kılınç and Çağdaş, 2012; Sezek, Kaya and Doğan, 2008). These studies have mostly preferred primary, secondary and high schools as their samples; and employed descriptive or relational research methodologies. Also, they have

¹ This study was produced from the second author's master thesis supervised by the first author.

reported the following conclusions: (a) ads affect nutrition/eating behaviors (Charry, 2014; Esmaeilpour, Hanzee, Mansouriani and Khounsiavash, 2018; Folkvord, Anschütz and Buijzen, 2016; Günlü and Derin, 2012; Kurt and Altun, 2014), (b) interventions in nutrition education change nutrition behavior(s) (Brown, Colson, Serre and Mangan, 2016; Cotugna and Vickery, 2005; Kararo, Orvis and Knobloch, 2016; Kennedy et al., 2015; Lin, Pan, Han, Li, Jiang and Jin, 2016; Malakellis, Hoare, Sanigorski, Crooks, Allender, Nichols and Millar, 2017; Peach and Martin, 2017; Rauber et al., 2018; Ünver and Ünüsan, 2004; Watson, Kwon, Nichols and Rew, 2009; Yoong et al., 2016), (c) such independent variables as environment, urbanization, cultural difference, individual factors influence behaviors/habits of healthy nutrition (Gerrits et al., 2010; Lee, Jin and Kim, 2013; Matthews, O'Neill, Kostelis, Jaffe and Vitti, 2015; Peach and Martin, 2017; Raiha, Tossavainen, Turunen, Enkenberg and Halonen, 2006; Sharma, Harker, Harker and Reinhard, 2010), (d) irregular nutrition and malnutrition prevent attitude(s) towards healthy nutrition (Şimsek et al., 2009; Thomas, 2005), (d) teachers have deficiencies at guiding behaviors of healthy nutrition (Kupolati, Gericke and MacIntyre, 2015; Theron and Egal, 2012), (e) healthy nutrition relatively decreases obesity (Savaşhan, Sarı, Aydoğan and Erdal, 2015), (f) health-related games positively develop health awareness (Alblas et al. 2018), (g) health messages in ads develop awareness of healthy nutrition (Esmaeilpour et al., 2018), and (h) parents are reluctant to implement advices on healthy nutrition (Ling, Robbins and Hines Martin, 2016). At the same time, these studies have recommended: (a) the development and enactment of health education programs (Alblas et al., 2018; Fidancı, Akbayrak and Arslan, 2017; Hamulka, Wadolowska, Hoffmann, Kowalkowska and Gutkowska, 2018; Kararo et al., 2016; Kennedy et al., 2015; Raiha et al., 2006; Sıyez, 2008), (b) raising awareness of healthy nutrition with classroom and school activities (Dixey, Sahota, Atwal and Turner, 2001; Thomas, 2005; Weybright, Mertrinez, Varrella, Deen and & Wright, 2018; Wilson, 2018; Yoong et al., 2016), (c) further studies enhancing parents' awareness of healthy nutrition (Büyük and Topçu, 2015; Ekim, 2016; Lin et al., 2016; Savaşhan et al., 2015; Şimsek et al., 2009), (d) handling attitudes towards healthy nutrition (Kupolati et al., 2015; Theron and Egal, 2012), (e) prioritizing the importance of advertising industry in developing healthy nutrition habits (Esmaeilpour et al., 2018; Folkvord et al., 2016; Günlü and Derin, 2012; Kurt and Altun, 2014), and (f) recruiting different methods/techniques/strategies to develop awareness of healthy nutrition (Alblas et al., 2018; Ogunsile and Ogundele, 2016; Weybright et al., 2018). Hence, the related literature has appeared the need of any teaching intervention using the Prediction-Observation-Explanation (POE) strategy to stimulate students' conceptions and awareness of healthy nutrition. A lack of such an intervention study at grade 3 calls for the current study.

The POE strategy, as a conceptual change method, arouses students' learning curiosity and overcomes their alternative conceptions (Akamca and Hamurcu, 2009; Aydın, 2010; Güven, 2011; Köseoğlu, Tümay and Kavak, 2002; Maşeroğlu, 2016). Therefore, it has a pivotal role in raising students' learning motivation and making them aware of their conceptions (Kabapınar, Sıpmaz and Bıkmaz, 2003). This strategy asks students to predict an outcome of any phenomenon, observe it and explain consistency or inconsistency between the prediction and observation (Akamca and Hamurcu, 2009; Kearney and Treagust, 2000, 2001; White and Gunstone, 1992). In addition, it helps students effectively improve their science process skills/high-order thinking skills by involving their pre-existing knowledge in the learning tasks, e.g., inquiry-based learning (Bilen, 2009; Güven, 2011). To enrich the POE strategy, some studies have also extended its phases, for example, Prediction-Explanation-Observation-Explanation (Ebenezer, Chacko, Kaya, Koya & Ebenezer, 2010), Prediction-Discussion-Explanation-Observation-Discussion-Explanation (Coştu, 2008) and Prediction-Discussion-Explanation-Observation-Discussion-Exploration-Explanation (Fратиwi, Samsudin, & Coştu, 2018). However, none of previous studies in the POE strategy have tested it for the topic 'healthy foods' at primary school.

Developing and implementing the POE worksheets, this study presents guide materials to primary school teachers and educators. Thus, this study may potentially increase the awareness of school-based healthy nutrition (Demirezen and Cosansu, 2005). The current study is important

for at least informing the students about healthy nutrition/foods and challenging overweight and obesity within health education.

This study aimed to develop the prediction-observation-explanation (POE) worksheets of healthy foods and to investigate their effects on grade 3 students' conceptions. Moreover, the following research questions guided the current study:

1. Is there any significant difference between the students' scores of pre- and post-Word Association Test (WAT)?
2. Is there any significant difference between the students' scores of pre- and post-Conceptual Understanding Test (CUT)?
3. Do the students' responses in the POE worksheets point to any conceptual growth?

METHODS

Because this study included a teaching intervention within pre- and post-test and only one grade 3 class at the school, it employed a pre-experimental research design. Even though the absence of a control/comparison group in a pre-experimental research design is generally criticized (Özmen, 2019), the current conditions (e.g., the absence of another grade 3 class for the control/comparison group) make this research design feasible to demonstrate any development/change by setting pre-test as the beginning point (Çalık, 2013; Kıryak and Çalık, 2018). Given the foregoing issues, the current study investigated the students' conceptions and conceptual growth via the results of WAT, CUT and POE Worksheets within the pre-experimental research design.

The Sample of the Study

The sample of the study consisted of 18 grade 3 students in a village primary school in the city of Bayburt. However, because the teaching intervention was conducted in the end of May, some students, who routinely migrated to the plateau, were unable to complete the teaching intervention. Therefore, the authors only used data from 10 grade 3 students (3 girls and 7 boys), who took part in all teaching sessions. Since the second author carried out the teaching intervention in her class, the present study exploited the convenient sampling method.

Data Collection

To collect data, Word Association Test (WAT), Conceptual Understanding Test (CUT) with open-ended questions and POE worksheets were used. The WAT and CUT were administered one week before the teaching intervention as pre-tests. After the teaching intervention, they were re-administered as post-tests.

Word Association Test (WAT)

Word association test probes students' conceptions, perceptions and schemes of any specific concept (Bahar, 2003). Students list their response words to the stimulus words within a certain time. While writing each response word, students revisit the stimulus word lined up one under the other (Bahar and Özatlı, 2003). The number and variety of the response words are used to evaluate students' conceptions and conceptual understanding of any subject (Yücel and Özkan, 2014). This study preferred WAT to clearly monitor any change in the number of the response words and interconnections before and after the intervention. Furthermore, the fact that this technique is easily prepared and administered also directed the authors to use it as a data collection tool (Tongaç, 2006). In selecting the stimulus words of healthy foods, the authors carefully examined relevant textbooks, internet sources and news (URL-1). Further, they invited 3 science educators and 3 primary school teachers to decide these words. Given their comments and suggestions, the authors selected the stimulus words 'healthy nutrition', 'healthy food' and 'additive.' After writing each stimulus word ten times in a page, the authors asked the students to complete each WAT sheet within 5 minutes (Bahar and Özatlı, 2003; Özatlı, 2006).

Conceptual Understanding Test (CUT)

While developing conceptual understanding test, the authors took the students' pre-existing knowledge into account and went over 'Science of Life' curricula at grades 1-3, mass media news and related researches. In scope of the stimulus words 'healthy nutrition', 'healthy food', 'additive,' the authors concentrated on such concepts as 'fabricated', 'shelf life', 'being healthy', 'naturalness', 'food appearance' and 'appetite.' The CUT preceded such foods as bread, juice, yogurt that the students had been more familiar and consumed frequently in their lives. The first question asked them to depict any relationship between 'health' and 'naturalness' concepts and the effects of the aforementioned foods on their healthiness levels. Because students are compliant with the concepts 'additive' and 'fabricated food' along with junk food, the authors improved the second question to identify their conceptions of these concepts. They developed the third question to determine whether the students understand any link between natural nutrition and being healthy. Similarly, they prepared the fourth question to elicit how the students associate expensiveness of natural foods with the concepts 'health' and 'additives'. In addition, the fifth question requested them to explain how appearance of any food influences their choices. In brief, the CUT with five open-ended questions aimed to determine their conceptions and reasons of the concepts under investigation (Coştu, Ayas, Açıkkar and Çalık, 2003; Er Nas, Şenel Çoruhlu, Çalık, Ergül and Gülay, 2019).

POE Worksheets

The authors used the students' responses in the POE worksheets to determine the degree to which their predictions overlap their observations and explanations.

Data Analysis

Word Association Test (WAT)

The authors initially created frequency tables for the stimulus words by considering the number of the response words in pre- and post-WAT. Afterwards, they decided cut-off points to portray the inter-connectedness between the stimulus and response words (Bahar, Johnstone and Sutcliffe, 1999). Because the authors used a 3-point cut-off range for each stimulus word, the response words, which had the highest frequency, firstly appeared on the concept network. Then, this procedure was repeated until all response words were apparent at the concept network (Bahar, Nartgün, Durmuş and Bıçak, 2006). In addition, they identified the first three response words with the highest frequency. Moreover, the authors independently scored their responses to the WAT, for example, a point for each valid response and zero point for each invalid one. Any disagreement was resolved through negotiation. Thus, total scores of all participants were imported into SPSS 18.0™ to run Wilcoxon Signed Rank Test, which is more suitable for small sample size and non-normal distribution.

Conceptual Understanding Test (CUT)

To classify the students' responses to the CUT, the authors used the criteria suggested by Abraham, Gryzybowski, Renner and Marek (1992): '*Sound Understanding (SU) (3 Points)*, which includes all aspects of valid scientific response, '*Partial Understanding (PU) (2 Points)*, which covers some aspects of valid scientific response, '*Partial Understanding with Alternative Conception (PUAC) (1 Point)*, which embraces some aspects of valid scientific answer and alternative conception(s), and '*No Understanding (NU) (Zero Point)*, which contains irrelevant or blank response(s).'

The authors separately answered the CUT to create an answer key. Then, they categorized the students' responses to the CUT and generated frequency tables for pre- and post-CUT. Because the sample of the current study was very small and did not meet parametric test criteria, their responses to the CUT were imported into SPSS 18.0™ to run Wilcoxon Signed Rank Test as a non-parametric test.

POE Worksheets

In categorizing the students' responses in the POE worksheets, the authors looked for certain key concepts (Ruiz, Primo and Furtak, 2004). In other words, any response incorporating all key concepts was labelled under SU, while that with some key concepts fell into PU. The response containing some key concepts and alternative conception(s) was classified under PUAC, whilst that with irrelevant concept(s) was categorized under NU. In addition, the authors independently evaluated the students' responses in the POE worksheets and negotiated any disagreement. Inter-rater consistency was found to be .85.

Treatment

While developing the POE worksheets, the authors took into account the students' pre-existing knowledge to actively engage them in their learning processes. They adopted the video in the POE worksheet 'Do we know breads?' from the internet sources (URL-1). The first phase of each POE worksheet asked them to make their predictions, while the second phase required them to conduct their observations through hands-on and/or minds-on activities. The third phase requested them to address any difference and/or similarity between their predictions and observation. Thereby, this phase encouraged them to reveal their newly acquired concepts.

As illustrated by the POE worksheet 'Surprising Eggs' (see Appendices), the students were asked to answer the related questions by considering food images with their prices (see Appendix 1). Thus, this procedure was intended to activate their pre-existing knowledge. The second phase (see Appendix 2) asked them to implement relevant experiment(s) and observe any difference (e.g., health, taste, price and consumption/shelf life) between the village and farm eggs. Afterwards, they were requested to write down their observations onto the worksheet. Finally, the third phase guided them to explain any difference between their predictions and observations (see Appendix 3).

As seen from Table 1, the authors developed five worksheets. The second author carried out all worksheets in her class within a total of ten class-hours (2 class hours a week).

Table 1. *The expected student roles and targeted concepts for the POE worksheets*

The POE worksheets	The expected student roles	The targeted concepts
Surprising eggs	Compared the village and farm eggs in terms of being healthy, taste, price and consumption life.	Healthy nutrition, healthy food, consumption (shelf) life
Juices under the lens	Compared homemade and fabricated orange juices in terms of being healthy, color, taste, additive, price and consumption life.	Healthy nutrition, healthy food, consumption (shelf) life, additive
Which one is healthier?	Compared snack foods (e.g., hazelnut and candy) in terms of being healthy, additive, color and shape.	Healthy nutrition, healthy food, additive
Do we recognize breads?	Compared homemade and fabricated breads in terms of being healthy, consumption life, additive and taste.	Healthy nutrition, healthy food, consumption (shelf) life, additive
We like yogurts	Compared homemade and fabricated yogurts in terms of being healthy, consumption life, additive and taste.	Healthy nutrition, healthy food, consumption (shelf) life, additive

Reliability and Validity

The current study exploited data triangulation to ensure reliability and validity of the data collection tools (e.g., WAT, CUT and POE worksheets). Thus, the authors proposed to deeply draw out the students' conceptions and conceptual schemes of the topic 'healthy foods.' Further, a group of experts (a chemistry educator and 3 primary school teachers, who had at least five-year teaching experiences) investigated and confirmed the content validity of the WAT. Similarly, a chemistry educator and a primary school teacher collaboratively determined the assessment

criteria and key concepts for the CUT. Then, the authors independently categorized and scored their responses to the CUT. Cronbach's alpha co-efficient of the CUT was found to be .85.

A chemistry educator and three science educators reviewed the WAT, CUT and POE worksheets and made some suggestions to improve their readability and understandability. By taking their suggestions into account, the authors revised them properly. For example, a new image was selected based on the suggestion 'the image should remind the content of the 'additive' stimulus word'. In a similar vein, the experts criticized some questions in the POE worksheets and CUT and suggested some revisions to clarify them. For instance, the question 'What does a healthy food mean?' in the POE worksheets was replaced with 'What does a healthy egg mean?' or 'What does a healthy bread mean?' Similarly, the question 'Which of healthy and fabricated (with additives) foods are more expensive? Please depict your reason(s). If you economically have enough income, which one will you prefer?' in the CUT was changed with the one 'Which of natural and fabricated (with additives) foods are more expensive? Please explain your reason(s).'

RESULTS

Results of the First Research Question

As seen from Table 2, pre- and post-WAT contained 212 and 256 response words respectively. While the frequencies of the response words for the stimulus words 'healthy nutrition' and 'healthy food' slightly decreased from pre-WAT to post-WAT, that for the one 'additives' obviously increased from pre-WAT to post-WAT.

Table 2. *Frequencies of the response words at pre- and post-WAT*

Stimulus Words	Pre-WAT	Post-WAT
Healthy Nutrition	88	84
Healthy Food	93	90
Additive	31	82
Total	212	256

As seen from Figure 1, the results of Cut-Off Points 7+ in pre-WAT indicated 5 and 3 response words for the stimulus words 'healthy nutrition' and 'healthy food' respectively. Cut-Off Points 4-6 covered 3, 5 and 2 response words for the stimulus words 'healthy nutrition,' 'healthy food' and 'additive' respectively. Further, inter-connectedness between the stimulus words 'healthy nutrition' and 'healthy food' appeared for Cut-Off Points 4-6. The results of Cut-Off Points 1-3 pointed that the stimulus words 'healthy nutrition and healthy food' contained 13 inter-connected responses words, whilst those 'healthy nutrition and additive' incorporated one inter-connected response word.

As seen from Figure 2, the numbers of the response words for the stimulus words 'healthy nutrition, healthy food and additive' in post-WAT were 2, 3 and 3 respectively for Cut-Off Points 7 and above. Further, one inter-connected response word was apparent for the stimulus words 'healthy nutrition and healthy food.' The numbers of the response words for the stimulus words were 3, 5 and 4 respectively for Cut-Off Points 4-6. Also, Cut-Off Points 4-6 included one inter-connected response word for the stimulus words 'healthy nutrition and healthy food.' Moreover, Cut-Off Points 1-3 contained 6 inter-connected response words between the stimulus words 'healthy nutrition and healthy food' and one inter-connected response word between the stimuli words 'healthy nutrition and additive'.

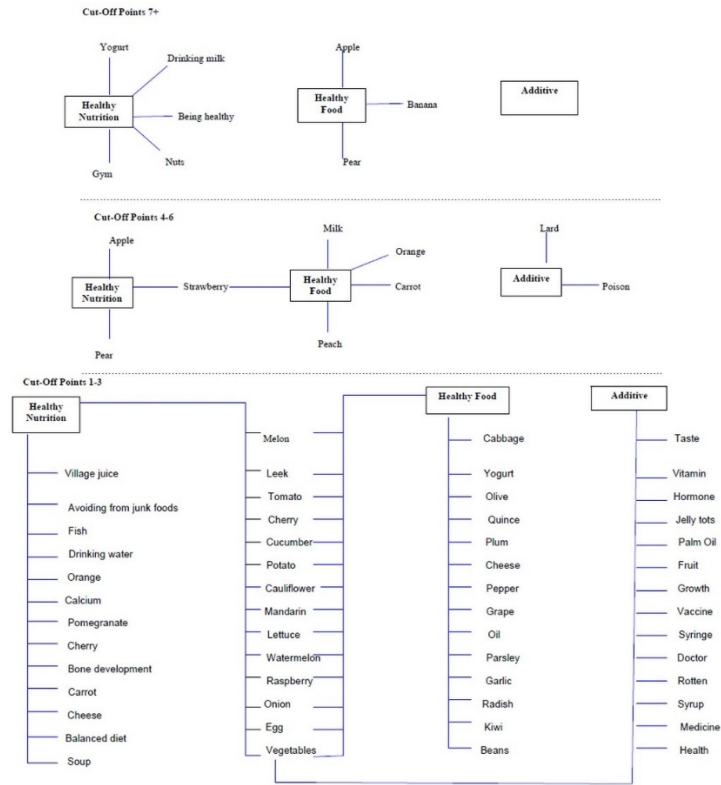


FIGURE 1. The inter-connectedness between the stimulus and response words for pre-WAT

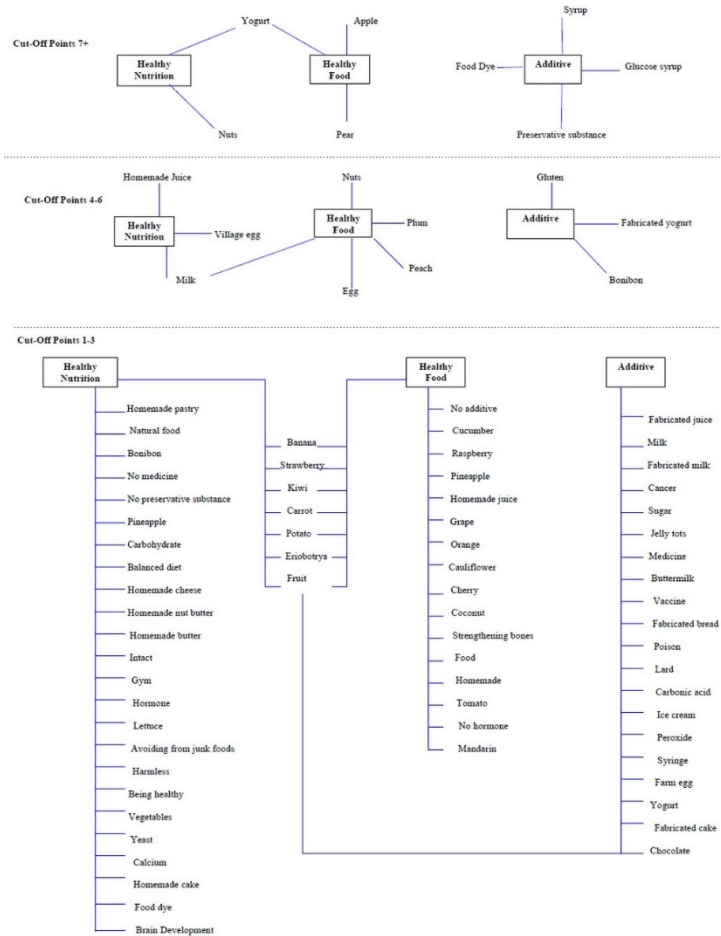


FIGURE 2. The inter-connectedness between the stimulus and response words for post-WAT

Table 3. Frequencies of the most frequently used response words for the stimulus words in pre-and post WAT

Stimulus Words	Pre-WAT	f	Post-WAT	f	
Healthy Nutrition	First response word	Nuts	9	Nuts	8
				Homemade yogurt	
	Second response word	Gym	7	Village egg	6
		Drinking milk			
		Being healthy			
		Yogurt			
	Third response word	Apple	4	Village milk	4
		Pear			
		Strawberry			
Healthy Food	First response word	Pear	8	Apple	9
		Apple			
	Second response word	Banana	7	Yogurt	8
	Third response word	Milk	6	Pear	7
	Additive	First response word	Lard	4	Glucose syrup
Poison					
Second response word		Vegetable	3	Syrup	8
		Doctor			
		Syringe			
Third response word		Medicine	2	Preservative substance	7
	Growth				

As can be seen from Table 3, the students firstly associated the stimulus word ‘healthy nutrition’ with the response word ‘nuts’ in pre-WAT and the response words ‘nuts and homemade yogurt’ in post-WAT. Likewise, they initially linked the stimulus word ‘healthy food’ to the response words ‘pear and apple’ in pre-WAT and ‘apple’ in post-WAT. Furthermore, their first response words for the stimulus word ‘additive’ covered ‘lard and poison’ in pre-WAT and ‘Glucose syrup’ in post-WAT. Their second and third responses were varied for pre- and post-WAT (see Table 3).

Table 4. The results of Wilcoxon signed rank test for pre- and post-WAT

Post-WAT-Pre-WAT	N	Mean Rank	Sum of Ranks	U	P
Negative Ranks	4	5	20,00	0,20	0,766
Positive Ranks	5	5	25,0		
Ties	1		0		

As seen from Table 4, there was no significant difference between pre- and post-WAT ($z=0,20$, $p>.05$). Moreover, the results of Wilcoxon Signed Rank Test revealed 4 negative ranks, 5 positive ranks and one ties.

Results of the Second Research Question

As seen from Table 5, most of the students’ responses to the first question fell into PU for pre- and post-CUT. Their responses to the second question were classified under SU (5 for pre-CUT and 9 for post-CUT) and PU (5 for pre-CUT and 1 for post-CUT). Similarly, their responses to the third question were labelled under SU (6 for pre-CUT and 4 for post-CUT) and PU (8 for pre-CUT and 2

for post-CUT). Moreover, their responses to the fourth question fell into SU (f=1), PU (f=4), PUAC (f=4) and NU (f=1) for pre-CUT, while those were classified under SU (f=4), PU (f=5) and PUAC (f=1) for post-CUT. For the fifth question, frequencies of their responses categorized under SU, PU, PUAC and NU were 3, 1, 4 and 2 in pre-CUT, whilst those were labelled under SU (f=6) and PU (f=4) for post-CUT.

Table 5. *Frequencies of the students' responses to pre- and post-CUT in regard to understanding level*

Questions	Tests	Criteria			
		SU	PU	PUAC	NU
1. Is there any difference between tastes of homemade and fabricated foods? Please explain your reason(s).	Pre-CUT	1	8	1	-
	Post-CUT	2	8	-	-
2. Why do the fabricated foods in the markets have longer shelf lives? Please explain your reason(s).	Pre-CUT	5	5	-	-
	Post-CUT	9	1	-	-
3. Which of people eating fabricated and natural foods are healthier? Please explain your reason(s).	Pre-CUT	6	4	-	-
	Post-CUT	8	2	-	-
4. Which of natural and fabricated (with additives) foods are more expensive? Please explain your reason(s).	Pre-CUT	1	4	4	1
	Post-CUT	4	5	1	-
5. Do appearance and color of foods influence your appetite levels? Please explain your reason(s).	Pre-CUT	3	1	4	2
	Post-CUT	6	4	-	-

The results of Wilcoxon Signed Rank Test for pre- and post-CUT are displayed in Table 6.

Table 6. *The results of Wilcoxon signed rank test for pre- and post-CUT*

Post-CUT-Pre-CUT	N	Mean Rank	Sum of Ranks	U	P	Hedge's g
Negative Ranks	0	0	0	2,50	0,011	1,532
Positive Ranks	8	4,50	36,00			
Ties	2					

As seen from Table 6, there was statistically meaningful difference between pre- and post-CUT ($z=2,50$, $p<.05$) in favor of positive ranks. Moreover, the results of Wilcoxon Signed Rank Test revealed 8 positive ranks and 2 ties. Further, Hedge's g effect size was found to be 1.532, which means a large effect of the teaching intervention on the students' conceptual understanding/conceptual growth.

Results of the Third Research Question

As seen from Table 7, the students' responses in the 'surprising eggs' worksheet generally fell into SU and PU. Moreover, few responses in the 'prediction and explanation' phases of the POE worksheet were also categorized under PUAC.

Table 7. Frequencies of the students' responses in the 'surprising eggs' worksheet in regard to understanding level

Phases	Questions	SU	PU	PUAC	NU	Sample responses
Prediction	Which of the foregoing eggs is healthier? Please defend your prediction	10	-	-	-	Village eggs, which are from chickens wandering outside. But the farm eggs come from chickens in a cage.
	Is there any difference between these eggs in terms of taste and color? Please write down your prediction	3	6	1	-	I think their tastes are different because the village egg's color is dark, and the farm egg's one is light.
	Why are their prices different? Please write down your prediction	7	2	1	-	Village eggs are more expensive because they are organic. But farm eggs, which are not organic, are cheaper.
Observation	Please compare the eggs in terms of color	10	-	-	-	Village egg's color is more yellow. Farm egg's color is darker.
	Please compare the eggs in terms of taste	10	-	-	-	The village egg was better and did not stick to my mouth. The farm egg stuck to my mouth and dried my throat up.
	Please compare the eggs in terms of consumption life	8	1	-	1	When we looked at the eggs, the village egg was yellower than the farm egg. Both smelt disgusting. The farm egg had a longer consumption life.
Explanation	Is there any similarity between your prediction and observation? Please explain your reason(s)	10	-	-	-	At the beginning, I predicted that the village egg was more tasteful. After my observation, I confirmed that my prediction was true. I've learned new things about the eggs.
	What does a healthy egg mean?	8	2	-	-	A healthy egg means that chickens feed on natural things.
	Why is shelf life of a farm egg longer than that of a village egg? Please defend your response	9	1	-	-	Because farm eggs contain additives, e.g., antibiotic, vaccination, preservatives.
	Is there any relationship between healthy nutrition and the village egg? Please explain your reason(s)	7	3	-	-	Village eggs are natural in that they are fresh and delicious. Also, they do not contain additives.
	Why are their prices different? Please defend your response	5	4	1	-	Village eggs are natural, but farm eggs are a hotbed of medicine. So, village eggs are more expensive.

As can be seen from Table 8, their responses in the 'juices under the lens' worksheet were mostly labelled under SU and PU. Furthermore, only one prediction for the question 'Which of the juices has a longer consumption (shelf) life? Please write down your prediction' was classified under PUAC.

Table 8. Frequencies of the students' responses in the 'juices under the lens' worksheet in regard to understanding level

Phases	Questions	SU	PU	PUAC	NU	Sample responses
Prediction	Which of the foregoing juices is healthier? Please defend your prediction	7	3	-	-	Homemade juice because it does not include any additive
	Which of the juices has a longer consumption (shelf) life? Please write down your prediction	4	5	1	-	Fabricated one because it contains additives
	Which of the juices contains more additive(s)? Please write down your prediction	1	-	-	-	Fabricated one because it is sold into the shelves for a long-time
	Why are their prices different? Please write down your prediction	9	1	-	-	Homemade is natural because it does not contain any additive. However, the other is cheap and contains several additives
Observation	Please compare the juices in terms of color	10	-	-	-	Homemade juice is more yellow than the other. Also, homemade smells good, while the other smells bad.
	Please compare the juices in terms of taste	10	-	-	-	Homemade juice is tasteful, but the other's taste is not good. Further, homemade includes pulp, whilst the other does not contain any pulp
	Please compare the juices in terms of ingredient(s)	7	3	-	-	Homemade juice includes water and natural orange. Fabricated juice contains water, additives and orange juice concentrate
	Please compare the juices in terms of shelf life	10	-	-	-	When we observed them in a 5-day period, the homemade juice soured. But the fabricated one did not sour.
Explanation	Is there any similarity between your prediction and observation? Please explain your reason(s)	10	-	-	-	My predictions were wrong. I predicted that the fabricated one would sour. However, I observed that the homemade one soured.
	What does a healthy juice mean?	5	5	-	-	A healthy juice means that it is natural and does not include any additive. But an unhealthy one contains additives.
	Why is shelf life of the fabricated juice longer than that of the homemade juice? Please defend your response	10	-	-	-	Because it contains additives.
	Why are their prices different? Please defend your response	3	7	-	-	Homemade juice is more expensive since it is healthier and does not incorporate any additive.

As can be seen from Table 9, their responses in the 'which one is healthier?' worksheet were classified under SU and PU. Furthermore, only one observation for the question 'Please compare them in terms of color' fell into NU.

Table 9. Frequencies of the students' responses in the 'which one is healthier?' worksheet in regard to understanding level

Phases	Questions	SU	PU	PUAC	NU	Sample responses
Prediction	Which of the foregoing snacks (e.g., hazelnut and candy called bonibon) is healthier? Please defend your prediction	4	6	-	-	Hazelnut is better because it contains no additive.
	Which of them contains more additives? Please write down your prediction	10	-	-	-	Bonibon (a kind of candy)
Observation	Please compare colors of water with hazelnut and candy (called bonibon)	8	2	-	-	Color of water with bonibon converted into green, while that of hazelnut was the same.
	Please compare their shapes/appearance	10	-	-	-	They were both rounds, but candies were broken and crushed.
	Please compare them in terms of color	9	-	-	1	Candies' (Bonibon) colors were yellow, brown, orange and red. But the current color was only brown.
Explanation	Is there any similarity between your prediction and observation? Please explain your reason(s)	7	3	-	-	Similar because I predicted that candies' (bonibon) colors would change and hazelnut's color would be the same. My observation confirmed my prediction.
	What does a healthy snack mean?	7	3	-	-	A healthy snack means that it triggers appetite and does not include any additive.
	Is there any relationship between healthy nutrition and snack foods? Please explain your reason(s)	6	4	-	-	Yes, because snack foods, which are naturel and do not contain any additive, are more suitable for healthy nutrition.

As can be seen from Table 10, their responses in the 'do we recognize breads?' worksheet fell into SU, PU and PUAC. Only the questions 'which of them can be stored and eaten in a longer time? Please write down your prediction' and 'is there any relationship between healthy nutrition and bread? Please explain your reason(s)' incorporated few responses classified under PUAC.

Table 10. Frequencies of the students' responses in the 'do we recognize breads?' worksheet in regard to understanding level

Phases	Questions	SU	PU	PUAC	NU	Sample responses
Prediction	Which of the foregoing breads (e.g., homemade and fabricated breads) is healthier? Please defend your prediction	6	4	-	-	Homemade because it does not contain any additive.
	Which of them can be stored and eaten in a longer time? Please write down your prediction	-	8	2	-	Homemade
	Which of them contains more additives? Please write down your prediction	8	2	-	-	Fabricated bread because I am sure that it contains additive(s)
Observation	Please compare the breads in terms of taste	9	1	-	-	Homemade bread is more tasteful than fabricated one
	Please compare them in terms of ingredient(s)	9	1	-	-	Homemade contains one cup of sour yeast, one glass of water, one teaspoon of salt and enough flour. Fabricated one also includes emulgator, antioxidant, lipase, sorbic acid and so forth
	Please compare them in terms of consumption (shelf) life	10	-	-	-	My weekly observations revealed that homemade bread included some bread mold, whilst fabricated one did not have anything
Explanation	Is there any similarity between your prediction and observation? Please explain your reason(s)	9	1	-	-	Similar because I predicted that homemade was healthy and would mold overtime. Also, I depicted that fabricated one's shelf life would be longer than homemade one since it included much more additives. Thus, my observations are in harmony with my predictions.
	What does a healthy bread mean?	10	-	-	-	A healthy bread means that it is natural and does not contain any additive.
	Why is shelf life of the fabricated bread longer than that of the homemade one? Please defend your response	9	1	-	-	Because fabricated bread includes additives and preservative substances, its shelf life is longer than that of homemade one. However, since homemade does not contain any additive and preservative substance, it molds and spoils overtime.
	Is there any relationship between healthy nutrition and bread? Please explain your reason(s)	6	2	2	-	Yes, because healthy bread supports healthy nutrition.

As seen from Table 11, their responses in the 'we like yogurts' worksheet were mostly categorized under SU and PU. However, few responses also fell into PUAC and NU.

Table 11. Frequencies of the students' responses in the 'we like yogurts' worksheet in regard to understanding level

Phases	Questions	SU	PU	PUAC	NU	Sample responses
Prediction	Which of the foregoing yogurts (e.g., homemade and fabricated yogurts) is healthier? Please defend your prediction	9	1	-	-	Homemade yogurt because it does not contain any additive
	Which of them can be stored in a longer time? Please write down your prediction	8	-	2	-	Fabricated yogurt can be stored in a longer time because it contains additive(s).
	Which of them contains more additives? Please write down your prediction	10	-	-	-	Fabricated yogurt
Observation	Please compare the yogurts in terms of taste	10	-	-	-	Homemade yogurt is a bit sour, but it is delicious. But, fabricated one is not tasteful.
	Please compare them in terms of ingredient(s)	8	2	-	-	Homemade includes milk and yeast of yogurt. Fabricated one also contains additives and preservative substances.
	Please compare them in terms of consumption (shelf) life	9	-	-	1	When we observed them through one-week, fabricated yogurt showed little change; but homemade yogurt smelled alike rotten.
Explanation	Is there any similarity between your prediction and observation? Please explain your reason(s)	8	2	-	-	Yes, because I predicted that fabricated yogurt's consumption (shelf) life would be longer. My observations proved my prediction.
	What does a healthy yogurt mean?	8	1	1	-	A healthy yogurt means that it does not include any preservative substance.
	Why is shelf life of the fabricated yogurt longer than that of the homemade one? Please defend your response	8	1	1	-	Because the fabricated yogurt contains additive(s), its shelf life is longer than that of the homemade one.
	Is there any relationship between healthy nutrition and homemade yogurt? Please explain your reason(s)	4	5	1	-	There is a strong relationship between homemade yogurt and healthy nutrition because homemade yogurt advocates healthy nutrition.
	Which of them do you prefer in your daily life? Please explain your reason(s)	6	4	-	-	Homemade yogurt because it does not include any additive.

DISCUSSION and CONCLUSIONS

Response diversity in pre-WAT may stem from the 'Science of Life' course in grades 1-2. That is, the students may have associated the goals of balanced nutrition/diet with their lives (Folkvord et al., 2016). In addition, the fact that they addressed many response words in pre-WAT may come from their healthy food alternatives in the rural area. Furthermore, the low number of the response words for the stimulus word 'Additive' in pre-WAT may result from their limited pre-existing knowledge or vocabulary (Güngör, 2016). Their response words in post-WAT may

stem from the idea 'homemade foods support healthy nutrition' or their newly gained concepts. Therefore, it can be deduced that the POE worksheets have an important role in affecting and facilitating their behaviors of healthy nutrition (Aydın, 2010; Dixey et al., 2001; Güven, 2011; Kupolati et al., 2015).

As seen from Figures 1 and 2, the response variety for the stimulus words 'healthy nutrition and healthy food' was higher in pre-WAT than post-WAT. This may come from different examples of fruits and vegetables in pre-WAT. The fact that the number of the response words for the 'additive' stimulus word was higher in post-WAT ($f=82$) than pre-WAT ($f=31$) may result from the relevant task in which the students had examined and discussed ingredients of packaged/fabricated foods. Phrased differently, handling various concepts within the fabricated/packaged foods and discussing their natural alternatives may have enabled them to re-think about related words throughout their cognitive frameworks (Tao and Gunstone, 1999a; Tekin, 2006). However, such an increase did not result in any statistically significant change between pre- and post-WAT (see Table 4). Overall, this showed that the POE worksheets were unable to yield a significant difference between the students' scores of pre- and post-WAT (Research Question 1).

Given the second research question, a large Hedge's g value and statistically positive change (see Table 6) pointed to a better conceptual understanding/conceptual growth (Bilen and Köse, 2012). In other words, the POE worksheets, which engaged the students in hands-on and minds-on activities, seem to have enhanced their learning capacities of healthy foods (McGregor and Hargrave, 2008; Tao and Gunstone, 1999a,b; Wu and Tsai, 2005). As seen from Table 5, the fact that the students' responses fell into PU and SU in post-CUT may result from the features of the POE worksheets, which ask them to make comparisons between the phases of the POE strategy (Tekin, 2006). Therefore, the POE worksheets may have played a pivotal role in shaping or developing their conceptual understanding/conceptual growth of healthy foods.

Given the third research question, the fact that their responses in the 'explanation' phase were categorized under SU and PU (see Tables 7-10) showed that the POE worksheets supported and guided their conceptual understanding/conceptual growth (Abdurrahman, Setyaningsih, & Jalmo, 2019; Atasoy, 2004; Driver and Bell, 1986). That is, their first-hand experiences and inquiries may have enhanced their awareness levels of healthy nutrition and healthy foods (Schifferstein and Oude-Ophuis, 1998).

The POE worksheets, which required the students to compare and associate their predictions with observations and explanations, may have supported their conceptual understanding/conceptual growth of healthy foods (Özdemir, Köse and Bilen, 2012). Moreover, activating their pre-existing knowledge in the 'prediction' phase of the POE worksheet may also have resulted in meaningful learning and a better conceptual growth (Kabataş Memiş and Ezberci Çevik, 2018; Say and Özmen, 2018). Thus, the POE worksheets afforded the students to not only practically compare foods with each other but also differentiate relevant concepts from one another. In brief, the POE worksheets were effective at improving the students' conceptions and awareness of healthy foods.

In light of the results, the current study suggests using the POE worksheets for science teaching in primary schools. In addition, given primary school teachers' concerns and biases about science education, sharing the developed POE worksheets may lessen their work burdens and overcome their concerns/bias. In a similar vein, because the current study only handled three key concepts (healthy nutrition, healthy food and additive) within the POE worksheets, a long-term study should be undertaken for other related topics.

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Appendices:

1. The 'prediction' phase of the 'surprising eggs' worksheet

Materials

- ❖ A boiled farm egg
- ❖ A boiled village egg
- ❖ Knife

Surprising Eggs



A farm egg
Price: 30 penny



A village egg
Price: 1 Turkish Lira

PREDICTION

- 1) Which of the foregoing eggs is healthier? Please defend your prediction
.....
.....
.....
- 2) Is there any difference between these eggs in terms of taste and color? Please write down your prediction
.....
.....
.....
- 3) Why are their prices different? Please write down your prediction
.....
.....
.....

2. The 'observation' phase of the 'surprising eggs' worksheet



OBSERVATION

1. Please cut down the eggs into half
2. Please compare their colors with each other
3. Please compare their tastes with each other
4. Please keep them in your class and observe their consumption (shelf) lives

Color:

Taste:

Consumption Life:

3. The 'explanation' phase of the 'surprising eggs' worksheet

EXPLANATION

- **Is there any similarity between your prediction and observation? Please explain your reason(s)**

.....
.....
.....

- **What does a healthy egg mean?**

.....
.....
.....

- **Why is shelf life of a farm egg longer than that of a village egg? Please defend your response.**

.....
.....
.....

- **Is there any relationship between healthy nutrition and the village egg? Please explain your reason(s)**

.....
.....
.....

- **Why are their prices different? Please defend your response**

.....
.....
.....
.....
.....