Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi
Cilt 17, Özel Sayı, Ekim 2023, sayfa 593-623. ISSN: 1307-6086
Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education
Vol. 17, Special Issue, October 2023, pp. 593-623. ISSN: 1307-6086

Research Article

Primary School Students' Cognitive Structures About Nutrient Content: Word Association Test

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Received : 20.04.2023 Accepted : 24.08.2023

https://doi.org/10.17522/balikesirnef.1286275

Abstract – The study aimed to examine the cognitive structures of primary school students about nutrient content by using a word association test. The case study design, which is a qualitative research method, was used in the study. Participants of the study included 41 fourth grade students in a public school in Bursa in the 2021-2022 academic year. Data were collected by a word association test and analyzed by the content analysis method. The study revealed that 11 themes related to proteins were formed and the most associated sub-theme was the milk, meat, fish, and egg food group. 14 themes were identified for carbohydrates and the most associated sub-theme was the bread and cereals. 13 themes related to fats were created and the most associated sub-theme was the oil seeds. Regarding vitamins 12 themes were created and the most associated sub-theme was the fruits. 13 themes were created for water and 14 themes were created for minerals. While the sub-theme most associated with water was the beverages, the most commonly associated sub-theme for minerals was mineral resources. The students mostly left blank and established wrong relationships was the concept of minerals.

Key words: Nutrient contents, word association test, primary education.

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* This research was presented as an oral presentation at the 4th National Biology Education Congress (UBEK, [6-7 Oct. 2022 in Ankara, Turkey])

Introduction

Teaching the concepts correctly and permanently is among the main objectives of science courses. Abstract concepts in science education programs are difficult for students to

understand. These concepts are difficult to understand by students (Ercan et al., 2010). To be able to effectively teach science, it is important to teach the basic concepts contained in it completely and correctly for the trainings to be held in the following years. Because the wrong concepts or misconceptions learned will make subsequent learning quite difficult (Balbağ, 2018).

Proteins, carbohydrates, fats, water, and minerals can be counted among the important concepts within the scope of science course. These concepts both constitute the nutrients that are important for people's healthy diet and are among the concepts that make up the basic components of living things, and it forms the basis of many subjects especially in biology lesson (Sinan et al., 2006).

A healthy diet is very important in every period of life. The habit of healthy eating begins during prenatal development and continues into early adulthood (Gökçay & Garipoğlu, 2002). Especially, the fact that people do not face any health problems when moving from adolescence to adulthood is very related to the healthy eating behaviors acquired during childhood (Charlton et al., 2020). Healthy nutrition is possible with adequate and balanced nutrition. Şanlıer and Yabancı (2005, p.11) describe adequate and balanced nutrition as follows "Even though adequate nutrition generally means providing the necessary energy for the body to live and work, balanced nutrition refers to the consumption of all nutrients as well as energy in regular manner as the body needs". For individuals to have balanced diet, they need to get enough of each food group daily. The 'healthy dinner plate' on the website of the Ministry of Health can be given as an example of how much of each food group we should consume (See Figure 1).

For adequate and balanced nutrition, the food groups listed below should be consumed in the recommended amounts (Ministry of Health, 2023).

- Milk group: This group includes milk and substitutes,
- Meat, egg, and legume group: In this group the food such as meat, chicken, fish, eggs, dried beans, chickpeas, and lentils are found. Oilseeds such as walnuts, hazelnuts, and peanuts are also included in this group,
- Vegetable and fruit group: All edible parts of plants are grouped under the heading of vegetables and fruits,

- Bread and cereals group: This group includes cereal grains such as wheat, rice, corn, rye and oats, as well as flour, bulgur, cracked wheat, cereals, and similar products made from them.

Figure 1 Healthy dinner plate (from Ministry of Health, 2017)

Edible animal and plant tissues are called nutrients, but nutrients are not composed solely of these tissues. Nutrients are composed of organic compounds, inorganic compounds, and water. These substances, which are necessary for our body, are called nutritional elements. Nutritional elements are divided into six groups; proteins, fats, carbohydrates, vitamins, water, and minerals (Baysal, 2007). In science textbooks, the term nutrient contents is used instead of the term nutritional elements (Yaman et al., 2019). These nutrient contents are:

- Proteins: They have constructive and restorative functions in their body. They play a role for people grow in taller, in healing injured people, and in events such as maturation, hair, and nail growth. If we do not get enough protein into our body,

problems such as growth and development decline, weakening of immunity may occur. Proteins can be of animal origin, such as meat, milk, yogurt, eggs, cheese, or vegetable origin, such as lentils, chickpeas, and bulgur. At the same time, peanuts, nuts, etc. it is rich in protein in dried nuts.

- Carbohydrates: People need to walk, sit down, get up, run, etc. We need energy in events. The food group that provides the energy that our body needs is carbohydrates. In cereals and cereal group products, fruits and vegetables, jam, honey, etc. the products are very rich in carbohydrates. We should consume enough of these products at every meal. If we consume too much, it can cause tooth decay and obesity.
- Fats: When people are hungry for a long time, the energy provided by our body from carbohydrates becomes insufficient. In such cases, people get the necessary energy from fats. Too much of it is stored in the body and causes weight gain. For creatures living in cold regions, body fat is used to keep body temperature warm. Vegetable oils are mostly found in olives, sunflower, walnuts, hazelnuts, sesame, and corn. Butter and tail fat can be given as an animal product example.
- Vitamins: They serve in the regular functioning of our organs in our body. They protect us against diseases by providing body resistance. Vitamins are especially abundant in fruits and vegetables. We need to consume enough fruits and vegetables every day. If we do not consume enough, body resistance decreases, and we get sick.
- Water and minerals: Our bodies need water. People meet these needs with food and drinks. All the food we eat contains water. Minerals are found in many foods, as well as in water and soil. Salts in rock are affected by environmental influences (wind, temperature, rain, etc.) And it mixes into the soil by crumbling, plants take up the minerals contained in the soil with their roots. Animals eat plants to feed and, thus get minerals into their body. They act as regulators in people's body.

When 1st, 2nd, and 3rd grade programs of the Life Science (LS) course in the 2021-2022 academic year are examined, the "Healthy Life" unit includes the achievements related to health and balanced nutrition (Ministry of National Education [MoNE], 2018):

- 1st grade objectives included in the classroom Life Science Course Curriculum are the following: LS. 1.3.2., LS. 1.3.3., LS. 1.3.4., and LS. 1.3.6.
- 2nd grade objectives included in the classroom Life Science Course Curriculum are the following: LS. 2.3.1., LS. 2.3.2., and LS. 2.3.6.

- 3rd grade objectives included in the classroom Life Science Course Curriculum are the following: LS. 3.3.2., LS. 3.3.3., LS. 3.3.4. and LS. 3.6.2.

When we examine the curriculum of the 4th grade Science (S) course curriculum, "Our Nutrients / Living Things and Life" includes the following objectives related to healthy nutrition and nutrient content (MoNE, 2018):

- 4th the grade objectives included in the classroom Science Course Curriculum are following: S. 4.2.1.1., S. 4.2.1.2., S. 4.2.1.3. and S. 4.2.1.4.

Within the scope of the Physical Education and Sports lesson program, there are objectives of balanced nutrition in the 5th grade objectives, objectives of preparing a nutrition program in the 7th grade objectives, and objectives of being a conscious consumer in food and beverage choices in the 8th grade objectives.

The objectives of protein, carbohydrate, fat, vitamin, water, and mineral in the 9th grade Biology (B) Curriculum:

- The objectives of B. 9.1.2.1. and B. 9.1.2.2. in the 9th grade related to the topic called "Basic compounds found in the structure of living things" in the "Life Science Biology" unit (MoNE, 2018).

In the study of Sakar and Açkurt (2019) named nutrition habits and nutritional knowledge status of teachers working in primary schools, they found that the subjects in the primary school curriculum of the teachers were insufficient in terms of nutrition education. In the study titled investigation of eating behaviors of second level primary school students conducted by Gün (2020), it was revealed that eating behaviors of the students participating in the study were at a low level. In the study of Şimşek et al. (2009) titled evaluation of lunchboxes of school-age children, it was found that students consume unhealthy foods more than healthier foods. Kösedag (2019) determined that the students had insufficient and unbalanced nutrition in her study titled examination of the contents of lunchboxes of primary school students.

When all these were considered, the concepts related to nutrient contents were among the important concepts we encounter throughout our education and training lives. In addition, nutrient content is among the concepts that lay the foundation for our adequate and balanced nutrition habits that will affect our lives.

Constructivist learning approaches have been used in recent years to explain these concepts to students in a more understandable way and to increase memorability. For meaningful learning to take place in the constructivist approach, the student reaches new knowledge and builds his cognitive structure by establishing a relationship with previous learning or experiences and builds his new knowledge on top of his existing knowledge (Arslan, 2007). In parallel with the use of the constructivist approach in education, traditional assessment and evaluation techniques have been replaced with alternative assessment and evaluation techniques.

Particularly, in the primary education program, which was renewed in 2005, attention was drawn to alternative measurement and evaluation techniques and suggestions which were made for their implementation (MoNE, 2005). Alternative measurement tools were aimed at measuring not only the cognitive behavior of students but also their psychomotor and affective behavior, in addition to traditional measurement tools. Among these measurement tools, rubric, attitude scales, structural grid testing, concept maps, and performance evaluation, etc. are used. One of these techniques is the word association test (WAT) (Kayhan, 2019).

WAT is among the most common used methods. In the word association test, the student's cognitive structure related to the subject, the connection between the concepts related to the subject and the level or significance of the relationship between the concepts in the long-term memory related to the subject were determined. In this method, students were given a certain amount of time according to their grade level and they were asked to write down which concepts / words they evoke first in their minds against the given key concept / word (Bahar & Özatlı, 2003). Among the purposes of using word association tests were detecting students' misconception and conceptual changes and revealing their cognitive structures can be counted (Işıklı et al., 2011).

According to literature review, there are some studies measuring the structures of the basic components of living things by using the WAT of the high school students (Bahar & Özatlı, 2003). However, no study has been found that aims to measure the cognitive structures of primary school students using word association test. In this current study, using word association test to determine the cognitive structures of the students regarding the nutrient content concepts in the "Our Nutrients / Living Things and Life" unit the primary school 4th grade science curriculum intended. The sub-problems of the research are as follows:

1. What are the cognitive structures of primary school students related to the concept of proteins?

2. What are the cognitive structures of primary school students related to the concept of carbohydrates?

3. What are the cognitive structures of primary school students related to the concept of fats?

4. What are the cognitive structures of primary school students related to the concept of vitamins?

5. What are the cognitive structures of primary school students related to the concept of water?

6. What are the cognitive structures of primary school students related to the concept of minerals?

Method

Research Model

In this study a case study design, which was one of the qualitative research methods, was used. Case studies are a type of research in which one or more events, groups, systems, and programs that are related to each other are examined in depth. Generally, it aims to explain and evaluate one or more situations within its own boundaries (Büyüköztürk et al., 2016).

Participants

Participants of the study included 41 fourth grade students from two different classes of a public school in Bursa in the 2021-2022 academic year. Sample was chosen by criterion sampling method. Criterion sampling method, which was one of the non-random sampling methods was used in the study (Büyüköztürk et al., 2016). Nutrient concepts were taught in the unit of "Our Food / Living Things and Life" in the 4th grade Science curriculum. Therefore, 4th grade students were chosen as a sample of the study.

Data Collection Tools

The word association test was used as a data collection tool in the study. WAT revealed that how the students made relationships between the concepts related to nutrient content. It helped to determine whether these relationships were significant or whether they were

sufficient. By using this technique, relevant and important concepts were selected, with at least five and at most ten concepts (Gündoğan & Gültekin, 2018). Each of the key concepts used in the word association test was prepared on one page. At the same time, the students participating in the study were asked to fill in the relevant sentence under key concepts. In this way, students were provided to establish a relationship with concepts (Bahar & Özatlı, 2003; Deveci et al., 2014).

To prepare the word association test in the study, the concepts of nutrient contents in the unit of "Our Food / Living Things and Life" in the 4th grade Science curriculum were included. These concepts were proteins, carbohydrates, fats, vitamins, water, and minerals. There were two main reasons for choosing these concepts. One of the reasons to choose these topics was, these concepts were asked to four classroom teachers working in a public school with the following question: 'Which subject do students have the most difficulty in understanding within the scope of science subject?' As a result of the unstructured interviews with the teachers, they reported that their students had the most difficulty in understanding the concepts of proteins and minerals. They mentioned that the students mixed the concepts of vegetable proteins with carbohydrates. The second reason to choose these topics was importance of the concepts of nutrient content within the scope of science course. The answers of the students to the concepts / words in the word association test about nutrient contents will also reveal their knowledge about proper nutrition. A sample of the form used in the study was given Figure 2.

Proteins: …….
Proteins: …….
Proteins: …….
Proteins: …….
Proteins: …….
Related Sentence:

Figure 2 A sample of the form used in the study

In this study, the WAT was applied to the students after the nutrient concepts had been instructed by traditional methods. First the students were given some information about the implementation of WAT. Then, they were asked to write down the first concepts / words that came to their minds for each concept respectively and fill in the related sentence part. 90 seconds were given to write each concept and related sentence in the test. After the given time was over, they move on to the next concept and the same time was applied for each new

concept. When the studies on the subject were examined, it was determined that this period may differ according to the grade levels (Kaya & Taşdere, 2016).

Data Analysis

The collected data of WAT have been analyzed by content analysis method. In this method, the aim was to identify the concepts / words that can explain the data and to determine their relationship with each other. Therefore, concepts that were related to each other or similar were collected and interpreted under the same category (Ekici & Kurt, 2014). Content analysis usually includes frequency and percentage tables that present the current situation.

The word association test used as the data collection tool was made ready for analysis. The data collected in the research were first transcribed and codes were created for the purpose. These generated codes were collected under the appropriate categories or themes (Ültay et al., 2021).

Themes, sub-themes, and frequency values were determined for each concept and frequency tables have been created in accordance with findings obtained by examining which words were written for the concepts given in the WAT (Kaya & Akış, 2015). To determine the validity of the study, the data were coded by the lecturers working in the department of biology education and validity percentages of the study were calculated using the formula proposed by Miles and Huberman (1994). Reliability: (Number of codes with a match) / (Total number of codes with and without a match) x 100. Reliability coefficient was found as %88.

Results

Results Related to the Concept of Proteins

11 themes were created related to students' cognitive structures about proteins. Themes, the sub-themes, and frequencies were presented in Table 1.

Table 1 Themes and sub-themes related to the concept of proteins

Themes	Sub-themes	*f*
Milk, Meat, Fish, Eggs Food Groups (111)	Meat, Steak, Doner, Meatball, Cutlet	30
	Egg	23
	Fish	16
	Milk	16
	Chicken	13
	Cheese	9
	Yoghurt, Buttermilk	4
Fruit (7)	Fruit	5
	Banana	1
	Kiwi	1
Vegetable (8)	Vegetable	5
	Pea	1
	Spinach	1
	Salad	1
Oil Seeds (9)	Hazelnut	3
	Peanut	2
	Almond	1
	Walnut	1
	Dried nuts	1
	Olive	1
Function (5)	Energy, Power	3
	Repair	2
Importance (12)	Health	5
	Sport	2
	Bone	2
	Benefit	1
	Illness	1
	Muscle	1
Foods High in Sugar (1)	Honey	1
Fats (5)	Olive oil	3
	Oil	2
Vitamin (2)	Vitamin	2
Water (1)	Water	1
Other (10)	Protein powder	4
	Nutrition	3
	Food	2
	Soup	1
Total	37	171

As seen in Table 1, six out of 41 students left this part blank. The total number of words obtained from all themes was 171. The words were mostly in the theme of milk, meat, fish, eggs food groups (111). The most frequently mentioned concepts under this theme are: Meat, steak, doner, meatballs, cutlets (30), eggs (23), fish (16), and milk (16). Respectively, it was followed by the themes of importance (12), other (10), and oilseeds (9). The most commonly written concept under the theme of its importance was health (5). The concept that was written the most under the theme of other, which comes in third place, was protein powder (4). Finally, the most frequently written concept under the theme of oilseeds was hazelnut (3).

While the students mostly associated the concept of proteins with animal protein sources, they did not make sufficient associations with other protein sources such as vegetable protein sources and oil seeds.

When the data obtained from the sentence analyses related to the concept of proteins were evaluated, the total number of sentences was 36 since five out of 41 students left the sentence part empty. The 36 sentences obtained were divided into three main categories: Informational sentences (12), related sentences (18), and unrelated sentences (6).

- Examples of informational sentences:

"Protein helps our bones to develop."

"It helps heal my wounds."

"Meat, milk and chicken contain plenty of protein."

- Examples of related sentences:

"We'll have meat tonight."

"I like to drink milk."

"The meat is very good."

- Examples of unrelated sentences:

"I wrote protein with my pen."

"I like sports ."

"I drank vitamins."

Results Related to the Concept of Carbohydrates

14 themes related to carbohydrates were formed, and the sub-themes and frequencies of each theme were presented in Table 2.

Table 2 Themes and sub-themes related to the concept of carbohydrates

Themes	Sub-themes	*f*
Foods High in Sugar (12)	Jam	3
	Cake	2
	Honey	2
	Molasses	1
	Sugar	1
	Chocolate	1
	Jellybean	1
	Wafer	1
Bread and Cereal Group (82)	Bread	21
	Pasta	17
	Rice, Pilaf	13
	Bulgur	7
	Wheat	6
	Cake, Cookie	5
	Cereal	4
	Barley, Rice	3
	Toast	2
	Flour	2
	Pastry	1
	Biscuit	1
Fruit (3)	Fruit	2
	Apple	1
Vegetable (8)	Fresh beans	3
	Vegetable	3
	Potato	1
	Okra	1
Form (1)	Solid	1
Function (10)	Energy, Power	10
Importance (7)	Vigorous	2
	Need	1
	Health	1
	Run	1
	Tiredness	1
	Sleep	1
Milk, Meat, Fish, Eggs Food Groups (7)	Sausage	3
	Meat	1
	Fish	1
	Egg	1
	Animal origin	1
Oil Seeds (9)	Hazelnut	3
	Snack	2
	Peanut	2
	Walnut	1
	Sunflower seed	1
Fats (2)	Oil	2
Water (1)	Water	1
Salt (1)	Salt	1
Other (4)	Food	2
	Junk food	1
	Frying	1
Unrelated (1)	Brain	1
Total	51	148

According to Table 2, 10 out of 41 students did not write any sentence. The total number of words obtained from all themes was 148. They were mostly gathered in the theme of the bread and cereal group (82). The most frequently written concepts in this theme were bread (21), pasta (17), pilaf, and rice (13). Respectively, the bread and cereals group were followed by foods high in sugar (12) and function (10). While the most frequently written concept in the theme of foods containing high sugar was jams (3), the most frequently written concept in the theme of function was energy and power (10). The students mostly associated the concept of carbohydrates with bread and cereal group carbohydrate sources and did not make sufficient associations with other carbohydrate sources such as fruits and vegetables and sugars. Based on the function theme in the third place, we can say that the students have detailed knowledge about the concept of carbohydrate.

In addition, according to the results of the analysis of the sentences related to the concept of carbohydrates, the total number of sentences was 33 and eight people left the sentence of carbohydrates empty. The 33 sentences were divided into three main categories: Informational sentences (14), related sentences (12), and unrelated sentences (7).

- Examples of informational sentences:

"It gives us energy."

"We must eat to store energy."

"We need energy while running, and carbohydrates provide it."

- Examples of related sentences:

"I ate bread today."

"I eat carbohydrates every day."

"I'm going to buy bread."

- Examples of unrelated sentences:

"I like to eat."

"I ate eggs for breakfast today ."

"I ate junk food."

Results Related to The Concept of Fats

13 themes related to fats were created in the cognitive structures of the students participating in the research by using WAT, and the sub-themes and frequencies of each theme were presented in Table 3.

Table 3 Themes and sub-themes related to the concept of fats

Themes	Sub-themes	*f*
Animal Fats (17)	Butter	13
	Margarine	2
	Animal fats	2
Vegetable Oils (26)	Olive oil	12
	Liquid oil	6
	Flower oil	6
	Corn oil	1
	Vegetable oil	1
Oil Seeds (32)	Hazelnut	9
	Dried nut	7
	Walnut	6
	Peanut	4
	Cashew	2
	Almond	2
	Pistachios	1
	Groundnut	1
Vegetables (12)	Potato	5
	Salad	4
	Celery	1
	Lettuce	1
	Onion	1
Foods High in Sugar (16)	Chocolate	7
	Sugar	5
	Carbohydrate	2
	Jellybean	1
	Ice cream	1
Bread and Cereal Group (9)	Biscuit	3
	Pasta	2
	Bagel	1
	Pancake	1
	Toast	1
	Cracker	1
Foods High in Fat (8)	Chips	5
	Frying	3
Milk, Meat, Fish, Eggs Food Groups (13)	Meat	5
	Yogurt	2
	Milk	2
	Fish	1
	Chicken	1
	Cheese	1
	Sausage	1
Color (1)	Yellow	1
Function (4)	Energy	4
Importance (11)	Weight	4
	Expensive	2
	Increment	1
	Obesity	1
	Weaken	1
	Body fat	1
	Damage	1
Other (1)	Soup	1

Unrelated (3)	Rain	2
	Brain	1
Total	53	153

As seen in Table 3, nine out of 41 students did not give any answer for this part. The total number of words obtained from the themes was 153. The words mostly grouped in the theme of oil seeds (32). The most common concepts in the theme of oil seeds were hazelnut (9), dried nuts (7), and walnut (6). Respectively, this theme was followed by the themes of vegetable oils (26) and animal fats (17). While olive oil (12) was the most common concept in the theme of vegetable oils, butter (13) was the most common concept in the theme of animal fats. The students mostly associated the concept of fats with the themes of oil seeds, vegetable oils and animal fats, that was, with the types of fats.

According to the results obtained from the sentence analysis related to the concept of fats, it was determined that the total number of sentences was 33. Eight out of 41 students have left the related sentence blank. The 33 sentences obtained were divided into three main categories. These three main categories were: Informational sentences (12), related sentences (14), and unrelated sentences (7).

- Examples of informational sentences:

"We should not consume too much fat, because we gain weight."

"It is one of the sources of energy."

"Found in dried nuts."

- Examples of related sentences:

"I used sunflower oil when I cooked."

"Olive oil is very good."

"I try not to eat fatty things."

- Examples of unrelated sentences:

"I went to get food."

"I only ate one of the prizes."

"I ate a lot of pasta."

Results Related to The Concept of Vitamins

Using the WAT for nutrient contents, 12 themes related to vitamins were formed in the students' cognitive structures. The sub-themes and frequencies of each theme were given in Table 4.

Table 4 Themes and sub-themes related to the concept of vitamins

Themes	Sub-themes	*f*
Fruits (78)	Orange	18
	Fruit	14
	Apple	11
	Strawberry	6
	Banana	5
	Watermelon	4
	Cherry	3
	Lemon	3
	Peach	3
	Cucumber	3
	Pineapple	2
	Tomato	2
	Pear	1
	Plum	1
	Apricot	1
	Kiwi	1
Vegetables (21)	Vegetable	10
	Carrot	6
	Radish	1
	Greenery	1
	Cabbage	1
	Leek	1
	Broccoli	1
Varieties (9)	Vitamin C	4
	Vitamin D	3
	Vitamin A	2
Milk, Meat, Fish, Eggs Food Groups (3)	Cheese	2
	Fish	1
Oil Seeds (2)	Walnut	1
	Almond	1
Foods High in Sugar (1)	Molasses	1
Bread and Cereal Group (1)	Pasta	1
Water (4)	Water	4
Minerals (2)	Calcium	1
	Iron	1
Function (6)	Energy, Power	6
Importance (16)	Health	10
	Medicine	4
	Doctor	1
	Sun	1
Unrelated (2)	Plastic	1
	Wood	1
Total	42	145

According to Table 4, seven out of 41 students left this section blank. The total number of words obtained from the themes was 145. The words were mostly collected in the theme of fruits (78). The concepts in this theme were collected most often in orange (18), fruit (14), and apple (11). Although orange (18) was the most frequently written concept in the fruit theme, the number of lemons (3) was quite low. Later, the themes of vegetables (21) and importance

(16) followed the theme of fruits. While the most common concepts in the theme of vegetables were vegetables (10) and carrot (6), the most common concept in the concept of importance was health (16). The students mostly associated the concept of vitamins with the theme of fruits. The students mostly constructed the key concept of vitamins correctly in their minds. However, the energy sub-theme in the function theme reveals that some of the students in the study associate vitamins with energizing nutrients. This association was not a correct one.

When the sentences related to the concept of vitamins were analyzed, it was determined that the total number of sentences was 33. It was observed that eight out of 41 students left the sentence blank. The 33 sentences were divided into three main categories. These three main categories were: Informational sentences (13), related sentences (17), and unrelated sentences (3).

- Examples of informational sentences:

"Fruits and vegetables contain lots of vitamins."

"It heals us when we are sick."

"It keeps us healthy."

- Examples of related sentences:

"I had an orange for lunch today."

"We drink orange juice for breakfast."

"We bought carrots from the market."

- Examples of unrelated sentences:

"I do not know."

"I ate it for breakfast."

"I drank."

Results Related to The Concept of Water

Using the WAT related to the nutrient content of the students, 13 themes related to water were formed in their cognitive structures and the sub-themes and frequencies of each theme were given in Table 5.

Table 5 Themes and sub-themes related to the concept of water

Themes	Sub-themes	*f*
Beverages (64)	Orange juice, Apple juice, Pomegranate juice, Lemonade	22
	Fruit juice	15
	Carbonated drinks	9

	Buttermilk	7
	Milk	5
	Soap	2
	Tea	1
	Mineral water	1
	Milkshake	1
	Erikli (Trademark)	1
Fruits (6)	Watermelon	2
	Tomatoes	1
	Fruit	1
	Melon	1
	Mandarin	1
Vegetables (2)	Vegetable	2
State in Nature (22)	Snow	8
	Rain	8
	Liquid	4
	Ice	2
Water Resources (10)	Sea	5
	Lake	2
	Dam	1
	Mountain	1
	Forest	1
Proteins (3)	Fish	2
	Meat	1
Foods High in Sugar (2)	Chocolate	1
	Molasses	1
Fats (2)	Fat	2
Vitamins (3)	Vitamin	3
Minerals(5)	Minerals	5
Related Items (11)	Bottle	3
	Water bottle	2
	Cup	2
	Fountain	2
	Glass	1
	Cologne	1
Function (9)	Health	6
	Regulator	1
	Balance	1
	Energy	1
Importance (27)	Live, Life	10
	Plant, Tree	3
	Dirt	2
	Bathroom	2
	Drought	2
	Bill	1
	Waste	1
	Fresh air	1
	Soil	1
	Fire	1
	Need	1
	Medicine	1
	Happiness	1
Total	55	166

As in Table 5, five out of 41 students left the related part blank. The total number of words obtained from the themes was 166. The words were mostly collected in the theme of beverages (64). The concepts in this theme were collected most often in orange juice, apple juice, pomegranate juice, and lemonade (22), fruit juice (15), and carbonated drinks (11). The themes of importance (27), and state in nature (22) followed the theme of beverages, respectively. While the most common concept in the theme of importance was live, life (10), the most common concepts in the theme of state in nature were snow (8) and rain (8). The students associated the key concept of water with beverages. Furthermore, it could be said that the students made the right conclusions about the importance of water in our lives and its physical properties. However, the energy sub-theme found in the theme of function was not a correct association with the concept of water.

When the sentences related to the concept of water were analyzed, it was observed that the total number of sentences was 34 and seven students left this part blank. The 34 sentences were divided into three main categories. These three main categories were informational sentences (16), related sentences (16), and unrelated sentences (2).

- Examples of informational sentences:

"They act as regulators in our body."

"Water is a basic need."

"Our bodies have plenty of water and human beings need water."

- Examples of related sentences:

"I took juice to school today."

"I drink a lot of water."

"Dams filled with water."

- Examples of unrelated sentences:

"Mom made meatballs today."

"I play sports."

Results Related to The Concept of Minerals

14 themes related to minerals were formed in their cognitive structures and the sub-themes and frequencies of each theme were given in Table 6.

Table 6 Themes and sub-themes related to the concept of minerals

Themes	Sub-themes	*f*
Mineral Resources (29)	Pebble stone	11
	Rock	6
	Mine	6
	Coal	2
	Fossils	1
	Soil	1
	Earth crust	1
	Brick	1
Fruits (25)	Orange	7
	Apple	5
	Mandarin	3
	Strawberry	3
	Watermelon	2
	Melon	2
	Pear	1
	Lemon	1
	Banana	1
Vegetables (4)	Lettuce	2
	Carrot	1
	Eggplant	1
Milk, Meat, Fish, Eggs Food Groups (12)	Milk	4
	Red meat	2
	White meat	2
	Egg	2
	Fish	1
	Protein	1
Foods High in Sugar (5)	Molasses	4
	Jam	1
Bread and Cereals Group (3)	Wheat	1
	Pasta	1
	Rice	1
Mineral Varieties (6)	Gold	3
	Copper	2
	Iron	1
Beverages (18)	Plain soda	7
	Carbonated drink	6
	Bubble	2
	Acid	1
	pH	1
	Tea	1
Function (8)	Regulator	4
	Energy, Power	4
Importance (8)	Microbe	3
	Health	3
	Life, Breath	2
Vitamin (1)	Vitamin	1
Water (18)	Water	18
Other (1)	Soap	1
Unrelated (5)	Air, Exhalation, Cloud, Sky	5
Total	49	143

As seen in Table 6, 12 out of 41 students did not write any sentence for minerals. The total number of words obtained from the themes was 143. The students' responses were mostly picked in the theme of mineral resources (29). The concepts in this theme were collected most often in pebble stone (11), rock (6), and mine (6). The themes of fruits (25), beverages (18), and water (18) followed the theme of mineral resources, respectively. The most frequently associated concepts in the fruit theme were orange (7) and apple (5), the concept most associated with the theme of beverages is plain soda (7) and carbonated drink (6), the concept most associated with the theme of water was water (18).

The students mostly associated the mineral key concept with mineral sources and fruits. The sub-themes of energy and power in the theme of function determine that students make an incorrect association in their cognitive structures about minerals. This result revealed that the concept of minerals was comprehended superficially by the students. Furthermore, among all the concepts analyzed for nutrient content, it was the concept with the most unrelated contact.

As a result of the sentence analysis related to the concept of minerals, the total number of sentences was 29. This number was the lowest among sentences containing other key concepts. 12 out of 41 students left the related sentence empty. The 29 sentences were divided into 3 main categories. These three main categories were informational sentences (12), related sentences (5), and unrelated sentences (12). The number of unrelated sentences was found to be quite high compared to other key concepts.

- Examples of informational sentences:

"Minerals are found in rocks."

"Minerals act as regulators."

"The difference of stones depends on the minerals in their structure."

- Examples of related sentences:

"It is found in almost every food."

"We found a fossil."

"Minerals are good for our body."

"Minerals are very important."

- Examples of unrelated sentences:

"We love it as a family."

"Water and soup are liquid."

"We should not pollute the air."

"I formed the word mineral with a sentence."

As a result, total frequencies of the themes and sub-themes of keywords including nutrient content were given in Table 7.

Table 7 Total themes and sub-themes of keywords related to nutrient content

Key Concepts	Total Themes *f*	Total Sub-themes *f*
Proteins	37	171
Carbohydrates	51	148
Fats	53	153
Vitamins	42	145
Water	55	166
Minerals	49	143

According to Table 7, the concept with the highest number of themes among the given key concepts was water (55), fats (53), and carbohydrates (51). The key concept with the highest number of words obtained from the themes was proteins (171). This was followed by water (166) in second place and fats (153) in third place.

The frequencies of the themes and sub-themes of the students' sentences related to nutrient contents were given in Table 8.

Table 8 Total themes and sub-themes related to the sentences about nutrient content

Themes	Total *f*	Sub-themes	Total *f*
Proteins	36	Informational sentences	12
		Related sentences	18
		Unrelated sentences	6
		No answer	5
Carbohydrates	33	Informational sentences	14
		Related sentences	12
		Unrelated sentences	7
		No answer	8
Fats	33	Informational sentences	12
		Related sentences	14
		Unrelated sentences	7
		No answer	8
Vitamins	33	Informational sentences	13
		Related sentences	17
		Unrelated sentences	3
		No answer	8
Water	34	Informational sentences	16
		Related sentences	16
		Unrelated sentences	2
		No answer	7
Minerals	29	Informational sentences	12
		Related sentences	5
		Unrelated sentences	12
		No answer	12

As seen in Table 8, the students wrote related sentences about proteins (18), water (16), and fats (14) respectively. While proteins (5) were the least frequently left empty, minerals (12) were the most frequently left empty among all key concepts. Moreover, the students wrote unrelated sentences about minerals at most.

Conclusions and Suggestions

In this study, a word association test was conducted to reveal the cognitive structures of fourth grade primary school students about nutrient content. The number of words and the number of words produced for the key concepts in the word association test applied in the study was one of the techniques used to evaluate the data. The quality and frequency of the words in response to key concepts can be used to determine whether the topic has been understood. A key concept that is not associated with any concept or word does not make any sense for the students (Çardak, 2009).

Concepts related to healthy and balanced nutrition, nutrition, and nutrient content were encountered by students especially in primary school. There were 14 learning outcomes related to this subject in the primary school curriculum within the scope of life science and science courses. In addition, in the 4th grade, there was a separate unit on the subject called 'Our Food / Living Things and Life'. Concepts and achievements related to the subject continue to be encountered in middle and high school periods. Similarly, Follong et al. (2022) examined the nutrition programs of primary schools and found that nutrition education topics were generally related to food groups.

In the study, the following concepts were examined in the word association test: Proteins, carbohydrates, fats, vitamins, water, and minerals. In addition, students were asked to write sentences about each key concept.

Among the key concepts given, the concept with the highest number of themes was water, fats, and carbohydrates. These were followed by minerals, vitamins, and proteins. The key concept with the highest number of words was proteins. This was followed by water, fats, carbohydrates, vitamins, and minerals.

In the study, the highest number of words was related to the concept of proteins with 171. In addition, proteins were the concept with the highest number of sentences in the related sentence section with 36 sentences. Similarly, in the study of Yurtbakan et al. (2021) about organic and non-organic foods for 4th grade primary school students, the word protein ranked first among the answers given by the students in the pre-WAT related to nutrients. As a sub-

theme in the concept of proteins, the food group of milk, meat, fish, eggs food groups sources ranked first with 111 words. This result proved that the students associated proteins mostly with animal proteins and their cognitive structures about other protein sources were weak. Therefore, teachers should emphasize the importance of other protein sources by using different teaching methods and techniques, especially when explaining protein sources. Vegetable protein sources are both more easily accessible and contain fewer harmful components than the animal protein sources (Çetiner & Ersus Bilek, 2018).

The second key concept with the highest number of words produced was the concept of water with 166 words. There were two prominent sub-themes related to the key concept of water: Beverages and importance. In the word association test study of Bahar and Özatlı (2003), the cognitive structures of high school 1st grade students about the basic components of living things were investigated. In this study, the words life, need and beverage came to the fore like the key concept of water. In the study by Young et al. (2021), both the importance of water in nutrition and its importance in our lives were mentioned. When the results obtained in the theme of beverages were examined, it was found that the students associated water with fruit juice the most and only one student associated it with drinking water. This result was quite remarkable. A future study can be conducted on this issue. Another concept in the beverages theme was milk. Milk is a strong source of protein (Ünal & Besler, 2008). Another important result was that some students associated water with milk. Although one person wrote the concept of energy under the theme of function, water was not among the energizing nutrients (Ünsal, 2019). Furthermore, a total of 34 sentences related to the key concept of water were formed. It was the second concept with the highest number of sentences among the given key concepts.

Then there were fats with 153 words. In the concept of fats, the most association was made with the theme of oil seeds. It was later associated with vegetable oils and animal fats. The students made stronger associations with vegetable fats than with animal fats. They mostly associated the concept of oil with the theme of oil types. Generally, it can be said that the cognitive structures of students related to fats are strong. A total of 33 sentences were formed about the concept of fats.

There were 148 words in the concept of carbohydrates. In this concept, the answers given by the students in the bread and cereal group theme were also found intensely. Although fruits and vegetables are an important source of carbohydrates, a weak relationship was established between them by the students. The reason for this can be investigated by

different methods such as survey or interview. It is recommended that teachers explain carbohydrate sources in a more memorable way with different methods. Similarly, in the study conducted by Çelik Kayapınar and Aydemir (2014), 42 percent of the high school students participating in the study related their carbohydrate sources to cereals. A total of 33 sentences were formed about the concept of carbohydrates.

145 words related to the key concept of vitamins were created. The concept of vitamins was most associated with fruits. Gündoğdu (2018) examined the misconceptions about organic molecules in biology course in a study conducted with 9th grade high school students. As a result of the study, it was determined that students did not perceive vitamins concretely very much and therefore they usually made connections with fruits. Although the concept of orange, which was included in the theme of fruits, was written by many students, lemon was written quite few. Orange and lemon are words that are usually used together in everyday life and have associations with each other. In addition, the students associated the theme of vegetables with vitamins less than the theme of fruits. Vitamin C is especially abundant in oranges, lemons, green vegetables, tomatoes, cauliflower, cabbage, broccoli (Dalkılıç, 2020). Energy written under the theme of functions by the students was among the misconceptions about vitamins since vitamins were not recognized as energy-giving nutrients in our bodies (Şahin, 2018). All these results show that students lack knowledge about vitamins. The concept of vitamin can be explained with different teaching methods and techniques and studies can be carried out to eliminate the lack of knowledge in students. There were 33 sentences about vitamins, just like carbohydrates and fats.

There were 143 words related to the key concept of minerals. The weakest key concept in which students' cognitive structures was minerals. In the word association test, it was both the key concept that students formed the fewest number of sentences with 29 and the key concept that was left blank the most with 12 students leaving it blank. It was highly associated with the theme of fruits, which suggests that the concept of minerals was not fully understood. Therefore, additional learning can be done, particularly regarding the key concept of minerals.

The students associated the key concept of water, vitamins, and minerals with energy in the theme of function in line with their answers. This result indicated that the students did not have enough information about the function of water, vitamins, and minerals. Similarly, the study of Şahin (2018) related to misconceptions about nutrients in middle school students concluded that vitamins, water, and minerals were characterized as nutrients that provide

energy. There was a lack of knowledge about energizing foods among the students. It is recommended that teachers do additional learning with students, especially about energizing foods.

In this study another concept that was associated with the concept of mineral in high numbers was water. The reason for this may be that the students have studied the concept of water and mineral under the same title in the national education textbook (Yaman et al., 2019). However, mineral was quite rare among the students' answers related to the concept of water. The reason for this result can be investigated in other studies too.

Depending on the results of the current study, in future studies

- the WAT technique can be used to identify students' cognitive structures and misconceptions about other basic concepts in science,
- the quantity of people in working groups can be more,
- the development of students' cognitive structures related to the subject can be determined by applying pretest and posttest,
- students' cognitive structures related to nutrient content can also be measured with techniques such as surveys and interviews.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

No conflict of interest.

Funding

None.

CRediT author statement

The article was collaboratively written by two authors, with each contributing equally to its content.

Research involving Human Participants and/or Animals

The study involves human participants. Ethics committee permission (Date: 16.04.2023, Number: E-19928322-302.08.01-248308) was obtained from Balıkesir University, Science and Engineering Sciences Ethics Committee.

İlkokul Öğrencilerinin Besin İçeriklerine İlişkin Bilişsel Yapıları: Kelime İlişkilendirme Testi

Özet:

Çalışmanın amacı, ilkokul dördüncü sınıf öğrencilerinin besin içeriklerine yönelik bilişsel yapılarını belirlemektir. Çalışmada, nitel araştırma yöntemlerinden durum çalışması desenini kullanılmıştır. Çalışma grubu, 2021-2022 eğitim-öğretim yılı Bursa'da bir devlet okulundaki 41 dördüncü sınıf öğrencinden oluşmaktadır. Veriler, kelime ilişkilendirme testi kullanılarak toplanmıştır. Verilerin analizinde içerik analizi yöntemi kullanılmıştır. Çalışma sonuçlarına göre, proteinlerle ilgili 11 tema oluşturulmuş ve en çok ilişkilendirilen alt tema süt, et, balık ve yumurta besin grubudur. Karbonhidratlarla ilgili 14 tema oluşturulmuş ve en çok ilişkilendirilen alt tema ekmek ve tahıl grubudur. Yağlarla ilgili 13 tema oluşturulmuş ve en çok ilişkilendirilen alt tema yağlı tohumlardır. Vitaminlerle ilgili ise 12 tema oluşturulmuş ve en çok ilişkilendirilen alt tema meyvelerdir. Su ve minerallerle ilgili sırasıyla 13 ve 14 tema oluşturulmuştur. Suyla en çok ilişkilendirilen alt tema içeceklerken, minerallerle ilişkilendirilen alt tema mineral kaynaklarıdır. Öğrencilerin en fazla boş bıraktıkları ve yanlış ilişkiler kurdukları kavram ise minerallerdir.

Anahtar kelimeler: Besin içerikleri, kelime ilişkilendirme testi, ilköğretim.

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