



## COGNITIVE STRUCTURE OF PRESERVICE PRIMARY SCHOOL TEACHERS FOR BASIC BIOLOGY CONCEPTS

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**Abstract:** This study aimed to determine the cognitive structures of preservice primary school teachers for basic biology concepts using Word Association Test (WAT). The study group consists of 50 preservice teachers studying in a university in Western Black Sea Region in Turkey. Four separate cut-off points were determined and analysed. Organ, living things, microscope were the most common response words. The conceptual network was structured as three different islets that were disconnected from each other at the third cut-off point. The desired conceptual network was formed only when cut-off point was taken further than the last cut-off point, and that these desired interconnections, network structure were formed in some students. It is suggested that this situation should be taken into consideration while determining cognitive structures using WAT and that lecturing should be performed according to the structure of the conceptual network that is desired to be shaped in the students' memory.

**Key words:** biology, cognitive structure, word association test, preservice primary school teachers

### 1. Introduction

There are many courses that students have difficulties in learning, and many reasons for this that originate from the student, the teacher, the family, the school conditions, the lesson, and the system are known. The biology course is one of the courses that students have difficulty in learning in terms of the subjects it includes (Çimer, 2012; Lazarowitz & Penso, 1992; Seymour & Longdon, 1991). Although it is actually an interesting course that examines living things, it can be said that students have difficulties while learning this course because it includes both invisible abstract subjects and the concepts that are the building blocks of knowledge and the connections between these concepts cannot be completely established by students (Jones & Rua, 2008; Lukin, 2013) because the inability of students to learn concepts correctly causes difficulties in the high-level learning process (Aydın & Balm, 2007). The Word Association Test (WAT) has been used as one of the complementary measurements and evaluation techniques since the past in determining connections between these concepts in students' cognitive structures, i.e. a network of knowledge (Bahar, Johnstone & Hansell, 1999). In addition to determining the cognitive structure about the subject desired to be investigated, the WAT is successfully used in determining the conceptual change process and detecting misconceptions (Balbağ, 2018; Ercan, Taşdere & Ercan, 2010; Taşdere, Özsevgeç & Türkmen, 2014; Yener, 2017). There are studies in which the cognitive structures of students related to some key concepts in science teaching, especially in biology, are determined by using the WAT. In these studies, for example, one or two stimulus concepts such as "dangerous animals" (Çardak, 2009a), "living cell and biodiversity" (Kostova & Radoynovska, 2008), "enzyme" (Kurt, 2013b), "evolution" (Önel & Yüce, 2016), "biological species" (Çardak & Dikmenli, 2018), "central dogma" (Sikumbang, Rakhmawati & Suwandi, 2019), "circulatory system" (Irbidayanti & Kurt, 2019) are focused on, or relationships between concepts in a subject such as "sunlight energy, photosynthesis, respiration, producer, separator, oxygen, carbon dioxide, ATP, glucose" (Çardak, 2009b) and the "environment, species, habitat, population, ecosystem, food chain, biological diversity, global warming" (Özata-Yücel & Özkan, 2015) are also focused on.

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## 2. Research Problem

One of the goals of biology education is to enable students to learn the concepts related to biology without memorizing them and to use these concepts and the relationships between them correctly when necessary. Since most of the biology concepts are within the scope of general biology courses, it is extremely important to determine how these relationships between concepts are shaped for increasing students' achievement. Therefore, the present study aimed to observe the cognitive structures of preservice primary school teachers in their minds regarding some basic biology concepts within the scope of the General Biology course as a network. In line with this purpose, the main problem of the study is "How are the cognitive structures of preservice primary teachers structured for basic biology concepts?" Based on this main problem, the following sub-problems are attempted to be responded:

- What are the differences between the total numbers of the response words given to key concepts in relation to basic biology?
- How were the connections between the basic concepts of general biology and response words established in the cognitive structures of preservice primary school teachers?

## 3. Materials and Methods

### 3.1. Research Design

Phenomenology, which is a design of the qualitative research method, was used in this study. With phenomenology, participants' feelings, perceptions, thoughts, constructions, and states of consciousness with regard to their experiences are investigated (Van Manen, 2007). In this study, the phenomenon in which a view is requested to be investigated in-depth is the perceptions of preservice primary school teachers of some basic biology concepts.

### 3.2. Study Group

The study group consists of a total of 50 preservice teachers, including 11 males and 39 females, receiving education in the 2018-2019 academic year in the Primary School Teaching Program of a university in the Western Black Sea Region of Turkey. Criterion sampling, one of the purposeful sampling methods, was used when forming the study group (Yıldırım & Şimşek, 2008). The fact that the preservice primary school teachers had taken the General Biology course was accepted as the main criterion. The other demographic characteristics of the preservice primary school teachers, other than this criterion, such as income levels, ethnic backgrounds, and family structures, were not taken into account since they were not related to the objective under examination.

### 3.3. Data Collection Tool

**3.3.1. Word Association Test (WAT).** The WAT is among the most common techniques used to determine the cognitive structures of individuals with regard to concepts, to analyse the links between the concepts in these structures, and to determine whether the links between the concepts in individuals' long-term memories are meaningful (Bahar, Johnstone & Hansell 1999; Hovardas & Korfiatis, 2006; Yener, 2017). In this study, ten key concepts (living thing, classification of living things, DNA, nucleus, genetics, microscope, cell, tissue, organ, system), which are considered to be basic according to the content of the General Biology course, were determined to be used in the WAT. In arranging these concepts and ensuring their validity, three experts in the field of primary school education and two instructors in the field of biology education were consulted, and the data collection tool was created by considering the experts' recommendations (Figure 1).

Cell.....  
 Cell.....  
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 Cell.....

**Figure 1.** *The WAT tool prepared according to the "cell" key concept*

**3.3.2. Application Process.** Prior to the application, it was ensured that the students understood the technique by performing an application on a different word with regard to the WAT technique. Explanations were made to the preservice teachers about the WAT, and an average of 30 seconds was given for each concept. This duration was determined in line with the studies in the literature (Bahar, Johnstone & Hansell, 1999; Yener, 2017). In WAT studies, preservice teachers were asked to write down the words they thought were related to each key concept, one under the other in the given time. The studies also stated that the reason why words related to the key concept were written one under the other was to prevent the risk of chain responses (Bahar, Johnstone & Hansell 1999).

### 3. 4. Data Analysis

The analysis of the data obtained from the WAT was performed as suggested by Bahar, Johnstone and Hansell (1999). In this process, a frequency table showing how many times all the words suggested for the key concepts given at the beginning for the WAT results were repeated was established, and a concept network map that clearly revealed the relationships between the words was created. This map is quite informative about the shape and complexity of students' cognitive structure. While creating this map, the cut-off point technique developed by Bahar, Johnstone & Hansell (1999) was used. In this technique, in the frequency table obtained from the WAT, the most common response word for any concept is defined, and a number range is determined and taken as the first cut-off point and written in the first part of the concept network. Then, this boundary is pulled down in line with the number range determined at the beginning, and this process continues until all key concepts that are given to preservice teachers as stimulus words are placed in the concept network. In this study, the cut-off point interval was selected as 9, and three cut-off points (46-37, 36-27, 26-17) were determined according to the frequency table prepared according to the given key concepts. Although the key concepts given to the preservice teachers emerged at the final cut-off point (26-17), it was observed that the frequencies of the response words given by the preservice teachers were concentrated at nine, and then the frequencies decreased considerably. This situation made us think that the interconnections and the conceptual network that were expected to be formed in an interconnected way and desired to be established by the preservice teachers could only be reached if an advanced cut-off point was taken. To this end, instead of the nine units predetermined as the cut-off point range, the final interval was reduced by seven units in the direction of the frequencies to create an additional cut-off point of 16-9, and this cut-off point was also included in the analysis. As a result of the analysis of the WAT data, the concept network formed according to the cut-off points was drawn using the Bubbl.us. (2009) application in the internet environment.

It is important to note that it is not necessary to draw two or more independent concept networks and compare them to find reliability since the concept network is established using the values in the frequency table and there is no other way to draw it differently. Only response words can be replaced at each cut-off point, and this does not affect the overall quality of the concept network drawn using exact frequency values.

### 3. 5. Ethical Consent of the Study

This study was approved by the Human Research Ethics Committee in Social Sciences of Bolu Abant İzzet Baysal University (Protocol No: 2017/129).

## 4. Results

In this study, in which the cognitive structures of the preservice primary school teachers regarding "living thing, classification of living things, DNA, nucleus, genetics, microscope, cell, tissue, organ and system" were examined, the total number of different responses given to each keyword is presented in Table 1.

**Table 1.** The total number of different response words given for each key concept in the WAT

Key concepts	The total number of different response words	The overall total
Microscope	246	1556
Organ	234	
Living thing	222	
Classification of living things	174	
DNA	159	
Cell	143	
System	116	
Genetic	106	
Nucleus	95	
Tissue	61	

As can be understood from Table 1, the total number of response words given for the "microscope" key concept was higher compared to the other key concepts. Such a high value may have resulted from the fact that the microscope is one of the basic research materials of biology and that preservice teachers frequently encounter it in both science and biology courses at other educational levels starting from primary school. Although biology is a discipline that studies living things, it is a surprising finding that the key concept of "living thing" did not appear at the highest frequency. Furthermore, it is thought that the number of response words created for the key concept of "organ" was high due to the fact that they are in close relationship with the physiological activities in their bodies, and tissues were in the last place according to the number of response words because they are more of micro-size than organs.

**Table 2.** Response words and frequencies given to basic biology concepts by the preservice teachers

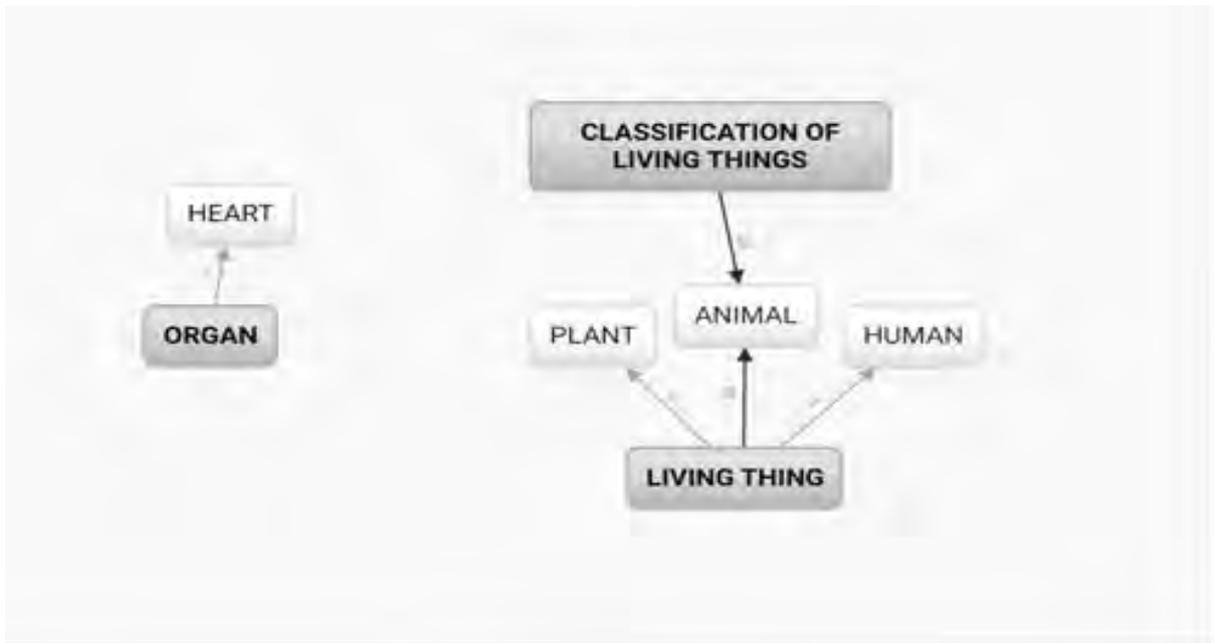
Cut-off points	Key concepts	The Response words and frequencies	The total frequencies	The overall total
46-37	Living thing	Plant (f=46), Animal (f=45), Human, (f=44)	135	214
	Organ	Heart (f=41)	41	
	Classification of living things	Animal (f=38)	38	
36-27	Microscope	Lamella (f=32), Slide (f=31)	63	188
	Classification of living things	Plant (f=35)	35	
	Nucleus	Cell (f=32)	32	
	Organ	Pulmonary (f=30)	30	
	DNA	Adenine (f=28)	28	
	Organ	Kidney (f=26), Liver (f=26), Stomach (f=22), Eye, (f=20), Intestine, (f=19),	113	
	Microscope	Optic (f=26), Lens (f=25), Tissue Slide (f=20), Cell (f=19), Lens (f=18)	108	
	Genetic	DNA (f=22), Disease (f=22), Mother-Father	96	

26-17		(f=18), Family (f=17), Eye (f=17)		665
	<b>DNA</b>	Guanine (f=26), Cytosine (f=23), Thymine (f=23), RNA (f=20)	92	
	<b>Living thing</b>	Organism (f=24), Movement (f=24), Breath (f=17)	65	
	<b>System</b>	Excretory (f=21), Digestion (f=19), Living thing (f=17)	57	
	<b>Classification of living things</b>	Human (f=21), Mammal (f=17)	38	
	<b>Cell</b>	Cell wall (f=18), Nucleus (f=18)	36	
	<b>Tissue</b>	Derm (f=18), Cell (f=18)	36	
	<b>Nucleus</b>	Center (f=24)	24	
16-9	<b>Cell</b>	Cytoplasm (f=16), Plant (f=16), Animal (f=16), Mitochondrium (f=15), Cell membrane (f=10), Cell parietal (f=9), E.R. (f=9), Microscope (f=9), Tissue (f=9)	107	489
	<b>Microscope</b>	Plate (f=15), Screw (f=14), Bacteria (f=12), Examination (f=12), Light (f=11), Genetics (f=11)	75	
	<b>Classification of living things</b>	Reptile (f=13), Body (f=12), Herbivorous-Carnivorous (f=10), Bacteria (f=10), Species (f=9), Vertebrate-Invertebrate (f=9)	63	
	<b>System</b>	Respiration (f=15), Circulation (f=15), Skeleton (f=10), Organism (f=10), Organ (f=9)	59	
	<b>DNA</b>	Helix (f=16), Gene (f=12), Mother-Father (f=11)	39	
	<b>Organ</b>	Noise (f=15), Brain (f=14), Living thing (f=12), System (f=9)	50	
	<b>Nucleus</b>	Cytoplasm (f=11), Management (f=10), DNA (f=9), Brain (f=9)	39	
	<b>Tissue</b>	Epidermis (f=14), Lenticule (f=11)	25	
	<b>Living thing</b>	Life (f=12), Respiration (f=10)	22	
	<b>Genetic</b>	RNA (f=10)	10	

#### 4. 1. Cut-off Point 46-37

It was observed that the key concepts of living thing, classification of living things, and organ emerged separately from other concepts and at a very high frequency at the cut-off point of 46-37 (Table 2). The concept network prepared according to the cut-off point of 46-37 regarding the frequency of the response words in Table 2 is presented in Figure 2.

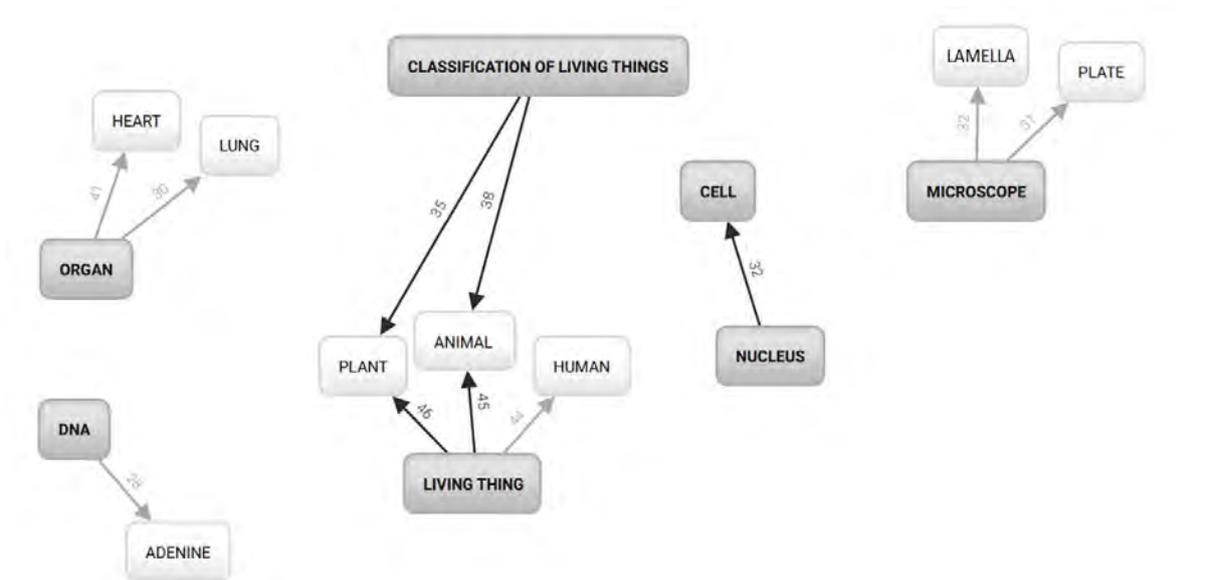
At this cut-off point, the words created by the preservice teachers for the concept of "living thing" repeat at a close frequency to each other as plant, animal, and human (Table 2). It is observed that bacteria, archaea, or some other eukaryotes were not mentioned by the preservice teachers. On the other hand, it is also an interesting finding that the key concept of the classification of living things at this cut-off point is related only to the concept of animals produced for the key concept of living thing. The heart with a very high frequency was the first thing that came to the mind of the preservice teachers for the concept of organ. This organ may have been considered more important by the preservice teachers in terms of vital activities (Figure 2).



**Figure 2.** The cognitive structures created by the preservice primary school teachers according to the cut-off point of 46-37 regarding the basic biology concepts (The response words given to the key concepts and not related to other key concepts or their response words are shown with black arrows, while those that have a connection are shown with gray arrows).

#### 4. 2. Cut-off Point 36-27

The concept network prepared according to the cut-off point of 36-27 regarding the frequency of the response words in Table 2 is presented in Figure 3.



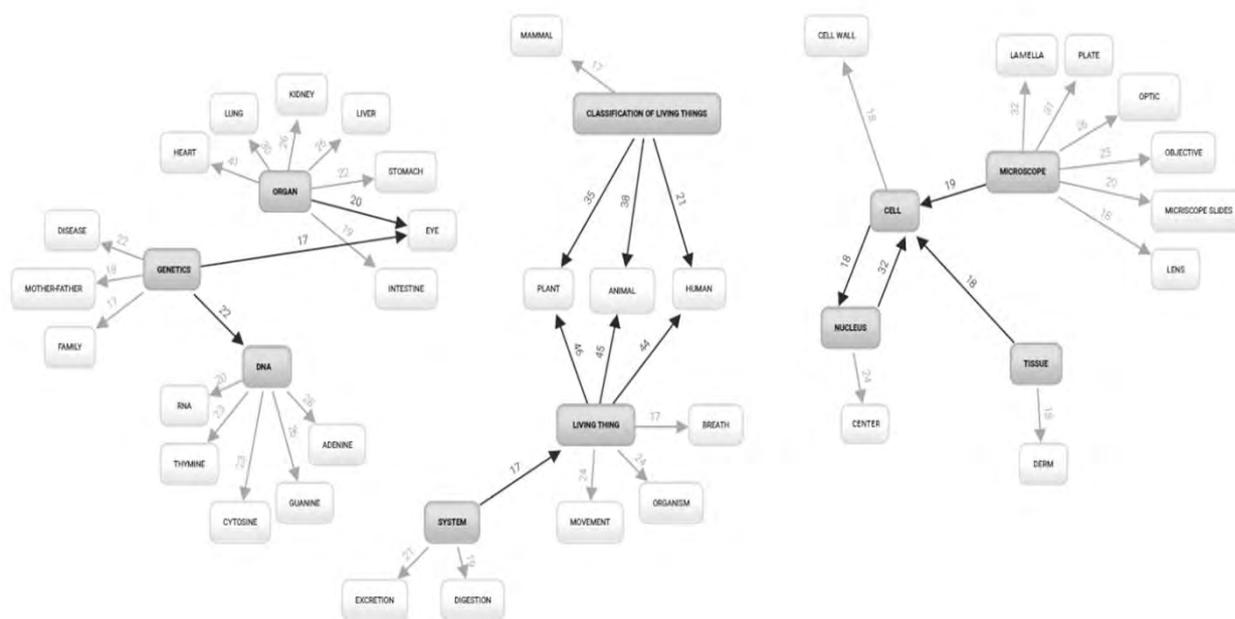
**Figure 3.** The cognitive structures created by the preservice primary school teachers according to the cut-off point of 36-27 regarding the basic biology concepts (The response words given to the key concepts and not related to other key concepts or their response words are shown with black arrows, while those that have a connection are shown with gray arrows).

When the concept network in Figure 3 is examined, it is observed that the key concepts of cell, DNA, nucleus, and microscope were added to the previously shaped concept network. Furthermore, the response word "plant" was added to the key concept of the classification of living things that had appeared before, and the response word "lung" was added to the key concept of organ. On the other

hand, adenine appeared to be at a high frequency at this cut-off point among the response words given to the key concept of DNA. The fact that preservice teachers frequently encounter this concept since adenine is a type of base that is involved in the structure of both DNA and RNA and molecules such as adenosine triphosphate (ATP), nicotinamide adenine dinucleotide (NAD), and flavin adenine dinucleotide (FAD) in the cell are also involved in their structures may have made it come to mind first compared to other base varieties. When the concept network at this cut-off point was examined, the key concept of "cell" appeared to be related to the key concept of "nucleus," but the concept of "DNA," an important molecule contained in the nucleus, was shaped in this network in a state disconnected from the nucleus. It is observed that the "living thing-cell-nucleus-DNA" connection that was expected to be established could not be established by most of the preservice teachers.

#### 4.3. Cut-off Point 26-17

The concept network prepared according to the cut-off point of 26-17 regarding the frequency of the response words in Table 2 is presented in Figure 4.



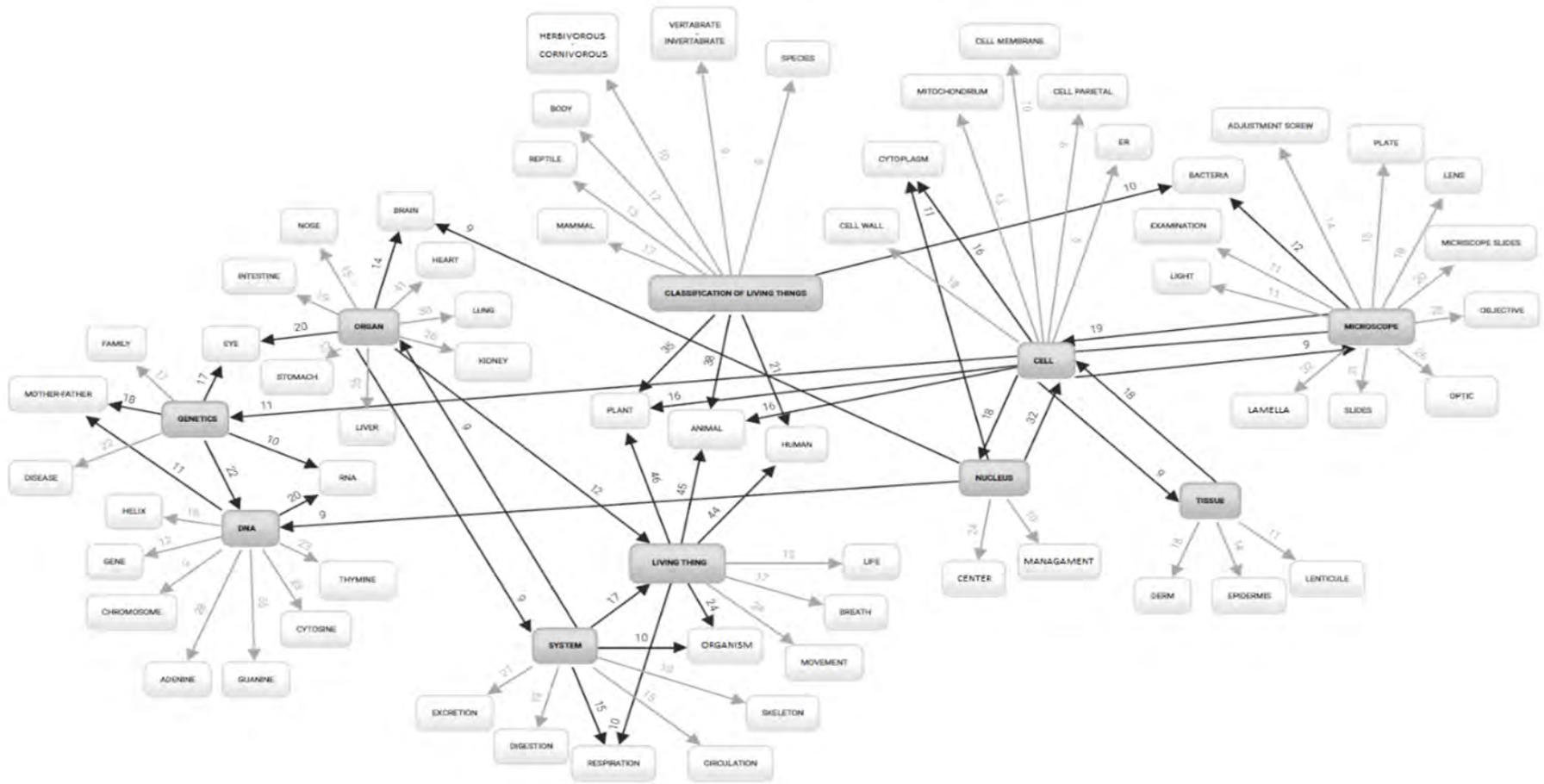
**Figure 4.** The cognitive structures created by the preservice primary school teachers according to the cut-off point of 26-17 regarding the basic biology concepts (The response words given to the key concepts and not related to other key concepts or their response words are shown with black arrows, while those that have a connection are shown with gray arrows)

When the concept network created according to the cut-off point of 26-17 is examined, it is observed that the keywords "genetics, system, and tissue" were added to the previously formed network and all key concepts were completed, and the number of response words given to the key concepts in the previous network also increased. In addition to the response words added to some other key concepts, the words "organism, movement, breath" were added to the key concept of "living thing," while the words "mammals and human" were added to the key concept of the "classification of living things." The other three bases that were included in the structure of DNA were added to the "DNA" key concept at this cut-off point. Furthermore, it can be said that the concept of "RNA," which mediates protein synthesis together with DNA, is also shaped together with the concept of "DNA" in the cognitive structures of preservice teachers. On the other hand, it is observed that the connection between the concept of "nucleus" and the concepts of "DNA and RNA" could not be established but perceived as the center of the cell with the response word "center" put forward by the preservice teachers. Although the microscope consists of optical systems and allows the examined sample to be observed through these optical parts, it was revealed that the response words "optic, objective, lens" expected to emerge at the previous cut-off point appeared in this interval. This situation shows that the

first thing that comes to mind when "microscope" is told to preservice teachers is the apparatus (slide and lamella) they benefit from when using it rather than the function of the microscope. Furthermore, it was observed that the concept of "cell" was also given as the response word by the preservice teachers at a lower frequency than these concepts mentioned ( $f=19$ ), and thus a conceptual network was established between the "microscope" key concept and the "cell" key concept. A similar network was also established between the "cell" key concept and the "tissue" key concept. The nucleus and cell wall were added to the "cell" key concept in this range, and a bidirectional connection was also established with the "nucleus" key concept. However, while the preservice teachers associated the concept of "nucleus" with the concept of "cell" at a high frequency ( $f=32$ ), they could not associate the concept of "cell" with the concept of "nucleus" at the same frequency ( $f=18$ ) (Table 4, Figure 3).

#### 4. 4. Cut-off Point 16-9

The concept network prepared according to the cut-off point of 16-9 regarding the frequency of the response words in Table 2 is presented in Figure 5.



**Figure 5.** The cognitive structures created by the preservice primary school teachers according to the cut-off point of 26-17 regarding the basic biology concepts (The response words given to the key concepts and not related to other key concepts or their response words are shown with black arrows, while those that have a connection are shown with gray arrows)

Although it is observed that all key concepts emerged at the cut-off point of 26-17, all key concepts are not connected to each other as a network, and it is observed that a connection takes place either directly or through response words in the form of three different islets ("tissue-cell-nucleus-microscope," "living thing-classification of living things-system," and "organ-genetics-DNA") (Figure 4). The cut-off point was reduced to 9 when it was observed that the frequency of the response words given by the preservice teachers to all key concepts was concentrated at 9. At the final cut-off point created, it was determined that most of the connections expected to be established in the cognitive structures of the preservice teachers were structured, and the network became much more developed and more complex (Figure 5). It draws attention that the connection between the key concept "cell" and the key concept "living thing" is established at an equal frequency ( $f=16$ ) through the response words "plant" and "animal." This indicates that the concepts of plant and animal evoke each other in the minds of preservice teachers. At this cut-off point, it was observed that the response words "life and respiration" were added to the key concept of "living thing," but it was surprising that the response word "respiration" emerged at this cut-off point. It was determined that the response words "species, reptile, vertebrate-invertebrate, carnivorous-herbivorous" and "bacteria" were added to the key concept of "classification of living things," and a connection was established with the key concept "microscope" through the response word "bacteria." The addition of the response word "management" to the key concept of "nucleus" indicates the presence of the knowledge that cellular management is performed by the nucleus in preservice teachers. It was also observed that there was a connection between the "organ" key concept and the "living thing" key concept at this cut-off point, which had been shaped in a disconnected way from each other at the previous cut-off point. It was found that some other connections, such as "cell and tissue," "organ and system," "nucleus and DNA," and "nucleus and cytoplasm," which were expected to be established among the key concepts by the preservice teachers, were established in this cut-off range, but the main connections required to be established, such as "living thing and the classification of living things" and "cell and DNA" could not be established. This situation demonstrates that the subject is structured incompletely in the minds of preservice teachers.

## 5. Discussion

A dynamic relational structure that includes connections with other concepts in addition to representing the concepts of a subject themselves is created in mind (Kostova & Radoynoyska, 2008). The WAT, which is used to reveal this structure, provides information about the number and variety of responses given by students to basic concepts and the complexity of the relationships between concepts. In this study, the cognitive structures of preservice teachers studying in the primary school teaching program with regard to basic biology concepts were revealed through the WAT. The number of response words given to key concepts in the WAT is the main method used at the evaluation stage of this technique. The numbers and qualities of other words that are related to the key concept can be used to determine whether that concept is meaningful or not. As the number of concepts that are interpreted emerges, how much knowledge the student has about the subject also emerges. The interpretation stage, which teachers also have to use, fails unless students associate concepts with their knowledge. Likewise, the more the student overlaps the key concept with his/her prior knowledge, the better the concept will be learned (Bahar, Johnstone & Hansell, 1999).

In the study, it was observed that the preservice primary school teachers' approaches towards the concepts related to biology were mostly directed to the principle from near to far, and they associated the concepts with their frequency of use in daily life or their proximity to their vital activities. Moreover, the scarcity of the preservice teachers' response words given to the key concepts can be explained by their lack of sufficient knowledge about the concepts and their not being properly interpreted in their minds because the number of different response words given for a concept in the WAT can be assumed to be an important and direct indicator of an individual's understanding the concept. The number of responses given by students about the concept and the excess of the connection between the concepts are regarded to be a symbol of the individual's level of understanding the concept. The response words not given to the WAT are considered to be meaningless by the individual because the meaning will be proportional to the number and complexity of the connections

an individual can establish (Bahar, Johnstone & Hansell, 1999). In other studies conducted with university students, it was determined that students' cognitive structures were based on traditional expressions and incomplete knowledge (Dikmenli, 2010; Kurt, 2013a).

According to the WAT, although the "living thing" key concept is an expected result at the first cut-off point, it is quite interesting that it ranks third when the frequency of the response words is examined. It was observed that the response words created by the preservice teachers for the key concept of "living thing" were repeated at close frequencies to each other as plant, animal, and human. Likewise, in the study carried out by Kurt (2013a) with preservice biology teachers, the response words given to the key concept of "living thing" were repeated at a very high frequency compared to other response words including "animal (f=22), human (f=19), and plant (f=22)," which supports our study. Furthermore, in our study, it is quite thought-provoking that the "reptile, carnivorous-herbivorous, bacteria, invertebrate" living groups emerged only at the last applied additional cut-off point, and even the "species" category, which is the basic category in the classification of living things, was suggested by only nine preservice teachers. Moreover, although all of the key concepts given to the preservice teachers were related to "living thing" and this key concept should be directly linked with other key concepts, not with the response words given, the fact that these connections could not be established indicates that the preservice teachers did not have a valid conceptual framework on this subject. However, in the WAT study performed by Taştan-Kırık & Kaya (2014) with 6th-grade students, "cell" was given as a stimulus concept, and it was observed that the response word "living thing" was given by approximately half of the students (f=31). Upon examining the student responses, it was stated that they were aware of the fact that the cell was present in living thing and that it was alive. In the same study, the response words "nucleus, (f=16)" and "tissue, (f=2)" at a low frequency were also the response words put forward by students. While these connections were found in the cognitive structures of students who first encountered the cell concept at the primary education level, their absence in students at the final level of education may have originated from the fact that they could not establish simple connections due to the addition of more concepts and their becoming more complex as the subjects progressed. Furthermore, the addition of the response word "RNA" to the key concept of "DNA," although at the third cut-off point, indicates that these two types of nucleic acids in the cell are known, and the knowledge that these nucleic acids are related to each other is in the cognitive structures of the preservice teachers. On the other hand, although DNA and RNA are present in the nucleus of the cell, it is observed that these concepts cannot be connected with the nucleus. Likewise, in their WAT study conducted with teachers, Kostova & Radoynovska (2008) found that most teachers associated the cell with its structural components, but they could not establish the connection with "DNA" due to its role in cell activities, although it ranked first among all chemical components of the cell. The researchers stated that this situation might have been caused by the teachers' inability to associate cytology with biochemistry.

In our study, the emergence of the word "center" among the response words given to the key concept of "nucleus" shows that the nucleus is perceived as the center of the cell by the preservice teachers. In fact, although the shape and position of the nucleus, which covers only 10% of a eukaryotic cell, varies according to the shape and functions of cells, it is generally located near or in the center in animal cells, while in plant cells, it is pushed aside due to the large and central vacuole in the cytoplasm (Alberts, 2002). This indicates that the aforementioned information is not included in the cognitive structures of preservice teachers. Furthermore, textbooks are one of the important reasons for the emergence of misconceptions in students (Ecevit & Özdemir-Şimşek, 2017; Kara & Aktürkoğlu, 2019; Yılmaz et al., 2017). The depiction of the nucleus material in the center of the cell in the visuals of cells in textbooks may have also led to the formation of such information in the minds of preservice teachers. In this context, it is also of great importance to prepare textbooks in a way that does not cause misconceptions.

In the current study, although all the key concepts given to the preservice teachers emerged at the final cut-off point, it was observed that all key concepts were not interconnected in the form of a network, and three different islets were created in the form of "tissue-cell-nucleus-microscope", "living thing-classification of living things-system," and "organ-genetics-DNA." However, when the cut-off point was reduced to 9, it was determined that the connections of the key concepts with each other were

established directly or through response words and the network was formed as a holistic structure. It is worrisome to see that the desired connections could not be established by all preservice teachers but were established by a very low number of the preservice teachers who participated in the study between 32% and 18% because the more connections are established between the concepts, the more the meaning of the word is enriched and learned (Schaefer, 1979). Sekin (2002) stated that the education system is predominantly based on knowledge loading and that students are trained directly for exams without giving place to their research and thinking. The situation that emerged in the current study may have resulted from the students' learning by rote without analyzing the information. One of the most important factors affecting learning is the existing accumulated knowledge and conceptual frameworks. Individuals cannot interpret any view that does not conform to scientific facts within this conceptual framework. If concepts are not learned and structured, learning becomes more and more difficult, leading to misunderstandings and misinformation (Kurt 2013a). Accordingly, before starting to teach any concept, students' conceptual frameworks, inaccurate and inadequate knowledge and concepts in their memory should be determined.

Although biology is the living science, while the total number of response words given for the key concept of "living thing" was expected to be the highest compared to others, it ranked third. Furthermore, the connection that was expected to be established directly between the "living thing" key concept and other key concepts or between the related key concepts could not be established by many preservice teachers who participated in the study, and very few of them were established through response words. The WAT used in the study reflects a snapshot of the mental structure of all students in terms of structure. Therefore, it does not mean that the desired interconnections and network structure cannot be observed in students, even in a very low number. To ensure that the desired connections are established by all preservice teachers attending the course, it is necessary to determine the cognitive structures of the students with regard to the subject before starting the educational activity. According to the results obtained, the course process can be carried out in a more concrete way in order to eliminate the wrong relationships detected in students and to create the conceptual links desired to be established. Thus, students will structure and encode new concepts and information properly in their minds, and more meaningful and permanent learning will be provided with the correct relationships they establish between them. In this way, training preservice teachers who have a cognitive structure with valid conceptual links related to the subject that is desired to be learned will enable them to provide more qualified and meaningful education to their students. Furthermore, the General Biology course, which was in the Primary School Education Undergraduate Program between 2007 and 2018 in Turkey, was removed from the program with the renewal of the teacher training undergraduate programs in 2018. The present study was performed with preservice teachers who had taken this course, and it was observed that these candidates did not have the cognitive structure with the desired conceptual framework. In this context, to eliminate these deficiencies in the biology concepts of preservice primary school teachers, the reduction of the number of subjects rather than removing the course is important for meaningful and in-depth learning. In addition to this, it is suggested that the General Biology course should not be removed from the program in order to establish the correct connections between concepts in their cognitive structures.

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