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Biology student teachers' cognitive structure about "Living thing"

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The current study aims to determine biology student teachers' cognitive structure on the concept of "living thing" through revealing their conceptual framework. Qualitative research method was applied in this study. The data were collected from 44 biology student teachers. A free word association test was used as a data collection instrument. The data collected were subject to content analysis. Analyzing the biology student teachers' responses to the concept of living thing on the free word association test, these responses were coded and divided into categories. Based on the categories, frequency and percentages were provided. The internal validity of the themes and subthemes categories was ensured by the author and two experts in Biology. The data collected through the study were divided into 7 categories. These categories were: examples of types of living things based on the levels of classification, levels of organization, characteristics of living things and metabolism, cell and its organelle, energy in living things, environment occupied by living things and the reactions shown to the conditions of the environment, and the concepts that a living thing revokes. When the words provided as answers by the biology student teachers were analyzed, it was noticed that they had closer word connections with the category of "examples of types of living thinks based on the levels of classification" than "characteristics of living thinks and metabolism" and "energy in living things". Moreover, it was determined that they had some misconceptions about living thing.

Key words: Living thing, free word association test, misconceptions, cognitive structure.

INTRODUCTION

To understand how students transfer knowledge to their minds and how they structure this knowledge is one of the most important issues that researchers are interested in. Constructive learning approach indicates that individuals construct knowledge actively through associating this knowledge with pre-existing knowledge and previous experiences (Anderson 1992; Bodner 1986). According to this approach, due to the associations with previous experiences, the existing cognitive structures in mind affect individuals' perceptions of new events and the new cognitive structures that they will construct. It is, then, possible that a weak cognitive structure will affect the process of constructing new knowledge in the mind adversely, and thus, leading to failure to construct new knowledge meaningfully (Tsai and Huang, 2002). One of the most common concepts related to constructing knowledge in the mind is cognitive structures. It is possible to define a cognitive structure as the mental schema that organizes and keeps the components that make up knowledge during any learning. *Cognitive structures* are the basic mental processes people use to make sense of information. Other names for cognitive structures include *mental structures, mental tools*, and *patterns of thought* etc.

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Individuals have intellectual interactions with their environment through five senses. Any knowledge received by these five senses is sent to the brain, and then the brain tries to structure meaningful knowledge based on these senses. This formation is based more on individuals' previous experiences as the brain tries to associate the coming knowledge with the previous or existing knowledge. According to most of the researches conducted, these are previous experience and prejudice. An individual views the world as she or he constructs in her/his mind, rather than as it really is. This is the very basic principles of constructivism. What exists in one's mind may not be true or definite; one can only explain for the validity of his/her experiences. The second fundamental principle holds pivotal implications for education, which implies that knowledge is not a passive gain. It is constructed through students' associating existing knowledge with the new one (Pereira, 1996). These principles are strongly related to the students' need for receiving knowledge (readiness). This process, which is very complex and based on individual characteristics, commences with at which knowledge level a student is and goes on through presenting concepts suitable for knowledge receiving and adding new knowledge to the existing experience and understanding. As such, students are provided with the opportunity to form relationships between the concepts and convert these relationships to multidimensional knowledge structures.

Individuals look for solutions to the problems they face while they are learning; however, in this search, they cannot create meaningful knowledge generally due to lack of or inaccurate information. This circumstance means that as a part of their learning, individuals will always have misconceptions since learning concept is depending on the fact that pre-concepts are fully understood and in accordance with other concepts (Wandersee et al., 1994). Herein, a set of alternative concepts should be determined, and teaching should be planned accordingly. In literature, there are a number of studies which stress the importance of determining and teaching alternative concepts in education (Bahar et al., 2008; Bodzin, 2012; Cavas and Kesercioglu, 2010; Cimer et al., 2011; Constantinou and Papadouris, 2012; Kaya, 2010; Lee and Liu, 2010; Liarakou et al., 2009; Musango and Brent, 2011). On the other hand, it is revealed that students had some misconceptions about the categorization of living and non-living things (Babai et al., 2010; Bahar et al., 2002; Opfer and Siegler, 2004; Venville, 2004).

Particularly in recent years, the effect of constructivist learning on educational contexts has revived conceptual understanding and different methods and strategies to be used in determining conceptual change. In this respect, rather than merely dealing with what knowledge students have, researchers have headed towards several techniques that help them evaluate students' different knowledge and the relationships between concepts, their cognitive structure, whether they can achieve meaningful learning through building a relationship between new and existing knowledge, and to what extent they can notice the similarities between the knowledge they have created in their minds and what happens in real world. In addition, some other techniques have assumed importance, which determine students' cognitive structure and the relationships between the concepts in this structure, as well as to find out whether these relationships are enough (Bahar et al., 2006). To this end, some strategies have been developed to induce and measure conceptual understanding and change. Bahar (2003) provides these strategies as follows: word association, structured grid, diagnostic tree, concept maps, texts of conceptual change, analogy, and predict-observe-explain. On the other hand, alternative techniques such as surveys, interviews, concept maps, fortune lines, and word association tests are used to determine students' opinions, understanding, or attitudes towards a specific issue (Bahar et al., 2008; White and Gunstone, 1998). Of the techniques that investigate students' cognitive structure, word association technique is the most commonly used and oldest one, which was used as a data collection instrument in this study. When the related literature is analyzed, it is observed that there are many studies conducted using free word association tests, notably in Biology. Some of these studies are briefly provided as follows.

Free word-association test has been used in many studies (Ad and Demirci, 2012; Aydin and Tasar, 2010; Bahar and Ozatli, 2003; Ercan et al., 2010; İsikli et al., 2011; Koseoglu and Bayir, 2011; Nakiboglu, 2008; Oren et al., 2011; Ozatli and Bahar, 2010; Perker, 2011; Timur and Tasar, 2011). This test is quite efficient in revealing individuals' cognitive structures and conceptual changes (Hovardas and Korfiatis, 2006). Free word-association test is a data collection technique used to determine individual's conceptual structures related to a concept. When the related literature is revised, it is observed that there are also important studies in biology conducted using free word-association tests. In this context, through word association tests, students', student teacher, and teachers' cognitive structures related to different concepts were revealed. In the studies conducted in biology, Kostova and Radoynovska (2008) investigated the cognitive structures related to "cell" and "biodiversity" of teachers and high school students with varying levels, to find out their cognitive structures and levels of knowledge; Kostova and Radoynovska (2010) studied high school students through the concept "humankind"; Dikmenli (2010a) investigated student Biology teachers through "biodiversity"; Dikmenli (2010b) did through the concepts "science" and "scientist"; Uzun et al. (2010) investigated "biodiversity" concept structures of student teachers of different disciplines and Dikmenli (2010c) investigated university biology students through "global warming". Through applying free-word association tests, the studies, while investigating students', student teachers'

and teachers' conceptual structures, revealed that they also had alternative concepts.

Concerning the literature review conducted, there is not any study conducted to investigate the participants' conceptual structures about the concept of "living thing" using the free word association test. Therefore, it is believed that the results of the current study will fill this gap in the related literature.

As can be seen from the reviews, the studies conducted on Biology education in recent years reveal that students have alternative concepts in various subjects. Herein, using a free word association test, it is possible to determine students' conceptual frameworks and reveal the alternative concepts that they have. However, to the best knowledge of the author, there is not any study in the literature that uses a free word association test to investigate Biology student teachers' cognitive structure on the concept of "living thing". As such, it is believed that the findings of the current study, which is conducted using a free word association test, will fill this gap in the literature, providing valuable data. Furthermore, the fact that the studies conducted on the concept of living thing focused mostly on the pre-university age groups (Leddon et al., 2009, 2011; Lorenzi et al., 2013; Margett and Witherington, 2011; Narli et al., 2010; Villarroel, 2013; Yorek et al., 2009) makes the data collected throughout this study more important. The aim of the current study is to investigate biology student teachers' cognitive structures related to "Living thing".

METHODOLOGY

Research design

Qualitative research method was applied in this study. The basic aim of the qualitative studies is not to obtain results that can be generalized through numbers, but to present a descriptive and realistic case related to the issue investigated. Considering the reliability and validity of the results, it is important to provide the data in detail and directly as much as possible. Accordingly, in this study, the views provided by the Biology teacher candidates on the concept of living thing were described as they were, and the results obtained were not generalized. According to Yildirim and Simsek (2006), qualitative study is a method of research that aims to provide the opportunity to consider a fact through individuals" own perspective and present the processes included in this perspective.

Participants

The study comprised 44 Biology student teachers studying at the 4th and 5th grades of Ahmet Kelesoglu Faculty of Education in Necmettin Erbakan University in spring term of 2011-2012 academic years. This study benefited from purposive sampling. Some criteria were taken into consideration in order to minimize the problems in purposive sampling (Knight et al., 2013). In this vein, several criteria were taken into consideration while selecting the participants such as having completed the field courses in Biology, willingness to participate in the study, being seniors in the department of Biology teaching and having completed the courses, and being available to the researcher. Moreover, the student biology teachers were informed by the researcher of the aim of the study and how to complete the measurement tool. Of the participants, 35 (79.5%) are females and 9 (20.5%) are males. In addition, 19 of the participants (43.20%) are 4th year students, and 25 (56.80%) are 5th year students.

Data collection tool

A free word association test was used as a data collection instrument. This data collected instrument prepared by author. A free word association test is a technique which aims to determine a student's or a group's cognitive structures. The principal aim of this technique is to present the words as stimuli to the participants one by one in each time (Atasoy, 2004). Free word association tests are one of the most frequently used and widespread techniques which aim to determine a student's cognitive structure and the relationships between the concepts in this structure; in other words, the information network, and to find out whether the relationships among the concepts in the long-term memory are enough or not. These tests have been used in many studies (Bahar and Ozatli, 2003; Ozatli and Bahar, 2010). This technique is based on the process in which an answer is suggested to a word that is used as an independent stimulus without limiting the mind to any specific response (Bahar et al., 1999; Sato and James, 1999). The participants are required to provide concepts that come to their minds in this free word association test, in a specific time (40 s); the words that are provided as answers are subject to frequency distribution that is followed by an in-depth analysis. In this way, it is possible to determine the participants' descriptions and gather findings on the related meanings of the word used as a stimulus. These practices of using free word association tests help reveal the meanings related to various concepts used in studies (Daskolia et al., 2006; Dikmenli, 2010b; Dikmenli, 2010c; Torkar and Bajd, 2006).

In this study, the concept of "living thing" has been provided for the Biology student teachers to complete the free word association test. In this test, the concept of living thing has been provided in the following format as the stimulus words:

Living thing-1 :……..
Living thing-2 :……..
.
.
.
Living thing-10 :……..

Moreover, the data collected from the participants using the free word association test (P31) are provided in Figure 1 as an example.

As can be seen from the example test in Figure 1, word association test consists of two sections;

In the first section, the Biology student teachers were asked to provide the very first 10 words that come to their minds in 40 s when they read or hear the concept "living thing" (Gussarsky and Gorodetsky, 1990). The key concept is providing one under the other in order to prevent sequential answering as they would just consider their answer and provide the words regarding that word rather than focusing on the key concept, which would threaten the validity and the reliability of the study.

In the second section, the participants were asked to write sentences related to the key concept given in 20 s, and these sentences were carefully investigated while doing the data analysis since the answer provided in relation to the key concept can only be an answer of association that is not meaningfully related to the word. Moreover, the data analysis is directly affected by some cases such as whether the sentence is scientific and whether it includes different misconceptions considering the possibility that the

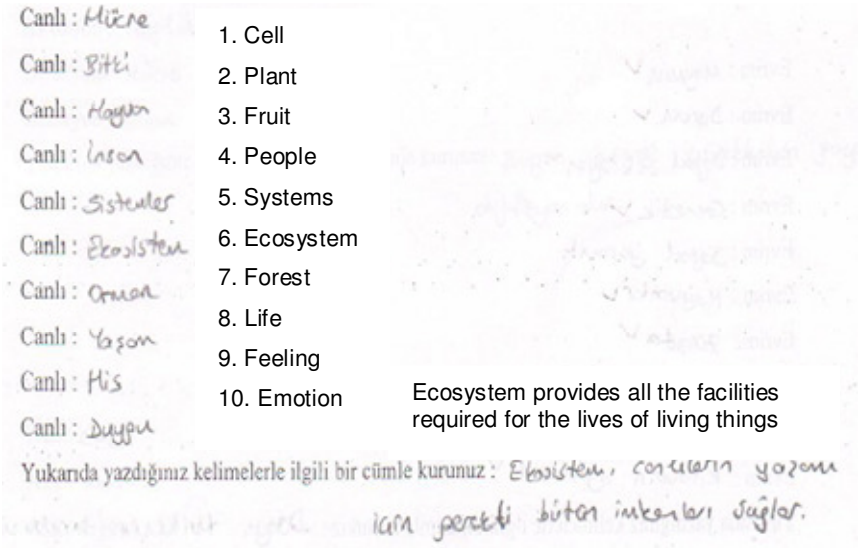

Figure 1. The answer sheet for P31.

sentence provided can be more complex and of high structure.

Reliability and validity of the data collection tool

Validity in qualitative studies means that a researcher observes the case that is investigated as it is and presents it objectively as much as possible (Yildirim and Simsek, 2006). It is also the approximation of what we believe to measure and what we plan to measure (Marvasti, 2004; Roberts and Priest, 2006). However, the biggest issue in ensuring validity in qualitative studies is how researchers can prove their objectivity. Subjectivity may emerge while researchers collect, save, or interpret data. It is possible to conduct a valid qualitative study of high quality only through minimizing this subjectivity as much as possible (Yildirim, 2010). In this research, the internal validity of the themes and subthemes categories was ensured by the author and two experts in Biology. Moreover, in this study, two important processes were realized to ensure the validity of the results of the study: (a) Data coding and analysis (how conceptual categories were obtained) were discussed in detail (Hruschka et al., 2004); (b) Teacher candidates' views that were believed to best represent each and every category obtained through the study were selected as examples, and these examples were provided in the findings section (Yildirim and Simsek, 2006).

Moreover, considering the reliability of the study, the codes and the categories provided by two researchers were compared in order to confirm whether the codes provided under each conceptual category represented the aforementioned conceptual categories. The list of codes and themes was finalized after two experts in the field of Biology coded the data individually. The consistency of the coding carried out by the participants independently was determined through the marks such as "Agreement" or "Disagreement". When the researchers used the same codes for the students' statements, these codes were considered as agreement. However, when they used different codes, these codes were considered as disagreement. When either of the researchers was not sure about the coding, s/he asked for the other's opinion, and then coded the data. The reliability of the data analysis was calculated using the formula, [Agreement / (Agreement + Disagreement) x 100] (Miles and Huberman, 1994). The average reliability between the coders was calculated as 93%.

Data analysis

Before the data analysis, the participants' answer sheets were numbered from 1-44. The data collected were subject to content analysis. In content analysis, the main aim is to determine the concepts and the relationships that will account for the data. In order to achieve this, similar data are categorized under specific concepts and themes and organized for easy understanding by readers (Yildirim and Simsek, 2006).

The data collected through the free word association test were analyzed using the techniques of number of words, number of answers and semantic relationship (Atasoy, 2004). The words that had the same meanings were classified under the category of the frequently stated words. The words that were not considered related, that were not related to the other words, and that were repeated 4 or fewer times were not taken into consideration during the data analysis. The words were categorized using the criterion of semantic relation, and the frequency calculations of these words under each category were made. In many studies, using this kind of data analysis is stated to provide reliable results (Daskolia et al., 2006; Kostova and Radoynovska, 2008; Kostova and Radoynovska, 2010).

The data of the free word association test have been analyzed with the Nvivo programme for preparing Figure 2.

FINDINGS

Through the data analysis, the words provided were divided into seven (7) categories. These categories and the words provided in each category were listed. When the words were provided once, twice, three or four times, they were not put together with the other words (Dikmenli, 2010b). As such, of the words, 32. 86% (140 words) were not included in the categories. These words not included in the categories were not provided in Table 1. The rest of the words in relation to the concept of living thing, that is 30 different words, were divided into seven (7) categories. The words included in each category and the

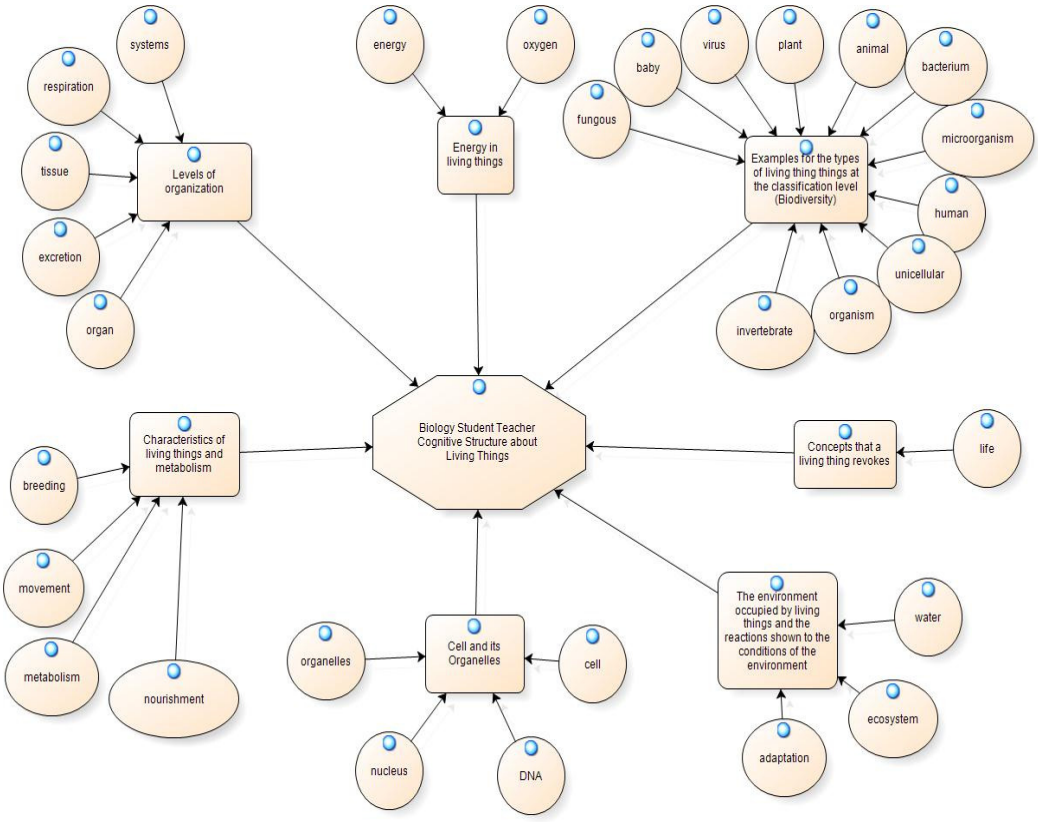

Figure 2. The model of students' cognitive structure of living things.

categories are provided in Table 1. In total, the participants provided 286 words as answers.

According to the results presented in Table 1, the responses provided by the biology student teachers and presented under the first category focused mostly on "examples of types of living things based on the levels of classification", and this category appeared as the dominant one (f=112). In this category, it was observed that while most of the participants focused on concepts "animal", "human", "plant", "bacterium" and "organism", few participants build a relationship with the concepts "virus", "invertebrates", "microorganism", "unicellular", "baby", and "fungus". This finding indicates that the participants associated the concept "living thing" more with "the examples of types of living things based on the levels of classification". The participants' association is similar to the findings of the study conducted by Cinici (2011). Moreover, it was determined that the participants paid more attention to the appearance of living things, their habitat, nourishment and ways of movement; in other words, the participants benefited from the approaches based mostly on artificial classification. The words that were provided to this category by the participants, but not included in the category as they were repeated 4 or less times were as follows: *alga, amoeba, tree, flower, multicellular, cat, dog, vertebrate, euglena worms, coelenterate, sponge,* and *green plants.*

In the second category, the participants had associations with "levels of organization" (f=42). The concepts provided by the participants in this category were "excretion", "respiration", "tissue", "organ", and "systems". As such, the participants associated "levels of organization" with the key concept, which indicated that they had a valid cognitive framework. Moreover, the words, which were provided to this category by the participants, but not included in the category, as they were repeated 4 or less time, were as follows: *circulation, eye, blood, digestion,* and *body.*

The concepts provided by the participants to the third category were related to characteristics of living things and metabolism (f=38). In this category, while the participants focused on "breeding", "movement", and "nutrition", a few of them provided the concept "metabolism". In addition, the words that were provided to this category by the participants, but not included in the category as they were repeated 4 or less times were listed as *growth, development,* and *food.*

The third category was determined as "cell and its organelle" (f=35). The associations presented by the participants were more related to the concept "cell". Few of the participants focused on the concepts "DNA", "nucleus", and "organelle". It was further determined that the Biology student teachers did not have enough associations with the concept "cell" and "its organelles".

Table 1. Associations with the concept "living thing" (categories and answers included in each category and cumulative frequency of response words).

Categories	Associations included in categories and their frequencies	Total frequency (f) of associations in this category	%
1.Examples for the types of living things at the classification level (Biodiversity)	"animal" (22) " human" (19) "plant" (18) "bacterium" (11) "organism" (10) "virus" (6) "invertebrate" (6) "microorganism" (5) "unicellular" (5) "baby" (5) "fungous" (5)	112	39,1
2. Levels of organization	"respiration" (14) "excretion" (8) "tissue" (7) "organ" (7) "systems" (6)	42	14,6
3. Characteristics of living things and metabolism	"breeding" (12) "movement" (12) "nourishment" (9) "metabolism" (5)	38	13,3
4. Cell and its organelles	"cell" (19) "DNA" (6) "nucleus" (5) "organelles" (5)	35	12,3
5. Energy in living things	"energy" (17) "oxygen" (7)	24	8,4
6. The environment occupied by living things and the reactions shown to the conditions of the environment	"water" (12) "adaptation" (5) "ecosystem" (5)	22	7,7
7. Concepts that a living thing revokes	"life" (13)	13	4,6
Total		286	100

Moreover, the words, which were provided for this category by the participants, but not included in the category, as they were repeated 4 or fewer times, were as follows: *cytoplasm, RNA, ribosome, mitochondrion*, and *cell membrane.*

In the fifth category, the responses provided indicated that the participants associated "living thing" with energy (f=24). The participants focused only on "energy" and "oxygen" in this category. It was further determined that the Biology student teachers did not have enough concepts associated with energy in living things. Without energy, living things cannot perform their activities. That the participants did not provide more associations with energy reveals that there is an inconsistency in their cognitive structure. In addition, the words, which were provided to this category by the participants, but not included in the category as they were repeated 4 or less times were concepts such as *photosynthesis, ATP,* and

carbon dioxide.

The sixth category included responses that focus more on environment occupied by living things and the reactions shown to the conditions of the environment (f=22). The participants considered the environment around the living things as "water". "Adaptation" and "ecosystem" were the responses that were least provided by the participants. Moreover, the words, which were provided for this category by the participants, but not included in the category, as they were repeated 4 or fewer times, were as follows: *food chain, the world,* and *habitat.*

The seventh category consisted of the concepts that a living thing revokes (f=13). The participants focused more on the concept "living (life)". The responses provided by the participants indicated that the Biology student teachers could not provide the responses that were closely related to a living thing revoked. Furthermore, the words that were provided to this category by the participants, but not included in the category as they were repeated 4 or less times were *living creature*, *bio, living, life,* and *inanimate.* It was observed that the Biology student teachers did not have the semantic meaning.

Other than these responses, the participants provided some concepts that were associated with the concept "living thing" and that were not included in the categories, as they were not related to the concept. Some of these concepts were *excitement, feeling,* and *dynamic.*

Some of the responses and explanations provided by the Biology teacher students on the concept "living thing" were as follows.

One of the participants defined the term "living thing", as, "*They are organisms that can live*" (P27). When the responses provided by this participant were analyzed, "breeding and movement" recalled the characteristics of living things"; "cell" did the "smallest unit of a living thing"; however, the participant did not provide these in sentences.

Another participant defined living thing as, "*They are structures that have features such as respiration, digestion, excretion, and circulation, and that maintain homeostasis due to the metabolism*" (P28). The participants" responses were provided in sentences. However, while defining living thing, the participants focused only on systems and preferred to use the concept of metabolism. Moreover, one of the responses provided by this participant was "cell", which was not used in a sentence.

Another participant defined living thing as "*The living things on the world*" (P29). The responses of this participant (*cell, plant, animal, microorganism, unicellular, function of living, active, living, organs, systems*) were found not to be used in sentences.

"*Living things can be divided into animals, plants, fungous, and monera*" (P30) was the response given by another participant. When the responses were analyzed, it was observed that this participant used the words such as breeding and movement, which are considered to be among the characteristics of living things; however, these responses were not used in sentences. This participant only classified the living things.

Regarding living things, another participant put forward that "*Ecosystem provides all the opportunities to living things for life*" (P31). The responses (*cell, plant, animal, human, systems, ecosystem, forest, life, sense, and feeling*) indicated that this participant focused on "*ecosystem*" while describing living things. Moreover, it was further determined that this participant had some associations which were not related to the key concept such as *sense* and *feeling*.

"*Anything with a cell is called a living thing. They can be unicellular or multicellular. DNA and RNA are the genetic materials of living things*" (P32) was another participant' response. The responses (*cell, virus, DNA, RNA, bacteria, fungous, protozoa, systems, organism, and tissue*) revealed that this participant benefited from semantic relationships.

Another participant defined living things as "*A living thing is a structure that can reproduce, excrete, breathe, and transfer its characteristics to another*" (P33). It was observed that the responses provided by this participant (*plant, animal, respiration, breeding, excretion, oxygen, human, DNA, and heredity*) were indirectly used.

"*Living things can reproduce, breathe, and have a digestive system. Kinds of living things are plants, humans, and animals. Life depends on water. Living things have blood*" (P36) was the response by another participant. This participant seemed to have some in-complete and inaccurate knowledge while providing the characteristics and kinds of living things such as w*ater is an inorganic matter that is required for all living things. Blood, on the other hand, is one of the kinds of cell that is the smallest part of a living thing.*

Another participant touched upon the process by saying that "*From the moment a cell is formed to the last cell accomplishing its activity is called being alive*" (P38). The responses provided by this participant (*human, microorganism, water, life activity, energy, food, excre-tion, cell, nucleus, and inanimate*) indicated that the participant did not use most of the concepts.

Other statements are as follows:

"*Creatures are the things that make the world meaningful"* (P41)
"Nucleus is the center of a cell; organelles are specialized structures of a cell; tissue is the material that forms organs. ..... Living healthy makes someone strong" (P42)
"Water is required to be alive" (P44)

It was observed that some of the participants did not provide any sentence, while some others did not provide meaningful sentences related to the words that they provided. The reason for this may be that they really did not know what to write or although they knew these

concepts, they just did not want to write anything. Most of the Biology student teachers limited themselves to defining living things, which reveals that their associations were just related to living things and their characteristics. However, these associations did not appear as the dominant category. Some of the participants could provide definitions of levels of organizations; some did of environment occupied by living things and the reactions shown to the conditions of the environment, and only one participant did classification of living things.

Analyzing the data collected, a model has been suggested for the students' cognitive structure of living things (Figure 2).

The Biology student teachers' cognitive structure of living thing is provided in Figure 2. According to this model, the Biology student teachers' cognitive structure of living thing was based on seven categories.

When this study is analyzed concerning the Biology student teachers' biological literacy, "*as stated by Uno and Bybee* (1994), *biological literacy should be based on the fundamental facts such as principles in Biology, important concepts in Biology, how humans affect biosphere, scientific research methodology, and the historical review of biological concepts. Subjective comments should be geared towards the biological information in scientific research; creative thinking should be encouraged; different questions should be asked, and knowledge should be both evaluated and processed*". It was determined that the Biology student teachers could not build enough relationships and touch upon the pivotal concepts in the main themes such as energy in living things, environment occupied by living things and the reactions shown to the conditions of the environment. As such, the Biology student teachers did not appear to have the intended and expected conceptual biological literacy (Uno and Bybee, 1994). Kurt et al. (2009) state that most of the Biology student teachers cannot associate their knowledge in Biology conceptually with daily life. Therefore, they stressed that most of the Biology student teachers were not literate in conceptual Biology.

RESULTS AND SUGGESTIONS

The main aim of the current study is to determine biology student teachers' cognitive structure on the concept of"living thing" using a free word association test since their cognitive structure of the concept "living thing" plays a pivotal role in structuring the concepts in Biology and the nature of Biology. Through this study, the Biology student teachers' positive and negative associations were revealed based on the concept "living thing". The data collected through the study were divided into 7. In this respect, the data were divided into seven categories. These were stated as follows: examples of types of living things based on the levels of classification, levels of some did on cell and its organelles; and some provided organization, characteristics of living things and metabolism, cell and its organelle, energy in living things, environment occupied by living things and the reactions shown to the conditions of the environment, and the concepts that a living thing revokes. In total, the participants provided 280 words as answers.

As stated in previous studies focusing on different concepts and terms, the associations determined in this study reflect the students' conventional statements (Dikmenli, 2010b). It can be put forward that the Biology student teachers' views of the concept "living thing" are superficial and limited. Kostova and Radoynovska (2008) found out that the teachers conceptualized their knowledge of the concepts "cell" and "biodiversity" meaningfully, using a free word association test. Of all the seven categories determined in this study, the Biology student teachers' level of knowledge was sufficient in the very first category, biodiversity; however, it was determined that the participants paid more attention to the appearance of living things, their habitat, nourishment and ways of movement. The findings of the current study are similar to those of the study conducted by Cinici (2011). It was also found out that the concept "animal" (f=22) commonly stated by the Biology student teachers was simply classified as "invertebrate" (f=6). Some lack of knowledge was also determined in other levels of classification. Trowbridge and Mintzes (1985, 1988), in the studies they conducted, revealed that the students had alternative concepts of animal classification.

It can be stated that the Biology student teachers have a conceptual validity in their cognitive structure although it is not at the expected level in the themes such as levels of organization, characteristics of living things and metabolism, and cell, and its organelles. However, they do not have satisfactory associations in the other themes, energy in living things, environment occupied by living things and the reactions shown to the conditions of the environment, and the concepts that a living thing revokes. In the other studies conducted with university students, the students' cognitive structures were determined to be based on conventional statements and incomplete knowledge (Dikmenli, 2010a). The results of this study are in alignment in this perspective. Moreover, the insufficient responses provided for the systematic categories (*universe, class, breed, and type)* and genetics (*gen and protein*) indicated that the Biology student teachers do not have a valid conceptual framework in these subjects. It was observed that some of the participants did not provide any sentence, while some others did not provide meaningful sentences related to the words that they provided. However, they generally provided sentences that focus on "living thing" and "its characteristics". On the other hand, while some of the participants associated living thing with the types of living things that at the levels of classification, some focused more on the levels of organization. Moreover, some participants dealt with characteristics of living things and metabolism; whereas

meaningless associations.

Considering the results, it can be stated that the Biology student teachers have closer associations with the types of livings things at the levels of classification and the levels of organizations However, they had fewer associations with the other categories, which indicates that the Biology student teachers have alternative concepts related to the themes under other titles. In the study conducted on students' cognitive structure of the concepts, living and non-living things, Tamir (1997) found out that they had many misconceptions. Alternative concepts exist since the relationships between the concepts are not achieved completely in individuals' minds while these concepts are being learned. Unless teachers provide the fundamental characteristics of a concept and explain the difference between this concept and the other similar ones, students in different ability groups will have misconceptions. Teachers should first discuss the characteristics of a concept before defining it and facilitate the understanding of its relationship with other concepts (Wandersee et al., 1994)

Moreover, the Biology student teachers did not have the expected biological literacy. When the sentences provided by the participants are analyzed, it is seen that the Biology student teachers do not go beyond some of the conventional definitions. It is worrying to see that the Biology student teachers are not equipped with the sufficient information in their field. Biology student teachers should provide subjective comments geared towards the biological information in scientific research, think creatively, ask different questions, and both evaluate and process knowledge. As such, during the undergraduate education, concept teaching and conceptual learning should be given pivotal importance.

One of the most crucial factors that affect learning is the existing accumulated knowledge and conceptual frameworks. Individuals cannot interpret any opinion that does not comply with scientific facts within this conceptual framework. Learning becomes more and more difficult, leading to misconceptions and inaccurate knowledge if the concepts are not learned and structured meaningfully. Accordingly, before starting to teach any concept, students' conceptual frameworks, inaccurate, insufficient knowledge, and concepts should be determined. Teaching should be put into effect using appropriate strategies, methods, and techniques. As such, students will appropriately structure and code new concepts and knowledge in their minds, and with the accurate associations between these, a more meaningful and permanent learning will be achieved.

RECOMMENDATIONS FOR FURTHER RESEARCH

In some studies (Jipson and Gelman, 2007; Narli et al., 2010; Villarroel, 2013; Yorek et al., 2009) data were collected on the concept of living things using various measurement tools. Data collection instruments such as open-ended questions, test, semi-structured interview forms and interview were used in these studies. The current study conducted through the use of free word-association test can be re-conducted with students and teachers using the interview technique in addition to different measurement techniques, which can contribute to the literature.

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