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THE COMMON METAPHORICAL PERCEPTIONS OF PROSPECTIVE TEACHERS AS TO DNA-GENE-CHROMOSOME CONCEPTS

Banuçiçek Özdemir

Abstract. *This research was performed to determine the Common Metaphorical Perceptions of Prospective Teachers on DNA-Gene-Chromosome Concepts, despite classroom levels and university differences. For the baseline group studies, two State Universities, one from the east and the other from the north of Turkey, were selected to be studied in the Fall Semester of 2017-2018. They were respectively called University A" and "B". The population sample contained a total of 326 students from 1st, 2nd, 3rd, and 4th- classroom level of the "Science Education Department" of "Education Faculties." The phenomenology design which is one of the qualitative research methods was applied. Answers to questions regarding "the metaphors of DNA-Gene-Chromosome concepts" and "under what theoretical categories the common features and metaphors were investigated" to be in line with the university differences. The research data were obtained by 'metaphor identification' for respective concepts and content examination studies in the framework of "Qualitative Analysis Methods." Correspondingly, it has been determined that Prospective Teachers have common metaphors concerning DNA-Gene-Chromosome concepts, regardless of their class or university differences.*

Keywords: *prospective teachers, metaphorical image for DNA-gene-chromosome, phenomenological research, content analysis*

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Introduction

The Biology Training Program, designed in education, is based on the constructivist approach. This approach is the process of facts that individuals observe and make sense of, in their surroundings. They construct knowledge by serving to be interpreted individually, according to their experience (Driver & Bell, 1986). This process focuses on how to teach individuals or teachers to plan learning, rather than, accepting what is taught. Also, this is important for the functionality of information in place of content. Metaphors are one of the teaching strategies that aids to determine the state of known knowledge in teaching and how to teach it in future education. Therefore, metaphors are the most preferred teaching resources in science coaching (Harrison & Treagust, 2006; Jeppsson et al., 2013). One challenge in bringing science literacy to a certain level is the individuals that have a low chance of being correctly observed, in making sense of biological concepts. The interest in learning biology reduces due to the intense course content of the biology curriculum, not using the majority of information in daily life, consisting in more than one abstract concept, and having difficulties reflecting knowledge of learners (Banet & Ayuso, 1999; Gilbet, 2006;). Although this problem may appear in different disciplines, particularly, in the fields of physics, chemistry, and biology, the most focus is on the concepts of biology courses (Ekici, 2016). And that is why scholars have difficulty expressing, "what was learned and how to practice" in their lives (Banet & Ayuso, 1999; Chuang & Cheng, 2003; Pelaez et al., 2005). Also, having intensity concepts makes it difficult to understand, relationships between perceptions depend on biology information that has abstract exterior terminology. It is expected that micro concepts can be observed with a microscope. In addition, it is expected, the concepts that are theoretically close create confusion. In biology, it is hardly possible for each of the terminological terms to be observed. The information is limited in representative phenomena that individuals create in their minds. Through these phenomena, information is made meaningful and expressed according to meaning reflection. Besides, it is observed that excessive ter-

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minological terms in biology science create different metaphorical perceptions in mind that diverts them from meanings. In addition to the conceptual difference, the common metaphorical perceptions, which are issued to different variables, attract attention.

According to the study of Mahaffy (2006), it has been determined that students preferred to explain the concepts that have had difficulty in comprehending, with metaphors. Also, it was stated that interest levels of students decreased due to huge abstract concepts, especially, in science lessons (Gilbert, 2006). The metaphors that are used in education have a particularly important place in explaining mixed phenomena and concepts (Eaglestone, 2009; Semerci, 2007). In order to describe any phenomenon as a metaphor, three questions need to be answered.

1. What is the subject of metaphor?
2. What is the source of metaphor?
3. What are the characteristics simulated to the subject from its source of metaphor (Forceville, 2002)?

A metaphor is an explanation of a determined phenomenon-case or idea with another case-phenomenon or concept (Kövecses, 2002; Oxford et al., 1998). The word Metaphor derived from "Metapherein", as well as, originated from the combination of two Greek words, which meant, Meta (change) and pherein (carry, code) (Levine, 2005).

The metaphors are information used to make situations understandable regarding conditions that individuals cannot realize as concrete and when phenomena become complicated (Yob, 2003). This is an important tool for organizing information in a planned manner and revealing ideas that individuals have (Clarken, 1997). In other words, metaphor is a way of understanding and perceiving the world (Morgan, 1998). Metaphor is also defined as establishing a relationship between two different phenomena and reflecting a different mental scheme on the existing mental scheme (Saban, 2009). If a picture is equivalent to 1000 words, a metaphor is equal to 1000 times the effect of a picture on humans. Moreover, while the picture expresses only certain phenomena stably, a metaphor draws the mental framework of this phenomenon (Shuell, 1990). While Lakoff and Johnson (2005) have described metaphors as elements that help individuals for perception the world. In addition, they expressed to make sense of one type of thing, according to the characteristics of another kind. Additionally, it is stated that metaphor is especially used for revealing the individual's perceptions (Alger, 2009; Cerit, 2008; Guerro & Villamil, 2002; Sanchez et al., 2000). Every vital activity in the world uses DNA as genetic material. A DNA molecule can contain many genes that encode proteins and act as heredity units. All genes that a eucaryote cell has — about 21,000 in humans — are placed in structures, located in the nucleus called chromosomes (Simon, 2015). The conceptual categories for DNA-Gene-Chromosome concepts are more than one. At the same time, the subject of genetics involving these concepts is one of the areas that are difficult to learn and teach in a science-training program (Lewis & Wood–Robinson, 2000; Tsui & Treagust, 2007). Since metaphors activate the teaching-learning process, they establish communication between the known and unknown concepts (Botha, 2009). If the individuals, who received an education, were provided with an accurate understanding of separation or association of biological concepts, mixing concepts would have been reduced significantly. Indeed, the use of determined metaphoric perceptions in concept teaching facilitates learning. The function of metaphors is a kind of communication tool that supports this issue (Steger, 2007). Furthermore, the metaphors in concepts that cannot be thought of or have a learning difficulty, should have a high impact and persistence on learning.

Within the framework of the literature review, leading scholars and respective areas in determining metaphors of biological concepts are examined to recognize whether the study was conducted previously, in order not to overlap studies. In this context, the following subjects were reviewed as tracks: Concept of the genome (Konopka, 2002); the concept of biological systems (Neuman, 2005); the concept of the gene (Vennille et al., 2006); concepts of "greenhouse effect", "ozone layer", "acid rains" and "biodiversity" (Selvi, 2007); metaphors of Darwin's book "Origin of Species: Natural Selection" (Al-Zahrani, 2008); metaphors for concepts of "evolution, regeneration and adaptation" (Eilam, 2009); the concept of climate (Coşkun, 2010), the concept of greenhouse effect (Shepardson et al., 2011); the concept of synthetic biology (Hellsten & Nerlich, 2011); the concept of biology (Gürbüzoğlu et al., 2013; Harman & Çökelez, 2017; Ulukök et al., 2015; Yapıcı, 2015); the concept of nature (Kahyaoğlu, 2015); the concept of global warming (Emli & Afacan, 2017); the concept of evolution (Özbuğutu, 2018); and the concept of Biology Education Laboratory Course (Cengiz & Ekici, 2019). Apart from metaphors of biological concepts stated above, it is understood that metaphoric perceptions feed on cognitive levels of individuals, past experiences, and socio-cultural structures, as a part of further literature review (Bargh & Bandrollar, 1996).

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Research Purpose

This research has been conducted to reveal the science prospective teachers' metaphors perceptions about the concept of DNA-Gen-Chromosome, to be according to the class levels and different university factors. On the other hand, the purpose of this research was in order to introduce the meaning of DNA-Gene-Chromosome to students with metaphors, rather than defining its meaning. The following research questions have been formulated in this regard accordingly.

1. What are the prospective teachers' metaphors about the concept of DNA-Gen-Chromosome?
2. Under which conceptual categories can these metaphors fall, in terms of common features?
3. What are the common categories of prospective teachers' DNA-Gen-Chromosome concepts in different university variables?

Research Methodology

General Background

The study was carried out with phenomenon (phenomenography) design, which is one of the qualitative research approaches. Phenomenography is a qualitative research approach that has been designed to find out peoples' qualitatively different experiences of the world in terms of categories of descriptions. (Marton, 1981, 1986). The phenomenon of science design (phenomenology) created a suitable research ground for studies aiming to examine phenomena that could not pick up the exact meaning of it. At the same time, it put forward the phenomenon, which was known without in-depth knowledge in various ways, such as case, experience, perception, and orientation (Yıldırım & Şimşek, 2008). Also, it was a research design that experienced the phenomenon described, and the philosophy and psychological infrastructure were built on bases (Creswell, 2014). It focused on how individuals perceived a specified phenomenon, how it was described, how they felt about it, how they talked about it (Patton, 2014).

Sample

Two State Universities were selected from the east (Eastern Anatolia Region) and north (Blacksea Region) of Turkey. Two universities were chosen because of the convenience sampling. They were defined as "A" and "B" University, respectively, for the Fall Semester 2017-2018, as the study group. The sample consisted of a total of 326 students. These two universities were chosen because they have the same course content, and their entrance scores are the same. The reason for preference is to determine the common metaphorical perceptions of pre-service teachers who study at different universities with the same education and the same level, towards the same concepts. The number of students was chosen on a voluntary basis because sample is formed in this way. These students were in their 1st, 2nd, 3rd, and 4th classroom level of university in the Science Education Department of Education Faculties. These individuals are considered to become science prospective teachers [please refer to Table 1 for detailed information].

The sample was determined with the help from easily accessible sampling methods, as this is a method that aids the researcher to be close and easily accessible when determining the sample (Yıldırım & Şimşek, 2011).

Table 1
Data Regarding the Prospective Teachers' University and Classroom Levels

Variable (University)	Variable (Classroom Levels)			
	1. Year	2.Year	3. Year	4.Year
East (Eastern Anatolia) Region (A University)	67	10	67	33
North (Black sea) Region (B University)	46	42	23	38
Sub-Total	113	52	90	71
Total	326			

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Data Collection

The data were collected through metaphors. In metaphors studied, semi-structured interview forms were one of the most preferred data collection tools (Pishghadam & Pourali, 2011). Yıldırım and Şimşek (2011) stated that metaphor could not adequately reveal the descriptive and visual power of metaphor itself. Thus, the question "why" or "how" must be asked to reveal the descriptive and visual power of metaphors. In this context, a semi-structured interview form was prepared for all prospective teachers who constituted the sample group. This form contains information such as follows: DNA is like …… because ……..; The gene is like …… because …… ....;The chromosome is like ……, because ……. Consequently, these sentences are used in the respective form.

Students were asked to only reflect on a single metaphor, for these concepts. Also, for the part that evokes, they were requested to complete the sentence by providing explanations after the word "because." In addition, prospective teachers were asked to write down which university they were in and their class. The pilot application of the form was prepared for the research. It was tested with the participation of 35 science teachers who had been graduated from various universities. Considering the obtained results from this application, the form was rearranged, and the time to be allocated to the group was identified, accordingly. Upon distribution of the upgraded forms, the metaphor phenomenon was explained to the students, and several examples were delivered to reveal the mental images. Besides, the justification for simulation between the source and subject was provided. 20 minutes were allocated to each student to complete the form. Thus, the metaphors and explanations that constitute the research data were obtained.

Data Analysis

The descriptive content analysis of qualitative research technique was used for "analysis and interpretation" of data. Also, the metaphors with certain common features were compiled under certain collective conceptual categories. The data analysis consists of two parts: metaphor analysis (Moser, 2000) and content analysis (Yıldırım & Şimşek, 2008). The content analysis is defined as a "systematic application where some words of a text summarized with smaller content categories with coding are based on certain rules" (Büyüköztürk, 2011). The metaphor analysis was conducted step by step (Moser, 2000).

The following stages were identified:

1. Screening Phase
2. Compilation and Category Development Phase
3. Validity and Reliability Phase

1. Screening Phase

The filled-in papers by prospective teachers were examined individually. Their metaphors were determined and placed in alphabetical order. Forms that were missing subject, resource section, or not metaphors, along with, forms that were metaphors, but descriptions did not match were excluded from the examination part (n:9). Additionally, forms that metaphoric perceptions or justifications for the DNA-Gene-Chromosome concepts were compared and ignored from analysis (n:4). The terms such as (S1,3.) in parentheses were interpreted as 1st student of 3rd grade in the samples. These were written by prospective teachers; in which, the writings were reported identically.

2. Compilation and Category Development Phase

The categories were determined to be in line with the common characteristics of metaphors in the compiled data for the identified concepts. These categories were identified as shape, function, feature, and content. The prospective teachers and metaphors were marked under these categories and used as codes.

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3. Validity and Reliability Phase

To ensure validity;

1. The process of creating common categories from all metaphors was explained in detail.
2. All metaphors were obtained as a result of the sorting process, as indicated in the table in the findings section.
3. The data were recorded by prospective teachers and kept without any additions. In research reporting, collecting, and citing the participants' statements without addition was stated as a measure that increases the validity (Yıldırım & Şimşek, 2011).

To ensure reliability;

Categorization of metaphors was consulted with expert opinion in a semi-structured document that was written by prospective teachers. A biologist trainer expert issued a document with written metaphors and two papers. The expert was asked to place metaphors in categories that were made by the researcher or expert for comparison. The number of consensus and disagreement was determined, and reliability was calculated by the formula of Miles & Huberman (1994; 64).

$$\text{Reliability} = \text{Consensus} / (\text{Consensus} + \text{Disagreement}) \times 100$$

The average reliability between expert and researcher was determined as 94%. In qualitative research, it stated that if the consistency between evaluations of expert and researcher is 90% and above, it provides reliability (Miles & Huberman, 1994). Hence, the result showed the level of reliability that had been reached in the research.

In the last stage, the number of teacher candidates representing each metaphor and category were calculated as frequency (*f*) and percentage (%). The obtained data were presented in tables and interpreted, accordingly.

Research Results

Metaphoric perceptions of the science-prospective teachers who participated in the study of DNA-Gene-Chromosome concepts were shown in tables. The frequencies and percentages were formed in relevant codes, and categories were indicated in the tables. The prospective teachers provided answers that created codes and categories. These were submitted as a quote in the following section, after the data tables. Upon examining the obtained data, it was understood that a total of 313 metaphors were collected from 326 participants, regarding DNA-Gene-Chromosome concepts. Among metaphors, a total of 11 common metaphorical perceptions were determined in A and B universities, in the category of DNA concept as related to the shapes (3), function (3), feature (2), and content (3). There was no common metaphoric perception in the category of the gene for the shapes. Yet, 14 common metaphoric perceptions were identified respectively for function (4), feature (6), and content (4). In the category of the concept of chromosomes, a total of 9 common metaphorical perceptions were determined for the shapes (7), function (1), and feature (1), despite lack of content common metaphoric perceptions. A total of 34 common perceptions were identified from 313 metaphoric perceptions. And 279 metaphors were differed according to the class and university variables.

Table 2
Total Valid Metaphors of the Prospective Teachers on DNA-Gene-Chromosome Concepts

	Category	Variable (university)	
		A University	B University
DNA	Shape	7	12
	Function	9	14
	Feature	5	19
	Content	9	12
	TOTAL	30	57

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	Category	Variable (university)	
		A University	B University
GENE	Shape	4	4
	Function	13	13
	Feature	26	30
	Content	26	18
	TOTAL	69	65
CHROMOSOME	Shape	13	18
	Function	11	8
	Feature	7	13
	Content	12	10
	TOTAL	43	49

Table 3

Perceptions of the Prospective Teachers in the Category of Shape for the Concept of DNA

Category	Variable (University)	Codes	1.Class		2.Class		3. Class		4.Class		Total f	%
			Student Codes	f	Student Codes	f	Student Codes	f	Student Codes	f		
SHAPE	A University	Ladder	$S_{8,14,42,48,49,50}$	6	$S_{1,3,5,6,7,8}$	6	$S_{1,3,4,6,7,8,9,11,12,3,17,18,19,20,21,23,24,25,26,28,29,30,32,34,35,37,42,43,44,45,47,48,49,50,51,54,55,57,58,59,60,61,62,64,65}$	45	$S_{6,7,8,10,11,14,20,24,28,29,30,31}$	12	69	87
		Bullbrier	$S_{18,64}$	2			S_{52}	1			3	4
		Earphone	S_{25}	1							1	1
		Snake	S_{55}	1			S_{38}	1			2	3
		Macaroni					S_{10}	1			1	1
		Minaret					$S_{14,53}$	2			2	3
		Confetti	S_{35}	1							1	1
	TOTAL										79	100
	B University	Macaroni	S_{19}	1	S_{10}	1					2	4
		Cylinder	S_{20}	1							1	2
		Ladder	$S_{21,22,23,25,29,31,33,35}$	8	$S_{14,15,17,27,28,34,37,39,40}$	9	$S_{1,3,7,8,11,13,17,23}$	8	$S_{3,7,13}$	3	20	43
		Plaited Cheese	$S_{39,40}$	2							2	4
		Bow			S_{5}	1	S_{9}	1			2	4
		Ice Cream			S_{16}	1					1	2
		Bullbrier			S_{30}	1	$S_{14,19}$	2	$S_{2,4,8,9}$	4	7	15
		Piece							S_{3}	1	1	2
		Ball							S_{19}	1	1	2
		Chair					$S_{2,16,21}$	3	$S_{10,14,15,19}$	4	7	15
		Thread					S_{6}	1	$S_{3,28}$	2	3	6
	TOTAL										47	100

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According to both universities (A and B universities) participants, the prospective teachers' common metaphorical perceptions of DNA in the Shape category were macaroni, ivy, and ladder [Table 3]. Besides, although the frequencies were different, the prospective teachers used common shapes.

Table 4

Perceptions of the Prospective Teachers in the Category of Function for the Concept of DNA

Category	Variable (University)	Codes	1.Class		2. Class		3. Class		4.Class		Total f	%
			Student Codes	F	Student Codes	F	Student Codes	F	Student Codes	f		
FUNCTION	A University	Human Skeleton	S_{7}	1							1	7
		Toy block	S_{2}	1							1	7
		Jigsaw	$S_{6,32}$	2			S_{15}	1	S_{9}	1	4	29
		Button	S_{10}	1							1	7
		Photocopier	S_{21}	1							1	7
		Sibling	$S_{53,67}$	2							2	14
		Key-Lock	S_{54}	1							1	7
		Pedestrian					S_{66}	1			1	7
		Manager							$S_{19,22}$	2	2	14
	TOTAL										14	100
	B University	Driver			S_{3}	1					1	4
		Key-Lock			S_{25}	1			S_{1}	1	2	8
		Teacher							S_{21}	1	1	4
		Seed			$S_{3,29}$	2	S_{9}	1			3	13
		Processor					S_{1}	1			1	4
		Road					S_{5}	1			1	4
		Board of Directors							S_{28}	1	1	4
		Sand							S_{29}	1	1	4
		Point							S_{31}	1	1	4
		Lover	S_{8}	1	$S_{7,20}$	2					3	13
		Book	S_{12}	1							1	4
		Jigsaw	S_{14}	1	S_{26}	1					2	8
		Brain			S_{23}	1	S_{10}	1			2	8
		Manager							$S_{12,18,21,37}$	4	4	17
	TOTAL										24	100

The common metaphorical perceptions of prospective teachers, in the function of DNA category, resulted in the metaphors 'jigsaw', 'key-lock' and 'manager' which were proven to be in line with the variable. Also, the frequencies of common metaphorical perceptions consisted of high metaphoric perceptions [Table 4].

The samples of prospective teachers were pointed out as follows;
"DNA is like a human skeleton. Because, in the absence of DNA, sequences cannot balance" (A, 1., S7).
"DNA is like a copier. Because it can match with the same one" (A, 1., S21).

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Table 5
Perceptions of Prospective Teachers in the Category of Feature for the Concept of DNA

Category	Variable (University)	Codes	1.Class		2. Class		3. Class		4.Class		Total f	%
			Student Codes	f	Student Codes	F	Student Codes	f	Student Codes	f		
FEATURE	A University	Zipper	$S_{1,5,11,15,19,24,26,27,62}$	9							9	69
		Branch	S_{34}	1							1	8
		Mother					S_{2}	1			1	8
		Cash Card					S33	1			1	8
		Fingerprint					S_{22}	1			1	8
	TOTAL										13	100
	B University	Jigsaw					$S_{4,12,20}$	3			3	8
		Class			S_{2}	1					1	3
		Zipper	$S_{11,15}$	2	$S_{4,31}$	2					4	10
		Personality	S_{11}	1	S_{38}	1	S_{7}	1	S_{11}	1	4	10
		Human			S_{6}	1					1	3
		Computer	$S_{33,44}$	2					$S_{17,32,37}$	3	5	13
		Telephone			S_{8}	1					1	3
		Atomic							$S_{10,12,14,19}$	4	4	10
		Husband-Wife			S_{12}	1					1	3
		Flash Disk			S_{18}	1					1	3
		Mother			S_{19}	1					1	3
		Word	S_{13}	1							1	3
		Code			S_{21}	1					1	3
		Password			S_{38}	1					1	3
		Brain			S_{35}	1	S_{16}	1	S_{36}	1	3	8
		Cufflink							S_{3}	1	1	3
		Ant							S_{15}	1	1	3
		Lock	$S_{3,4,10}$	3	S_{42}	1					4	10
		USB	S_{5}	1							1	3
	TOTAL										39	100

It was noted, the prospective teachers' common metaphoric perceptions in the feature category of DNA zipper and mother were in line with the university variable [Table 5].

The samples of the prospective teachers were stated as follows:

"DNA is like a zipper. Because it can divide into two and match itself" (A, 1., S1).

"DNA is like a mother. Because it carries viability functions and all instructions applicable to biological developments" (A, 3., S2).

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Table 6
Perceptions of the Prospective Teachers in the Category of Content for the Concept of DNA

Category	Variable (University)	Codes	1.Class		2. Class		3. Class		4.Class		Total f	%
			Student Codes	f	Student Codes	f	Student Codes	f	Student Codes	f		
CONTENT	A University	Wagon	S_3	1							1	5
		Thread	S_4	1							1	5
		Family	S_{39}	1							1	5
		Water	$S_{45,46}$	2							2	10
		Password	S_{41}	1							1	5
		Seed	S_{63}	1							1	5
		Chain	$S_{13,16,29,30,31,37,50,60,61}$	9			S_{56}	1	$S_{21,26}$	2	12	57
		FBI					S_5	1			1	5
		Library					S_{27}	1			1	5
	TOTAL										21	100
	B University	Thread	$S_{1,30,34}$	3	S_{41}	1					4	12
		Chain	$S_{2,16,17,38,41}$	5	$S_{24,29}$	2					7	21
		World	S_{27}	1					$S_{25,29}$	2	3	9
		House							S_{33}	1	1	3
		Pip			S_{36}	1	S_8	1			2	6
		Password	S_{28}				$S_{15,23}$	2	S_{13}	1	3	9
		Universe					S_2	1			1	3
		Room					S_{10}	1	$S_{18,26}$	2	3	9
		Flash Disk					S_{14}	1	$S_{35,38}$	2	3	9
		Class							$S_{23,27}$	2	2	6
		School							S_{25}	1	1	3
		Kite			S_1	1			$S_{11,17,23}$	3	4	12
	TOTAL										34	100

According to A and B University participants, it was noted that the prospective teachers' common metaphoric perception and codes with the highest frequency were 'chain'. Also, thread and password were common at different frequencies and in line with university variable, as common metaphoric perceptions [Table 6].

The samples of the prospective teachers are mentioned as follows;

"DNA is like the train wagons. Because deoxyribose sugar connects to phosphate as the phosphate connects a kind of base" (A, 1., S3).

"DNA is like a chain. Because genes keep together in DNA formation" (A, 1., S13).

"DNA is the FBI. Because it hides all the information and secretly turns business. It carries all the living creatures' genetic activities" (A, 3., S5).

"DNA resembles a kite tail. Because every piece on the tail represents the nucleotide" (G,2, S1).

"DNA is like a necklace chain. Because there are nucleotides on it, like a thread. It is like a chain since it is two-sided" (G,2, S24).

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Table 7
Perceptions of the Prospective Teachers in the Category of Shape for the Concept of Gene

Category	Variable (University)	Codes	1.Class		2. Class		3. Class		4.Class		Total f	%
			Student Codes	f	Student Codes	f	Student Codes	f	Student Codes	F		
SHAPE	A University	Pip	$S_{11,15}$	2							2	29
		Bonbon	S_{35}	1							1	14
		Toothpick					$S_{7,8}$	2			2	29
		Grit					$S_{3'52}$	2			2	29
	TOTAL										7	100
	B University	Piece					S_{3}	1			1	20
		Ball					S_{19}	1			1	20
		Cross (X)	S_{41}	1							1	20
		Ladder			$S_{39,42}$	2					2	40
	TOTAL										5	100

Category	Variable (University)	Codes	1.Class		2. Class		3. Class		4.Class		Total f	%
			Student Codes	f	Student Codes	f	Student Codes	f	Student Codes	F		
SHAPE	A University	Pip	$S_{11,15}$	2							2	29
		Bonbon	S_{35}	1							1	14
		Toothpick					$S_{7,8}$	2			2	29
		Grit					$S_{3'52}$	2			2	29
	TOTAL										7	100
	B University	Piece					S_{3}	1			1	20
		Ball					S_{19}	1			1	20
		Cross (X)	S_{41}	1							1	20
		Ladder			$S_{39,42}$	2					2	40
	TOTAL										5	100

The prospective teachers did not have common metaphoric perceptions in the category of the shape of the gene concept in line with the university variable [Table 7].

The samples of the prospective teachers are indicated as follows:

"The gene is like the fruit pip. Because it is very small like fruit pips. It is formed by combining of millions" (A,1, S11).

"The gene is like a bonbon. Because they have different inheritance features, but their structures are the same" (A,1, S35).

"The gene resembles a toothpick. Because it is in the form of a long or short stick" (A,3, S7).

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Table 8
Perceptions of the Prospective Teachers in the Category of Function for the Concept of Gene

Category	Variable (University)	Codes	1.Class		2. Class		3. Class		4.Class		Total f	%
			Student Codes	f	Student Codes	f	Student Codes	f	Student Codes	F		
FUNCTION	A University	Key-Lock	S_{1}	1							1	4
		Body	$S_{3,18}$	2	S_{3}	1					3	11
		Jigsaw	$S_{7,10,13}$	3					$S_{15,27}$	2	5	19
		Clip	S_{8}	1							1	4
		Magnet	S_{9}	1							1	4
		Ant	S_{25}	1							1	4
		Password	$S_{53,54}$	2					$S_{12,19,26,31}$	4	6	22
		Soil	S_{61}	1							1	4
		Lorry Driver					S_{13}	1			1	4
		Ladder	S_{12}	1			S_{27}	1			2	7
		Point			S_{1}	1	S_{38}	1			2	7
		Solitaire					S_{59}	1			1	4
		Corn					$S_{61,62}$	2			2	7
	TOTAL										27	100
	B University	Seed					S_{9}	1			1	6
		Key-Lock	S_{13}	1					S_{1}	1	2	13
		Teacher							S_{21}	1	1	6
		Processor					S_{1}	1			1	6
		Road					S_{5}	1			1	6
		Board of Directors					S_{2}	1	S_{24}	1	2	13
		Sand							S_{29}	1	1	6
		Point							S_{31}	1	1	6
		Magnet	S_{20}	1							1	6
		Password	S_{46}	1							1	6
		Father			S_{11}	1					1	6
		Bullbrier			$S_{23,41}$	2					2	13
		Tree			S_{34}	1					1	6
	TOTAL										16	100

The metaphoric perceptions of the prospective teachers with regards to the concept of gene in the common category of function were observed as key-lock, magnet, point, and password to be in line with the university variable [Table 8].

The samples of the prospective teachers are mentioned as follows:

"Gene is like a key lock. Because it can be connected, and has dent and bulge" (A,1, S1).

"Genes are like organs of the body. Because each of them is interconnected" (A,1, S3).

"Gene is like jigsaw pieces. Because in case of gene deficiency, it can lead to major negativities" (A,1, S7).

"The gene is like a paper clip. Because genes (A, T, G, S) are being connected with each other" (A,1, S8).

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"Gene is like an organ. Because every organ has a way of functioning, and a task" (A,1, S18).
"Gene resembles ants. Because it's small and useful, like an ant" (A,1, S25).
"Gene is like phone's password. Because it cannot be opened without clearing the password" (A,1, S53).
"Gene is like a point. Because it is located on chromosomes and special to it" (A,2, S1).
"The gene is like the lorry driver. Because it transports certain items from one place to another" (A,3, S13).
"The gene is like a rotating ladder. Because its spiral structure and connecting Adenin-Timin form the gene steps" (A,3, S27).

Table 9
Perceptions of the Prospective Teachers in Category of Feature for the Concept of Gene

Category	Variable (University)	Codes	1.Class		2. Class		3. Class		4.Class		Total F	%
			Student Codes	f	Student Codes	f	Student Codes	f	Student Codes	f		
FEATURE	A University	Identity	$S_{2,5}$	2			$S_{6,9,14,20}$	4	$S_{28,29,32}$	3	9	15
		Type of food	S_{16}	1							1	2
		Fingerprint	$S_{17,27}$	2			$S_{24,25,26}$	3	$S_{6,13}$	2	7	12
		Button	S_{19}	1							1	2
		Feeling	S_{39}	1							1	2
		Memory	S_{62}	1							1	2
		Root			S_{5}	1					1	2
		Brain					$S_{3,31}$	2	S_{14}	1	3	5
		Microchip					S_{4}	1			1	2
		Reign					$S_{5,63,64}$	3			3	5
		Chain					$S_{11,30,32}$	3			3	5
		Draw					S_{18}	1			1	2
		Culture					$S_{22,53}$	2			2	3
		Computer					S_{28}	1			1	2
		Processor					S_{33}	1			1	2
		Traditions					S_{36}	1			1	2
		Family Tree					S_{37}	3			3	5
		Fruit					S_{39}	1			1	2
		Vehicle Engine					S_{44}	1			1	2
		Head of Family					$S_{45,46}$	2			2	3
		Information					S_{50}	1			1	2
		Historical Artifact					$S_{65,66,67}$	3			3	5
		Ant							S_{3}	1	1	2
		Bead							$S_{10,11}$	2	2	3
		Password							$S_{1,12,20,23,31,33}$	6	6	10
		Atomic	S_{58}	1			S_{23}	1			2	3
	TOTAL										59	100

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Category	Variable (University)	Codes	1.Class		2. Class		3. Class		4.Class		Total F	%
			Student Codes	f	Student Codes	f	Student Codes	f	Student Codes	f		
	B University	Personality	S_{11}	1	S_{38}	1	S_{7}	1	S_{11}	1	3	3
		Computer	$S_{33,34,38}$	3					$S_{17,32,37}$	3	6	9
		Atomic			$S_{10,24}$	2			$S_{10,12.14,19}$	4	6	9
		Brain			S_{35}	1	$S_{15,16}$	2	$S_{35,36}$	1	4	6
		Cufflink							S_{3}	1	1	2
		Ant							S_{15}	1	1	2
		Fingerprint	$S_{1,5}$	2	$S_{6,20}$	2					4	6
		Human	$S_{3,6,7,16,19,27}$	6	$S_{17,22}$	2					8	12
		Stone	S_{9}	1							1	2
		Pin code	S_{18}	1							1	2
		Salt	S_{31}	1							1	2
		Sugar	S_{32}	1							1	2
		Chameleon	S_{42}	1							1	2
		House	S_{44}	1					S_{33}	1	2	3
		Chair			S_{1}	1					1	2
		Flag			S_{2}	1					1	2
		Word			S_{4}	1					1	2
		Planet			$S_{15,16}$	2					2	3
		Plastic Bottle			$S_{18,32}$	2					2	3
		Rainbow			S_{20}	1					1	2
		Case			S_{25}	1					1	2
		Heritage			S_{27}	1					1	2
		Atatürk Portrait			S_{28}	1					1	2
		Pip			S_{36}	1	S_{8}	1			2	3
		Password					$S_{15,23}$	2	S_{13}	1	3	3
		Universe					S_{2}	1			1	2
		Room					S_{10}	1	$S_{18,26}$	2	3	4
		Flash Disk					S_{14}	1	$S_{35,38}$	2	3	4
		Class							$S_{23,27}$	2	2	3
		Manager							S_{25}	1	1	2
	Total										66	100

The common metaphorical perceptions of prospective teachers, in the feature category of the concept of Gene, are computer, ant, password, atomic, brain, and fingerprint, per university variable [Table 9].

The samples of the prospective teachers are stated as follows:

"Gene is a small identity. Because it has characteristics of an individual" (A,1, S_{2}).
"Gene is like a fingerprint. Because genes are different and unique" (A,1, $S_{17.}$)
"Gene is like memory. Because it is tiny, and retains a lot of information" (A,1, S_{62}).
"Gene is like the brain. Because it stores every information" (A,3, S_{3}).
"Gene is like a microchip. Because it carries information like a gene on itself" (A,3, S_{4}).
"Gene looks like a striped sweater's lines. Because genes are lined up on the chromosome as dots" (A,3, S_{18}).

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"Gene is like culture. Because it has traces of everybody's culture" (A,3, S_{22}).
"Gene is like a vehicle engine. Because, if engines function in old vehicles, the next generation shall be solid, accordingly" (A,3, S_{44}).
"Gene is like the head of the family. Because information on features of the whole body is included in the gene. It manages the body" (A,3, S_{45}).
"Genes are like ants in the soil. Because there are too many" (A,4, S_3).
"Gene is like a chair. Because it carries one person" (G,2, S_1).
"Gene is like a flag. Because it represents an individual country" (G,2, S_2).

Table 10
Perceptions of the Prospective Teachers in the Category of Content for the Concept of Gene

Category	Variable (University)	Codes	1.Class		2. Class		3. Class		4.Class		Total f	%
			Student Codes	f	Student Codes	f	Student Codes	f	Student Codes	f		
CONTENT	A University	Seed	$S_{6,22}$	2			$S_{12,56}$	2			4	9
		Trefoil	S_{14}	1							1	2
		CD	$S_{21,28}$	2							2	4
		Code	$S_{24,64}$	2					S_{27}	1	3	6
		Star	$S_{32,34}$	2							2	4
		Snowflake	S_{33}	1					S_7	1	2	4
		Rainbow	S_{41}	1							1	2
		Pollen	S_{46}	1							1	2
		Yarn	S_{49}	1			S_{17}	1			2	4
		Sand	S_{56}	1							1	2
		Sea	S_{60}	1							1	2
		Fruit			S_6	1	S_{60}	1			2	4
		Mainboard			S_8	1					1	2
		Rosary					$S_{1,21}$	2			2	4
		Identity Card					$S_{6,9,14,20}$	4	$S_{17,24,30}$	3	7	15
		Letter					S_{34}	1	S_{20}	1	2	4
		Report Card					S_{35}	1			1	2
		Name-Surname					$S_{42,49}$	2			2	4
		Knot					$S_{47,55}$	2			2	4
		Salad					S_{48}	1			1	2
		Tree					$S_{51,58}$	1	S_9	1	2	4
		Moneybox							S_2	1	1	2
		Library							S_4	1	1	2
		Solar System							S_5	1	1	2
		Class							S_{18}	1	1	2
		Encyclopedia							S_{28}	1	1	2
	TOTAL										47	100

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B University	House							S_{33}	1	1	3
	Pip			S_{36}	1	S_{8}	1			2	5
	Password					$S_{15,23}$	2	S_{13}	1	3	8
	Universe					S_{2}	1			1	3
	Room					S_{10}	1	$S_{18,26}$	2	3	8
	Flash Disk					S_{14}	1	$S_{35,38}$	2	3	8
	Class							$S_{23,27}$	2	2	5
	Manager							S_{25}	1	1	3
	Flower	S_{2}	1							1	3
	Snowflake	$S_{4,8,12,15}$	4	$S_{12,14}$	2					6	17
	Fruit	$S_{10,14}$	2							2	5
	Raisin Pie	S_{26}	1							1	3
	Chain	S_{30}	1	S_{40}	1					2	5
	Family	$S_{37,43}$	2							2	5
	Proverb	S_{40}	1							1	3
	Seed			$S_{3,29}$	2					2	5
	Figure			S_{9}	1					1	3
	Teacher			$S_{33,37}$	2					2	5
TOTAL										36	100

Common metaphorical perceptions of prospective teachers in the content category of the concept of Gene is class, seed, snowflake, and fruits, per university variable (Table 10).

Samples of the prospective teachers are indicated as follows:

"Gene looks like a seed. Because as genes are passing down from generation to generation, same plants come out, when seeds fall into the ground" (A,1, S22).

"Gene is like computer codes. Because each code determines a different feature" (A,1, S24).

"Gene is like stars. Because its size and shape are different" (A,1, S32).

"Gene is like snowflakes. Because every gene has a different shape" (A,1, S33).

"Gene is like a rainbow. Because colors of the rainbow are different. Genes are different as colors" (A,1, S41).

"Gene is like a colored spiral thread. Because it consists of many nucleotides" (A,1, S49).

"Gene is like rosary beads. Because nucleotides in the gene structure are lined up like rosary beads" (A,3, S1).

"Gene is like an identity card. Because it has everyone's features" (A,3, S6).

"Gene is like a letter. Because when keeping together, meaningful words are formed" (A,3, S34).

"Gene is like knots. Because knots form knitting as combined, while genes form a hereditary structure" (A,3, S47).

"Gene is like salad. Because it combines to "form a whole" from different vegetables" (A,3, S48).

"Gene is like a flower on a tree. Because it is located on the DNA" (A,3, S58).

"Gene is like a money box. Because it is full of information" (A,4, S2).

"Gene is like a library. Because it retains a lot of information" (A,4, S4).

"Gene is like a proverb. Because it passes down from generation to generation. The gene passes to young individuals" (G,1, S40).

"Gene is like a teacher. Because one can learn all features of the whole body from it" (G,2, S33).

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Table 11
Perceptions of the Prospective Teachers in the Category of Shape for the Concept of Chromosome

Category	Variable (University)	Codes	1.Class		2. Class		3. Class		4.Class		Total f	%
			Student Codes	f	Student Codes	f	Student Codes	f	Student Codes	f		
SHAPE	A University	Latch	$S_{1,11,15}$	3			$S_{10,17,37}$	3			6	11
		Ladder	$S_{3,7,21}$	3							3	5
		Trefoil	$S_{5,22}$	2	S_{6}	1	$S_{31,57,58}$	3			6	11
		Cross (X)	$S_{8,9}$	2			$S_{2,45}$	2			4	7
		Scissors	$S_{18,50}$	2			S_{7}	1	$S_{13,24,30}$	3	6	11
		Butterfly	$S_{26,62}$	2			$S_{13,14,18,19,25,30,32,42,43,44,48,49,54,59,61,62}$	16	S_{20}	1	19	35
		Braid	$S_{60,61}$	2							2	4
		Bow-tie	S_{19}	1			S_{27}	1			2	4
		Worm			S_{1}	1	S_{50}	1			2	4
		Curly Hair					S_{26}	1			1	2
		Kangaroo					S_{28}	1			1	2
		Horn					$S_{47,55}$	2			2	4
		Leaf					S_{52}	1			1	2
	TOTAL										55	100
	B University	Latch	$S_{1,2,12}$	3			S_{14}	1	$S_{11,16}$	2	6	14
		Butterfly	$S_{14,22,23,30,32,39}$	6					S_{14}	1	7	16
		Scissors	$S_{16,46}$	2	S_{12}	1					3	7
		Pincers	S_{34}	1							1	2
		Sausage	S_{35}	1							1	2
		Spider Web	$S_{37,42,43}$	3							3	7
		Mosquito	S_{40}	1							1	2
		Ladder			$S_{11,32,41}$	3					3	7
		Bow-tie			S_{13}	1					1	2
		Cartoon Character			S_{18}	1					1	2
		Cross (X)			S_{29}	1	$S_{6,13,15,16}$	3			4	9
		Bullbrier			S_{38}	1	$S_{11,22}$	2	S_{24}	1	4	9
		Twin							$S_{13,18}$	2	2	5
		Thread							S_{9}	1	1	2
		Trefoil					$S_{12,20}$	2			2	5
		Chain					S_{4}	1			1	2
		Sandglass							S_{34}	1	1	2
		Branch							$S_{7,26}$	2	2	4
	TOTAL										44	100

According to university variable, common metaphorical perceptions of prospective teachers in the category of the shape of chromosome concept is latch, butterfly, cross (X), bowtie, trefoil, ladder, and scissors [Table 11].

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The samples of the prospective teachers are expressed as follows:

"Chromosome is like a latch. Because latch's clamp is like centromere in chromosome" (A,1, S11).
"Chromosomes are like a ladder. Because every step has a line" (A,1, S3).
"Chromosome is like a ladder. Because there are separate lines in each step" (A,1, S7).
"Chromosome is like a worm. Because it can move like a worm and may get longer" (A,2, S1).
"Chromosome is like curly hair. Because it looks like its structure" (A,3, S26).
"Chromosome is like a kangaroo. Because front legs are short and back legs are long" (A,3, S28).
"Chromosome is like sausage divided into four. Because it is similar in shape" (G,1, S35).
"Chromosome is like a mosquito. Because its wings look like chromosomes" (G,1, S40).

Table 12
Perceptions of the Prospective Teachers in the Category of Function for the Concept of Chromosome

Category	Variable (University)	Codes	1.Class		2. Class		3. Class		4.Class		Total f	%
			Student Codes	f	Student Codes	f	Student Codes	f	Student Codes	f		
FUNCTION	A University	X	$S_{16,37,39,42,48,49}$	6			$S_{1,15,21,64,65,66,67}$	7			13	48
		Photocopier	$S_{24,28}$	2							2	7
		Lover					S_{22}	1	S_{6}	1	2	7
		Two intersecting lines					S_{38}	1			1	4
		Elder sibling					S_{41}	1			1	4
		Friend					$S_{51,56}$	2			2	7
		Library							S_{4}	1	1	4
		Piece							S_{9}	1	1	4
		Twin							$S_{14,22}$	2	2	7
		Bus							S_{17}	1	1	4
		Toy							S_{19}	1	1	4
	TOTAL										27	100
	B University	Fruit Plate	S_{1}	1							1	6
		X	$S_{18,20,24,44}$	4	$S_{2,14,26,28}$	4					8	47
		Inseparable			$S_{1,33}$	2					2	12
		1 Digit			S_{5}	1					1	6
		Key-Lock			S_{42}	1					1	6
		Lover					S_{17}	1	S_{20}	1	2	12
		Compass							S_{10}	1	1	6
		Chip							S_{17}	1	1	6
	TOTAL										17	100

Common metaphorical perceptions of prospective teachers, according to university variable, in function category for the concept of chromosome, is the lover [Table 12].

The samples of the prospective teachers are explained as follows:

"Chromosome is like lovers. Because sometimes they are together and sometimes, they are separate from each other" (A,3, S22).

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"Chromosome is like a book. Because it explains how everything shall be" (A,4, S4).
"Chromosome is like grain. Because chromatids are formed as particles unite with each other" (A,4, S9).
"Chromosome is like fruit platter. Because, although it is separate, it makes sense when it is together" (G,1, S10).
"Chromosome is just valuable one. Because there is discomfort if too much or less" (G,2, S5).

Table 13
Perceptions of the Prospective Teachers in the Category of Feature for the Concept of Chromosome

Category	Variable (University)	Codes	1.Class		2. Class		3. Class		4.Class		Total f	%
			Student Codes	f	Student Codes	f	Student Codes	F	Student Codes	f		
FEATURE	A University	Sibling	$S_{27,38,54,55}$	4			$S_{9,20}$	2	S_5	1	7	50
		Husband-Wife	S_{35}	1							1	7
		Strap	$S_{53,67}$	2							2	14
		Case					S_{53}	1			1	7
		Lotus					S_{60}	1			1	7
		Bead							S_{10}	1	1	7
		Refugee Camp							S_{28}	1	1	7
	TOTAL										14	100
	B University	Link	S_4	1	S_3	1					2	7
		Sibling	$S_{3,6,7,17}$	4	$S_{6,14,17,21,27,40}$	5	S_{18}	1	$S_{4,28}$	2	11	38
		Mother	S_8	1					S_6	1	2	7
		Friend	S_{13}	1							1	3
		Military	S_{41}	1							1	3
		Glasses			S_{19}	1					1	3
		Swing Thread			$S_{20,23,25}$	3					3	10
		Seed							S_8	1	1	3
		Image			S_{31}	1					1	3
		Bag			S_{34}	1					1	3
		Sandglass			S_{36}	1					1	3
		Inseparable			S_{37}	1			$S_{2,19}$	2	3	10
		Latch			S_{39}	1					1	3
	TOTAL										29	100

Common metaphorical perceptions of prospective teachers, according to university variable in the feature category for the concept of chromosome, is sibling [Table 13].

The samples of the prospective teachers are stated as follows:
"Chromosome is like a human, and the paired chromosome is like husband and wife. Because it is paired with a chromosome that corresponds to it" (A,1, S35).
"Chromosome is like twins. Because they are similar in structure and are connected" (A,3, S20).
"Chromosome is like a case. Because it retains all the information" (A,3, S53).

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Table 14
Perceptions of the Prospective Teachers in the Category of Content for the Concept of Chromosome

Category	Variable (University)	Codes	1.Class		2. Class		3. Class		4.Class		Total f	%
			Student Codes	f	Student Codes	f	Student Codes	f	Student Codes	f		
CONTENT	A University	Child	S_{10}	1							1	8
		Cable	S_{13}	1							1	8
		Ribbon	S_{17}	1			S_{24}	1			2	15
		Abacus	S_{41}	1							1	8
		Atomic	S_{45}	1							1	8
		Encyclopedia	S_{63}	1							1	8
		Flash Disk	S_{64}	1							1	8
		Auto Part			S_{3}	1					1	8
		Body			S_{5}	1					1	8
		Star			S_{7}	1					1	8
		Fruit					S_{12}	1			1	8
		Chain							S_{27}	1	1	8
	TOTAL										13	100
	B University	Father-Mother	S_{9}	1							1	9
		Thread	S_{19}	1							1	9
		Molecule					S_{7}	1			1	9
		Family	S_{27}	1							1	9
		School			S_{10}	1			S_{23}	1	2	18
		Half Apple			S_{15}	1					1	9
		Raisin Pie			S_{35}	1					1	9
		Ship					S_{8}	1			1	9
		Train					S_{9}	1			1	9
		Storage					S_{10}	1			1	9
	TOTAL										11	100

According to the university variable, prospective teachers do not have a common metaphorical perception in the content category for the concept of chromosome [Table 14].

Samples of prospective teachers are indicated as follows:

"Chromosome is like a child in the family. Because the absence of a child led to great pain" (A,1, S10).

"Chromosome is like a surrounded cable. Because the formation of chromosome takes place by shortening and wrapping DNA" (A,1, S13).

"Chromosome is like an encyclopedia. Because it contains all the important information" (A,1, S64).

"Chromosome is like a star. Because there are nucleotides on it" (A,2, S7).

"Chromosome looks like two halves of an apple. Because parts represent chromosome threads, and core represents synapse" (G,2, S15).

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Discussion

Biology science examines many aspects of living and non-living creatures. These aspects include changes in the process starting from "time of existence up to the present." These are their distribution of nature and their development. They increase along with the structure (TDK, 2020). It is a discipline that reveals relationship levels of structures. These levels are interrelated in the human body (Zvi-Assafaf et al., 2013). They contain many abstract and complex concepts. It is significant to learn these concepts correctly and determine their relationships. At the same time, biology education in the Turkish education system is mostly oriented towards cognitive knowledge. Consequently, it requires implementation for effective information. The education life starts at the age of 5 and continues until the late '20s. During this educational process, while DNA-Gene-Chromosome concepts have been dealt with in various occasions, it emerges as concepts that cannot easily be solved. To challenge the concept complexity, metaphoric perceptions were used. In general, the usage of metaphor is a way of thinking that fits individuals' understanding of the world. In this respect, metaphor is a powerful resource that helps people understand and explain a highly abstract, complex, or theoretical phenomenon (Morgan, 1997). Therefore, this study validates the metaphoric perceptions of science prospective teachers, for DNA-Gene-Chromosome concepts. Also, it confirms that common metaphorical perceptions are in line with different variables that were identified to explain relationships.

As a result of this research, 326 science-prospective teachers produced 313 valid metaphors concerning DNA-Gene-Chromosome concepts. Thirty-four of these valid metaphors emerged as a common metaphoric perception. The remaining 279 metaphors differed, according to the class and university variables. It was ensured that common metaphoric perceptions in these different variables were compiled under specified conceptual categories. The points that draw attention, as a result of this research, indicated as follows:

First, prospective teachers used different metaphors to reflect their ideas concerning DNA-Gene-Chromosome concepts. Usage of metaphors is not a new technique in teaching. Metaphors are frequently used as teaching tools for subjects or concepts in educational research (Ben-Peretz et al., 2003; Botha, 2009). Also, metaphors are the reasons for being selected to reveal meanings that are being placed on the concept (Tynavcevic & Vaupot, 2009). It is understood that prospective teachers, who were the subject of this study group for DNA-Gene-Chromosome concepts, had continuously heard of the alleged concepts during their learning processes. Yet, they could not fully explore the relationship among the respective concepts (n=13).

Second, it was observed that prospective teachers had created more than one metaphor for these concepts, rather than creating certain metaphors. Weade and Ernst (1990) stated that "metaphors provide the opportunity to only explain part of the determined phenomenon." Also, it was understood that prospective teachers' metaphorical perceptions towards these concepts were limited with identified features. Another similar approach was mentioned in the study of Weade and Ernest. It indicates, "Metaphors represent only one part of the phenomenon." These relations are further supported by the statement expressing that "it does not explain the whole phenomenon (Weade & Ernst, 1990)." Also, it stated that metaphor was not identical to the phenomenon. It was only a symbol of the phenomenon, and only one phenomenon could be supported by multiple metaphors (Yob, 2003). Indeed, it explained that more than one metaphor was used for an individual phenomenon, in various studies that were conducted for the biological concepts (Al-Zahrani, 2008; Cengiz & Ekici, 2019; Coşkun, 2010; Eilam, 2009; Gürbüzoğlu et al., 2013; Harman & Çökelez, 2017; Hellsten & Nerlich, 2011; Kahyaoğlu, 2015; Konopka, 2002; Neuman, 2005; Vennille et al., 2006; Selvi, 2007; Ulukök et al., 2015; Yapıcı, 2015).

Third, based on different university or class variance, common metaphorical perceptions about DNA-Gene-Chromosome concepts were determined. While metaphors reveal ideas, it makes the ideas more permanent, understandable, and enlightening (Clarken, 1997). At the same time, metaphors reflect the thoughts and activities of those who used them to characterize certain concepts (Draaisma, 2007). Thus, as revealing perceptions of prospective teachers towards the concept of DNA-Gen-Chromosome, it was ensured to reflect the shapes of these concepts in minds, as well. Fourth, it is too difficult to overcome the complexity of the concepts of Biology, even if students have heard it many times. The used metaphors in daily life (Oxford et al., 1998), is a powerful mental tool that can be utilized to understand and explain concepts. These concepts are abstract, complex, and, not related to each other (Yob, 2003). Indeed, these concepts can be maintained for students by addressing different areas of intelligence, through relevant conceptual categories or codes. There might be many reasons, but one main reason is the concepts with a conceptual equivalent that could

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be related to being at the "microscopic level." Besides, it is possible to confuse the concepts that are invisible and related. Metaphors are reflections of facts in thought mechanisms of individuals concerning each other (Heywood, et al., 2002; Martinez et al., 2001). Meanwhile, metaphors enable the environment to keep the concepts in mind (Arslan & Bayrakçı, 2006; Goldstein, 2005). While individuals reflect accurate perceptions and interpretations in minds regarding the concepts. Also, they help to reflect their imagination and goals (Cornelissen et al., 2008; Lopez, 2007).

Conclusions

In this study, perceptions of prospective educators that loaded metaphorically related to DNA-Gen-Chromosome concepts, commonly used perceptions, according to different variables that had been determined. In fact, although there have been many studies in education concerning the determination of metaphoric perceptions. Yet, there has been no study to distinguish the concepts of DNA-Gene-Chromosome and relationship among them. Despite the different university and class variables, it has been observed that pre-service science teachers have common metaphorical perceptions of DNA-gene-chromosome concepts. The research results reflect the clues on "how science-prospective teachers perceive DNA-Gene-Chromosome concepts that have been obtained." Granting there were (326) students forming the study sample, the majority were not seen in the frequency percentages tables. On the other hand, the correct metaphorical perceptions concerning these concepts are limited. These limited parts provide a relationship between the subject and source. It shows that concepts are still mixed. This study was conducted only on prospective teachers who provided the correct subject-source relationship. Therefore, the frequency and percentages are less than the number of students.

Recommendations

The metaphors, obtained as a result of this research, may be used by the academicians who deliver lectures at the university level of education. Also, it can be used for high school teachers, who teach within the scope of biology lessons to plan the teaching process, shape the teaching-learning process, and measure and evaluate steps in the field of biology. Meanwhile, according to research data, metaphors reflecting DNA-Gene-Chromosome concepts, cover the hints on how science-prospective teachers perceive it. It can be used to determine the readiness of students with the same or different learning levels. Also, it reveals student's prior knowledge. The usage of determining metaphors by trainers may interest students' attention. It can enable students to distinguish between concepts, by bringing information to minds via terminology and practices. Thus, conceptual complexities can be eliminated. It can serve as a different teaching tool for biological terms, utilizing different techniques. The students' readiness for the course topic can be determined. Also, this research, which was conducted for the science-prospective teachers, may be used for the students that are studying other fields. It can also be utilized for high school students to challenge complex concepts. This research is not limited to only prospective teachers, but it can be applied in multidisciplinary fields.

This study exposed two university participants, one from the north and the other from the east of Turkey. Yet, it can be used for universities located in different regions, with various educational levels. At the macro level, metaphoric perceptions concerning the respective concepts or various concepts may be identified, as well. The biological concept metaphors set an example for each area included in the target content, in the educational process. Therefore, it can be used to perceive the terms DNA-Gene-Chromosome in all branches, starting from primary school up to higher education, using these concepts.

Although this study is only limited to concepts such as DNA-Gen-Chromosome, it creates examples for other concepts that are difficult to learn and relate to each other. This research result can aid in the determination of students' readiness levels for issues related to metaphors in new concepts, utilizing certain metaphors of these concepts.

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Turkey under the title of "Determining of Common Mental Images for DNA-Chromosome Concepts" while the data about the Gene Concepts submitted to the International Conference on Education in Mathematics, Science & Technology (ICEMST) took place on May 18 - 21, 2017 in Ephesus Kusadasi, Turkey under the title of " The Metaphoric Perceptions of Prospective Teachers on Gene Concepts".

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