An Analysis of Metaphors Used by High School Students to Describe Physics, Physics Lesson and Physics Teacher

Ali Çetin

Department of Elementary Science Education
Siirt University
Siirt, Turkey
alicetin@siirt.edu.tr

(Received: 09.04.2016, Accepted: 26.07.2016)

DOI: *10.20308/ejpe.35860*

Abstract
The purpose of this study was to describe high school students' "physics", physics lesson" and "physics teacher" conceptions by using metaphors. 313 students participated in the study from different high school types in Siirt, Turkey. A metaphorical perception form constructed by researcher was individually conducted, digitally recorded and analyzed. Codes and conceptual categories were created. The results demonstrate that students describe physics and physics lesson by using content, function, affective and cognitive characteristics and physics teacher by using cognitive, affective, personality and physical characteristics. Although constructivist approaches are applied in Turkish physics education program, the results show that most of the high school students still think that physics is a complex and difficult subject. The other result of the study shows that students think that physics is a developing subject area but physics lesson is not developing course. About physics teachers students believe that they are very knowledgeable and intelligent people. Some recommendations are made for researchers and program developers.
Keywords: *Physics Education, Metaphorical Conceptions, High School Students*

INTRODUCTION

Concepts are the first associations on people's mind related to object or entity (Çepni, 2011). Concepts are constructed on mind, they are abstract idea units and real-life examples to simplify our lives. This means, concepts are associated in human's mind with another concept (Senemoğlu, 2005). Successful learning increases when students make connections in coherence levels between concept and context (Felzman, 2014). According to Lakoff and Johnson (2003), metaphors can be explained by making an understanding or experiencing of a concept from another point. So the metaphors are the fundamental thought sources (Martinez, Souleda and Huber, 2001). Physics is a developing area in science and technology era, and metaphors have a special importance in understanding how students describe physics.

Physics have important qualities for the students in the understanding of daily life and natural events in science. These qualities result from the spread of a wide range of subject areas of physics. For example; some topics like mechanics, optics, electricity and thermodynamics are directly related to daily life events and simplify the students' understandings. According to Serway and Beichner (2012), the main purpose of the physics is to find limited number of fundamental laws related to natural events and to help us to develop theories for predicting the results of experiments. Thus, physics is a kind of science that has a social dimension and creates favorable changes in human's perspective to nature. On the other hand, physics education is

responsible for teachers' didactical and pedagogical knowledge (Mantyla and Nousiainen, 2014). So, the findings that are constructed by using metaphors can be described cognitive, affective and psychomotor dimensions of physics to develop physics education.

In literature, metaphors come into account when their similarities of the concepts are thought on our minds (Yalmancı & Aydın, 2013; Derman, 2014; Çelik & Çakır, 2015). Metaphors related to the concepts may reveal what can be done for this concept by using their affective, cognitive and psychomotor characteristics (Yalmancı & Aydın, 2013). In Turkish Language Association (TDK, 2015) dictionary, metaphor is described as synonym of figurative expression and defined as using a word or concept in a different way of real meaning. Hence, while creating a metaphor in human's mind, a phenomenon should be specified with a different phenomenon in an open or closed way. This shows that metaphors contain powerful activities on mind (Saban, 2008). In brief, metaphors help us to see the inside of the concepts (Töremen & Döş, 2009).

There are two important theories related to metaphors in literature. First one is set forth by Lakoff and Johson (1980) and includes conceptual and linguistic dimensions. According to this insight, the relationship between time and money described in saying "time is money" is a kind of conceptual metaphor. However, when someone says "spend your time well", the same relationship turns to a linguistic metaphor. Then, due to the second metaphor theory resulting as a modern metaphor theory, metaphors are divided into three; conceptual, existential and directional (Akşehirli, 2007). Conceptual metaphors are expressed as abstract concepts by using a concrete one or a concrete concept by using an abstract one such as "love is food". Existential metaphors are expressed as nonphysical terms by using a physical term or matter such as "my mind is full". Directional metaphors use spatial trends like "upward-downward", "in-out", "forward-backward", "shallow-depth" such as "my morale rose".

Many concepts are used to find out the related metaphors in literature like "culture and teacher"(Çelikten, 2006), "teacher" (Saban, Koçbeker & Saban, 2006), "curriculum development" (Semerci, 2007), "geography" (Öztürk, 2007; Aydın & Ünaldı, 2010), "manager" (Cerit, 2008), "student"(Saban, 2009), "inspector" (Töremen & Döş, 2009), "climate" (Coşkun, 2010), "earth" (İbret & Aydınözü, 2010), "earthquake" (Karakuş, 2013), "mathematics" (Oflaz, 2011), "chemistry" (Derman, 2014), and "biology" (Yalmancı &Aydın, 2013). The metaphoric studies in the literature show that many concepts can be searched and metaphorical perceptions of the students can be revealed. For scientific ideas, metaphors work independent of the particular features of the metaphor (Ogborn & Martins, 1996). In physics education field, Glose and Scherr (2015) constructed a blended environment to develop the understanding of energy transfers and transformations. The name of the environment was "Energy Theater" and at the end of the study they found that specific conceptual metaphors can supply a benefit for science instruction. Çelik and Çakır (2015) conducted a study related to heat and temperature unit with "melting", "boiling", "condensation" and "evaporation". The study was conducted with 226 high school students and metaphors were divided into four categories (phenomenological and conceptual, abstract, related to daily life, misconception). Lancor (2015) designed a study to find out the metaphors related to "energy" concept. In this study, six categories were founded as *energy as a substance that can be accounted for, that can change forms, that can flow, that can be carried, that can be lost, and that can be added, produced or stored.* Lancor (2014) states these categories change in physics, chemistry and biology fields. Consequently, within the literature review, no study has been found related to "physics", "physics lesson" and "physics teacher" concepts and besides, revealing these conceptions on high school students mind is a necessary process on behalf of physics education.

The aim of this study is to reveal high school students' metaphorical perceptions about "physics", "physics lesson" and "physics teacher". How students describe, how they make

sense and how they express physics, physics lesson and physics teacher are the main starting points of this study. Sub-problems are designed as following:

1. Which metaphors are used by high school students to describe physics, physics lesson and physics teacher concepts?
2. Which conceptual categories are emerging when the common characteristics of the metaphors are taken into account? What are the themes that are connected to these categories?
3. Is there any significant relationship between these conceptual categories and school types of the students?

METHODOLOGY

A qualitative research has been conducted to find out the students' metaphorical perceptions about "physics", physics lesson" and "physics teacher". Phenomenology study design has been used for this study. Phenomenology is defined as the study of essences and when it is applied to a problem, it attempts to define an essence, for example the essence of perception or the essence of consciousness (Merleau-ponty & Bannan, 1956). Phenomenon can be an event, en experience, a perception, a concept or a situation, and phenomenology design has focused on a phenomenon of which we are aware, but we could not detail with an in-depth understanding, (Yıldırım & Şimşek, 2013).

Participants

Purposive sampling, one of the non-random sampling types, has selected for the study. Criterion sampling procedure has been applied. Criterion sampling is appropriate to get firsthand and subjective data in phenomenology studies (Metin, 2014). It involves selecting cases that meet some predetermined criterion of importance (Patton, 2001). For this study, students that attend physics courses and from different school types have been selected to participate in the study. Science high school (SHS), Anatolian high school (AHS), vocational high school (VHS) and religious high school (RHS) are four different types of high schools that participated in the study in the city center of Siirt. 100 metaphorical perception forms were sent to each of these schools and they were requested to apply these forms to physics students of different grades. 313 of the total of 400 forms have been turned to the research to evaluate. In Table 1, the distribution of the accepted participant numbers has been presented in terms of school types and "physics", physics lesson", "physics teacher" concepts.

Table 1. *The Number of Participants in terms of School Types and Concepts*

	Physics		Physics Lesson		Physics Teacher	
	f	%	f	%	f	%
Science H. S.	72	31,7	70	29,3	67	30,7
Anatolian H. S.	81	35,7	85	35,6	77	35,3
Vocational H. S.	32	14,1	32	13,4	33	15,1
Religious H. S.	42	18,5	52	21,8	41	18,8
Total	227	100,0	239	100,0	218	100,0

Data Collection

Metaphorical perception form constructed by the researcher has been used to collect data for the study. This form includes three open ended questions: "physics looks like …….. because

……." , "physics lesson looks like …….., because ……." and "physics teacher looks like …….., because …….". Students use a word or a phrase to fill the first blank they make a connection with the main concept and then write the reason of why they select this word or phrase to the second blank. They fill the blanks to construct a meaningful sentence.
In metaphor studies, the participants can use some words or phrases related to concept; however, this may not be enough to reveal descriptive and visual aspects of the metaphor. So, the question of "why" must be asked to the participants (Yıldırım & Şimşek, 2013). To reveal the descriptive aspect of the metaphors, second part of the sentence starting with "because ……." has been added.

Analysis
The data taken from metaphorical perception form have been analyzed by using the steps used by Saban (2009) as follows; codification, classification, category development, reliability and validity, transferring data to computers.

Codification: Three temporary alphabetic sequential lists are constructed by metaphors for each concept; physics, physics lesson and physics teacher. Empty forms and the forms that do not include any metaphorical icons are not taken to the lists. 49 forms for "physics", 43 forms for "physics lesson" and 56 forms for "physics teacher" have been removed from the study.

Classification: 37 forms that include weak metaphorical icons have been removed from "physics" and the remaining 227 participants' responses have been accepted.125 metaphorical icons have been produced for this concept and classified in 11 codes. 31 forms that include weak metaphorical icons have been removed from "physics lesson" and the remaining 239 participants' responses have been accepted. 123 metaphorical icons have been produced for this concept and classified in 9 codes. 39 forms that include weak metaphorical icons have been removed from "physics teacher" and the remaining 218 participants' responses have been accepted. 91 metaphorical icons have been produced for this concept and classified in 8 codes.
Category Development: The common characteristics of metaphorical icons for physics, physics lesson and physic teacher are examined to develop categories. Four categories are constructed both for physics and physics lesson concepts. These are: (1) content, (2) function, (3) affective characteristics and (4) cognitive characteristics. Similarly, four categories are constructed for physics teacher concept as (1) cognitive characteristics, (2) affective characteristics, (3) personal characteristics and (4) physical characteristics.

Reliability and Validity: While reliability is paying attention on the accuracy of research results, validity is related to the reproducibility of research results (Yıldırım & Şimşek, 2013). For the reliability of this study, the detailed process of category development and the related metaphoric icons have been explained. For the validity, expert judgment is used. An academician, who completed a metaphorical analysis study before, made the same process with the researcher. An alphabetic list of metaphors, list of classification and list of categories have been given to the academician to make same classification and categorical analyzes. The new list which has been constructed by the academician has been used to determine consensus and dissidence numbers. The validity of the study has been calculated by using Miles and Huberman (1994) formula: Validity = Consensus / (consensus + dissidence). In qualitative studies, the consensus between expert and the researcher should be equal or more than 90 percent (Saban, 2009).

For physics concept, in 12 metaphorical icons, there was dissidence between the expert and the searcher. These icons were "family, life, engineering, tree root, brain, soup, space, puzzles, cookies, breath, water, and living". So the validity was calculated as 90 percent (113/(113+12)). For physics lesson concept, in 9 icons, there was dissidence. These were;

"puzzles, exam, foreign language, nightmare, key, song, philosophy". So the validity was 93 percent (114/(114+9)). For physics teacher, in 9 icons, there was dissidence. These were; "friend, good, angel, philosopher, ATM, answer key, genius, baklava and jesting". So validity was 90 percent (82/(82+9)).

Transferring Data to Computer: Metaphors and school types of participants are coded into Microsoft Office Excel. In the program, the alphabetic sequence is constructed for each concept. These lists are also used for expert judgment. Expert created a new column for his evaluation. At the end last decisions for each metaphorical icon are transferred to SPSS 21.0 program. For each category and classification frequency, percentage values are calculated. Additionally, *Pearson χ2* test is applied to understand whether there is a significant difference among school types.

Limitations

This study is limited with;

- The students participated in the study in 2015-2016 education year in the related schools in Siirt city center; Science, Anatolian, Vocational, Religious high schools
- The concepts of physics, physics lesson and physics teacher
- The current opinions of the participants about the concepts. Metaphors are not stable thought so the answers of the participants can change with the time.

RESULTS

1. Which metaphors are used by high school students to describe physics, physics lesson and physics teacher concepts?

The codes produced during classification, metaphors, frequencies and the metaphor numbers for physics concept are presented in Table 2.

Table 2. *Codes and Metaphors for Physics Concept*

Codes	f	%	Metaphor	Number of Metaphors
Related to Daily Life	33	14,5	Family, gold, friend, perspective, earth (2),universe, life (19)*, machine, logic, engineering, important, experience	12
Uses Shapes and Formulas	22	9,7	Puzzle, E=mc2, formula, geometry (2), complex, chemistry(2), mathematics (13), Sharlock Holmes	8
Having wide subject matter	38	16,7	Tree, root, smart phone, encyclopedia, atom (2), brain, büryan (a special meat dish), soup, nature, earth (2), universe (7), air, life (4), everything, chemistry, ocean (2), pilot pen.	17
Important and necessary	13	5,7	Family, love (2), knowledge, sun, light, medicine(2), breath, important (2), health, phone	10
Developing	24	10,6	Root, baby, tree, light, watch, water (11), uncompleted sentence, train, time, chain, nature (4)	11
Frightening	12	5,3	Fire, electricity, storm, nightmare, cactus, skeleton, horrible, death (2), saw, congestion, cliff	11
Enjoyable and Fun	5	2,2	Puzzle (29, crossword, cookies,	4
Undefined and Meaningless	12	5,3	1/0, nothing (4), empty (2), absurd (3),zero	5
Changes over time	11	4,8	Bitter chocolate (3), flower (3), sea, pumpkin seeds, watermelon, perfume, sweet gum	7

Complex and difficult	49	20,6	Love, trouble maker, Berlin wall, entwined rope, crossword, dead end, mountain, sink to bottom, Einstein (2), whirlpool, rose, life (6), impossibility, confusing, complex way, labyrinth (4), mathematics, forest (5), red pepper flakes, silly, I do not love, road (2), difficult (2), blood vessels, money, disability, pen, logic, game, water texture, remove the helmet in space, rain, puzzle, ability	34
Physical Appearance	8	3,5	Adriana Lima (2), car, ugly girl (2), outer world, physical appearance, human body	6
	227	100		125

*The numbers in parenthesis show the repeating time of the metaphor

According to Table 2, 11 codes are constructed by high school students by using 125 different metaphorical icons. Most of the students (f=49 and 20,6 %) think that physics is complex and difficult. 16,7 percent of the students (f=38) describe physics as having wide subject matter and 14,5 percent of them (f=33) uses daily life examples. In Figure 1, number of participants versus codes distribution is shown.

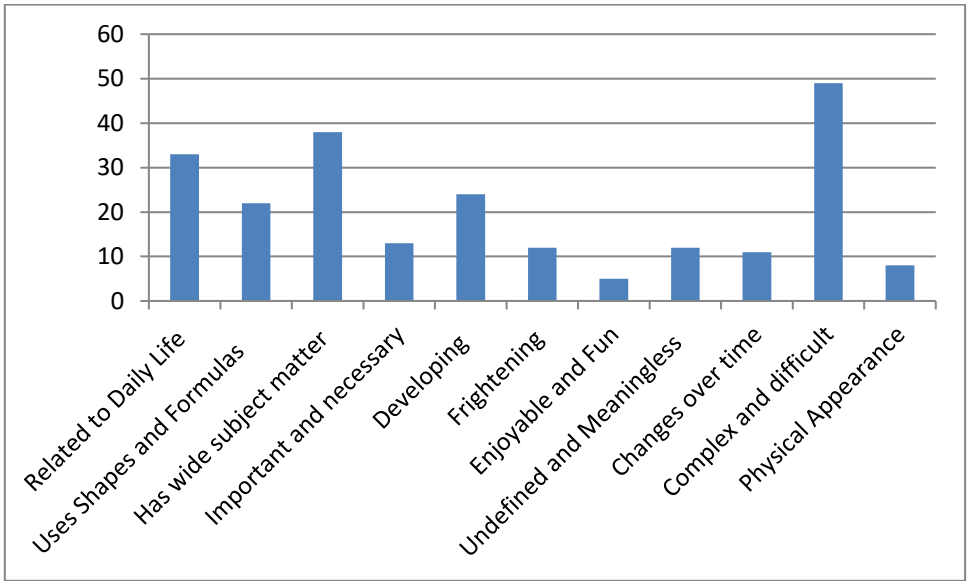

Figure 1. *Number of Participants versus Codes Distribution for Physics Concept*

Some students' responses to the metaphorical perception form are given below, in parenthesis, and besides, school types, metaphorical form number and the grade levels of the students are shown. For example, R 15 – 11 means religious high school; 15th student and the grade level are 11. Here, A is used for Anatolian, S is used for Science and V is used for Vocational high school students.

- Physics "looks" like **life** because even if we do not notice, physics is everywhere in our life (R 15 -11).
- Physics looks like **life** because it facilitates our lives. It is the middle part of puzzle, so if someone does not know it, the life becomes difficult (S 22 – 11).
- Physics looks like **a machine** because the working principles of the machines remind me of the physics (S 25 – 11).

- Physics looks like **mathematics** because many mathematical calculations are being used (S 52 – 11).
- Physics looks like **universe** because subject matter is wide (V 71 -12).
- Physics looks like **water** because while it is flawing, you try to fill the jug (V 150 – 12).
- Physics looks like **nature** because all things in physics have an order and definite answers (S 168 -11).
- Physics looks like **bitter chocolate** because at the begging it is sweet and then it becomes bitter (S 231- 11).
- Physics looks like **Adriana Lima** because when someone says physics, she comes to mind (S 221 – 11)
- Physics looks like **labyrinth** because all the ways are off to the other ways (A 205 – 11).

The codes produced during classification, metaphors, frequencies and the metaphor numbers for physics lesson concept are presented in Table 3.

Table 3. *Codes and Metaphors for Physics Lesson Concept*

Codes	f	%	Metaphor	Number of Metaphors
Related to Daily Life	20	8,4	Invention, house, real, life (12)*, ease, wallet, plug (2), balance	8
Uses Shapes and Formulas	23	9,6	Crossword, Formula (2), mathematics (18), quantitative, x-y and z	5
Having wide subject matter	27	11,3	Tree, white, computer, crossword, sea (2), earth (2), cow, rope (2), destiny, crowded, matruşka (2), ocean, lifetime, secret (2), infinity (3), space (4)	16
Important and Necessary	31	13,0	Mother, key (2), clothes tree, B vitamin, science (3), flower (3), cable, medicine, spoon, logic, fruit, cigarette (3), water (9), song, cover and pot, jug	17
Unlovable Lesson	16	6,7	Dislike, spinach, disgusting (2), dog, lemon, macaroni, tale (2), lullaby, school, disliked food, boring (4)	11
Enjoyable and Fun	30	12,5	Crossword (3), fun (5), pigeon, beautiful (4), loop, kebab (2), chemistry, game (6), cute, milk chocolate, weighing (2), Cornett, chamomile	13
Complex and Difficult	62	25,6	Puzzle (4), boring, crossword (3), murder, bag, fork, knotted rope, earth, E=mc2, Einstein, game (2), life (2), impossible, human (2), women, women bag, radiator, door, black hole (2), stomachache (2), complex (3), girls, labyrinth (4), machine, menemen (a special food including many vegetables), mixer (2), forest, colorful paint, quantitative, exam, sauce, balance, mountain, difficulty (3)	38
Fear	15	6,3	Enemy (2), phobia, story, cock, nightmare (3), fear (2), horror movie, fear tunnel (2), jump without parachute, remove the helmet in space	9
Other Lessons	15	6,3	Biology (2), Literature, Philosophy (3), Science (2), Geometry, Mathematics (6)	6
	239	100		123

*The numbers in parenthesis show the repeating time of the metaphor

According to Table 3, 9 codes are constructed by high school students by using 123 different metaphorical icons. Most of the students (f=62 and 25,6 %) think that physics lesson is complex and difficult. 13,0 percent of the students (f=31) describe physics lesson as an important and necessary subject and 12,5 percent (f=30) as enjoyable and fun. In Figure 2, number of participants versus codes distribution is shown as a graph.

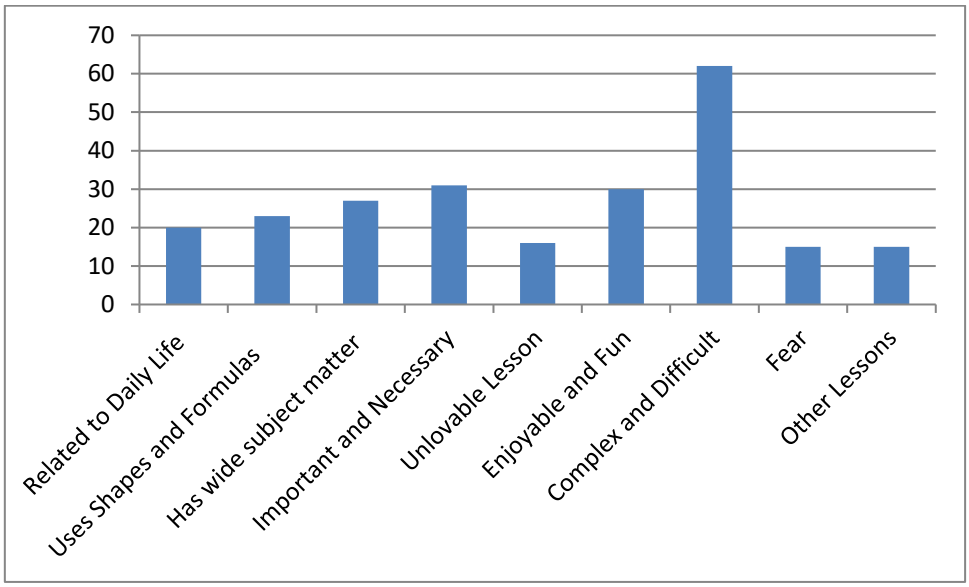

Figure 2. *Number of Participants versus Codes Distribution for Physics Lesson Concept*

As a comparison of physics and physics lesson concepts, it is obvious that the codes are similar for both of them. Even if there are new unfavorable codes named "fear" and "unlovable lesson", the number of participants that describe physics lesson as "complex and difficult" is still higher than those of physics concept. Physics lesson is described as unlovable, frightening and difficult by most of the participants (f= 93, 38,6 %). Some students' responses to the metaphorical perception form are given below as a similar notation to physics concept;

- Physics lesson looks like **sea** because starting and ending points are not certain (S 7- 11).
- Physics lesson looks like **mathematics** because it is a lesson based on formulas (V 202-12).
- Physics lesson looks like **life** because it is in all areas of life (S 231- 11).
- Physics lesson looks like **water** because you can't live without it (A 179 -12).
- Physics lesson looks like **jug** because you can use physics water without it (V 182 – 12).
- Physics lesson looks like **disliked food** because you have to learn reluctantly (S 147 – 11).
- Physics lesson looks like **milk chocolate** because it is funny when you solve problems (A 118 -11).
- Physics looks like **biology** because they are complementing each other (V 184 – 9).

The codes produced during classification, metaphors, frequencies and the metaphor numbers for physics teacher concept are presented in Table 4.

Table 4. *Codes and Metaphors for Physics Teacher Concept*

Codes	f	%	Metaphor	Number of Metaphors
Teaching Style	15	6,9	Slow motion (3), Refrigerator, storm, good (3)*, Izmir, jet, turtle, angel (3), author	9
Teacher Characteristics	28	12,9	Bulb (2), gardener (2), glass, electricity, diamond (2) philosopher, sun (3), light (2), medicine, illusionist, convex lens, lamp, angel, fruit tree, fount, expert (2)	17

Solution machine	13	6,0	Love FM, ATM, answer key, Formula (2), Newton, Problem, reflex, painter, genius, spaceman (3)	10
Intelligent and very knowledgable	86	39,4	Fire, Batman, Brain (2), Knowledge (2), Computer (3), Scientist (12), Bluetooth, intelligent, genius, correction fluid, mill, Einstein (4),heart (2), ant, book (15), bird, miracle, professor (17), robot (2), stone (2), chicken, plumber, dinner table, star (2), dolphin, poison, Rubik's cube (2), intelligent person (2)	29
Someone from family	22	10,1	Big brother (3), parents (2), friend (14), father(3),	4
Popular person	11	5,0	Cristiano Ronaldo, Fatih Terim, Messi, Muslera, Mustafa Pekdemek, Red Kit, Rıza Baba, Selçuk İnan (2), Süperman (2)	9
Personality Properties	32	14,7	Man (8), Baklava, Flower (2), Very good (6), rock, angel, cotton (2), playful (2), candy (6), sweet (2), summer,	11
Physical Properties	11	5,0	mirror (3), model (8)	2
Total	218	100		91

*The numbers in parenthesis show the repeating time of the metaphor

According to Table 4, 7 codes are constructed by high school students by using 91 different metaphorical icons. Most of the students (f=86 and 39,4 %) think that physics teachers are intelligent and very knowledgeable people. For some of them (f=43 and 19,7 %), personality and physical properties of teachers are dominant factors to describe physics teachers. 28 (28,9 %) students describe their physics teachers by using general teacher characteristics and 22 (10,1%) of them think that physics teachers behave like someone from their own families. In Figure 3, number of participants versus codes distribution is shown as a graph.

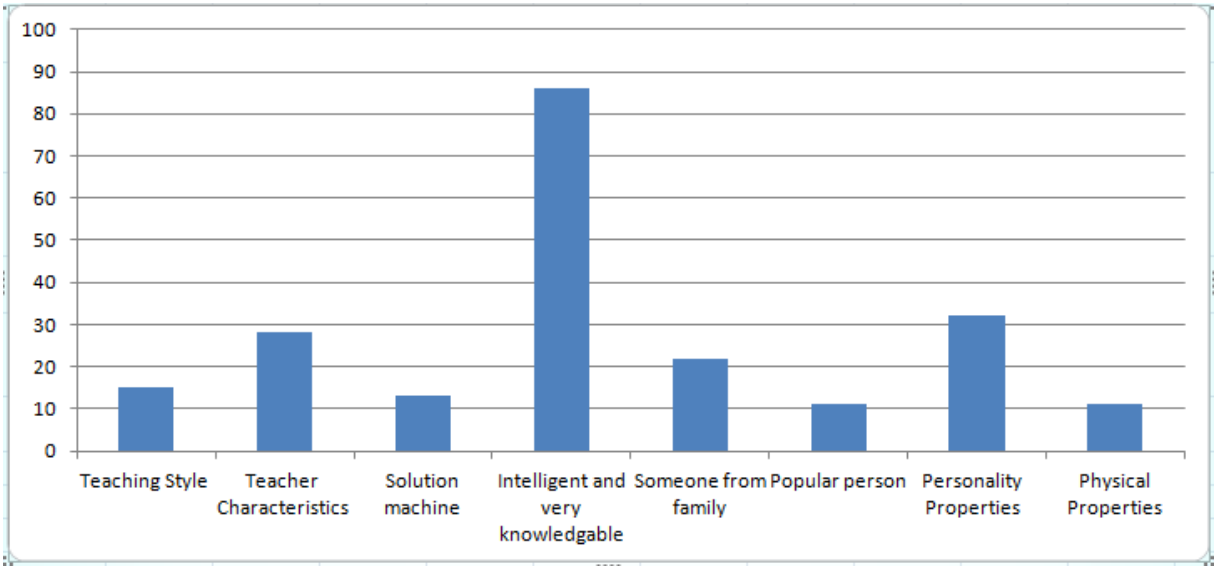

Figure 3. *Number of Participants versus Codes Distribution for Physics Teacher Concept*

Some students' responses to the metaphorical perception form are given below as a similar notation to physics concept;

- Physics teacher looks like **professor** because s/he knows too many things (V 148 -12).
- Physics teacher looks like **book** because there is treasury inside (A 127 – 10).

- Physics teacher looks like **scientist** because s/he searches the science and perspectives of scientists, then teaches them to us (R 100 – 11).
- Physics teacher looks like **friend** because s/he speaks very good with us, understands us and teaches well (A 10 -11).
- Physics teacher looks like **superman** because s/he has power to fly (S 33 – 11).
- Physics teacher looks like **flower** because s/he wants to give flower; anyone who wants to get smell or anyone who understands him negotiates with her/him (R 199 -12).
- Physics teacher looks like **candy** because you get the flavor you like (S 214 – 11).
- Physics teacher looks like **model** because s/he is long and thin (R 180 -12).
- Physics teacher looks like **mirror** because s/he always reflects knowledge to us (A 179 – 12).

2. Which conceptual categories are emerging when the common characteristics of the metaphors are taken into account? What are the themes that are connected to these categories?

Codes, categories and themes related to physics, physics lesson and physics teacher concepts are listed in Table 5.

Table 5. *Codes, Categories and Themes of Physics, Physics Lesson and Physics Teacher*

	Theme	Category	Code
Physics	Scope	Content	Related to Daily Life Uses Shapes and Formulas Having wide subject matter
	Teaching	Function	Important and necessary Developing
	Concept Characteristics	Affective	Frightening Enjoyable and Fun Undefined and Meaningless Changes over time
		Cognitive	Complex and difficult Physical Appearance
Physics Lesson	Scope	Content	Related to Daily Life Uses Shapes and Formulas Having wide subject matter
	Teaching	Function	Important and Necessary
	Concept Characteristics	Affective	Unlovable Lesson Enjoyable and Fun Complex and Difficult Fear
		Cognitive	Other Lessons
Physics Teacher	Sufficiency	Cognitive	Teaching Style Teacher Characteristics Solution machine Intelligent and very knowledgeable
	Attitude	Affective	Someone from family Popular person
	Individual Properties	Personality Properties	Personality Properties
		Physical Properties	Physical Properties

According to Table 5, physics is described as content, function, affective and cognitive properties and it has four categories; these are content, function, affective and cognitive characteristics. High school students think that physics content includes daily life events, uses shapes and formulas and having wide subject matter. Students believe that physics is important, necessary and developing. While affective dimension of physics concept characteristics is frightening, enjoyable, fun, undefined and meaningless, and changes over time, cognitive dimension includes complex and difficult physical appearance. The content of physics and physics lesson are the same. In the function of physics lesson, while students think physics as a developing concept, students do not describe the physics lesson as a developing one. While using complex and difficult metaphorical icons for physics concept, students use cognitive properties, similar codes for physics lesson concept used for affective characteristics. Students described physics teachers by using sufficiency, attitudes and individual properties. Students think that cognitive sufficiency of teachers is related to their teaching styles, teacher characteristics, solution ability of problems and their intelligence and knowledge base. For affective category, some students describe their physics teacher as someone from their family and a popular person. Some students use personality and physical characteristics of teachers for their individual properties.

3. Is there any significant relationship between these conceptual categories and school types of the students?

The distribution of codes and categories with school types are presented in Table 6 for physics concept.

Table 6. *Distribution of Categories and Codes Due to School Types Related to Physics Concept*

		School Type				TOTAL
		A H.S. f (%)	V.H.S. f (%)	R.H.S. f (%)	S.H.S. f (%)	f (%)
Content	Related to Daily Life	17(21,0)	1(3,1)	9(21,4)	6(8,3)	33(14,5)
	Uses Shapes and Formulas	6(7,4)	9(28,1)	3(7,1)	4(5,6)	22(9,7)
	Having wide subject matter	13(16,0)	6(18,8)	4(9,5)	15(20,8)	38(16,7)
	Total	36(44,4)	16(50,0)	16(38,1)	25(34,7)	93(41,0)
Function	Important and necessary	6(7,4)	0	2(4,8)	5(6,9)	13(5,7)
	Developing	3(3,7)	4(12,5)	5(11,9)	12(16,7)	24(10,6)
	Total	9(11,1)	4(12,5)	7(16,7)	17(23,6)	37(16,3)
Affective	Frightening	4(4,9)	0	5(11,9)	3(4,2)	12(5,3)
	Enjoyable and Fun	3(3,7)	1(3,1)	0	1(1,4)	5(2,2)
	Undefined and Meaningless	7(8,6)	0	2(4,8)	3(4,2)	12(5,3)
	Changes over time	1(1,2)	0	4(9,5)	6(8,3)	11(4,8)
	Total	15(18,5)	1(3,1)	11(26,2)	13(18,1)	40(17,6)
Cognitive	Complex and difficult	16(19,8)	11(34,4)	8(19,0)	14(19,4)	49(21,6)
	Physical Appearance	5(6,2)	0	0	3(4,2)	8(3,5)
	Total	21(25,9)	11(34,4)	8(19,0)	17(23,6)	57(25,1)
Total		81(100)	32(100)	42(100)	72(100)	227

Pearson $\chi 2$ test between codes * school types; $\chi 2$= 58,245; df= 30; p=0,001
Pearson $\chi 2$ test between categories * school types; $\chi 2$ = 13,038; df= 9, p=0,161

According to Table 6, there is a significant relationship between codes and school types of participants about the physics metaphors *(X^2=58,245; df=30; p=0,001).* However, there is no significant relationship between categories and school types *(X^2=13,038; df=9 ; p=0,161).* The important significant points that grab attention can be listed as following:

- In all school types, firstly participants mostly (41%) think of the content dimension of physics. According to them, physics content has three dimensions; it is related to daily life, it uses shapes and formulas and it has wide subject matter. Secondly, students (25,1%) describe physics by using cognitive properties and believe that physics is complex and difficult (21,6%). Thirdly, for the affective category (17,6%), most students' attitudes are unfavorable thinking it is frightening, undefined and meaningless and changes over time, which means physics can be loved at the beginning but over time it changes to be something unlovable . Only 2,2% of all participants describe physics as enjoyable and fun. Lastly, for the function category, students (16,3%) think that physics is a developing subject and it is important and necessary. This distribution is also represented in Figure 4.

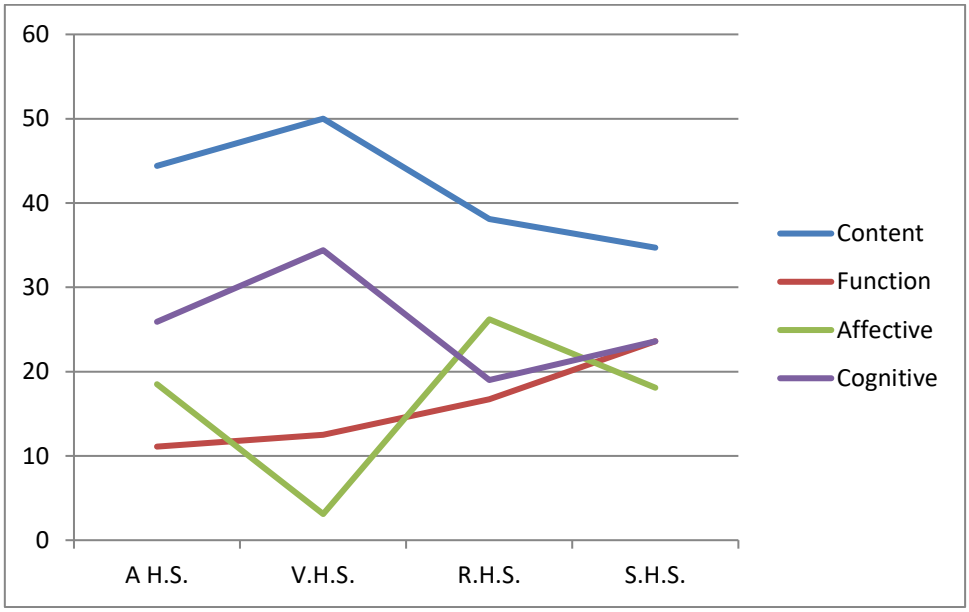

Figure 4. *School Type vs. Categories Distribution for Physics Concept*

- Anatolian high school students mostly (44,4%) think about the content of physics. They produced metaphorical icons "related to daily life" (21,0 %) and "having wide subject matter" (16,0 %). Secondly, they produced metaphors related to cognitive dimension of physics (25,1%) and in this category, most of them believe that physic is complex and difficult. Thirdly, 18,5 % of them describe physics by using affective metaphors especially physics as undefined and meaningless. Lastly, 7,4 % of them consider physics as important and necessary and 3,7 % as a developing subject in function category.
- Vocational high school students mostly produced metaphorical icons related to content and cognitive categories. The total of these two categories was 84,4 %. That means students mainly think cognitive dimension of physics. They did not produce any metaphorical icons related to the codes of "important and necessary", "frightening", "undefined and meaningless", "changes over time" and "physical appearance".

- Religious high school students produced metaphorical icons related to content (38,1) and most of them used metaphors related to daily life code. In affective category, none of them used metaphors related to its being enjoyable and fun. All used unfavorable metaphorical icons to describe physics.
- Science high school students mostly produced metaphorical icons related to content (34,7%) but unlike other school type participants, they produced metaphors about "having wide subject matter" code. That means the important point for these students is the subject matter of physics. Function and cognitive categories have the same percentages (23,6 %). 16,7 % of the students used metaphorical icons related to developing codes and 19,4 % used complex and difficult ones.

The distribution of codes and categories with school types are presented in Table 7 for physics lesson concept.

Table 7. *Distribution of Categories and Codes Due to School Types Related to Physics Lesson Concept*

		School Type				
		A H.S. f (%)	V.H.S. f (%)	R.H.S. f (%)	S.H.S. f (%)	TOTAL f (%)
Content	Related to Daily Life	9(10,6)	2(6,3)	4(7,7)	5(7,1)	20(8,4)
	Uses Shapes and Formulas	10(11,8)	9(28,1)	4(7,7)	0	23(9,6)
	Having wide subject matter	10(11,8)	1(3,1)	5(9,6)	11(15,7)	27(11,3)
	Total	29(34,1)	12(37,5)	13(25,0)	16(22,9)	70(29,3)
Function	Important and Necessary	6(7,1)	3(9,4)	6(11,5)	16(22,9)	31(13,0)
Affective	Unlovable Lesson	9(10,6)	1(3,1)	2(3,8)	4(5,7)	16(6,7)
	Enjoyable and Fun	15(17,6)	6(18,8)	4(7,7)	5(7,1)	28(12,6)
	Complex and Difficult	23(27,1)	5(15,6)	12(23,1)	22(31,4)	62(25,9)
	Fear	2(2,4)	0	10(19,2)	3(4,3)	15(6,3)
	Total	49(57,6)	12(37,5)	28(53,8)	34(48,6)	123(51,5)
Cognitive	Other Lessons	1(1,2)	5(15,6)	5(9,6)	4(5,7)	15(6,3)
TOTAL		85(100)	32(100)	52(100)	70(100)	239

Pearson $\chi 2$ test between codes * school types; $\chi 2$= 69,085 ; df= 24; p=0,001
Pearson $\chi 2$ test between categories * school types; $\chi 2$ = 21,648 ; df= 9, p=0,010

According to Table 7, there is a significant relationship between codes and school types of participants about the physics lesson metaphors *(X^2=69,085; df=24; p=0,001).* Additionally, there is a significant relationship between categories and school types *(X^2=21,648; df=9; p=0,010).* The important significant points that grab attention can be listed as following:

- In all school types, firstly participants mostly (51,5%) think of the affective dimension of physics lesson. According to them, physics lesson has four properties; unlovable lesson, enjoyable and fun, complex and difficult and fear. These codes are the same with physics ones except for complex and difficult. Students, who use complex and difficult code to describe physics and physics lesson, made different explanations. While they are evaluated in cognitive category in physics concept, they are evaluated in affective code in physics lesson concept. Most of the students in affective category use unfavorable metaphorical icons. Secondly, participants (29,3 %) use metaphors related to content to describe physics lesson. They use the same codes as physics concepts which are related to daily life, use shapes and formulas and have wide subject matter.

Thirdly, 13,0 % of the all students use function category and believe that physics lesson is important and necessary. Lastly, the rest of the students (6,3 %) describe physic lesson by using other lessons like biology, chemistry, science etc. This distribution is also presented in Figure 5.

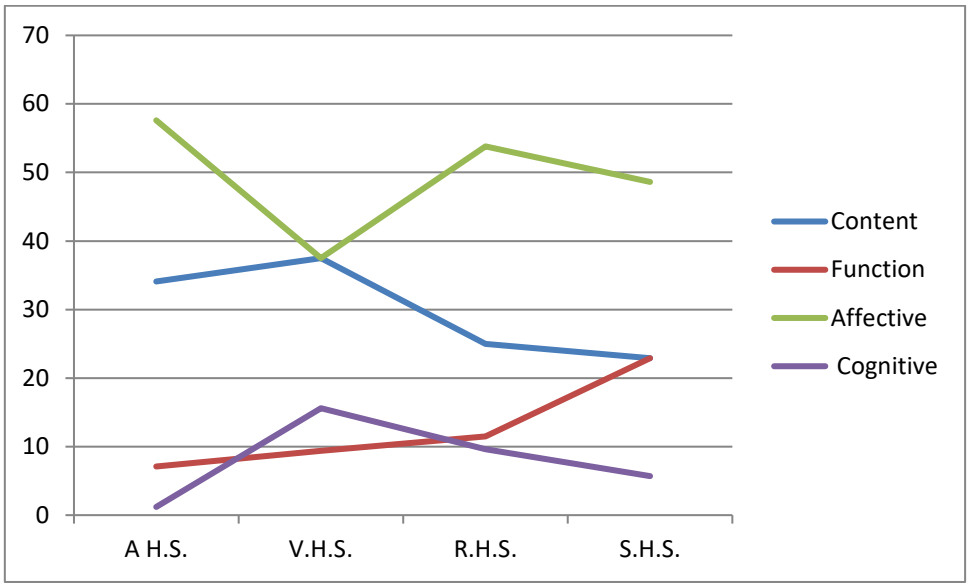

Figure 5. *School Type vs. Categories Distribution for Physics Lesson Concept*

- Anatolian high school students (57,6 %) mostly describe physics lesson by using metaphorical icons in affective category. While 40,1 % of them use unfavorable codes, unlovable lesson (10,6%), complex and difficult (27,1 %), fear (2,4%), 27,6 % of them use a favorable metaphorical icon, enjoyable and fun (17,6). Content category is in the second place (34,1 %) for Anatolian high school students to describe physics lesson.
- Vocational high school students use same number of metaphorical icons for content and affective categories. For affective category, none of them use fear code, and in this category 18,8 % of them say that physics is enjoyable and fun. For content category 28,1 % of the students use metaphorical icons about "using shapes and formulas" category, this percentage is highest one among all school types.
- Religious high school students (53,8 %) mostly describe physics lesson by using metaphorical icons in affective category. 23,1 % of them think that physics lesson is complex and difficult and 19,2 % of them feel fear. The percentage of the students that use metaphors in the code of enjoyable and fun is 7,7 %. Second one is content category with 25,0 % of students describing physics lesson in this category. The codes in this category have nearly same amounts.
- Science high school students (48,6 %) mostly produce metaphorical icons related to affective category and 31,4 % of them use complex and difficult code. However, the fear code has the lowest percentage with 4,3 %. The percentages of the content and the function categories are the same (22,9 %). In all school types, science high school students have the highest percentage for the code as important and necessary. None of the students in this school type describe physics lesson with the code of using shapes and formulas.

The distribution of codes and categories with school types are presented in Table 8 for physics teacher concept. According to Table 8, there is a significant relationship between codes

and school types of participants about the physics lesson metaphors *(X^2=60,720; df=21; p=0,000).* Additionally, there is a significant relationship between categories and school types *(X^2=41,373; df=9; p=0,000).*

Table 8. *Distribution of Categories and Codes Due to School Types Related to Physics Teacher Concept*

		School Type				
		A H.S. f (%)	V.H.S. f (%)	R H.S. f (%)	S.H.S. f (%)	Total f (%)
Cognitive	Teaching Style	7(9,1)	5(15,2)	1(2,4)	2(3,0)	15(6,9)
	Teacher Characteristics	12(15,6)	5(15,2)	4(9,8)	7(10,4)	28(12,8)
	Solution machine	2(2,6)	0	5(12,2)	6(9,0)	13(6,0)
	Intelligent and very knowledgeable	28(36,4)	14(42,4)	12(29,3)	32(47,8)	86(39,4)
	Total	49(63,6)	24(72,7)	22(53,7)	47(70,1)	142(65,1)
Affective	Someone from family	10(13,0)	4(12,1)	4(9,8)	4(6,0)	22(10,1)
	Popular person	5(6,5)	1(3,0)	0	5(7,5)	11(5,0)
	Total	15(19,5)	5(15,2)	4(9,8)	9(13,4)	33(15,1)
Personality Properties	Personality Properties	12(15,6)	4(12,1)	5(12,2)	11(16,4)	32(14,7)
Physical Properties	Physical Properties	1(1,3)	0	10(24,4)	0	11(5,0)
Total		77(100)	33(100)	41(100)	67(100)	218

Pearson χ2 test between codes * school types; *χ2*= 60,720 ; df= 21; p=0,000
Pearson χ2 test between categories * school types; *χ2* = 41,373 ; df= 9; p=0,000

The important significant points that grab attention can be listed as following:

- In all school types, firstly participants mostly (65,1%) think of the cognitive dimension of physics teacher. According to them, physics teacher has four properties; teaching style, teacher characteristics, solution machine and being intelligent and very knowledgeable. Most of the students (39,4 %) in this category use "intelligent and knowledgeable" code to describe physics teacher concept. Secondly, participants (15,1 %) use metaphors related to affective category and mainly produce "someone from family" metaphorical icons. Thirdly, 14,7 % of the all students use personality properties category. Lastly, the rest of the students (5,0 %) describe physic teacher by using physical properties. This distribution is also presented in Figure 6.

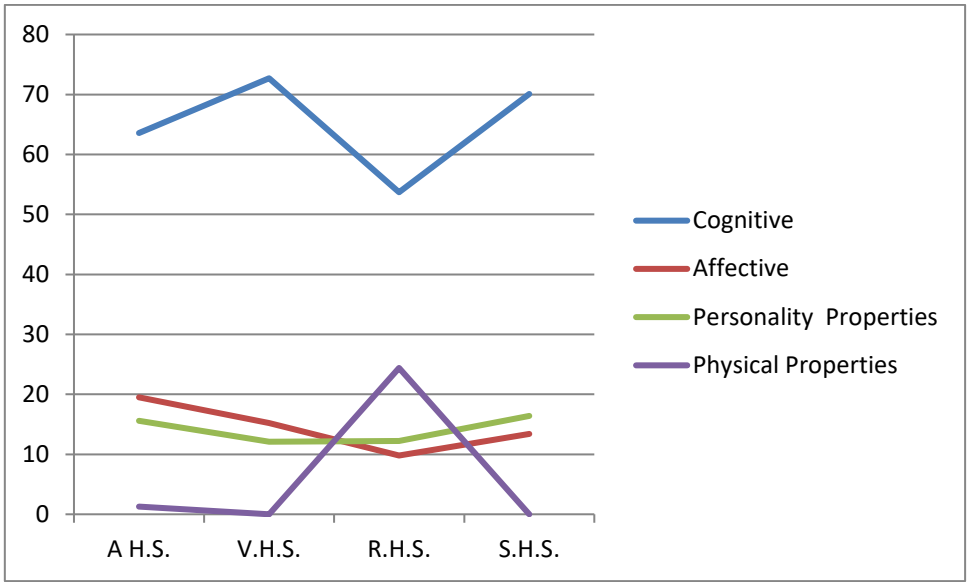

Figure 6. *School Type vs. Categories Distribution for Physics Teacher Concept*

- Anatolian high school students (63,6 %) mostly describe physics teacher by using metaphorical icons in cognitive category. 36,4 % of them think that physics teachers are intelligent and very knowledgeable. 19,5 % use affective code to describe physics teacher, while 13,0 % describe someone from family, 5,0 % use a popular person.
- Vocational high school students (72,7 %) mostly describe physics teacher by using cognitive category. 42,4 % think that physics teachers are intelligent and very knowledgeable. The number of students (15,2 %) who use teaching style and teacher characteristics are the same. None of the students use solution machine and physical properties to describe physics teacher.
- Religious high school students (53,7 %) mostly describe physics teacher by using cognitive category. They use affective category (9,8 %) at least. Among all schools, religious high school students (24,4 %) use physical property of physics teacher most.
- Science high school students (70,1 %) describe physics teacher by using cognitive category most. 47,8 % of them believe that physics teachers are intelligent and knowledgeable. 16,4 % of them produce metaphorical icons related to personality properties of physics teacher. None of them used physical properties to describe physics teacher concept.

CONCLUSION

This study aims to investigate how high school students describe physics, physics lesson and physics teacher concepts, which metaphorical icons are produced to describe them, which conceptual categories and themes can be produced from these metaphors and whether there is a relationship between codes, categories and school types of students or not.

First of all, in the first part of the study, students' perceptions about physics concepts have been searched. 125 metaphorical icons under 11 codes have been produced. 34 metaphorical icons, by 49 students, have been produced for "complex and difficult" code, 17 metaphors by 38 students have been produced for "having wide subject matter" and 12 by 33 students as "related to daily life". Three themes and four conceptual categories have been constructed by

taking the common characteristics of codes into account. These conceptual categories are content, function, cognitive and affective. Most of the participants produced content based metaphorical icons to describe physics, followed by cognitive, affective and function respectively. There is no significant difference between categories and school types. Content is the most selected category in all school types. Anatolian and vocational high school students produced more metaphorical icons than science and religious high school students in cognitive category. In affective category, Anatolian and science high school students produced nearly equal number of metaphorical icons and in the same category, at most religious high school students and at least vocational high school students produced metaphorical icons. Science high school students produced more metaphorical icons than the other school types in function category.

Secondly, students' perceptions about physics lesson have been searched. 123 metaphorical icons under 9 codes have been produced. At most 38 metaphorical icons by 62 students have been used to describe physics lesson as complex and difficult. The number of favorable perceptions (important and necessary, enjoyable and fun) was 30 metaphors and 61 participants respectively, which was less than the number of unfavorable perceptions (unlovable lesson, complex and difficult, fear) with 58 metaphors and 93 participants. Considering the common characteristics of codes, three themes and four conceptual categories have been constructed. These are content, function, affective and cognitive. Most of the participants produced affective based metaphorical icons to describe physics lesson, followed by content, function and cognitive in order. There is a significant difference between categories and school types. Anatolian, religious and science high school students produced more metaphorical icons for the affective category than vocational high school students. Anatolian and vocational high school students used more the content category than religious and science high school students. Science high school students thought of the function category at most.

Thirdly, students' perceptions about physics teacher concept have been searched. 91 metaphorical icons under 8 codes have been produced. At most, 29 metaphors by 86 participants have been used to describe physics teacher as intelligent and knowledgeable. No unfavorable codes have been produced for physics teacher. Considering the common characteristics of codes, three themes and four conceptual categories have been constructed. These conceptual categories are cognitive, affective, personality and physical properties. Most of the participants produced cognitive based metaphorical icons to describe physics teacher, then affective, personality and physical properties in order. There is a significant difference between categories and school types. In all school types, cognitive category is the most selected one. Physical properties are only more important for religious high school students.

As a conclusion, high school students often consider physics and physics lesson as complex and difficult. Physics include daily life events and wide subject matter similar to physics lesson. Physics is a developing area but physics lesson is not developing. Physics teachers are intelligent and very knowledgeable people.

DISCUSSION

In physics, laws are expressed in mathematical ways and tried to be explained with abstract concepts. This situation causes descriptions by students about physics as difficult, boring and filled with useless information (Tekbıyık and Akdeniz, 2010). This situation can explain why students think of physics as a complex and difficult code at most. Another result of this study shows that physics is a developing subject and has wide subject matter. This finding supports the literature. Physics has an experimental nature of real world phenomena in microscopic and

macroscopic perspectives as seen in general and special relativity or quantum mechanics theories (Kurnaz and Çepni, 2012).

In physics lesson, new teaching programs are established on the basis of how learning takes place rather than the knowledge. These programs are also student centered based on constructivist approach, so the teachers should be in the quality of guiding, motivating, facilitating, and preparing (Töremen, 2011). Additionally, physics contains daily life events and easy subjects; physics education program is constructivist and student centered, so students should describe physics lesson as understandable and enjoyable. However, previous research studies still support the findings of this study about the fact that physics is difficult and many students do not want to learn it (Clement, 1981; Kanlı & Yağbasan, 2001; Kaya & Büyükkasap, 2005; Çıbık & Yalçın, 2012).

Good qualified student development depends on the teachers (Özden, 2014). Students believe that physics teachers are intelligent and knowledgeable because teachers solve difficult and complex problems that they themselves may not easily solve. The recommendation of Veloo, Nor and Khalid (2015) about the behaviors of the teachers is that physics teachers should give more emphasis in not only the learning of physics but more importantly on students' attitudes toward the learning physics. This recommendation may eliminate the students' unfavorable opinions about physics and physics lesson like "physics is frightening, complex and difficult, undefined and meaningless, changes over time", "physics lesson is complex and difficult, unlovable lesson, fear".

RECOMMENDATIONS

- Metaphorical studies can be conducted not only related to physics but also other lessons to identify students' opinions.
- By analyzing the metaphors, how students construct the concepts and how they think about the subjects can be learned.
- Teachers can design their instructions and environments by learning students' expectations with the help of metaphors.
- Program developers can add some concrete and daily life phenomenon to curricula to create easily understandable and enjoyable physics lessons.

REFERENCES

Akşehirli, S. (2007). "Çağdaş Metafor Teorisi". Ege Edebiyat. Date of Access: 11th of February 2016, www.ege-edebiyat.org/docs/257.doc

Aydın, F. & Ünaldı, Ü. E. (2010). The Analysis of Geography Teacher Candidates' Perceptions Towards "Geography" Concept with the Help of Metaphors. *International Online Journal of Educational Sciences*, *2*(2), 600-622.

Cerit, Y. (2008). Students, Teachers and Administrators' Views on Metaphors with Respect to the Concept of Principal. *Education and Science, 33*(147), 3-13.

Clement, J. (1981). Students' preconceptions in Introductory Mechanics. *American Journal of Physics, 50*(1), 66-71.

Coşkun, M. (2010). The mental images (metaphors) of high school students about "climate" concept. *Turkish Studies International Periodical for the Languages, Literature and History of Turkish or Turkic, 5*(3), 919-940.

Çelik, H. & Çakır, E. (2015). The examination of metaphoric perception on the effects of heat on substance. *International Online Journal of Educational Sciences, 7*(2), 244-264.

Çelikten, M. (2006). Culture and teacher metaphors used in education system. *Erciyes Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 21*(2), 269-283.

Çepni, S. (2011). *Kuramdan Uygulamaya Fen ve Teknoloji Öğretimi.* Ankara: Pegem Akademi Yayıncılık.

Çıbık, A. S. & Yalçın, N. (2012). The effect of project based learning supported with analogies on attitudes of students towards physics. *Gazi Eğitim Fakültesi Dergisi, 32* (1), 185–203.

Derman, A. (2014). High school students' metaphoric conceptions for the concept of chemistry. *Turkish Studies - International Periodical For The Languages, Literature and History of Turkish or Turkic, 9*(5,) 749- 776.

Felzman, D. (2014). Using Metaphorical Models for Describing Glaciers. *International Journal of Science Education, 36* (16), 2795-2824.

Glose, H. G. & Scherr, R. E. (2015). Enacting conceptual metaphor through blending: learning activities embodying the substance metaphor for energy. *International Journal Of Science Education, 37* (5-6), 839-866.

İbret, B.Ü. & Aydınözü, D. (2011). The metaphors developed by elementary school-second stage students on the concept of "world". *Kastamonu Education Journal, 19* (1), 85-102.

Kanlı, U. & Yağbasan, R. (2001). In-service teacher training summer courses for physıcs teachers. *Gazi Eğitim Fakültesi Dergisi, 21* (3), 39-46.

Karakuş, U. (2013). The investigation of earthquake inexperienced and experienced students' perceptions by metaphor analysis. *Eastern Geographical Review, 18*(29), 97-116.

Kaya, A. & Büyükkasap, E. (2005). Physics student teacher' profiles, attitudes, and anxiety toward teaching profession: an Erzurum sample. *Kastamonu Education Journal, 13* (2), 367–380.

Kurnaz, M. A. & Çepni, S. (2012). An evaluation of changes to the Turkish high school physics curriculum. *International Education Studies, 5*(5), 92-108.

Lakoff, G. & Johson, M. (2003). *Metaphors we live by.* G.Y. Demir (Çev.). İstanbul: Paradigma Publishing.

Lakoff, G. & Johson, M. (1980). The metaphorical structure of the human conceptual system. *Cognitive Science, 4*, 195-208.

Lancor, R. (2014). Using metaphor theory to examine the conceptions of energy in biology, chemistry and physics. *Science & Education, 23*(6), 1245-1267.

Lancor, R. (2015). An analysis of metaphors used by students to describe energy in an interdisciplinary general science course. *International Journal Of Science Education, 37* (5), 876-902.

Mantyla, T. & Nousiainen, M. (2014). Consolidating pre-service physics teachers' subject matter knowledge using didactical Reconstructions. *Science & Education, 23*(8), 1583-1604.

Martinez, M., Sauleda, N. & Huber, G. (2001). Metaphors as blueprints of thinking about teaching and learning. *Teaching and Teacher Education, 17*(8), 965-977.

Merleau-Ponty, M. & Bannan, J.F. (1956). What is phenomenology? *Crosscurrents, 6*(1), 59–70. Retrieved from http://www.jstor.org/stable/24456652

Metin, M. (2014). *Kuramdan Uygulamaya Eğitimde Bilimsel Araştırma Yöntemleri.* Ankara: Pegem Academy Publishing.

Miles, M.B. & Huberman, A.M. (1994). *Qualitative data analysis.* Thousand oaks, CA: Sage Publications.

Oflaz, G. (2011). *İlköğretim öğrencilerinin "Matematik" ve "Matematik Öğretmeni" kavramlarına ilişkin metaforik algıları.* 2nd International Conference on New Trends in Education and Their Implications, Antalya.

Ogborn, J. & Martins, I. (1996). Metaphorical understandings and scientific ideas. *International Journal of Science Education, 16* (6), 631-652.

Özden, Y. (2014). *Öğrenme ve Öğretme.* Ankara: Pegem Academy Publishing.

Öztürk, Ç. (2007). Metaphor status about the concept of "geography" of prospective social science, science and classroom teachers. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi, 8*(2), 55-69.

Patton, M.Q. (2001). *Qualitative research and evaluation methods.* Thousand oaks, CA: Sage Publications.

Saban, A. (2008). Metaphors about school. *Educational Administration: Theory and Practice Summer, 14* (3), 459-496.

Saban, A. (2009). Öğretmen adaylarının öğrenci kavramına ilişkin sahip olduğu zihinsel imgeler. *Türk Eğitim Bilimleri Dergisi, 7*(2), 281-326.

Saban, A., Koçbeker, B. N. & Saban, A. (2006). An investigation of the concept of teacher among prospective teachers through metaphor analysis. *Educational Sciences: Theory&Practice, 6*(2), 461-522.

Serway, R. A. & Beichner, R.J. (2012). *Fen ve Mühendislik İçin Fizik 1*. Ankara: Palme Publications.

Semerci, Ç. (2007). A view to the new primary school curricula with the metaphors relating to "curriculum development". *Cumhuriyet University Sosyal Bilimler Dergisi, 31*(1), 139-154.

Senemoğlu, N. (2005). *Gelişim öğrenme ve öğretim: Kuramdan uygulamaya*. Ankara: Gazi Kitabevi.

Tekbıyık, A. & Akdeniz, A. R. (2010). A contemporary physics attitude scale for secondary school students: development, validity and reliability. *Turkish Science Education, 7* (4), 134-144.

Turkish Language Association (TDK). (2015). Metafor. TDK Dictionary. Retrieved from http://www.tdk.gov.tr/index.php?option=com_bts&arama=kelime&guid=TDK.GTS.563b264ff21b53.20025552

Töremen, F. (2011). *Eğitim Bilimine Giriş.* Ankara: İdeal Yayıncılık.

Töremen, F. & Döş, İ. (2009). The metaphoric perceptions of primary school teachers on the concept of inspection. *Educational Sciences: Theory & Practice, 9*(4), 1973-2012.

Veloo, A., Nor, R. & Khalid, R. (2015). Attitude towards physics and additional mathematics achievement towards physics achievement. *International Education Studies, 8*(3), 35-43.

Wiles, M.B. & Huberman, A.M. (1994). *Qualitative data analysis.* Thousand oaks, CA: Sage Publications.

Yalmancı, S. G. & Aydın, S. (2013). Preservice teachers' metaphorical perceptions towards biology. *Mustafa Kemal University Journal of Social Sciences Institute 10*(21), 208-223.

Yıldırım, A. & Şimşek, H. (2013) *Sosyal Bilimlerde Nitel Araştırma Yöntemleri*. Ankara: Seçkin Yayıncılık.