Eurasian Journal of Educational Research 71 (2017) 119-140

Eurasian Journal of Educational Research
www.ejer.com.tr

Prospective Chemistry and Science Teachers' Views and Metaphors about Chemistry and Chemical Studies*

Fatma ONEN OZTURK[1] Oya AGLARCI[2]

ARTICLE INFO

Article History:

Received: 06 January 2017

Received in revised form: 20 July 2017

Accepted: 21 September 2017

DOI: 10.14689/ejer.2017.71.7

Keywords

Teacher education
science education
chemistry education
teacher candidate
student perspectives.

ABSTRACT

Purpose: The aim of this study was to examine the metaphors created by prospective chemistry and science teachers and their views about how the studies in the field of chemistry are carried out in relation to the grade level and department.

Research Methods: Case study as a qualitative research design was used. Participants in the study included 16 freshmen and 25 senior prospective chemistry teachers and 52 freshmen and 41 senior prospective science teachers. The data were analyzed with content analysis.

Findings: The findings revealed that prospective teachers' views of chemistry were generally correct. However, a few of the participants' views were embedded with misconceptions. Also, the metaphors showed that they had different views toward chemistry.

Implications for Research and Practice: The views of prospective chemistry and science teachers are similar to each other, and the results are more comprehensive and detailed for the last-grade students. When prospective teachers' metaphors about the chemistry and justifications are compared in terms of grade levels, it is seen that the justifications put forth have various similarities and differences. When the findings obtained from the research are compared in terms of different fields, similarities and differences are present together in the results. It is seen that the metaphors set up by the prospective teachers are quite different from one another when they are compared in terms of the fields. It can be suggested that metaphors in different concepts and topics could be examined and studies could be conducted by determining the gaps in those areas.

*This study was partly presented at the 3rd International Eurasian Educational Research Congress in Muğla, 31 May – 03 June, 2016

[1] Corresponding author: Marmara University, TURKEY, fatma_onen@hotmail.com, fatma.onen@marmara.edu.tr, ORCID: orcid.org/0000-0002-6160-4671

[2] Marmara University, TURKEY, oya.aglarci@marmara.edu.tr , ORCID: orcid.org/0000-0003-2073-8734

Introduction

In 2004-2005, Turkish educational curricula were totally revised, starting from primary education on up, based on the reform movement in education. Instead of being based on the philosophy of behaviorism which fostered the transfer of knowledge to the students, constructivism was adopted as the new philosophical understanding because it allows learners to construct their own knowledge. According to the constructivist approach, knowledge is not directly transferred to other people from the knower; but instead learners construct the knowledge themselves (Driver, Asoko, Leach, Scott & Mortimer, 1994). In this direction, the new curricula described the branches of science, such as physics, chemistry, and biology, within the framework of the constructivist viewpoint. The new chemistry curriculum aimed to raise chemistry literate individuals with knowledge about the role and value of chemistry in everyday life, are interested in chemical issues, and have critical thinking skills (The Ministry of National Education-MNE, 2013). Students who take science courses in accordance with this goal have an accurate and contemporary understanding of scientists working in chemistry and in the field of science.

The new perspective given by the constructivist approach also provides alternatives to the assessment and evaluation processes. In addition to traditional assessment tools, the use of alternative tools, such as scoring rubric keys, portfolio evaluation, and concept mapping, is becoming increasingly important. In this way, it will be possible to obtain more detailed answers in the assessment and evaluation process regarding not only what the knowledge is but also how the individuals structure the knowledge in their minds. From this point of view, the research has benefited from metaphors that can be used as alternative assessment tools.

Thinking with metaphors is an important part of the scientific thinking process. The word metaphor comes from the Greek word "metapherin". "Meta" means to change and "pherein" means to carry. Thus, metaphors, or "carrying changes", help people to transform what they already know into new insights (Levine, 2005). The concept of metaphor is taken as a "trope" and is described as "using a word or concept in a way other than their accepted meaning" (Turkish Linguistic Society-TLS, 2016). This means that metaphors help us understand the world through more familiar things (Lakoff & Johnson, 1980). Metaphors are structures that facilitate the disclosure of abstract concepts and help to present them in a concrete way (Gultekin, 2013).

According to Lancor (2014), it is possible to learn about how students or teachers conceptualize abstract and concrete issues with the help of metaphors. Experienced teachers know that students have their own ideas about phenomena, and these ideas sometimes seem very different from teachers' ideas (Demircioglu, Demircioglu, & Ayas, 2004). Accordingly, Derman (2014) states that metaphors are constructed based on experience; therefore, each of the constructed metaphors can be evaluated as an experience. In this way, metaphors can be alternative assessment tools to learn about the perspectives of students. Metaphors also help educators compare different

concepts or find similarities between them and explain them interchangeably (Saban, 2004).

In recent years, educators have focused on determining the views of participants from different levels on various topics and concepts through metaphors, and in these studies, they have examined concepts such as teacher (Saban, 2004; McEwan, 2007; Aydin & Unaldi, 2010), student (Saban, 2009), and school (Saban, 2008). Chemistry can be thought of as an area where students can create rich metaphors because it examines the visible (macroscopic) and invisible (submicroscopic) areas. Especially in recent years, studies on metaphors for the concept of chemistry can be encountered in national and international literature (Jeppsson, Haglund, Amin, & Stromdahl, 2013; Derman, 2014; Donmez Usta, & Ultay, 2015). Jeppsson et al., (2013) used conceptual metaphors to solve the problems of entropy. The results emphasize the importance of including conceptual metaphors in the teaching of difficult subjects such as entropy. Derman (2014), on the other hand, pointed out the metaphors high school students used for chemistry concepts in their research. According to the results, it has been stated that state school students produce the most different metaphors and that the metaphorical perceptions provide indications about their perspectives of chemistry and their attitudes toward chemistry. The study conducted by Donmez Usta & Ultay (2015) aimed at determining the metaphors for "chemistry" used by prospective pre-school teachers at different grade levels. The findings of the study show that prospective teachers in different grades have similar metaphors about "chemistry".

A review of the related literature showed that studies conducted with prospective teachers include different branches, whereas a study in which the metaphoric perceptions of prospective science and chemistry teachers are evaluated together does not exist. Furthermore, any study that comprehensively presents the opinions regarding the metaphoric perceptions in a single area of study cannot be found in the literature. This research study aims to interpret the metaphoric perceptions of prospective teachers by also taking their opinions into consideration. In this way, it will be possible to assess the cognitive perceptions of prospective teachers together with their concrete definitions of concepts. The disciplines of chemistry and science study not only the visible phenomena but also those that are invisible and at the microscopic level. The phenomena taking place at the microscopic level contain different abstract concepts and the metaphors are accordingly the product of abstract thoughts. Also, sometimes a daily life event or situation can be explained in abstractions and it allows the relation with daily life to be indirectly constructed. In this respect, how the prospective teachers' opinions about chemistry can be explained in metaphors will be interpreted in the light of the findings of the research.

In addition, research carried out in different grade levels within the studies, specifically on chemistry, are conducted only with prospective pre-school teachers and these studies do not investigate the results regarding the grade differences both in science and in chemistry. In the light of the related literature, it is thought that we are in need of studies where prospective teachers' views about the field of chemistry are examined in detail.

In this context, the research will reveal the metaphorical perceptions of the prospective teachers as well as their views of the subject; in this way, the coherence between the metaphorical perceptions and the views on the subject will also be revealed. The research subjects are prospective science and chemistry teachers. The reason for choosing these two different groups is that prospective teachers in both fields are the ones who will teach chemistry to their students in the future and will influence their attitudes toward chemistry. Prospective teachers from these two different areas will also teach in the transition process from the secondary school to high school. Thus, prospective chemistry teachers would educate students who were previously educated by prospective science teachers, and therefore it is important to figure out the views of prospective teachers in different fields about chemistry. In addition, prospective teachers can reflect on their views on education from their high school experience onto their university education in the first years. With the various courses they have taken in university, especially with subject matter courses that are specific to the field of chemistry, their views may change by the last years of university education. In this context, it is thought that the examination of the views from different grade levels will contribute to the field. In this way, a richer portrait of the views of prospective teachers will be presented by examining the similarities and differences between the views of prospective teachers from different grade levels and different departments.

In this direction, the research aims to examine the metaphors created by prospective chemistry and science teachers and their views about how the studies in the field of chemistry are carried out in relation to the grade level and department.

Toward this end, answers to the following questions were sought:

1. How do the metaphors of prospective science and chemistry teachers about chemistry and their justifications differentiate according to the grade level and the department?

2. How do the views of prospective chemistry and science teachers about chemistry differentiate according to the grade level and the department?

3. How do the views of prospective chemistry and science teachers about chemical studies differentiate according to the grade level and the department?

Method

Research Design

The research is structured within the framework of the interpretive paradigm. Qualitative data collection and analysis methods were used in order to examine participants' explanations and metaphors of chemistry thoroughly. For this purpose, the research method of the study was case study from qualitative research designs. The research was conducted as a multiple holistic case study design. This design contains multiple situations that can be perceived as holistic on their own. Each

situation is handled holistically within itself, and afterwards they are compared with each other (Yin, 2008).

Qualitative research is defined as research that uses data collection methods, such as observation, interview, and document analysis, and follows a process in order to present perceptions and events in a natural, realistic and integrative way. The most important feature of the case study, one of the qualitative research methods, is the detailed examination and investigation of a case. The various components of a case are examined in its natural environment with an integrative interpretation. The focus is on the interactions of the components with the related case (Yildirim & Simsek, 2013).

Research Sample

The research was carried out in the spring semester of the 2014-15 academic year, and the participants were 16 prospective teachers (4 male, 12 female) studying at the first grade and 25 (4 male, 21 female) studying at the last grade of the chemistry teaching department and 52 prospective teachers (7 male, 45 female) studying at the first grade and 41 (7 male, 34 female) studying at the last grade of the science education department of a public university in Istanbul. Participants were 18–23 years of age. Prospective teachers participating in the research were selected from the students taking the courses given by the researchers. In this context, the research used easily accessible case sampling method from purposeful sampling methods.

Chemistry teaching is a five-year program and in this program the prospective teachers take chemistry-weighted courses as they are being prepared to teach chemistry at the secondary school level. They also take courses in pedagogical education. The program's chemistry courses are given by the Department of Chemistry at the Faculty of Arts and Sciences and the pedagogical courses by the Faculty of Education. The Science Education Department, on the other hand, offers a four-year program and the prospective teachers take courses in different fields such as physics, chemistry, and biology, as they are being prepared to teach sciences at the primary school level. In addition, the prospective teachers complete their pedagogical education in the related unit of the university. Prospective teachers of both branches prepare different lesson plans within the course of their education and use these plans in their internship practice. Internship courses are given in the fall and spring semesters of the last year in both departments and allow the prospective teachers to practice teaching in their field of study.

Research Instruments and Procedures

The research data were collected by three open-ended questions prepared by the researchers. Two of these questions aimed to measure what chemistry is and how chemistry studies are conducted, while the final question asked participants to identify metaphors for the concept of chemistry. Thus, in the last question, the prospective teachers were asked to complete the sentences "chemistry is like..., because…". They were also told to construct only one metaphor and to explain the relation between the metaphor that they have constructed and chemistry.

There was no time limit for students to answer the questions. The researchers took active roles in the class during the collection of the research data and clarified the questions that the prospective teachers did not understand. Also, in order to increase the variety of metaphors to be created by prospective teachers about chemistry and to structure their justifications, various examples of metaphor (school, teacher, student etc.) were provided by the researchers beforehand. In addition, the prospective teachers were not allowed to communicate with one another while answering the questions.

Validity and Reliability

During the analysis of the data, the researchers codified the data independently of each another. Afterwards, they came together and discussed the consistencies and inconsistencies in their codifications. According to Lederman, Abd-El-Khalick, Bell & Schwartz (2002), when more than one researcher is involved in an analysis process, establishing inter-rater agreement or reliability is a very important part of the study. The consistency among researchers in such a situation is achieved when the researchers analyze the same data sets independently of each other. The inconsistencies are addressed and either different data sets (such as interview data) are used together or the researchers come to an agreement on one particular data set. Because this research involved a single data set, consensus among the researchers ease the goal.

The consistency between the encodings in the study was determined by the formula for the agreement percentage set by Miles and Huberman (1994). For this reason, the data were also evaluated by another expert from the field of science education. According to Miles and Huberman (1994), analyses are reliable when there is a consistency of 80% and over between two encodings. In this study, it was determined that the data obtained from the research was 86% consistent.

Data Analysis

The analysis of the research data was evaluated separately for each question and in this process, content analysis was carried out in order to examine the data in more detail. Accordingly, the data were first coded separately, and then the themes were constructed. The themes were then presented in tables. Metaphors constructed by prospective teachers were first coded according to justifications and then transformed into themes. Subsequently, the constructed metaphors were categorized and interpreted under these themes.

In order to increase the clarity of the findings, the results are presented with frequency and percentage values in terms of each of the themes. Because some themes were expressed by more than one prospective teacher, the sum of the frequency values can exceed the number of students participating in the study. Similarly, the sum of the percentages can also exceed 100%.

Results

The findings obtained from the research questions were presented in tables after being analyzed separately for each title.

The Findings Regarding the Metaphors Constructed By Prospective Chemistry and Science Teachers and Their Justifications

In the first question of the research, prospective teachers were asked to construct metaphors about chemistry and to justify why they used this metaphor. The metaphors constructed by prospective chemistry teachers are arranged according to their justifications and presented in Table 1.

Table 1.

The Findings Obtained from Prospective Chemistry Teachers Regarding the Question "Chemistry is…Because…"

1st grade				*5th grade*			
Justification	*Metaphor*	*f*	*%*	*Justification*	*Metaphor*	*f*	*%*
Chemistry as a needed field	Family Water Bread	4	25	Chemistry as a needed field	Life Creating power Cell nucleus Water Chili pepper Medicine	7	28
Chemistry as a field within life	Life Curtain Nature Scene	4	25	Chemistry as a field within life	Music Life Cell nucleus Shame Chili pepper Old aunty in the bus	7	28
Chemistry as a field of diversities	Pomegranate The meal with different vegetables Babushka doll	3	19	Chemistry as a field of diversities	The meal with different vegetables Flower	2	8
Chemistry as a field requiring constant work	Plant Craftsman	2	13	Chemistry as a field requiring constant work	Labor Ocean Infinity	3	12
Other	Magic Stylist	2	13	Chemistry as a mysterious field	Infinity Human	2	8
				Chemistry as a field bringing about harm or benefit according to its purpose of use	Chili pepper Fire Medicine Meteorology	5	20
				Other	Factory Treasury Marsh Universe	4	16

As seen in Table 1, prospective chemistry teachers at different grade levels constructed different metaphors by presenting similar justifications. Prospective teachers in the first grade constructed different metaphors by pointing out reasons, such as being the basic necessity of life (25%), being in every area of life (25%), containing diversity (19%), and requiring constant work (13%). On the other hand, last-grade prospective teachers expressed with different metaphors that chemistry is a basic necessity of life (28%), is in every area of life (28%), includes diversity (8%), requires constant work (12%), is mysterious (8%), and brings benefits and harms according to its purpose of use (20%). The metaphors that prospective teachers constructed and their justifications are set forth in the following citations:

"Chemistry is like pomegranate. They both appear single but when you open the inside there are many pieces of pomegranate/knowledge." (1st grade/S11)

"Chemistry is like water. Without chemistry it is impossible for people to maintain their lives today." (5th grade/S23)

The answers given by the prospective science teachers to the same question are given in Table 2.

Table 2.
The Findings Obtained from Prospective Science Teachers Regarding the Question "Chemistry is…Because…"

1st grade				*4th grade*			
Justification	*Metaphor*	*f*	*%*	*Justification*	*Metaphor*	*f*	*%*
Chemistry as a field within life	Life The smallest unit of structure	2	4	Chemistry as a field within life	Water Life Kitchen Seed Food Taste of fruit Light source	10	24
Chemistry as a branch of science	Stairs Labyrinth Toy block Puzzle	5	10	Chemistry as a branch of science	Jigsaw Sand in ocean Puzzle Chain ring Sea Ocean	6	15
Chemistry as a field using trial-and-error method	Curious child Shop Life	4	8	Chemistry as a field using trial-and-error method	Puzzle Cooking Kitchen	3	7
Chemistry as a field producing new products	Music cooking adventurers	8	15	Chemistry as a field presenting new products	Photosynthesis Plant Factory Cooking	4	10
Chemistry as a field open to development	Cleaning Material foaming Soap growing Tree	3	6	Chemistry as a field open to development	Atom Life Dough	3	7

Table 2 Continue

1st grade				*4th grade*			
Justification	*Metaphor*	*f*	*%*	*Justification*	*Metaphor*	*f*	*%*
Chemistry as a field bringing about harm or benefit according to its purpose of use	Volcano Bomb ready to explode Soil	3	6	Chemistry as a field bringing about harm or benefit according to its purpose of use	Blood Knife Amusement park	3	7
Chemistry as a field linking the known to the unknown	Bridge Dictionary Magnifying glass Kitchen of substances	4	8	Chemistry as a field of diversities	Sea World Ocean Mixture Chain ring Bottomless well Virus Labyrinth	8	20
Chemistry as a guiding field	Light Moon Fire	3	6	Chemistry as a needed field	Water Blood Bread Food Fish Self-understanding	6	15
Chemistry as field with complex knowledge	Puzzle	3	6	Chemistry as a field with certain rules of study	Puzzle Cooking	2	5
Chemistry as a field teaching while entertaining	Game Play dough	2	4	Other	Kitchen Source of light Factory Country Supermarket	5	12
Other	Wood Theatre Jewelry Love Cooking Education Fruit tree Game House	9	17				

As seen in Table 2, while the justifications for the metaphors constructed by prospective science teachers about the field of chemistry have differences in terms of the first and last grades, some of the metaphors have similar justifications. It is seen that prospective teachers' suggestions were often on common ground, such as taking part in every area of life, being a part of science, reaching results by trial and error, obtaining new products, being open to development, bringing benefits and harm according to its use. When the metaphors and justifications are examined separately, it is observed that first-grade prospective teachers stated with different metaphors that chemistry takes part in all areas of life (4%), is a part of science (10%), reaches results by trial and error (8%), acquires new products (15%), is open to development

(6%), has positive/negative features (6%), makes a connection between the known and the unknown (8%), is a guiding light (6%), contains a whole of complex information (6%), and educates by entertainment (4%). The final grade prospective teachers, on the other hand, presented justifications such as it is in all areas of life (24%), is a part of science (15%), reaches results by trial and error (7%), acquires new products (10%), is open to development (7%), has positive/negative features (7%), contains different fields in one (20%), is needed (15%), and depends on certain rules (5%) and they also produced different metaphors. The metaphors that the prospective teachers constructed are illustrated in the following citations:

"Chemistry is like life. Everything is all about trial and error. A mistake at any stage of study or in the substances to be included in the experiment is irreversible like life itself." (1st grade/S38)

"Chemistry is like dough. The more we knead it, the better the shape will be." (4th grade/S40)

The findings regarding the views of prospective chemistry and science teachers about chemistry

For the second question of the research, prospective teachers were asked the question of "What is chemistry?" Findings obtained from the answers of prospective chemistry teachers are given in Table 3.

Table 3.

The Findings Obtained from Prospective Chemistry Teachers Regarding the Question "What is Chemistry?"

1st Grade	*f*	*%*	*5th Grade*	*f*	*%*
Everything in universe	8	50	Science that explains matter and its interactions	14	56
The science of the structure of matter	6	38	The field existing in many spheres of life	10	40
The branch of science for the creation of matter	1	6	The field in cooperation with different disciplines	3	12
			The field trying to understand the natural world	3	12
			One of sciences	2	8
			Other	5	20

As can be seen in Table 3, first-grade prospective teachers often described everything in the world (50%) as chemistry. In addition, it is also seen that the prospective teachers described chemistry as the science of the structure of matter (38%). When the explanations by last-grade prospective teachers about the meaning of chemistry are analyzed, it is seen that they mostly choose the explanations of "science that explains matter and its interactions" (56%) and "the field existing in many spheres of life" (40%). Prospective teachers have also explained chemistry as "the field in cooperation with different disciplines" (12%) and "the field trying to

understand the natural world" (12%). The answers to the question are illustrated in the following citations:

"Chemistry is the science which studies the matter and its structures, interactions, and characteristics." (1st grade/S4)

"Chemistry is the part of science which studies the essence of the matter." (5th grade/S15)

The answers to the same question by prospective science teachers are given in Table 4.

Table 4.

The Findings Obtained from Prospective Science Teachers Regarding the Question "What is Chemistry?"

1st Grade	*f*	*%*	*4th Grade*	*f*	*%*
The science of the structure of matter	14	27	The science studying the inner structure and contents of the matter	28	68
The science studying the matter	3	6	The science explaining the relation among molecules	9	22
The science studying natural phenomena	3	6	The science studying physical-chemical changes	5	12
Other	8	15	Field of inter-disciplinary study	2	5
			Other	7	17

As can be seen in Table 4, most of the prospective teachers in the first and last grade of science education gave similar answers about what chemistry is. It is seen accordingly that a large majority (27% - 68%) of the prospective teachers at both the grade levels identified chemistry as "the science of the structure of matter". In addition to this result, first-year prospective teachers also think that chemistry "studies the matter" (6%) and "studies natural phenomena" (6%). Prospective teachers of the final grade, on the other hand, identified chemistry as science "studying relations among molecules" (22%), "studying physical/chemical changes" (12%), and "working inter-disciplinarily" (5%). The answers to the question are illustrated in the following citations:

"Chemistry is the structure and molecular features of a matter; in short it is the identity of the matter." (1st grade/S2)

"Chemistry is the branch of science which studies the structure, features, interactions and reactions of the matter." (4th grade/S22)

The findings regarding the views of prospective chemistry and science teachers about the chemical studies

In the third question of the research, prospective teachers were asked to explain how studies on chemistry are conducted. The findings obtained from the responses given by prospective chemistry teachers are given in Table 5.

Table 5.

The Findings Obtained from Prospective Science Teachers Regarding the Question "How are Chemical Studies Conducted?"

1st Grade	*f*	*%*	*5th Grade*	*f*	*%*
Experiments in the laboratories	9	56	Experiment	16	64
In a careful way	1	6	Observation	10	40
Research-investigation	1	6	Research	5	20
Trial and error method	1	6	In compliance with the scientific method	5	20
			Trial and error method	1	4

As seen in Table 5, first-year prospective teachers think that chemistry studies are mostly conducted "by experiments in the laboratory" (56%). Last-grade prospective teachers, on the other hand, stated that chemical studies can be carried out by "experiment" (64%), "observation" (40%) and "research" (20%), and "with different studies in compliance with scientific method" (20%). The answers to the question are illustrated in the following citations:

"Studies in chemistry are carried out by making additions to the available data and by the experiments in the laboratory or by examining the results of experiments using trial and error method with some foresight." (1st grade/S15)

"Studies in chemistry are made through experimentation and observation." (5th grade/S20)

The answers given by the prospective science teachers to the same question are given in Table 6.

Table 6.

The Findings Obtained from Prospective Science Teachers Regarding the Question "How are Chemical Studies Conducted?"

1st grade	*f*	*%*	*4th grade*	*f*	*%*
Experiment	19	37	Experiment	22	54
Observation	9	17	Observation	11	27
In the laboratory	7	13	In the laboratory	6	15
Other	5	10	Scientific method	6	15
			Calculations	4	10
			Data collection	3	7
			Research-literature review	2	5
			Other	7	17

As can be seen in Table 6, while both first and last-grade prospective teachers think that most of the studies in chemistry (37-54%) are conducted through "experiment and observation", they also think (13%-15%) that "laboratory environment" can be used in this process. In addition, last-grade prospective teachers think that chemical studies depend on "the scientific process" (15%), collect data by various calculations (10%), and are carried out with the research process (5%). The answers to the question are illustrated in the following citations:

"Studies in chemistry are carried out by experiments, observations, and calculations of the results obtained from these." (1st grade/S17)

"Studies in chemical sciences are conducted using chemical tools and calculations to understand chemical mechanisms." (4th grade/S16)

Discussion and Conclusion

The results obtained from the research indicated that the prospective teachers created different metaphors about chemistry by offering similar justifications when their departments and grade levels are considered. Prospective chemistry teachers who took part in the research from both grade levels explained their metaphors about chemistry with the common justifications of chemistry being a field, which is needed, is from within life, contains diversities, and requires constant work. Prospective science teachers from different grade levels, on the other hand, offered common justifications such as chemistry being involved in life, being a branch of science, using the trial-and-error method, presenting new products, being open to development and bringing about harm or benefit according to its use. This result reveals that prospective teachers from different departments and different grade levels offer common justifications in explaining their metaphors. Accordingly, the study by Donmez Usta and Ultay (2015) also pointed out that the metaphors about chemistry created by prospective pre-school teachers from different grade levels share similarities when grade levels are considered. It is thought that this result is directly related to the education that the prospective teachers receive in their basic schooling.

When the answers given by prospective chemistry teachers from different grade levels are studied, it is observed that prospective teachers describe chemistry as "a needed field and involved in life," even though they come from different grade levels. This result also suggests that prospective teachers are aware that chemistry is part of daily life. Such results obtained from the research are in compliance with some of the results obtained from Derman's research (2014) with high school students. It shows that the students have certain images about chemistry in their minds, even if they belong to different age groups. In a study conducted by Ultay and Ultay (2009) with 7th, 9th, and 11th grade students, it is seen that the 7th grade students associate chemistry with experiments and observations while 11th grade students associate it with chemical reactions. This research hasn't obtained similar results and the prospective chemistry teachers emphasized the significance of chemistry rather than its associations, by offering reasons such as chemistry being needed and being involved in life. It is thought that the reason for this difference is related to the age group level and the courses taken during the undergraduate education. While the students of basic education see chemistry as a field composed of symbols and formulas, the undergraduate students have the opportunity of practicing chemistry in their laboratory courses. They comprehend the study process of chemistry and its significance for the human life more closely with different major courses.

It has been observed in the research that prospective chemistry teachers offered different justifications along with the common ones. One of these justifications is that chemistry brings about harm or benefit according to its use. Last-grade prospective teachers have taken more intense laboratory courses and have frequently interacted with chemicals in the process. Prospective teachers were warned against the negative circumstances to be caused by chemicals when they were engaged in laboratory experiments conducted under security precautions. It can be said in this regard that the prospective teachers might have thought of the various negative circumstances that the field of chemistry can embody. Another justification frequently offered by the prospective teachers was that chemistry is a mysterious field. This justification not only is an interesting supposition but also puts suggests that the prospective teachers emphasize chemistry's abstract nature and its relation with alchemy, when it is considered in regard to the related metaphors (infinity and human).

When the results of the research are analyzed in consideration of the prospective science teachers, it is seen that the first-grade prospective teachers have justified metaphors about chemistry as producing new products. Today there are many new products in different areas thanks to chemical research and it is, therefore, thought that the justifications by the prospective teachers can be related to chemistry's areas of usage in our lives. Along with this result, it is also observed that the first-grade prospective teachers describe chemistry as a branch of science. Last-grade prospective teachers, on the other hand, mostly describe chemistry as being involved in life, containing diversity, being needed, and being a branch of science. Thus, justifications offered by the last-grade prospective teachers are more comprehensive than those offered by the first-grade prospective teachers. Prospective teachers start their education with certain images in their minds; however, their minds are reshaped over time. As Thomas & McRobbie (1999) point out, each metaphor is in compliance with the opinions of the student as the learner, the learning processes, and the learning environment. In this regard, the metaphors and their justifications can be connected to the education received in secondary school and the undergraduate levels. It is also thought, therefore, that the different justifications offered by the last-grade prospective teachers could have been acquired through the courses they took in the course of their education.

When the justifications put forth in the research are investigated, it is observed that the prospective teachers generally define chemistry as a branch of science. Accordingly, in their explanations for what chemistry is, both prospective chemistry teachers and prospective science teachers indicated that chemistry is a branch of science, is involved in life, is shaped in the light of the needs, and consists of various disciplines. Hence, it is thought that the metaphors and the answers given to the questions overlap and that the results are consistent.

On the other hand, when the metaphors created by the prospective teachers are compared in terms of the fields of study, it is observed that the metaphors are very different from each other. For example, the results obtained from the first-grade students show that the prospective teachers from both groups are in agreement about a single common justification such as "chemistry exists in all aspects of life".

When the results are analyzed, the last-grade prospective teachers, on the other hand, put forth more justifications than the first-grade students. This difference in the metaphors and justifications offered by the prospective teachers could be due to their field of study. While the prospective chemistry teachers have a chemistry-heavy education in their undergraduate program, prospective science teachers are taught courses from different fields such as physics and biology. It is thought that this result could be related to the fact that prospective chemistry teachers are always engaged in chemistry as a necessity of their education and cannot view the topics/concepts independently of the patterns in their field of study.

Conclusion and Discussion Regarding the Question "How Do the Views of Prospective Chemistry and Science Teachers about Chemistry Differentiate According to the Grade Level and the Department?"

After evaluating the research results in terms of different grade levels, it is seen that the views of prospective chemistry and science teachers are similar to each other, and the results are more comprehensive and detailed for the last-grade students. For example, first-grade prospective chemistry and science teachers think that chemistry is "the scientific branch that studies the structure of the matter" while the last-grade prospective teachers stated that chemistry "tries to understand the natural world and cooperate with different disciplines". This result obtained from the last-grade students in the research despite their different departments may be related to the fact that the prospective teachers in both groups took common courses such as Scientific Research Methods, Special Teaching Methods, and laboratory courses. Such courses included in the education process have a positive contribution toward the views of the prospective teachers. Accordingly, Demircioglu et al., (2004) stated that the teaching of abstract concepts should be given more emphasis in laboratory courses where students are encouraged to learn by actively participating and experiencing.

Conclusion and Discussion Regarding the Question "How Do the Views of Prospective Chemistry and Science Teachers about the Chemical Studies Differentiate According to the Grade Level and the Department?"

When the findings obtained from the research are compared in terms of different fields, similarities and differences are present together in the results. For example, prospective teachers agree that "chemistry is the scientific branch which studies the structure of the matter" and that the studies in this area are conducted through "experiments". Even though the answers given by the prospective teachers are correct, they also indicate that their minds can carry wrong judgments as well as the correct ones. Indeed, it is believed that the prospective teachers' view that studies on chemistry are conducted by "experimentation" can lead to a new misunderstanding. This view is often found also in the literature, but it reveals a misconception (Wenning, 2006). McComas (2000) notes that experimenting is the most useful tool in science, but not the only one; many scientists also use non-experimental techniques to improve knowledge. The source of this view may have arisen from the teacher candidates in our study having carried out their studies in the field of chemistry via laboratory experiments before and during their undergraduate education. Moreover,

many images in everyday life depict the use of chemical equipment in a laboratory environment.

Conclusion and Recommendations

When the present results are evaluated together, it is seen that the views of the prospective teachers about the field of chemistry are generally correct but can also contain various misconceptions. The metaphors constructed by the prospective teachers also show that there may be different views about the field of chemistry. It further shows that different and new views of prospective teachers can be identified when they are moved out of their molds. In this context, it can be said that metaphors are a tool that can be used effectively in the identification of both the misconceptions and the substructure existing in the cognitive thinking process. According to Thomas & McRobbie (1999), metaphors can be used to improve the learning process and strengthen the subconscious, which leads to a clear picture of the students' views. Accordingly, Derman (2014) asserts that the use of metaphors in chemistry teaching makes chemistry more attractive for students and at the same time gives students the chance to create a comprehensive, multidimensional, and rich cognitive image of the concept of chemistry. In line with the results obtained from the research, we offer these suggestions:

* The reasons for the results obtained from the research should be examined by face-to-face interviews or by different methods of measurement so that the underlying grounds for the metaphors and their justifications shall be identified. It is thought that this way would provide more detailed information about positive/negative images and true/false concepts in students' minds, and that the teaching process can be made more functional in this regard.

* The association between the constructed metaphors and the presented justifications should be presented in the course of teaching the subject with individual examples within the scope of the handled subject, and in this way the established relations shall be made more meaningful.

* The researchers working in the field are encouraged to conduct studies by examining the different concepts and metaphors constructed by the participants from different grade levels and identifying the deficiencies of the field in this respect.

References

Aydin, F., & Unaldi, U. 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.

Demircioglu, H., Demircioglu, G., & Ayas, A. (2004). Sinif ogretmeni adaylarinin bazi temel kimya kavramlarini anlama duzeyleri ve karsilasilan yanilgilar [Prospective primary school teachers' levels of understanding and misconceptions about some basic chemical concepts]. *Hasan Ali Yucel Egitim Fakultesi Dergisi, 1*(1), 29-49.

Derman, A. (2014). Lise ogrencilerinin kimya kavramina iliskin metaforik algilari [High school students' metaphoric perceptions for the concept of chemistry]. *Turkish Studies, 9*(5), 749-776.

Donmez Usta, N., & Ultay, N. (2015). Okul oncesi ogretmen adaylarinin "kimya" metaforlarinin karsilastirilmasi uzerine bir calisma [A comparative study of preschool student teachers' "chemistry" metaphors]. *Karadeniz Sosyal Bilimler Dergisi, 7*(1), 163-177.

Driver, R., Asoko, H., Leach, J., Scott, P., & Mortimer, E. (1994). Constructing scientific knowledge in the classroom. *Educational Researcher*, *23*(7), 5-12.

Gultekin, M. (2013). Ilkogretim ogretmen adaylarinin egitim programi kavramina yukledikleri metaforlar [The metaphors that primary education teacher candidates use regarding curriculum]. *Egitim ve Bilim, 38*(169), 126-141.

Jeppsson, F., Haglund, J., Amin, T. G., & Stromdahl, H. (2013). Exploring the use of conceptual metaphors in solving problems on entropy. *Journal of the Learning Sciences, 22*(1), 70-120.

Lakoff, G., & Johnson, M. (1980). Conceptual metaphor in everyday language. *The Journal of Philosophy, 77*(8), 453-486.

Lancor, R. A. (2014). Using student-generated analogies to investigate conceptions of energy: a multidisciplinary study. *International Journal of Science Education*, *36*(1), 1-23.

Lederman, N.G., Abd-El Khalick, F., Bell, R.L., & Schwartz, R.S. (2002). Views of nature of science questionnaire: toward valid and meaningful assessment of learners' conceptions of nature of science. *Journal of Research in Science Teaching, 39*(6), 497–521.

Levine, P. M. (2005). Metaphors and images of classrooms. *Kappa Delta Pi Record, 41*(4), 172-175.

McComas, Z. F. (2000). The role and character of the nature of science in science education. In W. F. McComas (Ed.), *The principal elements of the nature of science: dispelling the myths.* Dordrecht, Boston, London: Kluwer Academic Publishers.

McEwan, A.E. (2007). Do metaphors matter in higher education? *Journal of College and Character, 8*(2), 1-8.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis* (2nd Edition). Thousand Oaks: Sage Publications.

The Ministry of National Education (MNE). (2013). *Ortaogretim Kimya Dersi (9, 10, 11 ve 12. Siniflar) Ogretim Programi [High School Chemistry (9, 10, 11 and 12. Grades) Teaching Programme].* Ankara, Turkey.

Saban, A. (2004). Giris duzeyindeki sinif ogretmeni adaylarinin "ogretmen" kavramina iliskin ileri surdukleri metaforlar [Entry level prospective classroom teachers' metaphors about the concept of "teacher"]. *Turk Egitim Bilimleri Dergisi, 2*(2), 131-155.

Saban, A. (2008). Okula iliskin metaforik algilar [Metaphors about school]. *Kuram ve Uygulamada Egitim Yonetimi, 55*, 459-496.

Saban, A. (2009). Ogretmen adaylarinin ogrenci kavramina iliskin sahip olduklari zihinsel imgeler [Prospective teachers' mental images about the concept of student]. *Turk Egitim Bilimleri Dergisi, 7*(2), 281-326.

Thomas, G. P., & McRobbie, C. J. (1999). Using metaphor to probe students' conceptions of chemistry learning. *International Journal of Science Education, 21*(6), 667-685.

Turkish Linguistic Society (TLS). (2016). Guncel Terimler Sozlugu [Dictionary of Turkish Terms]. Retrived from http://www.tdk.gov.tr.

Ultay, N., & Ultay, E. (2009). A cross-age study on the development of "chemistry" concept through different grades: 7th, 9th and 11th grades. *Eurasian Journal of Physics and Chemistry Education, 1*(2), 52-69.

Wenning, C. J. (2006). A framework for teaching the nature of science. *Journal of Phyisics Teacher Education Online, 3*(3), 3-10.

Yildirim, A., & Simsek, H. (2013). *Sosyal bilimlerde nitel arastirma yontemleri*. [Qualitative research methods in social sciences]. Ankara, Turkey: Seckin.

Yin, R.K. (2008). *Case study research: Design and methods* (Vol. 5). New York: Sage.

Kimya ve Fen Bilgisi Öğretmen Adaylarının Kimyaya ve Kimyasal Çalışmalara İlişkin Görüşleri ile Oluşturdukları Metaforlar

Atıf:

Onen Ozturk, F. & Aglarci, O. (2017). Prospective chemistry and science teachers' views and metaphors about chemistry and chemical studies. *Eurasian Journal of Educational Research,* 71, 119-140, DOI: 10.14689/ejer.2017.71.7

Özet

Problem Durumu: 2004-2005 yılında eğitim alanında yapılan yenilenme çalışmalarıyla birlikte öğretim programlarında ilköğretim seviyesinden başlanarak yapılandırılmaya gidilmiştir. Bu doğrultuda, öğrencilere bilginin aktarımını amaçlayan davranışçılık felsefesi yerine, öğrenenlerin bilgiyi kendilerinin oluşturmasına fırsat veren yapılandırmacılık felsefesi bir anlayış olarak benimsenmiştir. Bu doğrultuda, öğretim programları; fizik, kimya ve biyoloji gibi bilim dallarını, yapılandırmacı bakış açısı çerçevesinde tanımlamaktadır. Yapılandırmacı yaklaşımın ortaya koyduğu yeni bakış açısı, ölçme değerlendirme sürecine yönelik de alternatifler getirmektedir. Geleneksel ölçme değerlendirme araçlarının yanı sıra; dereceli puanlama anahtarı, portfolyo değerlendirme, kavram haritası …gibi alternatif araçların kullanımı giderek önem kazanmaktadır. Bu noktadan hareketle araştırmada da alternatif bir ölçme değerlendirme aracı olarak kullanılabileceği düşünülen metaforlardan faydalanılmıştır. Literatürde yer alan çalışmalar incelendiğinde öğretmen adaylarıyla yapılan çalışmaların farklı branşları içerdiği, buna karşın fen bilgisi ve kimya öğretmen adaylarının görüşlerinin değerlendirildiği bir çalışmanın yer almadığı görülmüştür. Ayrıca kimya alanına özgü yapılan çalışmalarda farklı sınıf seviyelerinde gerçekleştirilen araştırmaların yalnızca okul öncesi öğretmen adaylarıyla yürütüldüğü; gerek fen bilgisi gerekse kimya açısından sınıf seviyeleri farklılıklarına ilişkin sonuçların irdelenmediği görülmüştür. İlgili literatür ışığında, öğretmen adaylarının kimya alanına ilişkin görüşlerinin ayrıntılı olarak incelendiği çalışmalara ihtiyaç duyulduğu düşünülmektedir. Bu bağlamda araştırmada öğretmen adaylarının görüşlerinin yanı sıra konuya ilişkin metaforik algıları da ortaya konacak; böylece konuya ilişkin görüşler ile metaforik algılar arasındaki uyum da ortaya konacaktır. Bunun yanı sıra araştırmada fen bilgisi ve kimya öğretmen adaylarıyla çalışılmıştır. Bu iki farklı grubun seçilme sebebi, her iki alandaki öğretmen adaylarının, gelecekteki öğrencilerine kimya konularını anlatacak ve kimyaya özgü tutumlarını etkileyecek kişiler olmalarıdır. Bu iki farklı alandan gelen öğretmen adayları, ileride, ortaokuldan liseye geçiş sürecindeki öğretim sürecini de gerçekleştireceklerdir. Dolayısıyla fen bilgisi öğretmen adaylarını yetiştirmiş olduğu öğrenciler, kimya öğretmen adaylarının yetiştireceği öğrenciler olacaktır ve bu sebeple farklı

alanlardaki öğretmen adaylarının kimyaya ilişkin görüşlerini belirlemek önemli bir nokta olacaktır. Ayrıca, üniversitedeki öğrenimlerine başlayan öğretmen adayları, ilk senelerinde, lisede sahip oldukları görüşleri eğitim yaşantılarına yansıtabilmektedir. Üniversitede aldıkları çeşitli derslerle, özellikle kimya alanına özgü olan alan bilgisi dersleriyle, son yıllara doğru görüşleri farklılaşabilmektedir. Bu bağlamda farklı sınıf seviyelerindeki görüşlerin incelenmesinin alana yönelik katkısının olacağı düşünülmektedir. Bu sayede farklı sınıf seviyelerindeki ve alanlardaki öğretmen adaylarının görüşleri arasındaki benzerlikler ve değişikliklerin incelenmesi ile öğretmen adaylarının görüşlerine dair daha zengin bir portre sunulacaktır. Bu doğrultuda araştırmanın problemini "kimya ve fen bilgisi öğretmen adaylarının, kimya alanına ve kimya alanındaki çalışmaların nasıl yapıldığına ilişkin görüşleri nelerdir?" sorusu ile "öğretmen adaylarının kimyaya dair oluşturdukları metaforlar sınıf seviyesi ve alana göre değişmekte midir?" sorusu oluşturmaktadır.

Araştırmanın Amacı: Bu doğrultuda araştırmada kimya ve fen bilgisi öğretmen adaylarının, kimya alanına ve kimya alanındaki çalışmaların nasıl yapıldığına ilişkin görüşleri ile kimyaya dair oluşturdukları metaforların sınıf seviyesine ve alana göre incelenmesi amaçlanmıştır.

Araştırmanın Yöntemi: Katılımcıların kimya alanına dair açıklamalarının ve metaforlarının derinlemesine incelenebilmesi amacıyla nitel veri toplama ve analiz yöntemleri kullanılmıştır. Bu amaçla araştırmada nitel araştırma desenlerinden durum çalışması araştırma yöntemi olarak kullanılmıştır. Araştırma 2014-2015 eğitim-öğretim yılı bahar döneminde gerçekleştirilmiş olup; araştırmaya İstanbul'daki bir devlet üniversitenin ortaöğretim kimya öğretmenliği anabilim dalı birinci sınıfında okuyan 16 (4 erkek, 12 kadın) ve son sınıfında okuyan 25 (4 erkek, 21 kadın) öğretmen adayı ile ilköğretim fen bilgisi öğretmenliği birinci sınıfında okuyan 52 (7 erkek, 45 kadın) ve son sınıfında okuyan 41 (7 erkek, 34 kadın) öğretmen adayı katılmıştır. Katılımcılar 18-23 yaş aralığında yer almaktadır. Araştırmaya katılan öğretmen adayları araştırmacıların vermiş olduğu ders/dersleri alan öğretmen adayları içerisinden belirlenmiştir. Bu bağlamda araştırmada nitel araştırma desenlerinden biri olan amaçlı örnekleme yöntemlerinden "kolay ulaşılabilir durum örneklemesi" ile kullanılmıştır. Araştırma verileri araştırmacılar tarafından hazırlanmış olan üç açık uçlu soru ile toplanmıştır. Bu sorulardan iki tanesi kimyanın ne olduğu ve kimya alanındaki çalışmaların nasıl yapıldığını ölçmeyi hedeflerken; son soru ise katılımcıların kimya kavramına ilişkin oluşturdukları metaforları belirlemeye yöneliktir. Bu doğrultuda son soruda öğretmen adaylarının "kimya .... gibidir çünkü……" cümlelerini tamamlamaları istenmiştir. Ayrıca sadece tek bir metafor oluşturmaları ve oluşturdukları bu metafor ile kimya arasındaki ilişkiyi mutlaka yazmaları gerektiği belirtilmiştir. Araştırma verilerinin analizi her bir soru için ayrı ayrı değerlendirilmiş olup; bu süreçte verilerin daha ayrıntılı bir şekilde incelenebilmesi amacıyla içerik analizi yapılmıştır.

Araştırmanın Bulguları: Araştırmadan elde edilen bulgular farklı sınıf seviyeleri açısından değerlendirildiğinde, hem kimya hem de fen bilgisi öğretmen adaylarının kimyaya ilişkin görüşlerinin benzer olduğu, bununla birlikte sonuçların son sınıflar açısından daha kapsamlı ve ayrıntılı olduğu görülmektedir. Öğretmen adaylarının

kimyaya dair oluşturdukları metaforlar ve gerekçeler sınıf seviyeleri açısından karşılaştırıldığında ise ortaya konan gerekçelerin sınıf seviyeleri açısından çeşitli benzerlikler ve farklılıklar içerdiği görülmektedir. Araştırmadan elde edilen bulgular farklı alanlar açısından karşılaştırıldığında ise mevcut sonuçların benzerlikleri ve farklılıkları bir arada içerdiği görülmektedir. Öğretmen adaylarının kurmuş oldukları metaforlar alanlar açısından karşılaştırıldığında ise kurulan metaforların birbirinden oldukça farklı olduğu görülmektedir.

Araştırmanın Sonuçları ve Öneriler: Mevcut sonuçlar bir arada değerlendirildiğinde öğretmen adaylarının kimya alanına ilişkin görüşlerinin genellikle doğru olduğu bununla birlikte çeşitli yanılgıları da içerebildiği görülmektedir. Öğretmen adaylarının kurmuş oldukları metaforlar ise kimya alanına ilişkin farklı görüşlerinin olabileceğini de gösterir niteliktedir. Bu durum kalıpların dışına çıkarıldığında öğretmen adaylarının farklı ve yeni görüşlerinin belirlenebileceğini de gösterir niteliktedir. Bu bağlamda metaforların gerek sahip olunan yanılgıların gerekse zihinsel düşünme sürecinde var olan alt yapının belirlenmesinde oldukça etkin olarak kullanılabilecek bir araç olduğu söylenebilir. Araştırmadan elde edilen sonuçların nedenleri, gerek yüz yüze görüşmeler gerekse farklı ölçme yöntemleriyle irdelenmeli böylece ortaya konan metaforlar ve sunulan gerekçelerin altında yatan temeller belirlenmelidir. Öğretim sürecinde, ortaya konan metaforlar ile sunulan gerekçeler arasındaki ilişkilendirmenin, ele alınan konu kapsamında birebir örneklerle sunulması; böylece kurulan ilişkilerin daha da anlamlı hale getirilmesi gerektiği düşünülmektedir.

Anahtar kelimeler: Öğretmen eğitimi, fen eğitimi, kimya eğitimi, öğretmen adayı, öğrenci algıları.