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CHEMISTRY WITH METAPHORS: CASE OF KOCAELI (TURKEY) VOCATIONAL SCHOOL

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Abstract:
The aim of this study is to investigate the metaphors of chemistry students about chemistry science. For this purpose, a single question was asked to measure their perceptions about chemistry. Qualitative method was adopted in the research. Content analysis was applied to the data obtained. The sample of the study consists of students of Chemistry Program of Kocaeli Vocational School. Data were collected in the fall semester of 2018-2019. 68 students participated in the study. The reliability of the study was found to be 96% according to expert opinion. 32 metaphors were obtained. The metaphors obtained were collected in 7 themes: danger, comprehensive, cumulative, happiness, exploratory, innovative, magical. Only one of the metaphors has been negatively evaluated under the others positive theme. It was observed that "life" metaphor was used the most. Female students produced 25 metaphors and male students produced 11 metaphors. Metaphors for two themes were produced by female students. Female students differ from male students in terms of the metaphors they produce.

Keywords: metaphor, chemistry, content analysis

1. Introduction

Metaphor, ıt means metaphor which has been translated into Turkish from French. (TDK). Transferring a name that belongs to one thing to another (Zhang and Hu, 2009: 77) is the use of a concept to express a similar concept other than its normal meaning (Lakoff, 1992) is a characteristic of everyday speech used in all languages (Perry, 2011). Shuell (1990, p. 102) says that if a picture is worth a thousand words, a metaphor is worth a thousand pictures. Because a picture presents only an image, and a metaphor presents a mental framework based on thinking about a phenomenon. According to Dickmeyer (1989), the metaphor, while providing the use of known concepts to explain unknown concepts, simplifies the transfer of complex concepts with a single concept

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allows (akt., Akbaba-Altun and Apaydın, 2013, p. 330). In short, it is used in the conception and perception of abstract concepts.

2. Literature Review

According to Lakoff and Johnson (2003), people try to express the unknown by using metaphor to match the truths and facts with their experiences consciously or unconsciously (cited in Gültekin, 2013, p. 128). Strenski (1989) states that metaphor has a role in shaping and transforming people's attitudes into behavior.

Lakoff and Johnson (1980) also stated that there was an increase in the frequency of use of the metaphor in the field of educational science due to the impressive aspect of the human behavior of the metaphor (cited., 2017, p. 8). When Özdemir and Arık (2018) examined the studies on the concept of metaphor, they found that 89.47% of the studies were subjected to content analysis by qualitative research method. Arık and Özdemir (2016) examined the metaphor perceptions of science and technology teacher students towards the science laboratory. Saban (2008), on the other hand, investigated the metaphoric perceptions of the school in the study which was composed of the sample of primary school students.

Akbaba-Altun and Apaydın (2013) measured prospective teachers' perception of education through metaphors. Gültekin (2013), on the other hand, requested metaphors to express the opinions of the students studying at primary school teaching department. Aykaç and Çelik (2014) metaphorically examined teachers' views on preschool curriculum.

Derman (2014) examined the metaphors of high school students about chemistry. Eraslan Çapan (2010) examined the perceptions of the students in the faculty of education about gifted students through metaphors. Özdemir (2012) examined the perceptions of the faculty of education students about the concept of education from a metaphorical point of view.

Ekici (2016) investigated the perceptions of biology students about the microscope from a metaphorical point of view. Assured et al. (2011) examined the metaphors about mathematics in the study which consisted of the sample of primary school students.

In the study, qualitative research design was adopted. The phenomenology approach involves efforts to make sense of people's experiences (Altunışık et al., 2012, p. 65; Karademir et al., 2017, p. 56).

The nature of qualitative research allows arı to share understanding and perceptions of others and to examine how daily life is structured and given meaning (Berg & Lune, 2015, p. 25).

Qualitative research makes it possible to understand and interpret the world from the perspectives of subjects (Kuş, 2009, p. 183). The data obtained from qualitative research can be analyzed using different analysis techniques. One of these techniques is content analysis. Content analysis is based on categorizing concepts that describe the data obtained.

The concepts used in close sense are brought together (Yıldırım & Şimşek, 1999, p. 162). Content analysis, ıt is "*the research technique used to make reproducible and valid inferences from meaningful contents*"(Berg and Lune, 2015, p. 384).

Although there is not much research on the subject of science in terms of metaphorical aspects, it has been found that there are generally studies in which prospective teachers are selected as samples.

It is thought that this study, which examines the metaphors of chemistry students of vocational high school students who will enter working life as chemistry technician who prefer chemistry as a profession, will contribute to the literature.

3. Material and Methods

Knowing how chemistry is perceived by students in educational science and knowing what students match or transfer to the concept of chemistry will contribute to measuring the effectiveness of learning. The aim of this study is to determine the chemistry perceptions of chemistry students studying at Kocaeli Vocational School of Higher Education through metaphors. For this purpose, the questions to answer are:

- What are the metaphors that students are associated with the concept of chemistry?
- Do they differ by gender?

In the study where qualitative research method was preferred, the content analysis was interpreted. Content analysis is a form of systematic interpretation in which the scope and direction are determined and can be controlled by the researcher (Gökçe, 2006, p. 18). Metaphors obtained in content analysis constitute the coding, while the codes are collected under themes. Themes show attitudes, perceptions and values expressed by the participants (Altunışık et al., 2012, p. 327). The relationship between the obtained data was evaluated and the significance analysis was performed in determining the themes (Yıldırım & Şimşek, 1999, p. 163).

The research was applied to Kocaeli Vocational School Chemistry program students in 2018-2019 fall semester. 68 students participated in the study. Students who voluntarily participated in the study were included. Students were asked "*Chemistry is like ..... because ....*"; they were asked to complete the gaps appropriately. They were asked to metaphorize the concept of chemistry using preposition, and to establish a causal connection to the concept they prefigure with preposition. The students completed the gap consisting of a line such as quiz within one hour.

While the data were obtained from the forms collected from the students, it was passed through the following stages in order to be evaluated within the context of content analysis (Saraç, 2019, p.26).

Examination of the forms, exclusion of the unsuitable for evaluation, re-examination and compilation of the remaining spreads after the elimination, numbering the forms to be evaluated, determination of metaphors in the forms taken into

consideration, examination and theme of metaphors, determination of validity and reliability, quantification of qualitative data, interpretation.

Reliability of qualitative research, it was controlled by the expert with the formula; Reliability = consensus / consensus + disagreement x 100 (Kodan Çetinkaya, 2014, p. 140).

The consensus is that the themes assigned to the metaphors are consistent with the opinions of the researcher and the expert, and the difference of opinion is that the researcher and the expert assign the metaphors to different themes.

In qualitative research, it can be said that when the consensus between the expert and the researcher is at most 90%, the obtained reliability is obtained (Derman, 2014, p. 758; Yadigaroğlu, 2018, p. 74). A total of 32 metaphors were gathered under 7 themes. There was a difference of opinion between the researcher and the expert in two metaphors, and the reliability was found to be 96%.

4. Results

In this section where findings related to the analysis of the data collected for the purpose of the research are given; The metaphors developed by chemistry department students about the science of chemistry, the common features attributed to these metaphors, and the statements of the students were examined on the basis of gender.

Content analysis, which is one of the qualitative research methods, is used in the research; qualitative data were interpreted and quantified. The students were coded as (S) and gender as male (E) and female as (K). In addition, each student was given a sequence number during the analysis.

Metaphors used by students for chemistry; medicine (2), love (2), ocean (1), book (1), bomb (1), nature (1), closed box (1), apron (1), experiment (2), mother (1) , life (23), world (2), universe (2), milk (1), spider web (1), water (3), notebook (1), plant (1), alphabet (1), light (1)), chain (1), fiber (1), cooking (1), basic necessity (1), tree (3), laboratory (1), atom (1), death (1), human (1), space cavity (1), children (1), cookery (1), research (1), madness (1), important (1), potion (1), science (1) is. 68 students participated in the study; students expressed chemistry with 37 metaphors.

Because some of the metaphors that students were asked to connect to a logical reason prepositively, they were not included in the analysis as they did not explain the science of chemistry sufficiently.

Metaphors excluded from the analysis are as follows: medicine (S48, F), "*chemistry is like a medicine because it is similar to health, plastic, paint boy; drug (S1, M), made to save people*"; apron (S8, F), "*chemistry is like an apron, because it is worn*"; madness (S24, M), "*chemistry is like madness"*; important (S17, F), "*chemistry is important because there is life in chemistry*"; science (S51, F) is "*different and different*". The 5 metaphors used by 6 students were not included in the analysis because the mentioned metaphors were not descriptive of the science of chemistry, they tried to explain science with science, or the logical explanation of the metaphor was completed by analogy.

The metaphors produced by the students were classified by the researcher according to their common characteristics.

The metaphors used by students to express the science of chemistry were evaluated under 7 themes. In line with the common characteristics of the students' metaphors, the hazard has been collected in seven themes as comprehensive, cumulative, happiness, exploratory, innovative and magical.

6 students used 6 different metaphors for the theme of danger. The metaphors used by the students are bomb (1), milk (1), fiber (1), laboratory (1), child (1) and death (1).

Table 1: Danger Themed Chemistry Metaphors

Metaphor	Theme	Gender	n	f (%)
Bomb (1) Milk (1) Fiber (1) Laboratory (1) Child (1) Death (1)	Danger	Male	3	50,0
		Female	3	50,0
		Total	6	100

Danger themed metaphors use 6 of the students, while half of the students using this theme are male and half are female.

One of the students (S5, M) metaphorizes chemistry as "*it is like a bomb because our lives are in danger in the slightest mistake; another student*" (S13, M) chemistry "*is like milk, because when we make a mistake, milk can turn into cheese at any moment*", another student (S57, F) described chemistry as "*staple because it is dangerous and colorful*". Another student who metaphorized chemistry as a laboratory (S65, F) reported his thoughts about chemistry as "*sometimes complex, sometimes fun and sometimes dangerous*". Another student who metaphorized chemistry with death (S29, F) said, "*because we breathe chemicals too much, it hurts us*". Another student who metaphorized chemistry as a child (S41, M) replied that "*bad things can happen if we do not pay attention*".

15 metaphors approved by 43 students for their comprehensive theme; nature (1), mother (1), life (23), world (2), universe (2), plant (1), alphabet (1), basic necessity (1), tree (3), water (3), research (1), book (1), atom (1), light (1), notebook (1) is.

Table 2: Comprehensive Themed Chemistry Metaphors

Metaphor	Theme	Gender	n	f (%)
Nature (1) Mother (1) Life (23) World (2) Universe (2) Plant (1) Alphabet (1) Basic necessity (1) Tree (3) Water (3)	**C**omprehensive	Male	9	16,28
		Female	34	83,72

Research (1) Book (1) Notebook (1) Atom (1) Light (1)	Total	43	100

While 43 of the students used comprehensive themed metaphors, 16.28% of them were male and 83.72% were female.

A student who uses the metaphor of nature is like nature for chemistry for its comprehensive theme (S6, M), says that "*there are too many kinds of matter in nature*" the metaphor of life (S10, M), (S11, S), (S14, M), (S16, F) , (S19, F), (S21, M), (S22, F), (S25, F), (S26, F), (S33, F), (S34, F) (S38, M), (S39, F), (S40, F), (S42, F), (S43, F), (S44, F), (S46, F), (S66, F), (S68, M) used as 6 male and 17 female students.

In total, 23 times the metaphor of life was shared by the students: "*it is in all parts of life*". 2 students used the world metaphor: One (S12, F) said "*there is everything in liquid and solid"*, and the other (S18, F) said "*it has a very wide area*". The universe metaphor was used by two students (S27, F) and "*everything in the universe has something to do with chemistry and the other (S47, F)"* covers every field. A student who metaphorized chemistry with plants (S53, M) said you always come across you. A student who metaphorizes chemistry as an alphabet (S54, F) said "*there is chemistry in every field from A to Z in our live*". One female student (S59, F) said "*it is found at every point in our lives while metaphorizing chemistry as a basic necessity*". Three students metaphorized chemistry as a tree and (S62, F) said "*each branch contains important features and subjects*", while another student (S64, M) said that they have more than one branch; another student (S45, F) said there are many branches. All three students (S60, F), (S20, F), (S23, F) said that chemistry is "*like water and the common feature of the water metaphor they use for chemistry is it concerns all our lives / everywhere*". One student said it is necessary and necessary in every aspect of our lives for the chemistry that he metaphorizes as a mother (S36, F).

One female student (S49, F) said in a research metaphor that "*we would go into more than one item and examine it".* A female student using the book metaphor (S4, F) said "*every page is covered with another topic*". Another student using the notebook metaphor (S50, F) said "*it contains information that does not end with writing*". A student who uses the atomic metaphor (S67, F) said "*something comes out of it all the time*". One student (S55, F) said he gave direction to most things with light metaphor.

The cumulative / connected theme, 4 students used 4 different metaphors as space (1), spider web (1), chain (1) and human (1).

Table 3: Cumulative / Connected Themed Chemistry Metaphors

Metaphor	**Theme**	**Gender**	**n**	**f (%)**
Space (1)		Male	1	25,0
Spider web (1)	Cumulative /	Female	3	75,0
Chain (1)	Connected			
Human (1)		Total	4	100

While 4 of the students used cumulative metaphors, 25,0% of them were male and 75,0% were female.

One student (S35, F) stated that chemistry is a space metaphor, "*it consists of a lot of knowledge and situations*". A student who used spider web as a metaphor (S15, M) said that "*chemistry is connected like the connection of spider web to each other*". A student using the chain metaphor (S56, F) stated that "*everything is connected to each other and it is difficult to connect when it breaks"*. A student who metaphorizes chemistry as a human being (S31, F) said "*we learn more and more about it*".

For exploratory theme, two students used two separate metaphors in the form of ocean (1) and closed box (1).

Table 4: Exploratory Themed Chemistry Metaphors

Metaphor	Theme	Gender	n	f (%)
Ocean (1)	Exploratory	Female	2	100
Closed box (1)		Total	2	100

While 2 of the students use metaphors with explorer theme, all of the students using metaphors defined in explorer theme are female students.

A student (S3, F) metaphorizing chemistry as the ocean (1) for the explorer theme said, as we go deeper, we come across new things. Another student (S7, F) in chemistry as a closed box (1), "*Each time we learn new ones*" he said.

For the theme of happiness, 3 students used 2 different metaphors. The metaphors used by the students are love (2), cooking (1).

Table 5: Happiness Themed Chemistry Metaphors

Metaphor	Theme	Gender	n	f (%)
Love (2)	Happiness	Male	1	33,33
Cooking (1)		Female	2	66,67
		Total	3	100

While 3 of the students used metaphors with the theme of happiness, 33.3% of the students using metaphors with the theme of happiness were male and 66.67% of them were female.

One student, using the metaphor of love (S2, F), said "*love and experimentation both feel good, while another student"* (S52, M) says "*every moment requires a separate labor, giving labor is happiness*". One student (S37, F) stated that "*the metaphor of cooking is happiness as an experiment in the laboratory while cooking*".

For the innovative theme, 2 students used 3 different metaphors. These metaphors are: experiment (2) and cookery (1).

Table 6: Innovative Themed Chemistry Metaphors

Metaphor	Theme	Gender	n	f (%)
Experiment (2)	Innovative	Male	2	66,67
Cookery (1)		Female	1	33,33
		Total	3	100

While 3 of the students use innovative themed metaphors, 66,67% of the students producing the metaphors of the innovative theme are male and 33,33% are female students.

One student (S30, M) used the experiment metaphor: "*we mix a few substances and do something*". He also said a similar expression (S9, F). Another student (S28, M) used the culinary metaphor "*while chemists came to an end with the experiment, they did some work like us and produced a product. The only difference is that we deal with chemicals and fruits and vegetables*".

For the magical theme, 1 student used the potion (1) metaphor (Ö32, F) and said "*mixtures like potions can be prepared*".

Table 7: Magical Themed Chemistry Metaphors

Metaphor	Theme	Gender	n	f (%)
Potion (1)	Magical	Female	1	100
		Total	1	100

All of the students who produce metaphors in the magical theme are female students. Of the students participating in the research, 48 were female and 20 were male. 32 metaphors were produced by 68 students and the metaphors were divided into 7 categories.

The identified categories can be considered negative under the dangerous theme and the other six themes can be considered as positive. 1 girl for magical theme, 2 girls for innovative theme, 2 girls for explorer theme, 2 girls for happiness theme, 3 girls for cumulative theme, 34 girls for comprehensive theme, 3 female students for dangerous theme producing metaphors; While male students could not produce metaphors for magical theme and explorer theme, they produced 2 men for innovative theme, 1 male for happiness theme, 1 male for cumulative theme, 9 male for comprehensive theme, and 3 male student metaphors for dangerous theme.

The metaphors produced and their themes are shown in the table below in terms of gender:

Table 8: Chemistry Metaphors and Themes

Metaphor	Theme	Gender	n	f (%)
Fiber, laboratory, death, bomb, milk, child	Danger	Female	3	4,83
		Male	3	4,83
Water, mother, research, light, book, notebook, atom, life, world, universe, alphabet, basic necessity, nature, life, plant, tree	**C**omprehensive	Female	34	54,83
		Male	9	14,51
Space, spider web, chain, human	Cumulative / Connected	Female	3	4,84
		Male	1	1,61
Ocean, closed box	Exploratory	Female	2	3,23
Experiment, cookery	Innovative	Female	1	1,61

		Male	2	3,23
Love, cooking	Happiness	Female	2	3,23
		Male	1	1,61
Potion	Magical	Female	1	1,61
Total			62	100

While 47 female students produced 25 metaphors for chemistry, 16 male students produced 11 metaphors. Of the metaphors produced, life, experiment, love are common metaphors produced by both gender. As can be seen, the most metaphor was the female students. In addition, it is seen that metaphors produced by female students emerged in two different themes in the form of exploratory and magical based on gender.

4. Discussion

Metaphor used to transform abstract concepts into a known concept in concretizing abstract concepts; chemistry is a method that can be used to teach the unknown.

Knowing how students perceive chemistry will help educators in chemistry teaching. In this research, the relationship between students' gender and their perceptions of chemistry was examined through metaphor. Five of the metaphors were in danger.

Metaphors that are considered as negative are considered to be used to identify the undesirable situation to be encountered when errors are made with chemicals in the experimental environment. However, the students should first be trained to provide their own safety, theoretical information should be transferred to the student clearly and clearly in the direction that the student can understand, if this process works properly in the experimental environment will not encounter faulty behavior and unwanted results.

Other metaphors other than dangerous theme were supported with positive expressions. 9.66% of the students produced negative metaphors for dangerous contact. The proportion of students who produce positive metaphors about chemistry is 90.44%. Another striking element is that the themes of positively produced metaphors are directed towards science philosophy and science.

It will not be wrong to mention cumulative, exploratory and innovation themes as features of science. In addition, metaphors form the cornerstones of constructivist learning theory (Karaırmak and Aydın, 2007, p. 93; Küçüktepe and Gürültü, 2014, p. 283). The majority of students (69.34%) stated that chemistry was comprehensive. It is possible to interpret that the use of expressions, such as the fact that life metaphor has been used 23 times and that it exists everywhere for chemistry, is present in every area of our lives, has made chemistry students internalize chemistry with life.

The metaphors produced differ according to gender. When the obtained metaphors are evaluated on the basis of gender, it is possible to state that female students produce more metaphors.

5. Recommendations

This study was applied to Kocaeli Vocational School Chemistry Program students. It is recommended for future researches to make comparisons between the same teaching levels in different universities or to include the level of family education on a single sample in the analysis.

6. Conclusion

There was no causal explanation of the fear of chemical science in the metaphors produced.

It is also possible to state that students are not afraid of chemistry. Moreover, when the metaphors examined under the theme of happiness are examined, it is possible to state that students enjoy the science of chemistry. It would also be appropriate to state that chemistry students are in the right department for their future careers. While metaphors help to make abstract concepts concrete, they also make it easier to keep them in mind.

The use of metaphors in chemistry education helps students to match concepts that they do not know to what they already know, and to match previously learned concepts to new ones. Increasing the persistence in mind will also allow the creation of a concept map through metaphors. Even the experiences gained in daily life are transmitted to others by using metaphor.

About the Author(s)
Serpil Özkurt Sivrikaya completed his undergraduate, graduate and doctorate studies at Karadeniz Technical University. She is working at Kocaeli University. She has scientific publications in various journals. She is currently working on Science and Chemistry education.

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