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Investigation of How Freshman Pre-Service Teachers Relate Chemistry Laboratory with Daily Life

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Abstract

Chemistry includes observable phenomena and materials related to daily life, but learners sometimes have difficulties in understanding the theoretical and abstract nature of chemistry as well as its applications and relating it to everyday experiences. In this manner, the aim of the study is to determine and assess whether pre-service science and pre-service chemistry teachers could relate the experiments conducted in the chemistry laboratory with daily life or not. The research is designed as a case study and the study group consists of pre-service science (n=18) and chemistry teachers (n=18) who are studying at a state university in Istanbul. Research data is collected with open-ended questions in accordance with the general chemistry laboratory I course content. The questions aimed to investigate the conceptual understanding and the views of pre-service teachers. The results showed that the participants could not adequately make the conceptual explanations, however, they were able to establish the connection with daily life. Also, the pre-service teachers stated that they did not have any difficulties in integrating chemistry with daily life in the interviews. In the light of the findings, some implications were drawn to establish a relationship between the content and laboratory courses and daily lives to make more a meaningful learning.

Key Words: Chemistry Education, Chemistry Laboratory, Teacher Education, Daily Life Chemistry, Pre-service teachers

Introduction

The major outcome of science education is achieving scientific literacy. One of the most important aspects of a scientific literate student is that he/she can understand daily life issues by using scientific knowledge and use that knowledge in daily life decisions (DeBoer, 2000). Therefore, science education should help students to make a connection/association between daily life situations/problems and the scientific knowledge that they learn in science classes.

Students sometimes have difficulties in understanding the theoretical and abstract nature of scientific knowledge and relating it to their everyday experiences (Niebert et al., 2012). However, they mostly learn scientific theories, laws and concepts which can explain the order of nature as well as what students observe and encounter in their daily lives. Hence, what they studied and learned in science classes are quite related to their experiences in their lives (Yadigaroğlu et al., 2017). Some students consider science lessons difficult to understand, even though being intertwined with daily life (Ormancı et al., 2020). Even though teachers and experts usually consider easy and plausible to relate scientific content taught in science lessons with daily life, making that connection is a complex and difficult task for students to accomplish (Cajas, 1999). Most students cannot understand the important role of scientific knowledge in their daily lives without meaningful learning opportunities (Campbell & Lubben, 2000; Yadigaroglu et al., 2017).

Chemistry includes observable phenomena and materials related to daily life (Gilbert & Treagust, 2009). Scientific explanations for observable phenomena include various abstract mechanisms and concepts in chemistry. These mechanisms are involved with submicroscopic (e.g. atoms, ions, molecules, particles) and symbolic levels (e.g. symbols for chemical elements) of chemistry (Johnstone, 1991). Since the chemistry course includes abstract concepts and symbolic representations, students consider this discipline challenging and difficult to comprehend (Mete & Yıldırım, 2016). Research on chemistry education showed that students actually are successful in

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solving mathematical problems, but they cannot use the chemistry knowledge they learned and studied in science classes in their daily lives (Haidar & Abraham, 1991; Uluçınar Sağır, 2020).

Gilbert (2006) states that conceptual understanding of students from different grade levels generally improves when chemistry concepts are presented in relation to daily life. Relating chemistry with daily life in science classes will have a positive effect on students' understanding and teachers will teach chemistry in a more effective way (Ormancı & Çepni, 2018). However, studies in the literature showed that students (Kenar et al., 2015) and pre-service teachers (Canpolat& Ayyıldız, 2019; Balkan Kıyıcı & Aydoğdu, 2011; Yadiroğlu et al., 2017) have difficulties in relating scientific knowledge with daily life. Canpolat and Ayyıldız (2019) found that pre-service science teachers were inadequate in explaining concepts and materials (such as diamonds and coals), and the reason for what they observe in daily life (such as cooking in a pressure cooker, the air gets warm when it snows on a cold winter day). Also, they had various misconceptions about these issues. Pabuçcu (2016) examined how pre-service science teachers could relate gas pressure with daily life. The study showed that the prospective teachers had some misconceptions about the scientific explanations of the chemical phenomena they encountered in daily life. Similarly, in another study by Balkan Kıyıcı and Aydoğdu (2011), only half of the pre-service teachers were able to explain correctly about the pressure cooker question. In addition, Yadigaroglu et al. (2017) showed that pre-service science teachers were not successful in relating their chemistry knowledge with daily life issues including the reason of decompression sickness, road salt in winter, and feeling chilly when perfume is sprayed on the skin.

It has vital importance that pre-service teachers can point out the relationship between scientific knowledge and daily life to guide their future students. They should be able to make necessary connections and learn to use scientific knowledge to give meaning to their experiences during their education as pre-service teachers. Laboratory practices have a very important place in science and chemistry education (Nakiboğlu & Meriç, 2000) as well as have a great contribution to students' understanding of abstract subjects and issues encountered in daily life (Coştu et al., 2005). In this regard, examining how pre-service teachers can relate the experiments and scientific knowledge learned in those experiments with daily life will make important contribution to the related literature. Ormancı and Çepni (2018) have found that most of the studies investigated middle school and high school students' levels of relating daily life with science. Also, in those studies, the topics were usually related to physics (e.g. force and motion, magnetism), biology (e.g. cell division and heredity, parts of the body) and chemistry (e.g. heat and temperature, change of state, acids and bases, physical and chemical changes). However, the relationship between the theoretical content knowledge, laboratory practices and daily life was not examined. In this respect, examining and comparing whether laboratory practices are related with daily life or not in two different groups (pre-service science and chemistry teachers) enrolled in the general chemistry laboratory course will contribute to the studies in the literature.

The aim of this present study is to determine whether pre-service science and pre-service chemistry teachers could relate the experiments carried out in chemistry laboratory with daily life or not. The research questions guiding the study are given below:

1. What is the conceptual understanding of pre-service science and chemistry teachers about general chemistry laboratory experiments?

2. How do pre-service science and chemistry teachers relate experiments in chemistry laboratory with daily life?

3. What are the views of pre-service science and chemistry teachers on the relationship between general chemistry laboratory experiments and daily life?

Method

The research was designed as a case study, which is one of the qualitative research designs. Case study is described as a holistic and in-depth description and analysis of a phenomenon which could be a program, a process, a person or a social unit (Merriam, 1998). In the study, holistic multiple-case design was used as one of the case study types. In this design, more than one situation is handled

holistically, and then the situations are compared with each other (Yin, 2008). The two cases examined here are how two different groups of pre-service teachers (science and chemistry teachers) relate chemistry laboratory experiments with daily life.

The study group consists of pre-service science (n=18) and pre-service chemistry teachers (n=18) who are studying at a state university in Istanbul. In both groups, the participants enrolled in general chemistry laboratory I course in the fall semester of teacher education program.

Data Collection Tools

Research data was collected with questions prepared in accordance with the general chemistry laboratory I course content. Those questions were constructed by the researchers who were also the co-instructors of the laboratory courses. The first two weeks of the laboratory course included explaining students the laboratory safety, rules for laboratory safety, and demonstration of the uses of laboratory equipment. The course content in both programs involved experiments about the law of conservation of mass, the relationship between matter and energy, stoichiometry, determination of the heat of fusion, determination of the specific heat of metal, determination of the molar mass of a volatile liquid, determination of the equivalent weight of metal, diffusion of gases, and preparation of different kinds of solutions.

A question pool including different types of questions was constructed in order to determine pre-service teachers' conceptual understanding of laboratory experiments and their relationship with daily life. After preparing a draft version of the questions, different types of questions in the question pool were re-examined by the researchers and 5 questions that were out of the scope of the research were eliminated. The questions were administered to the pre-service chemistry and science teachers who were at different grade levels other than the study group. At that part of the process, no question has been eliminated, and two questions that are difficult to understand in terms of language and expression have been revised. After the pilot application, the final version of the questions was arranged and were evaluated by two science educators who have Ph.D. degrees in science education and gave content courses in chemistry and science education. As a result of the final examination of the questions, the final version of open-ended questions consisting of 3 questions aimed at conceptual understanding and relationship with daily life was constructed.

In the study, it was also aimed to determine the views of pre-service teachers about the experiments they carried out in the general chemistry I laboratory. For this purpose, a method was followed as in the conceptual understanding questions and an interview form consisting of 3 open-ended questions was constructed.

Data Analysis

The analysis of the data was carried out by evaluating separately for conceptual understanding questions, daily life related questions and interview questions.

In the questions in which conceptual understanding was investigated, primarily the answers given to the questions were examined and these answers were analyzed in terms of three categories; scientifically correct, partially correct, and incorrect (Table 1). While examining the answers to the questions, the opinions of two experts were consulted and it was aimed to ensure the reliability of the data with the compatibility between the experts. The answers described as different among the experts were discussed and a consensus was reached. After this process, the frequency values (f) were determined and the results were tabulated by calculating the percentages (%).

Table 1

Categorization of conceptual understanding questions

Category	Description
Scientifically correct (C)	Answers with scientifically correct explanations of the question
Partially correct (PC)	Answers that are scientifically partially correct or scientifically correct

	but qualify as incomplete
Incorrect (I)	Answers with unscientific propositions about the question

In the questions aimed at determining the pre-service teachers' levels of relating chemistry laboratory with daily life, the answers were classified under three categories yes, no and partially relating. The results were presented in tables; furthermore, the data was exemplified by direct quotes from participants' answers.

The questions asked to determine the opinions of the pre-service teachers about the experiments they conducted in the chemistry laboratory were examined with content analysis. Establishing inter-coder agreement is an important process of qualitative research design in order to ensure validity and reliability. Therefore, the data was examined by two coders other than the researchers and the rate of agreement was calculated as 95%. Also, illustrative quotes from participants' answers were given in order to support the explanations and interpretations presented in the findings section.

Findings

1. What is the Conceptual Understanding of Pre-service Science and Chemistry Teachers about General Chemistry Laboratory Experiments?

In the first question, the pre-service teachers were asked to describe physical changes and chemical changes in a detailed way. The answers to the question are given in Table 2.

Table 2

Answers to the Concepts of Physical and Chemical Change

Major	Physical Change						Chemical Change					
	C	%	I	%	P	%	C	%	I	%	PC	%
Science Education	10	56%	1	6%	7	39%	11	61%	-	-	7	39%
Chemistry Education	7	39%	-	-	8	44%	8	44%	-	-	7	39%

Both pre-service science and chemistry teachers gave answers that was either correct or partially correct about physical and chemical changes (Table 2). In addition, three of the pre-service chemistry teachers did not give any answer to the question. In their explanations about physical change, 56% of the pre-service science teachers answered the question correctly, while 39% answered partially correctly. On the other hand, 39% of the pre-service chemistry teachers answered the question correctly and 44% of them gave partially correct answers. In the explanations about chemical change, 61% of the pre-service science teachers answered the question correctly, and 39% of them answered partially correctly. Meanwhile, 44% of the pre-service chemistry teachers made the definition correctly, while 39% of them made a partially correct explanation.

In another question asked in order to determine the conceptual understanding, the pre-service teachers were expected to define heat and temperature. The results are given in Table 3.

Table 3

Answers to the Concepts of Heat and Temperature

Department	Heat	Temperature

	C	%	I	%	PC	%	C	%	I	%	PC	%
Science Education	5	28%	6	33%	7	39%	3	17%	7	39%	8	44%
Chemistry Education	-	-	5	28%	11	61%	3	17%	3	17%	9	50%

28% of pre-service science teachers defined the concept of heat correctly, 39% of them gave partially correct answers, and 33% of them gave incorrect answers (Table 3). While pre-service chemistry teachers could not make a correct definition of the concept of heat, 61% of them gave partially correct answers and 28% of them answered the question incorrectly. In addition, two of the pre-service chemistry teachers did not give a definition about heat. In the explanations about the concept of temperature, 17% of pre-service teachers answered the question correctly in total. Also, nearly half of the pre-service teachers answered the question partially correctly (44%/50%). In addition, incorrect explanations about the concept of temperature were higher in pre-service science teachers (39%), while this ratio was quite low in pre-service chemistry teachers (17%). Also, three of the pre-service chemistry teachers did not define temperature.

In another question, pre-service teachers were asked to define the concept of energy. The answers given to the question are given in Table 4.

Table 4

Answers to the Concept of Energy

Department	C	%	I	%	PC	%
Science Education	12	67%	5	28%	1	6%
Chemistry Education	8	44%	3	17%	3	17%

While the majority of pre-service science teachers (67%) defined energy correctly, less than half (44%) of the pre-service chemistry teachers answered the question correctly (Table 4). The incorrect answers to this concept were low (28% - 17%) in terms of both pre-service science and chemistry teachers. However, four of the pre-service chemistry teachers did not give an answer for the energy definition.

2. How do pre-service science and chemistry teachers relate experiments in chemistry laboratory with daily life?

In the second research question, it was aimed to determine whether pre-service teachers were able to relate conceptual knowledge with daily life issues. For this purpose, different examples (haircut, hair coloring, dough leavening, frying meatballs, grating carrots, dissolving salt in water, and melting of wax) were presented to the pre-service teachers in a written text describing events from daily lives. After reading the text, the pre-service teachers were asked to determine whether physical or chemical change did occur in those examples. The answers given to the question are presented in Table 5.

Table 5

Answers to the Examples of Physical and Chemical Changes from Daily Life

Example	Department	C	%	I	%
Haircut	Science Education	18	100%	-	-
	Chemistry Education	18	100%	-	-

Hair Coloring	Science Education	13	72%	5	28%
	Chemistry Education	13	72%	5	28%
Dough Leavening	Science Education	18	100%	-	-
	Chemistry Education	18	100%	-	-
Frying Meatballs	Science Education	16	89%	2	11%
	Chemistry Education	16	89%	2	11%
Grating Carrots	Science Education	18	100%	-	-
	Chemistry Education	18	100%	-	-
Dissolution of Salt in Water	Science Education	11	61%	7	39%
	Chemistry Education	12	67%	6	33%
Melting of Wax	Science Education	13	72%	5	28%
	Chemistry Education	11	61%	7	39%

All of the pre-service teachers gave correct answers about what kind of change occurs during haircut, dough leavening, and carrot grating (Table 5). In addition, the majority of the pre-service teachers in both departments gave correct answers to different examples such as hair coloring, frying meatballs, dissolution of salt in water and melting of wax, while some of the pre-service teachers in both departments gave incorrect answers.

Also, the participants examined two statements about the concepts of heat and temperature. These two statements were again derived from the possible daily life experiences of the participants. They were asked to evaluate each statement as true or false, and the reasons why.

The first statement is "The temperature of a burning matchstick is higher than the temperature of seawater", which is a correct statement. Whereas, the second one is "The heat of a burning matchstick is higher than the heat of seawater" and it is an incorrect statement. The answers of the pre-service teachers regarding these statements are given in Table 6. The incorrect statement is given in italic type.

Table 6

Answers to the statements about burning matchstick

Statement	**Department**	**C**	**%**	**I**	**%**	**PC**	**%**
The temperature of a burning matchstick is higher than the temperature of sea water	Science Education	3	17%	4	22%	11	61%
	Chemistry Education	6	33%	2	11%	10	56%
The heat of a burning matchstick is higher than the heat of sea water	Science Education	5	28%	9	50%	4	22%
	Chemistry Education	7	39%	5	28%	6	33%

The pre-service teachers in both departments were able to partially relate the concept of temperature with a daily life example (61% - 56% - Table 6). In addition, 33% of the pre-service chemistry teachers make correct relations and 11% of them incorrect relations. Only 17% of the pre-service science teachers related the question correctly, while 22% made incorrect relations.

In their explanations about the concept of heat, the majority of pre-service science teachers made incorrect (50%) relations whereas 28% of them made a correct relation. In addition, 22% of them were able to establish a partially correct relationship. When the results were examined for pre-service chemistry teachers, the majority (39%) related the question regarding the concept of heat correctly, 28% made incorrect relation, and 33% could establish a partially correct relationship.

In order to determine how pre-service teachers relate the concept of heat and temperature with daily life, another question was asked: "Why does the weather get warm when it snows?" The answers to the question are given in Table 7.

Table 7

Answers to the question "Why does the weather get warm when it snows?"

Department	C	%	I	%	PC	%
Science Education	11	61%	5	28%	2	11%
Chemisty Education	9	50%	6	33%	3	17%

The majority of pre-service science teachers (61%) and half (50%) of pre-service chemistry teachers gave scientifically correct answers to the question; "Why does the weather get warm when it snows?" (Table 7). However, the frequency of incorrect answers was higher than the partially correct ones.

Finally, it was investigated how the pre-service teachers used these concepts including heat, temperature and energy in their lives. When the answers were examined, the pre-service teachers were generally able to exemplify the concept of heat and temperature, and they have difficulties in exemplifying the concept of energy. The answers of the pre-service teachers regarding the daily use of heat-temperature concepts are exemplified in the quotes given below (SE: Science Education; CE: Chemistry Education).

> *The heat is high today (SE19)*
>
> *80 Joule of heat is needed to melt ice... The air temperature is 20^0 C (SE8)*
>
> *When a substance is heated, it absorbs heat. (The heat it absorbs is 100 cal. Its' temperature is 100^0C) (CE5)*

The answers of the pre-service teachers regarding the daily use of energy concept are exemplified in the quotations given below.

> *When we put water in the beaker and put it on the stove, the energy goes to the water and the beaker (SE16)*
>
> *Light energy converted into heat energy (SE1)*
>
> *The energy of a substance that absorbs heat increases. Water gives heat to ice (CE12)*

3. What are the views of pre-service science and chemistry teachers on the relationship between general chemistry laboratory experiments and daily life?

In this section, the pre-service teachers' views on relating experiments with daily life issues are presented. The answers to the questions of "Can you relate chemistry laboratory experiments with daily life events and issues? How do you explain the relationship between experiments in the laboratory and your daily life experiences?" are given in Table 8 and the reflecting quotes from the participants are also presented.

Table 8

The answers to the question: "Can you relate chemistry laboratory experiments with daily life events and issues?"

Department	Yes	%	No	%	Partially relate	%
Science Education	15	83%	1	6%	1	6%
Chemistry Education	10	56%	3	17%	2	11%

Most of the pre-service science teachers (83%) and more than half of the pre-service chemistry teachers (56%) stated that they could relate chemistry experiments with daily life issues (Table 8). Three of the pre-service chemistry teachers did not express any opinion on this question. Also, a small number of the pre-service teachers stated that they could not relate the experiments. The examples given by the pre-service teachers are exemplified in the quotes below.

**In fact, we have not done any experiments that I can make associations yet.* (SE5)

**I guess we haven't done any experiments that I can associate with daily life yet. We did experiments mostly with chemical materials, that is, with materials that we do not use much in our normal life (CE12)*

Another question posed to pre-service teachers was "Can you relate chemistry laboratory practices with theoretical knowledge that you learn in class? How?" The answers to the question are given in Table 9 and the quotes that follow.

Table 9

The answers to the question: "Can you relate chemistry laboratory practices with theoretical knowledge that you learn in class?"

Department	Yes	%	No	%	Partially Relate	%
Science Education	15	83%	-	-	3	17%
Chemistry Education	15	83%	-	-	1	6%

The majority of the pre-service science and chemistry teachers (83%) stated that they could relate the experiments with theoretical knowledge (Table 9). Two of the pre-service chemistry teachers did not express any opinion regarding this question. None of the pre-service teachers expressed that they could not relate chemistry laboratory practices with theoretical knowledge. Meanwhile, some of the pre-service teachers (17% and 6%) stated they could partially relate laboratory with theoretical knowledge. Some of the answers given by the pre-service teachers are quoted below.

**Yes, definitely I can relate. We observe theoretical knowledge practically in laboratory experiments. (SE1)*

**Partially. After all, experiments on orbitals or electron configurations are not done in the course. (CE10)*

In a different question, pre-service teachers were asked "Do you think chemistry and daily life are related? Give an example." Their answers to this question are given in Table 10.

Table 10

The answers to the question: "Do you think chemistry and daily life related?"

Department	Yes	%	No	%	Partially Relate	%
Science Education	15	83%	-	-	3	17%
Chemistry Education	15	83%	-	-	3	17%

The majority of pre-service teachers (83%) in both departments stated that chemistry and daily life are related to each other (Table 10). While their examples given for the question varied, there are some common answers. The pre-service teachers generally related chemistry with daily topics such as cooking, cleaning, and rusting of iron in common. Some of their examples are presented in the following quotes:

** We definitely prepare our meals thanks to chemical reactions. Acidic substances and cleaning materials etc. are always chemically intertwined. (SE18)*

**Of course, it is related. Gases coming out of car exhausts, coins, the phones we use are examples that I could think of. (CE14)*

Conclusion and Discussion

In the study, the results showed that both pre-service science and chemistry teachers were able to explain physical/chemical change correctly and their conceptual understanding of the related concepts is adequate. In addition, the results showed that the number pre-service science teachers who can explain physical/chemical changes more accurately is higher than the number of pre-service chemistry teachers. However, when pre-service were expected to evaluate the examples about physical/chemical changes; they were not adequate in some of them. As a matter of fact, there are many studies in the literature in which the misconceptions of the participants regarding the concepts of physical/chemical change are identified (Ayvacı & Şenel Çoruhlu, 2009; Canpolat & Ayyıldız, 2019; Demircioğlu et al., 2006). Therefore, it is possible to presume that these misconceptions are common among participants from different levels.

Pre-service teachers in both departments were able to correctly establish the conceptual relationship regarding the examples of haircut, dough leavening, and grating carrots; on the other hand, they could not establish the conceptual relationship regarding different examples such as hair coloring, frying meatballs, dissolution of salt in water and melting of wax. This may be related to the fact that the pre-service teachers have not previously experienced this kind of examples. Similar results were also obtained in the study conducted by Demircioğlu et al. (2006), and this was associated with the fact that teachers did not explain the physical /chemical change at the sub-microscopic level. In our study, some of the misconceptions (such as dissolution of salt in water example) might have stemmed from such a reason.

The results showed that less than half of the pre-service science teachers answered the concept of heat correctly, while there were no pre-service chemistry teachers who answered correctly. Less than half of both pre-service science and chemistry teachers could establish a correct relationship in the explanations made about the concept of heat in the proposition of "comparing the temperature of a burning matchstick and sea water". This result showed that pre-service teachers have difficulties in explaining and making sense of an abstract concept such as "heat" theoretically, but they could establish its relevance in daily life. This may be related to the fact that pre-service teachers encountered a similar situation in their daily life and experienced it. In this regard, as stated by Ültay and Can (2015), students start to learn about the concepts of heat and temperature in informal learning environments during pre-school years. That kind of learning is beneficial for younger ones;

however, it could cause stereotypes and misconceptions regarding scientific concepts when those are presented in an unscientific way.

In their explanations regarding the concept of temperature, very few of the pre-service science and chemistry teachers answered the question correctly, and nearly half of them answered partially correctly. In the proposition of "comparing the temperature of a burning matchstick with the sea water", which aimed to determine relating with daily life, the majority of pre-service science and chemistry teachers could make a partially correct relation with the concept of temperature. In that sense, pre-service teachers could make sense of and understand the concept of "temperature", which they use and concretize more frequently in daily life, in comparison to a more abstract concept such as "heat".

The results showed that although the pre-service teachers could relate the scientific concept with examples from daily life, their explanations in the conceptual dimension were insufficient. The related literature demonstrates that the concepts of heat and temperature are frequently included in daily life and these concepts are familiar; however, there are different misconceptions regarding these concepts (Çelikler & Kara, 2016; Demirci & Şahin, 2014; Kaptan & Korkmaz, 2001). Similarly, in this study, pre-service teachers were insufficient in explaining the concept of heat and temperature, but they were able to relate the concepts with daily life examples. According to Türkoğuz and Yankayış (2015), the concepts of heat and temperature are related to their use in our environment, and the meanings attributed to these concepts can be affected by culture and language.

The results related to the concept of energy showed that the majority of pre-service science teachers and nearly half of the pre-service chemistry teachers answered the question correctly. In order to determine the relating the concept of energy with daily life, pre-service teachers were asked to give example to the concepts of heat-temperature and energy in a daily use. In the examples they gave, the concept of energy included different titles such as energy types and energy conversion. Similarly, Yürümezoğlu et al. (2009) stated that the concept of energy is used in different disciplines, and therefore, it can be structured with incomplete or alternative concepts while it is learned.

The pre-service teachers in both departments stated that they could relate the experiments carried out in the laboratory with daily life. In addition, pre-service teachers thought that chemistry and daily life were related to each other. In order to explain this relationship, pre-service teachers gave different examples such as the materials used for cooking and cleaning, and the gases coming out of the exhausts. Despite pre-service teachers had problems in defining chemistry concepts scientifically, they could relate with daily life. Some of the pre-service teachers stated that they were able to establish this relationship while some stated that they could not.

The pre-service teachers could not adequately make the conceptual explanations; however, they were able to establish the connection with daily life. This situation may be related to the information and experiences obtained from the environment. Concepts that are not fully grounded in students' minds would not be understood scientifically, and accordingly, a full learning process will not take place. This situation could cause possible misconceptions. As a matter of fact, previous experiences are one of the main reasons for misconceptions (Coştu et al., 2007).

Implications for Future Study

In line with the results of this study; establishing a relationship with daily life and giving more examples from daily life in theoretical and laboratory courses, including courses that will make connections with daily life in teacher education programs, determining and comparing the views of different groups such as students, teachers and teacher candidates are suggested for science education programs.

Numerical problems or conceptual questions that are not related to daily life are usually used in the assessment phase in science classes (e.g. Calculate the molecular weight of glucose). However, it is possible to establish the context of daily life even in numerical problems. For example, in a question that is related to stoichiometric calculations, science teachers might prefer to design the questions in the context of chemistry without any reference to daily life. However, the same type of a question can

be asked in the context of daily life, such as the amount of glucose in the blood by making a connection with an important health issue; diabetes (e.g. Increasing glucose levels in blood might cause some serious health problems including diabetes. A blood sugar level less than 7.8 mmol/L is normal. Calculate the amount of glucose levels in mg/L for healthy individuals.) In this way, students will be able to realize that problem solving in chemistry also has an important relationship with daily life.

References

Ayvacı, H. Ş., & Şenel Çoruhlu, T. (2009). Effects of explanatory stories on elimination of students' misconceptions about physical and chemical change. *Ondokuz Mayıs University Journal of Education Faculty, 28*(1), 93-104.

Balkan Kıyıcı, F., & Aydoğdu, M. (2011). Determination of pre-service science teachers' levels of relating the scientific knowledge to their daily lives. *Necatibey Faculty of Education, Electronic Journal of Science and Mathematics Education, 5*(1), 43-61. https://dergipark.org.tr/tr/download/article-file/39812

Cajas, F. (1999). Public understanding of science: Using technology to enhance school science in everyday life. *International Journal of Science Education*, *21*(7), 765-773. https://doi.org/10.1080/095006999290426

Campbell, B., & Lubben, F. (2000). Learning science through contexts: Helping pupils make sense of everyday situations. *International Journal of Science Education, 22*(3), 239-252. https://doi.org/10.1080/095006900289859.

Canpolat, E., & Ayyıldız, K. (2019). Level of 8th grade students' ability to relating science course with daily life. *Anadolu University Journal of Education Faculty, 3*(1), 21-39. https://dergipark.org.tr/en/pub/aujef/issue/44113/459926

Coştu, B., Ayas, A., Çalık, M., Ünal, S. & Karataş, F. (2005). Determining preservice science teachers' competences in preparing solutions and in use of laboratory tools. *Hacettepe University Journal of Education, 28*, 65-72. http://193.140.229.233/yonetim/icerik/makaleler/765-published.pdf

Coştu, B., Ayas. A., & Ünal, S. (2007). Misconceptions about boiling and their possible reasons. *Kastamonu Education Journal, 15*(1), 123-136. https://dergipark.org.tr/tr/pub/kefdergi/issue/49108/626702

Çelikler, D., & Kara, F. (2016). Determining the readiness level of 5th grade students' on relating their knowledge about "change of matter" unit to daily life experiences. *Jornal of Institute of Social Sciences, (17),* 21-39. https://doi.org/10.9775/kausbed.2016.002

DeBoer, G. E. (2000). Scientific literacy: Another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching, 37*(6), 582-601. https://doi.org/10.1002/1098-2736(200008)37:6<582::AID-TEA5>3.0.CO;2-L

Demirci, C., & Şahin, E. (2014). Students' misconceptions about heat and temperature as perceived by their teachers. *Journal of Education and Humanities:Theory and Practice, 5(9)*, 67-76. https://dergipark.org.tr/en/pub/eibd/issue/22668/242073

Demircioğlu, G., Özmen, H., & Demircioğlu, H. (2006). Primary student teachers' understanding levels and misconceptions about physical and chemical change. *The Journal of National Education*, *170*(35), 260-273.

Gilbert, J. K. (2006). On the nature of "context" in chemical education. *International Journal of Science Education*, *28*(9), 957-976. https://doi.org/10.1080/09500690600702470

Gilbert, J. K., & Treagust, D. (2009). Macro, submicro and symbolic representations and the relationship between them: Key models in chemical education. In E. Gilbert, J. K. Gilbert, & D. Treagust (Eds.), *Multiple representations in chemical education* (pp. 1– 8). Springer. https://doi.org/10.1007/978-1-4020-8872-8_1

Haidar, A. H., & Abraham, M. R. (1991). A comparison of applied and theoretical knowledge of concepts based on the particulate nature of matter. *Journal of Research in Science Teaching, 28*(10), 919-938. https://doi.org/10.1002/tea.3660281004

Johnstone, A. H. (1991). Why is science difficult to learn? Things are seldom what they seem. *Journal of Computer Assisted Learning,* 7(2), 75-83. https://doi.org/10.1111/j.1365-2729.1991.tb00230.x

Kaptan, F., & Korkmaz, H. (2001). Primary school preservice teachers' misconceptions about heat and temperature in science teaching. *Hacettepe University Journal of Education, 21*, 59-65. http://www.efdergi.hacettepe.edu.tr/yonetim/icerik/makaleler/1030-published.pdf

Kenar, I., Sekerci, A. R., Erdem, A. R., Geçgel, G., & Demir, H. I. (2015). An investigation of ninth grade students' attitudes toward daily life chemistry. *Educational Research and Reviews, 10*(12), 1695-1701. https://doi.org/10.5897/ERR2015.2255

Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education*. San Francisco, CA: Jossey-Bass.

Mete, P. & Yıldırım, A. (2016). Views of teaching staff about application in chemistry classes of context-based learning method. *Journal of Bayburt Education Faculty*, 11 (1), 100-116. https://dergipark.org.tr/en/pub/befdergi/issue/23129/247047

Nakiboğlu, C., & Meriç, G. (2000). Genel kimya laboratuvarlarında V-diyagramı kullanımı ve uygulamaları. *Journal of Balıkesir University Institute of Science and Technology*, *2*(1), 58-75.

Niebert, K., Marsch, S., & Treagust, D. F. (2012). Understanding needs embodiment: A theory-guided reanalysis of the role of metaphors and analogies in understanding science. *Science Education*, *96*(5), 849-877. https://doi.org/10.1002/sce.21026

Ormanci, U., & Cepni, S. (2018). The thematic review of relating with daily life studies in science education. *Necatibey Faculty of Education Electronic Journal of Science & Mathematics Education*, *12*(2), 350-381. https://dergipark.org.tr/tr/download/article-file/616191

Ormancı, Ü., Çepni, S. & Ülger, B. B. (2020). Determining secondary school students' understanding and relationship with daily life on cell subject. *Journal of Science Mathematics Entrepreneurship and Technology Education, 3* (2), 125-143. https://dergipark.org.tr/en/pub/fmgted/issue/56406/739593

Pabuçcu, A. (2016). Preservice science teachers' levels of associating the concept of gas pressure with everyday life. *Journal of the Turkish Chemical Society, Section C: Chemical Education, 1*(2),1-24. https://dergipark.org.tr/tr/pub/jotcsc/issue/32793/364441

Türkoğuz, S., & Yankayış, K. (2015). Teacher' views related to the effects of misconceptions about heat and temperature on daily life. *Journal of Bayburt Education Faculty, 10*(2), 498-515. https://dergipark.org.tr/tr/pub/befdergi/issue/17275/180480

Uluçınar Sağır, Ş. (2020). Determining the levels of university students' chemistry knowledge associating with the daily life. *The Online Journal of New Horizons in Education*, *10*(3), 137. https://www.tojned.net/journals/tojned/articles/v10i03/v10i03-02.pdf

Ültay, E., &, Can, M. (2015). Determination of preschool student teachers' conceptual knowledge about heat and temperature. *The Black Sea Journal of Social Sciences, 7*, 179-203. https://dergipark.org.tr/tr/pub/ksbd/issue/16219/169876

Yadigaroğlu, M., Demircioğlu, G., & Demircioğlu, H. (2017). The level of pre-science student teachers of relating their chemistry knowledge in daily life. *Ege Journal of Education, 18* (2), 795-812. https://doi.org/10.12984/egeefd.310426

Yin, R.K. (2008) *Case Study Research Design and Methods*. 4th Edition, Sage Publications, Thousand Oaks.

Yürümezoğlu, K., Ayaz, S. & Çökelez, A. (2009). Grade 7-9 students' perceptions of energy and related concepts. *Necatibey Faculty of Education, Electronic Journal of Science and Mathematics Education, 3*(2), 52-73. https://dergipark.org.tr/tr/pub/balikesirnef/issue/3369/46505