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Examining of Preservice Science Teachers' Conceptions of Learning Science: A Q Method Study

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Abstract

The purpose of this study is to examine the pre-service science teachers' views about learning science. Learning science means to use specialized conceptual language in reading and writing, reasoning and problem solving, daily life, and leading practical actions in the laboratory. This study was designed using Q-method. Ten pre-service science teachers voluntarily participated in this study. Data were collected by using 'The Conceptions of Learning Science' (COLS) questionnaire. The significance of the factors was demonstrated by using the 'Graphical Rotation' and 'Varimax Rotation' analysis in the PQmethod software. According to the results of Q analysis, participants thought that learning science is not related to science achievement or getting high scores from exams, but they stated that learning science means explaining nature and the topics related the nature. They also believed that science should be learned not by memorizing, that should be learned by experimenting, and by integrating it into daily life. It has not been found any relationship between participants' views of learning science and their understanding of nature of science. It is recommended that empirical studies might be conducted in future studies to improve the understanding of pre-service and in-service teachers about learning science.

Introduction

Learning science means learning to use specialized conceptual language in reading and writing, reasoning and problem solving, daily life, and leading practical actions in the laboratory. This might be expressed in the sense of learning to communicate in the language of science and to act as a member of the community of people who do this (Lemke, 1990). According to Lee et al. (2008), learning science means memorizing definitions, laws, formulas and special terms; being successful in science tests or getting high scores in exams; applying a number of calculations or tutorial problems; increasing knowledge through learning and scientific knowledge; understanding how to use knowledge and skills; acquiring scientific knowledge to gain a new perspective for the creation of integrated and theoretically consistent information structures in science. On the other hand, international reform documents have stated that learning science is more than accumulation of knowledge and it includes the development of skills and attitudes (AAAS, 1990, 1993; MoNE, 2018; National Research Center, 2012; NGSS Lead States, 2013).

The studies have also revealed the relationship between learning science and nature of science (NOS), which is accepted as an important component of science literacy, and it is thought that science teachers might have difficult to teach scientific concepts to students without having informed knowledge of NOS (Murcia & Schibeci, 1999). Morgil et al. (2009) stated that when science teachers have a clear understanding of NOS, their decisions in their teaching will be in a way to further support scientific literacy. It is also noteworthy that teachers acquire the above knowledge about NOS during their undergraduate years. Having an informed understanding of scientific knowledge for pre-service teachers is important in raising individuals who are scientifically literate. Considering that epistemological beliefs, learning approaches, and learning concepts are important factors in the formation of science concepts teaching (Şahin et al., 2016). As a result, developing positive attitudes towards science, scientists, and learning science is gradually more of a concern (Osborne et al., 2003). Therefore, teachers are the only people who can eliminate this concern.

Teachers' opinions about learning science have been frequently examined in the literature. The first studies on the concept of learning were done by Saljo (1979) (Marshall et al., 1999). When Saljo asked the study group what it means of learning, he identified 5 qualitatively different, hierarchically related learning concepts from the analysis of the data. These include (1) increasing knowledge, (2) memorizing, (3) obtaining facts or procedures that can be kept or used in practice, (4) abstraction of meaning, (5) understanding of reality.

Tsai (2009) investigated the 83 Taiwanese undergraduate students' conceptions about Web-based learning. Using the phenomenographic method to analyze students' interview transcripts, various categories about the concept of learning and web-based learning have been revealed. Analysis of interview results showed that web-based learning concepts are more complex than learning. For example, it has been found that many students conceptualize learning in a web-based context as a quest to see in a new way than real understanding and learning in general.

In Turkey, although there are not enough studies in which focus on in-service or pre-service teachers' conceptions about learning science, there are some studies partially focus on this issue. Sadi and Lee (2018), comparing Taiwan and Turkish high school students' biology learning concepts, found that there was a significant difference between students' mean scores in four learning concepts such as memorization, calculation and practice, increasing their knowledge and seeing them in a new way. Duarte (2007), in his study, tried to determine the Portuguese university students' conceptions of learning and learning approaches. Pre-service teachers responded open ended questions about the meaning, process, and context of learning. The results from content analysis repeated most of the learning concepts defined by phenomenographic research (e.g., the distinction between learning as memorization and learning as understanding). Moreover, new variants of known learning conceptions have emerged (e.g., learning; exploratory practice; learning to learn; motivation) and a seemingly new understanding (e.g., learning as understanding and practice).

Şahin et al. (2016), who investigated the extent to which Turkish pre-service teachers' orientations towards science teaching can be explained with their epistemological beliefs, learning concepts and approaches to science learning, determined that developing student-centered/orientation towards science teaching was mostly explained by constructivist learning approaches in science.

This study is theoretically based on six conceptions of learning science, which were identified in recent studies (Bahcivan & Kapucu, 2014; Tsai, 2004). These six conceptions are learning science means as memorizing, as preparing for tests, as calculating and practicing tutorial problems, as increasing of knowledge, as applying, and as understanding and seeing in a new way (Tsai, 2004). Teachers' conceptions about learning science are examined in these frameworks.

Purpose of the Study and Research Questions

There are few studies that reveal the pre-service teachers' conceptions related to learning science in Turkey. While some researchers focus on the attitudes of teachers (e.g., Akbaş, 2010; Nuhoğlu, 2008), some focus only on their beliefs (e.g., Erdem, 2008; Özkan & Tekkaya, 2011). This study might also have a potential value in terms of its unique research method for examining pre-service teachers' conceptions about learning science. The aim of this study is to examine the pre-service science teachers' views about learning science which focuses on the different perspectives of the participants and the underlying causes of these conceptions. Therefore, this study makes it possible to obtain more in-depth findings regarding the pre-service teachers' views about learning science based on their own expressions. The following research question guides the study:

> What are the pre-service science teachers' conceptions about learning science?

Method

This study was designed using Q-method (Stephenson, 1955), which is known as a mixed method. In studies conducted using the Q-method, the data are collected and analyzed quantitatively, but the results are mostly interpreted qualitatively (Ramlo & Newman, 2011). The Q method is defined as the measurement of subjectivity by William Stephenson (Stephenson, 1955). The Q-method allows participants express their feelings, thoughts, and beliefs about a topic, usually by sorting the statements. Selected expressions are called Q samples. Despite its mathematical structure, the purpose of the Q-method is to reveal its subjective structures, attitudes, and perspectives from the viewpoint of the person or people have been observed (Brown, 1996).

Participants

Ten pre-service science teachers (6 females; 4 males with an average age of 20) voluntarily participated in this study at a traditional four-year education faculty in a Turkish state university on their third year. Participants have a similar educational background and have taken general physics, chemistry and biology courses. Besides, they are currently taking education psychology and science method courses. In a Q study, the aim was to define typical representations of different perspectives and to demonstrate how different perspectives are represented, rather than finding the proportion of individuals with specific perspectives (Akhtar-Danesh et al., 2008; Simons, 2013). Although it is generally recommended to be between 12-20 participants in Q studies (Cairns, 2012; Webler et al., 2009), the use of fewer participants does not pose a major disadvantage. (McKeown & Thomas, 1988; Valenta & Wigger, 1997).

Data Collection Source

Data were collected by using "The Conceptions of Learning Science" (COLS) questionnaire (Lee et al., 2008). The questionnaire has been mostly used a five-point Likert scale from strongly disagree to strongly agree. The questionnaire consists of thirty-one items and six factors. The factors were named based on the Tsai's (2004) study, and these are (a) memorizing, (b) preparing for tests, (c) calculating and practicing tutorial problems, (d) increasing of knowledge, (e) applying, and (f) understanding and seeing in a new way (Tsai, 2004). The reliability (Cronbach’s alpha) coefficients of COLS questionnaire for those factors were respectively found 0.85, 0.91, 0.89, 0.90, 0.84 and 0.91 in exploratory factor analysis (Lee et al., 2008). Adaptation of COLS questionnaire to Turkish language was done by Bahçivan and Kapucu (2014), and the reliability (Cronbach’s alpha) coefficients of these factors were found very similar to recent findings.

Data Collection Procedure

In this study, each pre-service science teacher was asked to sort the Q samples (31 learning science statements in the COLS questionnaire (Lee et al., 2008), as shown in the Figure 1, from the statement they mostly agreed (+4) to the statement they least agreed (-4).

-4	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**
25	29	21	17	26	4	22	2	6
	28	19	10	13	3	30	20	
		16	8	14	11	23		
		27	9	7	12	18		
			31	15	5			
				1				
				24				

Figure 1. Example of classification scheme for a Q method with 31 statements

The Q set consisting of 31 statements in the COLS questionnaire was given to pre-service science teachers as randomly numbered cards. Firstly, the pre-service teachers divided the random cards into three groups as "I agree", "I disagree" and "I am neutral", and then they ranked the statements in each group from the least agreed to most agreed. As a result of these sequences, a distribution like Figure 1 was obtained. During the ranking process, the participants were reminded that they were free to change their rankings at every stage of the process. In this way, pre-service teachers made changes in their rankings with their reasons of explanations. While the pre-service teachers sorted the statements, the participants were asked to explain the statement they put in each range and tried to reveal the underlying reason(s) of this sort by asking why the statement was included in that order. All the interviews were audio recorded for further analysis.

Data Analysis

Q sort data for all participants were entered into PQMethod (version 2.35) (Schmolck, 2014), a program specifically designed for Q analysis. All data were sent to factor analysis. Principle component analysis (PCA) was performed for the sorts in this study, but there was no statistically significant aggregation. The factors were obtained by using the centroid factor analysis (CFA) method, which is a factor extraction method frequently used in Q method studies (Akhtar-Danesh, 2017; Brown, 1980; Schmolck, 2008; Stephenson, 1955). The significance of the factors was demonstrated by using the 'Graphical Rotation' and 'Varimax Rotation' analysis. As a result of the analyzes, a series of tables were created for each factor. Among these tables, there is a representative Q sort for each factor. In these tables, the extent to which the pre-service teachers in the relevant factor, Q ranking values (columns indicated by Q) refer to the corresponding item within the range of -4 (strongly disagree) and +4 (strongly agree); Z-score values (columns indicated by Z) refer to standardized score of the respective Q values.

In addition, the proportion of representing consensus and disagreement statements between factors was reported in the outputs of Q analysis (values expressed in the variance of explanation (%) in Table 1 and Table 2 (Brown, 1980; McKeown & Thomas, 1988). Each factor obtained in the Q method represents a specific perspective within the group. Although each Q sort is subjective, the factors identified in Q are based on concrete behavior and are typically reliable and reproducible (Brown, 1980). The interview transcriptions were analyzed in Hype-research qualitative program as a content analysis for supporting to results obtained from the Q analysis. The validity and reliability of a Q method study, as a mixed method, is considered different from quantitative research methods. There is no external criterion for evaluating the individual's perspective (Friedman & Wyatt, 1997). The rankings made by each individual are accepted as a valid expression of their views (Brown, 1996).

Results and Discussion

According to the results of Q analysis, a single factor called comprehensive factor was created by Graphical Rotation, the factors determined as a result of the centroid factor analysis within 10 pre-service science teachers, 31 items (sample Q) and 9 intervals (between -4, +4). As shown in Table 1, 9 out of 10 participants (excluding a pre-service teacher coded Selim) were included in this factor in a meaningful way. It was seen that the comprehensive factor explained the 63% of pre-service science teachers' common learning science views (Table 1).

Table 1. Factor matrix with an X indicating a defining sort for graphical rotation

Participants	Comprehensive Factor
Emir	0.7200 **X**
Merve	0.8472 **X**
Lale	0.7692 **X**
Beril	0.8493 **X**
Murat	0.8921 **X**
Gamze	0.8747 **X**
Seda	0.8346 **X**
Zafer	0.7096 **X**
Melis	0.7611 **X**
Selim	0.6740
% expl.Var.	63

Mean: .00; St. Dev: 1.915

Table 2. Factor matrix with an X indicating a defining sort for varimax rotation

	Factors			
Participants	1	2	3	4
Emir	0.8466 **X**	-0.0115	0.3338	0.2184
Merve	0.6634 **X**	0.5009	0.0291	0.3915
Lale	0.2945	0.3008	0.0301	0.8300 **X**
Beril	0.5468 **X**	0.3070	0.4376	0.4109
Murat	0.6954 **X**	0.5072	0.1363	0.3589
Gamze	0.5003	0.6952 **X**	0.3053	0.2377
Seda	0.3780	0.3846	0.3477	0.5565 **X**
Zafer	0.2423	0.2562	0.8795 **X**	0.2061
Melis	0.2268	0.1227	0.4109	0.7824 **X**
Selim	0.0612	0.8956 **X**	0.1999	0.2186
% expl.Var.	25	22	19	23

Mean: .00; St. Dev: 1.915

When the factors obtained as a result of centroid factor analysis are rotated in the Varimax rotation, a model has been created in which the participants are distributed among 4 factors. The four factors that emerged at the end of the Varimax rotation reflect the science learning beliefs expressions in which pre-service teachers have accumulated in a statistically significant way. These factors explain 25%, 22%, 15%, and 23% of the common science learning belief views of all pre-service teachers, respectively (Table 2). As a result of this rotation, 4 pre-service teachers were loaded in factor 1; 2 pre-service teachers were loaded in factor 2; 1 pre-service teachers were loaded in factor 3; and 3 pre-service teachers were loaded in factor 4 (Table 2).

Graphical Rotation: Comprehensive Factor

According to graphical rotation, nine pre-service science teachers who were statistically loaded in this factor, believed that learning science does not mean that getting high scores in the exams or being successful in the school via memorizing definitions, formulas, or laws in the textbook. They thought that learning science enables individual to understand natural phenomena or topics related to nature, and thus people can find a better way to make sense of natural life. Table 3 shows the most and least agreed to statements by all nine pre-service science teachers.

Table 3. Comprehensive factor: Three most and least agreed to statements by all participants

Item	Statement	Q Sort Value	Z-score
28	Learning science helps me view natural phenomena and topics related to nature in new ways.	+4	1.960
29	Learning science means changing my way of viewing natural phenomena and topics related to nature.	+3	1.462
30	Learning science means finding a better way to view natural phenomena or topics related to nature	+3	1.333
...	....	...	...
1	Learning science means memorizing the definitions, formulae, and laws found in a science textbook.	-3	-1.459
8	There are no benefits to learning science other than getting high scores on examinations. In fact, I can get along well without knowing many scientific facts	-3	-1.550
6	Learning science means getting high scores on examinations.	-4	-1.688

Gamze: Learning science is not related to school success or getting high scores on exams. Learning science is learning nature, natural phenomena, and developing new perspectives to the natural life.

Murat: Science is not just something that is taught or learned in schools. For centuries, people have been learning and using scientific knowledge for their needs. Many of these people didn’t even go to school. It should not be thought that science is something only for school success or getting high scores on exams. That is not learning science but memorizing it briefly and keeping it in mind.

Merve: Science means nature. It means to understand and explain nature and things related to nature. For this reason, we learn science in order to understand and explain nature with a wide perspective, and to discover new ways.

Varimax Rotation: Factor 1, 2, and 3.

Table 4. Factor 1: Three most and least agreed to statements by Emir, Merve, Beril, and Murat

Item	COLS Statements	Q Sort Value	Z-score
24	We learn science to improve the quality of our lives.	+4	1.778
20	Learning science helps me acquire more facts about nature.	+3	1.639
19	Learning science means acquiring more knowledge about natural phenomena and topics related to nature.	+3	1.355
...	....	...	...
1	Learning science means memorizing the definitions, formulae, and laws found in a science textbook.	-3	-1.164
2	Learning science means memorizing the important concepts found in a science textbook.	-3	-1.670
6	Learning science means getting high scores on examinations.	-4	-1.889

Factor 1: Utilitarian & Against Memorization

According to Varimax rotation, four pre-service science teachers (Emir, Beril, Merve, and Murat), who were statistically loaded in factor 1, believed that learning science is not something highly related to be successful in school, or memorizing scientific concepts found in a textbook. Unlike the comprehensive factor, these pre-service science teachers thought that the most important goal of learning science is improving the quality of human beings' lives, as well as attempting to understand natural phenomena and topics related to nature. Table 4 shows the most and least agreed to statements by four pre-service science teachers.

> Beril: Before anything else, a person who learns science, a science literate individual, can make own life easier and improve the quality of it. For example, someone who knows science can know how to make his house lighter with much less cost, or when we think more globally, learning science will cause its technology to develop and our quality of life will increase.

> Emir: Learning science means learning and understanding nature. Science education is not just about getting high scores from exams or memorizing formulas in books. The routine education based on memorizing that has been imposed on us for years causes the generation who are afraid of science more than learning science.

> Murat: Human beings' curiosity of learning and understanding science and nature has been on-going efforts for centuries. The biggest goal here is to have a better quality of life. Looking at scientific developments, science has had vital goals such as survival, hunting, sheltering, comfortable living, using technology for the benefit of the human being, as well as understanding nature and responding to the humorous sense of curiosity.

The statements that distinguish the pre-service teachers included in this factor from the participants loaded in the other factors are shown in Table 5. According to this, it was seen that the participants in this factor were strongly agree to the statement "We learn science to improve the quality of our lives", in which the pre-service teachers, who loaded in the other factors, were disagree or partly agree. In addition, it was seen that the pre-service science teachers in this factor, had undecided view in the statement of "Learning science involves a series of calculations and problem-solving", that the participants in the second factor did not agree, while other participants in the 3rd and 4th factors agreed on this statement.

Table 5. Distinguishing statements for Factor 1

		Factor 1		Factor 2		Factor 3		Factor 4	
Item	COLS Statements	Q-sv	Z-scr	Q-sv	Z-scr	Q-sv	Z-Scr	Q-sv	Z-scr
24	We learn science to improve the quality of our lives.	+4	1.78*	0	0.18	-2	-0.73	0	0.25
12	Learning science involves a series of calculations and problem-solving.	0	0.00	-2	-0.85	+3	1.57	+2	1.14

(p< .05; Asterisk (*) indicates significance at p< .01)
Q-Sort Value (Q-sv) and the Z-Score (Z-scr) are shown in Table

> Merve: The quality of life of someone who learns science and applies it to her life improves both philosophically and physically. At least I learn science for myself for this reason, because everything I learned about science improves my quality of life.

> Murat: While learning science sometimes involves calculations or problem solving, sometimes we do not include any calculations, for example biology, we do not encounter any calculation or problem solving. I am undecided about this.

Factor 2: Increasing and Applying Knowledge & Against Examinations

According to Varimax rotation, two pre-service science teachers (Gamze, and Selim), who were statistically loaded in factor 2, thought that learning science refers to understand scientific knowledge and to learn how to apply this knowledge in a new situation. Like in the comprehensive factor, these pre-service teachers believed that learning science does not mean to get high scores on the examinations or science- related tests. Table 6 shows the most and least agreed to statements by two pre-service science teachers.

Table 6. Factor 2: Three most and least agreed to statements by Gamze and Selim

Item	COLS Statements	Q Sort Value	Z-score
23	Learning science means learning how to apply knowledge and skills I already know to unknown problems.	+4	1.956
17	Learning science means acquiring knowledge that I did not know before.	+3	1.530
26	Learning science means understanding scientific knowledge.	+3	1.404
...	....	...	...
10	I learn science so that I can do well on science-related tests.	-3	-1.404
6	Learning science means getting high scores on examinations.	-3	-1.784
8	There are no benefits to learning science other than getting high scores on examinations. In fact, I can get along well without knowing many scientific facts.	-4	-1.956

> Selim: Science literacy does not mean getting a high score on exams. Getting high scores on exams is perhaps the most irrelevant benefit of learning science. We learn science to learn new things and to apply these new things in our daily life.

> Gamze: Learning and implementing things I never seen before is my most important goal in learning science. When I become a teacher in the future, I will try to teach my students science with this logic, not to get higher scores on the exams.

> Selim: Getting a high score on the exam does not mean that science is learned, learning science means understanding scientific knowledge and applying it in our daily life. This means already in science literacy.

The below statement that distinguishes the pre-service teachers included in this factor from the participants loaded in the other factors is shown in Table 7. According to this, the pre-service teachers, who were loaded in this factor, were strongly disagree on the statement “Learning science involves a series of calculations and problem-solving", while the other participants in the other factors, were mostly agree or undecided.

Table 7. Distinguishing statements for Factor 2

		Factor 1		Factor 2		Factor 3		Factor 4	
Item	COLS Statements	Q-sv	Z-scr	Q-sv	Z-scr	Q-sv	Z-Scr	Q-sv	Z-scr
12	Learning science involves a series of calculations and problem-solving.	0	0.00	-2	-0.85	+3	1.57	+2	1.14

($p < .05$; Asterisk (*) indicates significance at $p < .01$)
Q-Sort Value (Q-sv) and the Z-Score (Z-scr) are shown in Table

> Selim: Learning science is not just about calculations, it is based on many applications, especially in primary school level, and it is learned by using it in daily life.”

> Gamze: We learn science by criticizing, explaining and practicing, not by calculating or solving problems.

Selim, who was not statistically in the comprehensive factor, thought a little differently than other participants about learning science through memorizing.

> Selim: Scientific concepts do not need to be memorized especially in elementary school level, but as science is divided into different fields, like chemistry, biology, and physics in higher levels,

scientific concepts and definitions need to be memorized, so I have been undecided view in such statements.

Selim: I think that learning will not be without memorization, but of course I believe that everything should be practiced more than memorization for learning science.

Factor 3. Problem Solving & Against Examinations

According to Varimax rotation, a pre-service science teacher (Zafer), who was statistically loaded in factor 3, believed that learning science means acquiring knowledge and solving unknown questions. Unlike the comprehensive factor, this pre-service science teacher thought that learning science involves a series of calculations and problem-solving. As stated in comprehensive factor, this participant also believed that learning science does not mean getting high scores on exams or memorizing some conceptions in the science textbooks. Table 8 shows the most and least agreed to statements by one pre-service science teacher.

Table 8. Factor 3: Three most and least agreed to statements by Zafer

Item	COLS Statements	Q Sort Value	Z-score
17	Learning science means acquiring knowledge that I did not know before.	+4	2.089
12	Learning science involves a series of calculations and problem-solving.	+3	1.567
25	Learning science means solving or explaining unknown questions and phenomena.	+3	1.567
...	....	...	...
6	Learning science means getting high scores on examinations.	-3	-1.567
2	Learning science means memorizing the important concepts found in a science textbook.	-3	-1.567
8	There are no benefits to learning science other than getting high scores on examinations. In fact, I can get along well without knowing many scientific facts.	-4	-2.089

Zafer: I think learning science involves learning the knowledge of unknown things, and solving problems. To learn science, calculations must be made and a problem must be solved.

Zafer: I am against a memorizing education. Unfortunately, in our country, exams are accepted as the fundamental criteria of success, and the level of the exams forces students to memorize scientific concepts. That's why we just memorize it, and when we pass the exam, we suddenly forget it. That's why I am against to the memorizing-based science education. This way there is no learning. Learning happens by understanding, inquiring, and solving our daily problem.

The below statement that distinguishes the pre-service teacher included in this factor from the participants loaded in the other factors is shown in Table 9. It was seen that the pre-service teacher in this factor, was disagree on the statement of "We learn science to improve the quality of our lives", while other participants, who were loaded in other factors, were mostly agree on it.

Table 9. Distinguishing statements for Factor 3

		Factor 1		Factor 2		Factor 3		Factor 4	
Item	COLS Statements	Q-sv	Z-scr	Q-sv	Z-scr	Q-sv	Z-Scr	Q-sv	Z-scr
24	We learn science to improve the quality of our lives.	+4	1.78	0	0.18	-2	-1.04*	0	0.25

(p< .05; Asterisk (*) indicates significance at p< .01)
Q-Sort Value (Q-sv) and the Z-Score (Z-scr) are shown in Table

Zafer: I think learning science for a purpose is not necessary. Science seeks to answer what we wonder, to learn what we do not know, to access scientific knowledge. Increasing our quality of life should not be our primary aim. It might be a byproduct resulting from science.

Factor 4. Understanding Nature & Against Memorizing

According to Varimax rotation, three pre-service science teachers (Lale, Seda, and Melis), who were statistically loaded in factor 4, thought that learning science means getting more knowledge about natural phenomena and topics related to nature as well as applying this knowledge into a problem in daily life. As parallel to comprehensive factor and other three factors, the pre-service science teachers, who were loaded in factor 4, believed that learning science does not mean memorizing the definitions, formulae, or scientific conceptions. They thought that learning science refers to understanding, internalizing, and applying scientific knowledge in our daily life. Table 10 shows the most and least agreed to statements by three pre-service science teachers.

Table 10. Factor 4: Three most and least agreed to statements by Lale, Seda, and Melis

Item	COLS Statements	Q Sort Value	Z-score
28	Learning science helps me view natural phenomena and topics related to nature in new ways.	+4	1.794
19	Learning science means acquiring more knowledge about natural phenomena and topics related to nature.	+3	1.714
23	Learning science means learning how to apply knowledge and skills I already know to unknown problems.	+3	1.310
...	....	...	...
1	Learning science means memorizing the definitions, formulae, and laws found in a science textbook.	-3	-1.714
5	Learning science means memorizing scientific symbols, scientific concepts, and facts.	-3	-1.794
3	Learning science means memorizing the proper nouns found in a science textbook that can help solve the teacher's questions.	-4	-1.960

Melis: Learning science is the understanding of scientific information and its application in daily life problems.

Lale: Learning science is an effort to understand nature. If we learn science, we better understand nature and things we do not know and bring logical explanations.

Seda: Science learning is not something that related to memorizing scientific concepts, definitions and formulas. Science education brings scientific explanations to the difficulties and problems we encounter in daily life, and it makes a better understanding of nature.

The below statement that distinguishes the pre-service teachers included in this factor from the participants loaded in the other factors is shown in Table 11. According to this, even it is not statistically meaningful, it was seen that the participants in this factor were definitely not involved in the statement "Learning science means memorizing scientific symbols, scientific concepts, and facts", while other participants were also disagreed with this statement.

Table 11. Distinguishing statements for Factor 4

		Factor 1		Factor 2		Factor 3		Factor 4	
Item	COLS Statements	Q-sv	Z-scr	Q-sv	Z-scr	Q-sv	Z-Scr	Q-sv	Z-scr
5	Learning science means memorizing scientific symbols, scientific concepts, and facts.	0	-0.27	-1	-0.43	-1	-0.52	-3	-1.79

($p < .05$; Asterisk (*) indicates significance at $p < .01$)
Q-Sort Value (Q-sv) and the Z-Score (Z-scr) are shown in Table

Discussion, Conclusion, and Implications

In this study, which attempts to examine pre-service science teachers' conceptions on learning science using the Q method, it was found that pre-service teachers, in general, thought that learning science is not related to science achievement or getting high scores from exams, but they stated that learning science means explaining nature and the topics related the nature. These findings differ from the findings of Saljo (1979), and are similar to the study of Sadi and Lee (2018). By using the Q method, each participant's profile was formed based on the participants' responses towards to learning science statements. Among the factors revealed in Tsai's (2004) study, it was shown in which factors the participants were loaded most and how they sort the statements. In this context, parallel to the study of Lee et al. (2008), it was concluded that in this study, science should be learned not by memorizing, that should be learned by experimenting, and by integrating it into daily life. Although some pre-service teachers thought that memorizing was a necessary step for learning, they mostly emphasized the disadvantages of a completely memorized science education. It has been concluded that a science education based on memorization only benefits the students in a short time but not performs a meaningful learning. Thus, students are generally afraid of science lessons and do not like science. the pre-service science teachers in this study mostly pointed out the importance of helping students in early ages to love science with hands-on activities, and inquiry-based learning.

According to Q analysis, some pre-service teachers thought that science should be learned in order to benefit humanity, while some thought that science should be learned for solving out the problems in our daily life. Also, in this study, it was observed that the gender factor did not have a significant effect on pre-service teachers' conceptions of learning science. It was observed that there was no statistically significant difference in the factors involving male and female participants. When the distinguishing statements for each factor are examined, it is seen that pre-service teachers have different conceptions especially regarding the aims of learning science. As well as those who stated that the importance of the relationship between science and daily life and said that science facilitates our lives and increases our welfare level, there were also pre-service teachers who argued the importance of learning the subject content knowledge and calculations in science. This Q study differs from other quantitative studies related to learning science by revealing the reasons for the views of pre-service teachers. For this reason, it is recommended to use Q method in other samples to understand and improve the conceptions of teachers and pre-service teachers about learning science.

Despite mentioning the relationship between learning science and NOS in the literature (Morgil et al., 1999), in this study, it has not been found any relation between learning science and NOS. Exploring the pre-service science teachers' NOS views and the level of development can reveal the relationship between their understanding on learning science and the aspects of NOS. Thus, it is suggested that new studies should be carried out to understand the relationship between teachers' NOS views and their conceptions of learning science, and also to improve the pre-service teachers' understanding about learning science, just like the studies have been performed on developing learners' NOS views.

Another important feature of this study is its unique methodology. It is possible to come across applications of this method, which is not very common in science education, especially in recent years (e.g., Jason et al., 2008; Mesci & Cobern, 2020). The q method, as a mixed method, serves to reveal the subjective views of the participants based on their personal worldview, viewpoint, socio-economic, and educational background. In this way, it provides a great opportunity for researchers especially in socio-scientific subjects and educational sciences. In this q study, it was focused on pre-service science teachers' subjective worldviews, and revealed their responses to statements about learning science. For this reason, it is recommended to increase the applications of this method and to gain literature in both science education and other educational studies.

It is thought that this study might contribute to science education literature and teacher development programs since there are a few studies in Turkey that reveal the conceptions of teachers and pre-service teachers about learning science. The problems that are brought by memorization in science education where most pre-service teachers draw attention should be emphasized, and this awareness should be developed in both in-service and pre-service teachers by revising the goals of new programs such as making science lessons more enjoyable and making students love it, not only being successful in lessons, but also seeking ways to integrate science in daily life. In this context, revealing the pre-service teachers' opinions about learning science with q method is important for the construction of new science education programs.

This study is limited with the pre-service teachers participating in the study. It has been previously stated that there are no disadvantages using small sample sizes in Q studies, the size of the sample chosen in the study might be a limitation of this study. Therefore, it is recommended that similar studies should be carried out in larger and different samples. In addition, it is suggested that empirical studies might be conducted in future studies to improve the understanding of pre-service and in-service teachers about learning science, focusing on the factors underlying their views.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the authors.

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