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Determining The Cognitive Levels of Preservice Science Teacher in Daily-life Problems Prepared on The Density Subject

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Abstract

The aim of this study is to evaluate the cognitive levels of pre-service science teachers according to Bloom's Taxonomy about "density" using daily life problems. The case study design was used in the study. This study was carried out with 45 pre-service teachers. In order to identify the cognitive levels of pre-service teachers about the density subject, a cognitive level test have been used created in line with the Bloom's Taxonomy, formed with the purpose of identifying their views about daily life problems requiring higher level thinking skills. When the cognitive levels of pre-service teachers have been analysed, it has been found out that all the pre-service teachers have completed the knowledge, comprehension and application levels while 20 of them have got through analysis level. 13 of them have passed into the synthesis level which requires a higher level thinking skill while 9 of them have reached the last stage, 'evaluation'. According to the findings, in order to progress within the cognitive thinking levels while learning 'density' subject, students should overcome the mathematical deficiencies and concentrate more on daily life problems which require a higher-level thinking skill.

Keywords: Cognitive Levels, Daily-Life problems, Density, Pre-service Science Teacher.

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INTRODUCTION

In today's scientific age, one of the purpose of science classes taught in schools is giving students the ability of using their acquired knowledge in their daily life rather than trying to reach it. Besides, the role of teachers is explained in the curriculum as "developing students towards the levels of higher-level thinking, product development, making invention and innovation by guiding them to be able to integrate science, technology, engineering and mathematics" (Ministry of National Education (MoNE), 2018, p.10). Since the role of teachers in giving desirable skills to students is of much importance, it is utmost necessity to develop the pedagogical content knowledge and expertise of teachers by attaching the necessary attention to teacher training (Hashweh, 2016). Cachapuz and Paixao (2002) propose student-centered classes related to daily life, offering teaching strategies that force Pre-service teachers to higher-level thinking and encourage questions. Therefore, Pre-service teachers' skills related to high level cognitive processes need to be improved. Along with obtaining skills and abilities related to higher-level cognitive processes, students will be able to solve new problems arising from different situations and use process skills related to scientific method (Önder & Hürcan, 2012). Higher-level thinking is described as the ability of realising and controlling individual mental processes and re-organising and improving it when necessary for quality learning (Güneş, 2012). According to Bloom's Taxonomy, the levels of cognitive development has been described in six levels, sorted from simple to complex, and all six levels are as follows: knowledge, comprehension, application, analysis, synthesis, and evaluation. According to this taxonomy, knowledge, comprehension, and application levels are low-level thinking skills while the latter three, analysis, synthesis, and evaluation, are higher-level thinking skills (Şahinel, 2002). Therefore, according to this difference, individuals do not need to use much of their cognitive skills in the first three stages while the latter three are those that need to be used to reach and test one's own knowledge, comprehend the problem and look for a solution. Hence, while assessing the student success, teachers should not only ask questions evaluating the same level of learning but also use questions assessing different levels of learning (Gündüz, 2009).

Questions can be prepared for different levels of learning from daily life. It is provided by this way that science class do not consist of a pile of knowledge that needs to memorised, instead, it includes the very basic knowledge to be used in daily life (Yıldırım & Maşeroğlu, 2016). With the changes made in the science curriculum in 2018, it is aimed to provide students with the necessary knowledge and skills by providing exercises that will enable them to use science in their daily lives (Ministry of National Education (MoNE), 2018). In order to examine how the cognitive levels of the students change, the subject of density, which is constantly encountered during their studentship, can be examined. Mass, volume, and density are basic concepts in the science curriculum taught at all levels of education (Martínez-Borreguero, Naranjo-Correa, Cañada, Gómez & Martín, 2018). Density is a complex concept and therefore difficult for students to understand. This difficulty can be associated with the abstract nature of density as it must be understood by working with ratios or unit proportions. It cannot be observed directly as a clear property of matter, but instead must be calculated by first finding the mass and volume of the object and then dividing the mass by volume. Therefore, it is defined as the mass of an object per unit volume (Almuntasheri, Gillies & Wright, 2016). Although students are successful in calculating density by dividing mass and volume numbers when given numbers, they have difficulty understanding what this ratio means (Dawkins, Dickerson, McKinney & Butler, 2008; Kiray & Simsek, 2020). The subject of 'density', which has been included in science lessons since the sixth grade in Turkey, is also included in the curriculum of high schools and universities. According to Karakaş (2012), teaching practices made by associating the concept of density with daily life situations contribute to the professional development practices of science teachers. Moreover, teaching in this way can help Pre-service science teachers train in the future to teach their students a sound mind and perform skilfully.

The density subject is taught to Pre-service teachers in their field knowledge and teaching classes and they are required to develop themselves in analysis, synthesis and evaluation stages which necessitate higher level thinking skills. Allen and Taner (2012) have found out that the questions used to improve thinking skills during learning and teaching period are of importance in terms of both

assessing the student learning and affecting student thinking. According to Austin (2010), forcing students to think and solve scientific density problems results in more interesting and realistic science education and effective teaching on learning. Besides, Karamustafaoğlu, Sevim, Karamustafaoğlu and Çepni (2003) have indicated that using questions assessing the extent of learning from different levels helps students gain higher level thinking skills. Accordingly, students can think at the analysis, synthesis and evaluation levels by being asked their learning level at different stages.

The purpose of this study is to evaluate the cognitive levels of Pre-service science teachers with regard to the Bloom's Taxonomy on the 'density' subject which exists in the curriculum of universities, as well. In accordance with this purpose, problems related to the density subject have been used which, instead of memorising, requires transferring the learnt knowledge into daily-life. In line with this purpose, the sub-questions below have been identified:

1.What is the cognitive levels of Pre-service teachers related to 'density' subject?

2.What do the students think about daily-life problems requiring higher-level thinking skills?

METHOD

Of the qualitative research methods, case study method has been utilised within this study which examines the cognitive levels of Pre-service science teachers in terms of Bloom's Taxonomy in the 'density' subject. Since the density subject has been deeply analysed in terms of cognitive levels of Bloom's Taxonomy, this study has been assumed as a case study.

Participants

This research has been carried out on 45 first grade students, coded as 'S1, S2,…S45', attending Science Teaching Department of the Faculty of Education at a state university located. The study has been carried out with the students attending General Chemistry I course.

Data collection tools

In order to identify the cognitive levels of Pre-service teachers about the density subject, a cognitive level test created in line with the Bloom's Taxonomy and interview questions, formed with the purpose of identifying their views about daily life problems requiring higher level thinking skill, have been used.

The cognitive level test prepared in accordance with Bloom's Taxonomy

The cognitive level test about the density subject used as the data collecting tool has been created after an extended literature review and applying for expert's views (science education, mathematics education specialist). The level test prepared by considering the knowledge, comprehension, application, analysis, synthesis and evaluation stages of Bloom's Taxonomy has been given in Table 1 below.

Table 1. Pre-test success score results of the cognitive level test

Stage	Questions
Knowledge	The density of ethylene glycol at 20°C is 1.11g/mL. What do you understand from this information? (The mass of 1mL solution is 1.11 gram).
Comprehension Application	What is the mass of 452mL of ethylene glycol in terms of grams? What is the mass of 18.6 L of ethylene glycol in terms of kilograms? What is the volume of 23.9 kg of ethylene glycol in terms of litres?
Analysis	How can you calculate the mass of cylindrical stainless steel having 18.24 cm height and 1.88 cm radius? The density is 7750 g/mm3. The mass of a wooden log having dimensions of 1.08 m, 5.1 cm and 0.62 dm is 2.52 kg. Knowing that it is a rectangular prism, what is the density in grams of the wooden log?
Synthesis	The mass of a 1 cm3 diamond is 3.5 gr or 17.5 carats. The size of world famous Kaşıkçı diamond is 86/17.5 = 4.91 cm3. What can be said about the density of this diamond?
Evaluation	Evaluate by comparing the solution stages of daily life problems and routine problems (in course books).

The questions related to identifying lower-level cognitive skills are at the knowledge level (an expression about knowing the dependent variables of density concept [mass, volume and density]), comprehension level [placement within formula, making calculations, use of data], and application level [two questions requiring measurement of mass and calculating volume through calculating density formula; converting unit rates into required units (kilograms to grams, litres to millilitres)] (Table 1).

However, the questions related to the analysis level of the higher-level cognitive skills test prepared in accordance with the Bloom's Taxonomy aims to find out, through questions related to a cylindrical and a rectangular prism, the success level of students in;

1. Calculating the volume and density of the matter by considering its geometric shape,
2. Calculating the density of daily life objects,
3. Analysing the relationship between density and mass.

For the synthesis level of the higher level cognitive skills test, a screenshot from the news about Kaşıkçı diamond has been shown them (Fig. 1).

"The frame of Kaşıkçı Diamonds contains 49 brilliant stones and by this means, the diamond is like a full moon among the stars in the night sky. The mass of 1 cm^3 diamond is 3.5 grams or 17.5 carats. The size of Kaşıkçı diamond is 86/17.5 = 4.91 cm^3."

(https://www.arkeolojikhaber.com/haber-kasikci-elmasi-kasikci-elmasi-efsaneleri-23398/)

Figure 1. The screenshot of the news about synthesis question

It is aimed to find out the cognitive thinking skills of Pre-service teachers about the density subject within the synthesis level and a problem has been created for them in order to identify whether they are able to interpret the results by correlating the data they encounter in their daily life. Within the evaluation level, they have been asked to assess the solution of the problem given in synthesis level.

Interview questions

The questions below have been used at the end of the application to find out the views of Pre-service students about daily life problems requiring higher-level thinking skills

Have you had difficulty in solving the daily life problems?

1. If your answer is "yes", please write the possible reasons.

2. If your answer is "no", please write how you have used the given data.

Data analysis

A cognitive level test has been applied to Pre-service science teachers and the results have been evaluated. Two researchers have descriptively analysed the answers of the questions prepared in accordance with the cognitive thinking levels of Bloom's Taxonomy. After this analysis, the percentages and frequencies of correct answers of respective levels have been calculated while content analysis has been applied to answers of interview questions. In order to be coded, all the data has been divided into meaningful sections and all the sections have been given a name. Then, the data has been coded and 4 themes have been created using these codes. These codes and themes have been systematically transformed into tables and some expressions of Pre-service teachers have been given as quotations. To determine the coding reliability for themes. The codes were determined separately by the two researchers and then the reliability level of the code analysis was determined with the formula of agreements/ (agreements+disagreements) x100 (Miles & Huberman, 1994). The reliability for two the coders is found to be approximately 96%.

FINDINGS

The findings of the study have been given under the titles of 'cognitive levels of Pre-service teachers in the density subject' and 'views of Pre-service teachers about daily life problems requiring higher-level thinking skills'.

Cognitive levels of Pre-service teachers in density subject

A cognitive skills test was applied to Pre-service science teachers and the results was evaluated. The percentages and frequencies of questions prepared in accordance with the levels of Bloom's Taxonomy have been given in Table 2.

Table 2. Cognitive Levels of Pre-service Science Teachers

Level	f	%
Knowledge	45	100
Comprehension	45	100
Application	45	100
Analysis	42	93.33
Synthesis	22	48.88
Evaluation	9	20

In Table 2, it is observed that while all the students have correctly answered the questions in knowledge, comprehension and application levels, the percentage of correct answers in analysis, synthesis and evaluation levels are 93.33%, 48.88%, and 20%, respectively. It is observed that all the

Pre-service teachers have completed the knowledge, comprehension and application levels. It has been found out that they know such dependent variables of density subject as mass and volume at the knowledge level and they correctly use the given data by properly placing it within formula and carrying out mathematical calculations at the comprehension level. At the application level, it has been determined that they are able to convert units into another one (kilograms to grams, litres to millilitres) and using them within the formula, calculating mass and volume through the formula, interpreting the density problem. It is found out that 93.33% of Pre-service teachers have correctly solved the density problems at the analysis level. They are required to calculate the volume and mass of matters by considering their geometric shapes, use the relationship between the density and mass, make an analysis by using their knowledge to calculate the density of objects and matters they encounter in their daily life. Two questions have been used at the analysis level and both questions require them to comprehend the geometric shape and calculate its volume and mass.

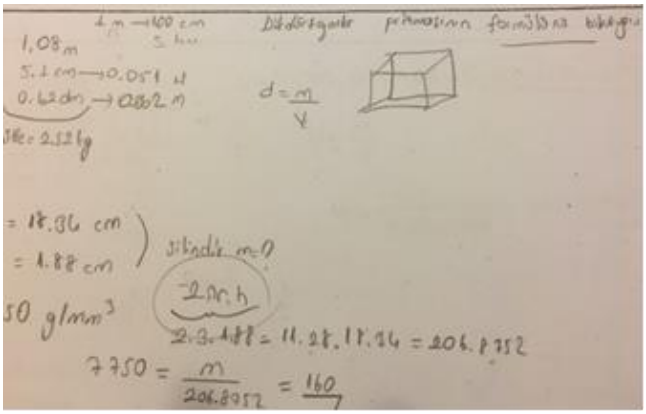

Figure 2. The solution of S35 at the analysis level

Fig. 2 shows the Pre-service teacher coded S35 that have reached the analysis level but haven't been able to find the correct solution. The student have tried to make some calculations while trying to find the solution but have written that he/she doesn't know the formula of rectangular prism. The same student has not been able to reach the correct result since he/she has wrongly calculated the volume of geometric shape in the second question.

48.88% of the students have correctly solved the problem of synthesis level. The aim of synthesis level question is to examine whether the student could use extraordinary data by making a correlation between them to reach the solution and decide whether the given data is useful or not while trying to find the solution of the problem. When Table 2 is examined, it is observed that there is a sharp decrease from 93.33% to 48.88% while passing to synthesis level from analysis level and this fact indicates that Pre-service teachers have difficulty in using the data while solving daily life problems and interpreting the result.

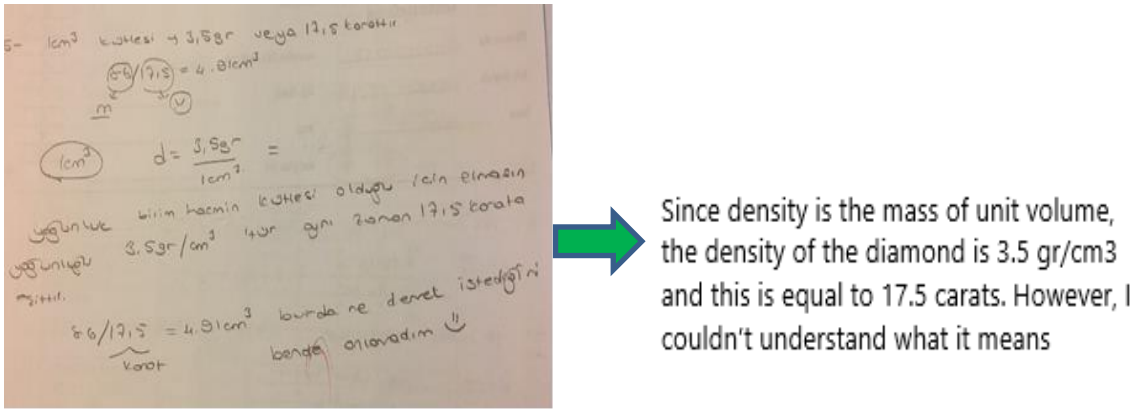

Figure 3. The solution of S19 at the synthesis level

The data in Fig. 3 indicates that S19 doesn't have an idea about how the data from daily life news could be used and by writing "Since density is the mass of unit volume, the density of the diamond is 3.5 gr/cm3 and this is equal to 17.5 carats. However, I couldn't understand what it means," it is understood that the student has failed at the synthesis level.

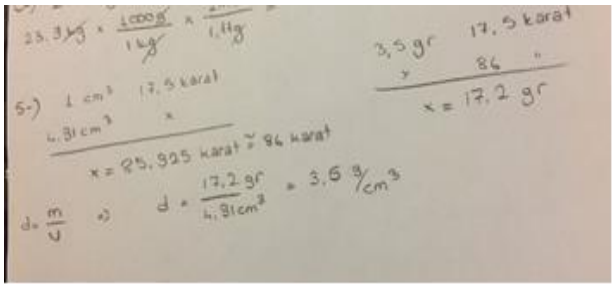

Figure 4. The solution of S23 at synthesis level

The solution given in Fig. 4 demonstrates that S23 has correctly reached the result. Properly completing the synthesis level, the student has not made any evaluation although he/she is required to interpret the result at the evaluation level.

According to the data given in Table 2, 20% of the students has correctly interpreted the results. While 22 students has correctly answered the question in the synthesis level, 13 of them has not made any interpretation at the evaluation level. Pre-service teachers are expected to express their views about and evaluate phenomena and daily life problems at this level.

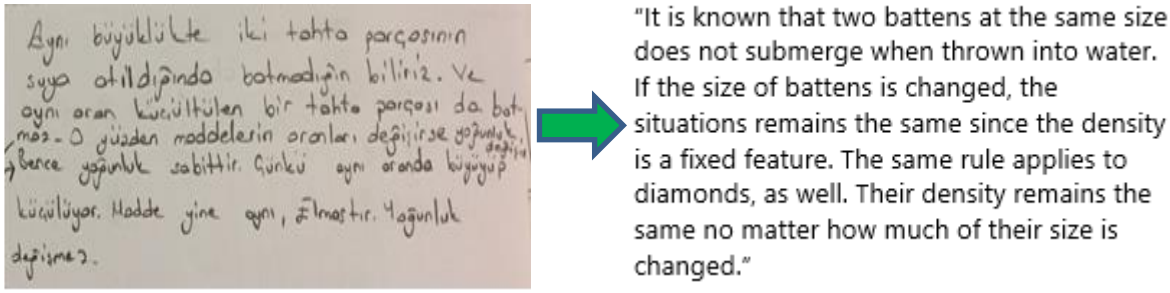

Figure 5. The solution of S44 at evaluation level

In Figure 5, it is observed that S44 has tried to explain the problem through another example by making the necessary evaluation required from them at the higher cognitive level.

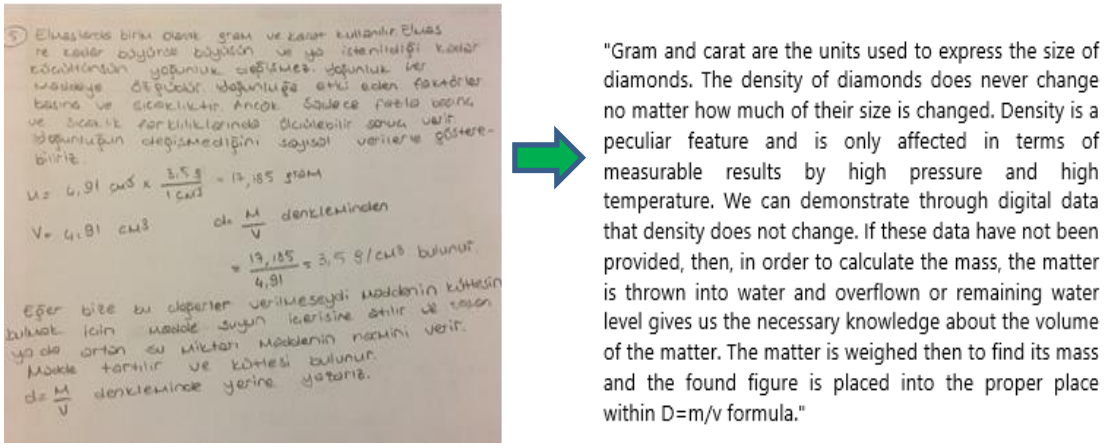

Figure 6. The evaluation of S38

Fig. 6 shows the correct solution of S38 where he/she has commented on the news and supported his/her idea scientifically by establishing a relationship between the current knowledge and the problem sentence. It is observed that the student has reached the knowledge, tested his/her own knowledge on the subject, understood the problem and come up with different solutions at the higher-level skills.

Views of Pre-service teachers about daily life problems requiring higher-level thinking skills

The codes and themes obtained after content analysis which has been applied to the data from answers to interview questions created with the aim of finding the views of Pre-service teachers about daily life problems requiring higher-level thinking skills have been presented in Table 3. Apart from this information, some other expressions of Pre-service teachers have also been given to support the themes.

Table 3. Codes and Themes obtained from the views of Pre-service teachers

CODE	STUDENT	Frequency (f)	Theme
Being realistic	S9	1	**Interesting**
Incentive to think	S2, S7, S8, S33, S44	5	
Permanent learning	S2, S8, S10, S13, S20, S22	6	
Keeping away from memorising	S2, S19	2	
Being instructive	S8, S10	2	
Relationship between theoretical knowledge and daily life	S28	1	
Improve analysis skills	S33	1	
Total		**18**	
Thinking oriented	S10, S44	2	**Hard**
Requiring comment	S8, S11, S12, S19, S27, S29	6	
Being peculiar	S7, S13, S17, S18, S19, S20, S22, S25	8	
Commenting the result	S7, S14, S15	3	
Identifying necessary data	S6, S21, S23, S29, S30	5	
Unit conversion	S31, S45	2	
Analysis of question	S13, S21, S22, S23	4	
Total		**30**	
Commenting on the knowledge	S27	1	**Easy**
Relationship with daily life	S11, S26, S27	3	
Evaluating the result	S27	1	
Envisioning	S18	1	
Answer supporting data	S25, S26	2	
Total		**8**	
Non-routine problem	S13, S18	2	**Extraordinary**
Having redundant data	S16	1	
Identifying new concepts within question	S16, S17, S18, S22, S23	5	
Total		**8**	

In Table 3, 30 of the Pre-service teachers have had difficulty in solving daily life problems. The common reason of this difficulty is that they, daily life problems, have an extraordinary nature (f:8). Other expressions of Pre-service teachers include 'requiring comment (f:6), identifying necessary data (f:5), evaluating the result (f:3), thinking oriented (f:2) and analysis of the question (f:4)'. Below are the comments of some Pre-service teachers:

S7: ...I'm confused since the problem includes a regular density question and the Kaşıkçı diamond…

S16: The information given about carat has puzzled me. It has made the question more difficult…

According to the data given in Table 2, the Pre-service teachers have frequently (40%) indicated that the use of daily life problems has given the question an interesting feature. The most common view under this title has been that use of daily life problems has yielded permanent learning (f:6). Some comments of Pre-service teachers related to this information has provided below:

S13: …I will remember these questions more easily. Besides they are fun to engage…

S20: …I think I've permanently learnt the subject…

S3: …Rather than applying in daily life, we use the knowledge we learn from course books only in exams. Trying to solve daily life problems make us think deeply. This way of learning is more permanent and let us use the knowledge in our daily lives…

The Pre-service teacher coded S3 has not made it through synthesis and evaluation levels. The reason of this failure could be that the student is able to use the knowledge only in exams by memorising and then forgetting it.

The comments of Pre-service teachers about daily life problems requiring higher-level thinking skills within the theme of 'being interesting' are that being realistic (f:1), incentive to think (f:5), keeping away from memorising (f:2), being instructive (f:2), relationship between theoretical knowledge and daily life (f:1), and improving analysis skills (f:1). The comment of one of the Pre-service teachers is provided below:

S8: …I think that this question requires commenting on and deep-thinking…

According to the data given in Table 2, it is observed that 8 of Pre-service teachers are of the opinion that the use of daily life problems requiring higher-level thinking skills is extraordinary. The most common view (f:5) under this theme is identifying new concepts within the question. Other views following this comment are non-routine problem (f:2) and redundant data (f:1). One of the comments is given below:

S16: …the expression of 17.5 carats has confused me. I haven't used all the given data. The information about carat has given only to puzzle the things…

In Table 2 indicates 8 of Pre-service teachers think that it is easy to use daily life problems. The codes obtained within 'easy' theme are that relationship with daily life (f:3), supporting the answer (f:2), commenting on the knowledge (f:1), evaluating the result (f:1), and envisioning (f:1). When the answers of Pre-service teachers given to the questions requiring higher-level thinking skills are examined, it is observed that they are on the evaluation stage.

DISCUSSION AND CONCLUSION

When the cognitive levels of Pre-service teachers about 'density' subject were analysed, it was observed that all of them have thoroughly completed the knowledge, comprehension and application levels while 93.33% of them have completed the analysis level. The reason of this result could be that the 'density' subject has repeatedly taught them throughout their education. According to the results, it could be stated that all the Pre-service teachers have correctly configured the density subject as the mass of unit volume since all of them are at the application level. Since they have calculated the mass and volume by using the relationship between the variables within the density formula with 100% success, it could be stated that Pre-service teachers have established the necessary relationship between the variables of d=m/V formula. Kalın and Arıkıl (2010) have indicated that rather than memorising formulae, it is of much importance to know what they stand for and how to use them. In this sense, it has been determined that the Pre-service teachers who will teach the density concept in following years know the meaning of density formula and could use it while solving problems. When the solutions of failed students at the analysis level have been examined, it has been observed that

although they have successfully comprehended the geometrical shapes, they couldn't calculate the density of solids because of improper use of the formula. It could be stated that they failed to complete the analysis level due to the lack of mathematical knowledge (Austin, 2010; Dawkins et al., 2008; Hitt, 2005; Hashweh, 2016). In this case, 42 of Pre-service teachers have properly calculated the density of solids by correctly finding the volume of geometrical shapes and accordingly, they have been able to reach the synthesis level by completing the analysis level. The reason of this success could be explained by the fact that the density subject exists in the curriculum acquisitions of the Ministry of Education and is repeated in a volute way (MoNE 2013; MoNE 2018).

It is observed that 48.88% of Pre-service teachers have successfully completed the synthesis level. The reason of this decline from analysis level to synthesis level could be that they do not know how to use the data, density is a unital rate, and the question contains unfamiliar concepts. According to the findings obtained from the solutions at the synthesis level, it has been identified that Pre-service teachers have had difficulty in using the data and evaluating the result while solving daily life problems which they do not encounter in course books. Even though they have correctly placed the given data within d=m/V formula in earlier stages, they have not been able to make a correlation between extraordinary data obtained from daily life news while they couldn't identify necessary data to solve the problem and couldn't convert grams into carats in the synthesis level. Although Dawkins, Dickerson, McKinney and Butler (2008) pre-service teachers developed an understanding of density, it was stated that most of them had difficulty in connecting them to mathematical relationships. Pekdağ, Azizoğlu, Topal, Ağalar and Oran (2013) have identified that while students succeed in chemistry class, they have serious difficulty in using and transferring the knowledge into their daily life. Ürey and Cerrah (2015) have determined that although Pre-service primary school teachers are able to describe the concepts used in science, they have great difficulty in finding the equivalents of these concepts and using them in their daily life (Ürey & Cerrah Özsevgeç, 2015). It could be stated according to the findings of the study that Pre-service science teachers have difficulty in passing through analysis level up to higher levels in density subject which has been taught from secondary school.

It has been determined that 20% of the Pre-service teachers are at the evaluation level, which equals to 9 students out of 45. It has been found out from their responses that they are able to make generalisation by using the amount of substance and volume, both are the variables of the density of substances (wooden log), that the density does not change depending on changing of (increasing of decreasing) substance amount and volume, and that the density is not affected unless pressure and temperature changes. The fact that Pre-service teachers have made generalisation by correlating the density of diamonds and that of Kaşıkçı diamond through the result they obtained at the synthesis level indicates they have gained higher-level thinking skills. When the solutions of Pre-service teachers at the evaluation level have been examined, it is observed that 36 of them have wrongly commented on the subject and as a result have not been able to make a proper evaluation. In order to succeed at the evaluation level, Pre-service teachers should make and comment on inferences affecting their whole life; however, it has been found out that they have had great difficulty in solving the questions at synthesis and evaluation levels. Pre-service teachers could be given lots of higher cognitive level questions in order for them to be able to solve and comment on these type of questions. Üner, Akkuş and Kormalı (2014) have indicated that questions at the higher-level cognitive skills are rarely used in the exams; students are generally able to answer the questions at the knowledge level; about half of them solves the questions at the application level and the questions in the chemistry course book are generally at the application level. Ayyıldız, Aydın and Nakiboğlu (2019) have found out that the comprehension level has the highest number of acquisitions in the curriculum while the synthesis and evaluation levels has the least number of acquisitions. Zorluoğlu, Kızılaslan and Sözbilir (2016) have determined that the curriculum should be enriched in terms of content through the acquisitions having metacognitive knowledge and creation skills in higher level classes. Earlier studies examining course books and examinations have revealed that students rarely come across questions about higher-level cognitive skills since the knowledge is usually measured at lower cognitive levels (Nakiboğlu & Yıldırır, 2011; Özmen & Karamustafaoğlu, 2006; Zorluoğlu, Güven & Korkmaz, 2017). Other studies suggest that students given lower cognitive level tests throughout their education years have difficulty

in solving higher cognitive level tests (Ayyıldız, Aydın & Nakiboğlu, 2019; Üner, Akkuş & Kormalı 2014). Students could be given the opportunity of coming across much more tests questioning higher-level cognitive skills in order to be able to solve and comment on these type of questions. Enrichment of science teachers' pedagogical content knowledge specific to the subject of density will facilitate teaching the subject to secondary school students (Hashweh, 2016). Since Pre-service teachers will transfer their knowledge into their students, it is of much importance for them to be equipped with knowledge to the greatest extent possible. Therefore, students enrolling in universities with such lower-level cognitive skills as comprehension and application should be supported with the contents that will improve their higher-level cognitive skills in terms of pedagogical knowledge. In addition, it is recommended that the questions in the exams measure the difficulties and skills (Upahi, Israel & Olorundare, 2017).

When the views of Pre-service teachers about daily life problems requiring higher-level thinking skills have been analysed, it could be stated that they find these questions "interesting" by thinking they are realistic about the density subject, encourage them to think, provide permanent learning by keeping them away memorising, are instructive and have them correlate theoretical knowledge with daily life. The fact that Pre-service teachers, even those who couldn't succeed in solving the questions requiring higher level thinking skills, show interest in these questions about daily life, that they think them as necessary and would like to deal with them more frequently is a very important result. Pre-service teachers could gain higher-level cognitive skills by being exposed to daily life questions more frequently requiring higher-level thinking skills within learning environments where density subject is being dealt. Within this context, articles from newspapers, information in the websites and scientific subjects within movies could be given as homework to students and their higher-level thinking skills are supported by this way.

According to the findings, almost half of the Pre-service teachers have indicated that questions in the synthesis and evaluation levels are thinking oriented and extraordinary; requires commenting and evaluating the result and identification of the necessary data. They have also stated that they tried to solve the question, have lack of knowledge in conversion of the units and lastly they had great 'difficulty' in solving the question. Due to these reasons, Pre-service teachers have not been able to answer the questions in synthesis and evaluation levels. The possible reasons of this failure could be the lack of pre-conditioned learning, allocating insufficient time for and putting less importance on developing of thinking skills, failure in determining the given and required data – the important steps of problem-solving – and giving insufficient time for non-routine problems (Dawkins, et. al., 2008; Hitt, 2005). The statements of Pre-service teachers give clues about the underachievement in reaching higher-level cognitive skills. Higher-level thinking in chemistry teaching requires conceptual understanding (Tsaparlis, 2020). Accordingly, conceptual learning is important in order to develop higher-order thinking skills in intensity teaching.

Some of the Pre-service teachers have found the questions measuring higher-level cognitive skills as extraordinary in that they contain non-routine problems, include redundant data and necessitate identifying new concepts. The fact that the Pre-service teachers have not encountered non-routine problems identified as 'extraordinary' could be the reason of this thought. According to earlier studies, it has been found out that non-routine problems have positive effect on developing higher-level thinking skills (Apino & Retnawati, 2017; Retnawati, Djidu, Kartianom, Apino & Anazifa, 2018). Besides, Saido, Siraj, Nordin and Amedy (2015) have determined that teachers should make use of proper teaching methods in order for students to actively participate in learning process with the aim of developing or improving higher-level cognitive skills. In this case, the effect of non-routine problems in reaching higher-level cognitive skills could be explored.

Another important inference from the statements of Pre-service teachers is that they have found the questions measuring higher-level thinking skills as 'easy' in that they require commenting on the knowledge, necessitate a correlation between daily life and theoretical knowledge and evaluating the result, and support the given answer. These views prove that it is not a coincidence that

the cognitive levels of Pre-service teachers related to density subject is at the evaluation level, which is the highest level skill within Bloom's Taxonomy.

It could be recommended that the lack of knowledge of students related to mathematical operations (unit rates, changes between variables, volumetric calculations of solids, conversions between unit rates) should be overcome in order for students to improve themselves within cognitive thinking skills while learning density subject.

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