Cilt 8 / Sayı 4, 2020
Eğitimde Nitel Araştırmalar Dergisi - ENAD
Journal of Qualitative Research in Education - JOQRE

Examination of Context Based Question Writing Skills of Science Teachers Participated in a Scientific Literacy Course*

Fen Okuryazarlığı Kursuna Katılan Fen Bilimleri Öğretmenlerinin Bağlam Temelli Soru Yazma Becerilerinin İncelenmesi

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To cite this article/ Atıf icin:
Çepni, S., Ormancı, Ü., & Ülger, B. B. (2020). Examination of context-based question writing skills of science teachers participated in a scientific literacy course. *Egitimde Nitel Araştırmalar Dergisi – Journal of Qualitative Research in Education*, 8(4), 1249-1270. doi: 10.14689/issn.2148-2624.8c.4s.8m

Abstract. In this study, an in-depth examination of teachers' context-based question writing skills in the scientific literacy course developed for science teachers was aimed. In the study, a case study model from qualitative research was used. The study group consists of 25 science teachers working in middle schools in Bursa. Teachers were given theoretical and practical context-based question writing training on the basis of scientific literacy developed by the researchers. Questions and observation were used as data collection tools in the study. The data obtained were analyzed using descriptive analysis. The findings from the study showed that teachers learned context-based question structures that measure scientific literacy. Although teachers had some deficiencies in writing context-based question, it was understood that their ability to write questions had improved through the scientific literacy course. We concluded that developing more context-based questions by teachers will decrease the deficiencies identified in the study.

Keywords: scientific literacy, context-based, open-ended question, science teacher, writing skills.

Öz. Fen okuryazarlığının günümüzdeki önemine paralel olarak, bağlam temelli sorular ölçme-değerlendirme sistemlerinde yer almaya başlamıştır. Bu önem göz önüne alınarak yapılan çalışmada, fen bilimleri öğretmenlerine yönelik geliştirilen fen okuryazarlık kursunda, öğretmenlerin bağlam temelli soru yazma becerilernin derinlemesine incelenmesi amaçlanmıştır. Çalışmada, nitel araştırmalardan durum çalışması modeli kullanılmıştır. Çalışma grubunu, Bursa iline bağlı ortaokullarda görev yapan 25 fen bilimleri öğretmeni oluşturmaktadır. Öğretmenlere, araştırmacılar tarafından geliştirilen fen okuryazarlığı temeline yönelik bağlam temelli soru yazımı teorik ve uygulamalı eğitim verilmiştir. Çalışmada veri toplama aracı olarak "ulusal ve uluslararası sorulardan oluşan form", "yapılandırılmamış gözlemler" ve "öğretmenler tarafından hazırlanan bağlam temelli açık uçlu sorular" kullanılmıştır. Veriler betimsel analiz kullanılarak analiz edilmiştir. Çalışmadan elde edilen bulgulara göre; öğretmenlerin, fen okuryazarlığını ölçen bağlam temelli soru yapılarını öğrendikleri anlaşılmıştır. Bununla birlikte öğretmenlerin bağlam temelli soru yazmada bazı eksikleri olmasına rağmen, verilen eğitime paralel olarak soru yazma becerilerinin geliştiği anlaşılmıştır. Çalışmada belirlenen eksikliklerin, daha fazla bağlam temelli soru hazırlayarak azalacağı düşünülmektedir.

Anahtar Kelimeler: Fen okuryazarlık, bağlam temelli, açık uçlu soru, fen bilimleri öğretmeni, yazma becerisi.

Article Info
Received: 17.01.2020
Revised: 20.06.2020
Accepted: 08.10.2020

* The study was presented at the 27th International Congress on Educational Sciences.

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Introduction

In parallel with the advances in technology and science, we can say that people who cannot adapt to change have difficulty in adapting to their environment and the world. In order to find a solution to this adaptation problem, countries have started to make changes in their education policy. In the updated curriculum of Turkish Ministry of National Education (MoNE), the aim is to understand the nature of science and to ensure that the information obtained is utilized in daily life, thus the main purpose of the science curriculum in Turkey is to educate students as science literate individuals (MoNE, 2018). Students are expected to be individuals who know science subjects, who can relate the concept they have learned to daily life, who have high level thinking skills, who understand the nature of science, who are willing to learn science subjects. As Sülün, Işık and Sülün (2008) states, individuals need to be science literate individuals in order to transform their education into skills they can apply in their daily lives, to be in a lifelong learning process and to distinguish between right and wrong by using scientific data. Because it is critical for individuals and societies to be science literate in order to comprehend and use new information and technological developments consciously (Özdemir, 2010).

In order for students to grow up as science literate individuals, teachers should be science literate individuals and reflect this into their classrooms. Similarly, Saracaloğlu, Yenice and Özden (2012) states that teacher is one of the most important factors that affect students' ability to develop the knowledge, skills, attitudes, understanding and values required for their development as science literate individuals. If a good science teacher wishes to raise science literate students, the teacher needs to behave exemplary (Sülün, et all., 2008). Teachers who will educate science literate individuals should also be highly science literate (Karademir, 2012). At this point, we can say that in order to be science literate, teachers need to develop themselves and receive training for this purpose. Considering the trainings teachers took during their undergraduate education, although the courses serve to scientific literacy, the main purpose of their content is not scientific literacy. Kaya and Bacanak (2013) state that education faculties should emphasize scientific literacy in teacher education. In order for science teachers to become science literate individuals, we thought that they need to improve themselves through in-service trainings. In this context, the scientific literacy course with teachers will be important for both teachers, students and the literature.

Changes are being made in the measurement and evaluation system in Turkey and updates are made in question structures in parallel with PISA applications. In this regard, Berber and Anılan (2018) indicates that new exam systems have been developed for the applied program in response to the changes in the education programs. Scientific literacy levels of the countries are also examined in PISA applications and questions that require high level thinking skills/competences are asked. In parallel with scientific literacy, which is considered as the main objective of the development of science programs in Turkey, the transition to context-based questions has begun. Because it is known that students are unable to reconcile the science subjects they have learned with daily life and therefore have difficulty in solving these exams related to daily life (Sak & Gürel, 2018). In parallel with this situation, changes in the understanding of assessment and evaluation take place and context-based questions related to daily life are gaining importance. In parallel with all these reasons, we thought an in-depth study of context-based question writing skills, which is a requirement for scientific literacy of teachers, is important.

When we look at the literature, Sülün, et. all., (2008) concluded that teachers' scientific literacy levels were not sufficient in their study with classroom teachers. Özdemir (2010) determined that the scientific literacy of pre-service teachers was at medium and low levels. Chin (2005)'s study of first-year pre-service teachers in Taiwan, where they investigated scientific literacy, determined that basic scientific literacy was generally satisfactory. At this point, we can say that the literacy levels of the teachers are low and the trainings to be given on this subject will be important. In the scientific literacy course developed for science teachers within the scope of the study, examining context-based question writing skills of teachers is another important step. In the literature, the effects of context-based questions on participants' anxiety, success, attitude, and problem solving were investigated (Hill, 1998; Kurbanoğlu & Nefes, 2015; Kurbanoğlu & Nefes, 2016; Tekbıyık & Akdeniz, 2010) or provided examples of context-based questions (Kaltakci & Eryilmaz, 2011). Additionally in the literature, determining prospective science teachers' ability to write context-based questions about the concepts of radioactivity subject found its place as an aim (Ültay & Usta, 2016). In our literature review we could not find any other study. In this context, we think that this study will contribute to the gap in the literature and at the same time, it will be more effective to examine context-based question writing skills in parallel with a given education. In this study, we aimed to examine in depth the context-based question writing skills of the scientific literacy course developed for science teachers. In this context, the problem sentence of the research is as follows;

- How are the context-based question writing skills of science teachers participating in the scientific literacy course?

The sub-problems of the research are as follows:

- How do science teachers understand scientific literacy questions in literature?
- How do science teachers analyze the skills/competences of a scientific literacy question?
- How do the science teachers distinguish scientific literacy/context-based questions?
- How do the science teachers write scientific literacy/context-based questions?

Theoretical Framework

Scientific Literacy

Scientific literacy involves knowing and understanding the scientific concepts and processes necessary for economic efficiency, participation in civil and cultural affairs, and personal decision-making (National Research Council, 1996). DeBoer (2000) defined scientific literacy as what people should know about science in order to live more effectively and efficiently. Basically, scientific literacy can be thought of as having the process skills necessary to interpret culturally important information (Turgut, 2007). Similarly, scientific literacy is considered as a citizen qualification that requires rational thinking about science when seeking solutions to personal, social, economic problems and to potential problems that people may encounter throughout their lives (Yetişir, Batı, Kahyaoğlu & Birel, 2018). At this point, one of the important points in the concept of scientific literacy is the skills/competences that individuals

should have. In this regard, Özdemir (2010) defines scientific literacy as a "competence" situation that serves to understand, monitor, assimilate and consciously use scientific and technological developments and includes all cognitive, affective and psychomotor skills that can protect human quality of life and natural life. In this context, studies aiming to improve scientific literacy of students in different countries were carried out. The main focus of the standards set by the NRC (2013) in the USA have been scientific literacy and life skills.

An important point in scientific literacy is the association of concepts with everyday life and integration into life. Similarly, Kesik (2016) states scientific literacy as the use of theoretically learned information in solving problems encountered in daily life and being responsible to society when making decisions on any issue. Because it is possible for individuals to develop their critical thinking abilities, to discover ways to access information instead of retrieving and memorizing, and to inquiry and question the individual with the characteristics of scientific literacy (Sahin, Sanalan, BektaS & Kaygısız, 2010). As can be understood so far, science literate individuals have basic knowledge of science (Biology, Physics, Chemistry, Earth, Celestial and Environmental Sciences, Health and Natural Disasters) and scientific process skills for the exploration of the natural environment (MoNE, 2018). The science literate person understands the nature of science and scientific knowledge, basic science concepts, principles, laws and theories and uses them appropriately (Duban, 2010; Sülün, et. all., 2008). But the main point that makes these possible is that they know the concepts of science. In other words, students need to know science concepts in order to understand the nature of science, examine the relationship between science-technology-society-environment, thinking and interpreting science to develop interest and attitude towards science, in short, become science literate (Kavak, Tufan & Demirelli, 2006). In this context, a science literate individual needs to know the basic concepts of science, to use them in problems or situations encountered in daily life and to use the necessary skills/competences in this process.

In order to increase the scientific literacy status of individuals, it is necessary to focus on this variable in the courses and to process the courses in parallel. Anagün (2011) states that the variable that most affects scientific literacy in Turkey in terms of teaching-learning processes is "time devoted to learning" followed by "experiments" and "inquiry-based learning activities". Therefore, in order to improve scientific literacy in the courses, teaching activities must be organized accordingly. At this point, the responsibility falls on the teachers. As Kaya and Bacanak (2013) points out, teachers need to be science literate in order to develop these skills in their students and have knowledge about activities that improve science literacies their students. From this basic point of view, the importance of scientific literacy trainings with teachers emerges.

Programme for International Student Assessment (PISA)

One of the applications where scientific literacy is important is the Programme for International Student Assessment (PISA). PISA defines scientific literacy as the scientific knowledge of a person and utilizing this knowledge in identifying questions, obtaining new knowledge, drawing experience based conclusions on science related issues, understanding the characteristics of science for learning and research purposes, realizing how science and technology shapes our material, cultural and intellectual environment and being interested in science-related issues and scientific ideas as a responsible citizen (MoNE, 2010). In this context, we can state that literacy is a very important variable for PISA applications. As Sadler and Zeidler (2009) points out, one

of the unique and improbable features of PISA is the articulation of scientific literacy that serves as a conceptual determinant of the project.

The PISA is an international assessment that measures the abilities of 15-year-olds in reading, mathematics and scientific literacy every 4 years (Fleischman, Hopstock, Pelczar & Shelley, 2010). The PISA exams are a combination of open-ended, closed-ended and multiple-choice questions that last for 2 hours, and these groups of questions are prepared in paragraphs and adapted from real life (Döş &Atalmış, 2016). The PISA application does not aim to measure the extent to which students have learned the subjects (mathematics, science and reading skills/competences) addressed in their curriculum, but to measure their ability to use and transfer their knowledge and skills/competences in the face of certain situations in today's information society (Acar & Öğretmen, 2012). As Bybee and McCrae (2011) notes, international assessments provide important information about science education and help inform decisions about policies, programs and practices in participating countries. Policy makers around the world use PISA results to compare the knowledge and skills/competences levels of students in their home countries with those of other countries participating in the research, to establish standards for raising the level of education and to identify strengths and weaknesses of their education systems (Taş, Arıcı, Ozarkan & Özgürlük, 2016). Therefore, PISA applications play an important role not only in terms of students' scientific literacy but also in determining the educational policies and teaching programs of many countries.

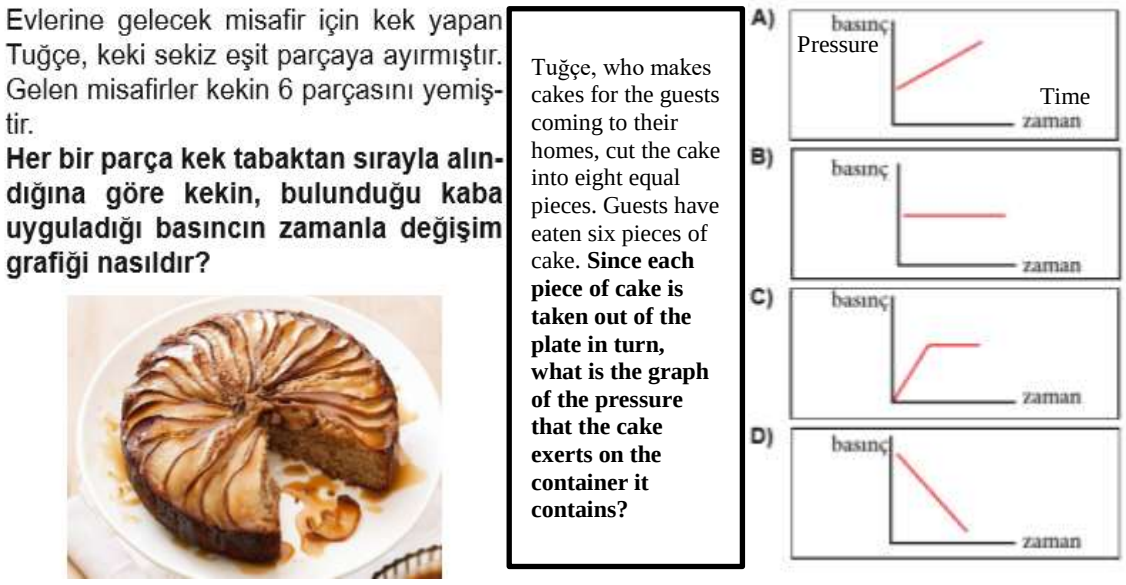
High School Transition System (LGS) and Context Based Questions

High school transition exams are administered centrally by the Ministry of National Education in Turkey in order to determine how much of the intended behaviours the students gained during the primary school (primary and lower middle school) process (Gündüver & Gökdaş, 2011). In this system, schools are divided into two categories as middle education institutions, high schools which will take students by examination and high schools that will take address-based registration (Biber, Tuna, Uysal & Kabuklu, 2018). While the former high school transition exams were measurement exams because they placed all students to all high schools, the new system is more of a selection exam because only a limited number of students are placed to a limited number of high schools (Ormancı, 2019). In addition to the questions at the level of knowledge and understanding in which the basic concepts are questioned, context-based questions have also been introduced.

Context-based questions are questions that present the subject or concept with the help of an appropriate context, allowing the students to respond based on this context with the help of their knowledge (Kabuklu, Yüzbaşıoğlu & Kurnaz, 2019). The students are directed to a question enriched by their daily life, experiences or a context that interests them (Sak & Gürel, 2018). In this context, context-based questions need to contain some characteristics. Elmas and Eryilmaz (2015) stated these characteristics as follows:

- It needs to include a problem that concerns the individual or society.
- Science concepts, formulas and laws need to be in a relationship with the context while constructing the problem.
- The answer needs to arise as a result of a thinking process, not memorization.

Thus, the most important feature of context-based questions is that it contains a problem that concerns the individual from daily life. In addition, the problem needs to be related to the science concept that is intended to be questioned. Finally, as Kabuklu, et. all., (2019) states, context-based questions should keep students from answering by memorizing or formulization and encourage reasoning. An example of a context-based question is given Photograph 1.



Photograph 1. Example of Context-Based Question (Çepni, 2020)

The question developed for pressure is an example of context-based questions. In the question, an example of solid pressure in daily life is given and the question is based upon a context. In addition to being a situation that concerns the individual, the question is related to the concepts of science. Besides, memorization information is not sufficient for the answer of the question, the student must understand the question, be able to read and interpret the graphics. In this context, it can be stated that the question meets most of the features required by the context-based questions.

Methodology

Case study was preferred in this study, where the implementation process of the scientific literacy course developed for science teachers and the teachers were examined in depth in terms of context-based question writing skills. These cases are “understanding scientific literacy questions”, “analyzing skills/competences in these questions”, “distinguish the scientific literacy/context-based questions” and “writing appropriate context-based questions”. Case study is a research method based on ‘how’ and ‘why’ questions and examines a phenomenon or event that the researcher cannot control (Yıldırım & Şimşek, 2018). The most important advantage of this method is that it gives the opportunity to concentrate on a particular subject or situation and provides an opportunity to investigate the subject in depth (Çepni, 2019). Since we aim to examine the application process of the scientific literacy course developed in our study in depth

in terms of context-based question writing and we use qualitative data collection tools in this process, we used the case study method.

Research Participants

The participants consist of 25 science teachers working in middle schools in Bursa. In this process, we first received the teachers' applications and conducted the process on a voluntary basis. Participants were selected from among the teachers who applied, whether or not they received a similar education before, in parallel with the counties and schools they served. In this context, the participants consist of science teachers working in central districts of Bursa. Table 1 shows the characteristics of the teachers.

Table 1.

Demographic Characteristics of Participating Teachers

Teacher	County	School	Gender
Teacher A and B	Nilüfer	Üçevler Şehit Faik Gökçen Middle School	F, F
Teachers C, D and E	Nilüfer	Abdurrahman Vardar Middle School	F, F, F
Teachers F and G	Nilüfer	Sadettin Türkün Middle School	F, F
Teacher H	Nilüfer	Özlüce Nurettin Topçu AIH High School	F
Teachers I and J	Nilüfer	Koç Middle School	F, M
Teacher K	Nilüfer	Meral Muammer Ağım Middle School	F
Teachers L and M	Nilüfer	Süleyman Cura Middle School	F, F
Teacher N	Nilüfer	Alara Middle School	M
Teacher O	Osmangazi	Bisaş Middle School	M
Teacher P	Osmangazi	Panayır Middle School	M
Teacher R	Osmangazi	Sabiha Köstem Middle School	M
Teacher S	Osmangazi	İbni Sina Middle School	F
Teacher T	Yıldırım	Samanlı Latif Dörtçelik Middle School	M
Teacher U	Yıldırım	Şehit Piyade Er Nezir Akgül Middle School	F
Teacher V and W	Yıldırım	Kızıklar Middle School	M, M
Teacher Y	Yıldırım	Setbaşı Middle School	F
Teacher Z	Yıldırım	Selçuk Hatun Middle School	F
Teacher Q	Yıldırım	Emek Middle School	M

As shown in the table, 14 teachers from Nilüfer district, four teachers from Osmangazi district and seven teachers from Yıldırım district participated in the scientific literacy course. 16 of the teachers were female and nine were male. In addition, teachers have at least five years of teaching experience. Each teacher was actively involved in both scientific literacy and the context-based question writing process, which is essential for scientific literacy.

Implementation

The study was carried out in Bursa in the spring term of 2014-2015 academic year. The training concerning scientific literacy was given by three instructors (authors) and lasted five weeks and 30 hours. We conducted the trainings every week on Fridays within a six-hour curriculum. Instructors are experts who have been studying in context-based questions and scientific literacy for many years.

The scientific literacy course includes theoretical and practical training developed by researchers. The content of the training is the introduction of national exams, PISA and TIMSS applications,

understanding of teaching-learning approaches and measurement-evaluation approaches, examinations of scientific literacy concept and PISA scientific literacy concept, realization of question writing activities. After the determination of education content, we created the content and activities to be implemented every week. The contents applied for five weeks are as follows:

- ***Week one:*** First, we made a general introduction to scientific literacy, context-based question writing and a five-week process. Then, we applied scientific literacy questions to the teachers and enabled them to see the question structures. These questions were used in PISA and TIMSS, and these are included in the findings section. In addition, we asked teachers to look at the questions from this perspective in order to determine the proficiency levels of scientific literacy questions with teachers and discussed the questions with the teachers in terms of structure and scientific literacy.

- ***Week two:*** First, we focused on international exams and gave examples of questions about these exams. Then we introduced PISA, TIMSS and exams in our country. We examined the questions in all exam systems in terms of scientific literacy. Here, after the theoretical part, we analyzed practical exam questions. We conducted a practical activity with teachers about which questions the exams could contain and their effectiveness in terms of scientific literacy. In this activity, a checklist was formed and participants were asked to fill this out for each question. In this way, we aimed to familiarize the questions in line with context-based questions and analyze their features.

- ***Week three:*** This week is a more theoretical week and we first talked about the relationship between learning theories of international exams. For example, it has been stated that the context-based questionsshould be more appropriate for a constructivist or context-based learning approach. Or, for questions requiring experimental process or skills/competences, it is suggested to prefer laboratory approaches. Then, we focused on the assessment and evaluation approaches on which the exams are based, and with the participation of teachers, we tried to reach a conclusion about the approaches on which the questions were based. Then, we have sampled some of the questions from the PISA and TIMSS exams.

- ***Week four:*** From this week onwards, we have moved from scientific literacy and theoretical to context-based question writing. When writing questions at this stage, first a context was given and partly included in the question. The teachers are asked to complete the existing question. In this way, teachers who had little or no context based question-writing experience were asked to get used to this process. Then, it was progressed step by step and after the teachers were given only context and asked to write the question they wanted. As a final step, teachers writed original context-based questions. At this point, since the questions closest to scientific literacy are in PISA practices, we first proceeded to write gradually by examining the structure of these questions. During the lecture hours, we mainly conducted question-writing activities. Examples of this process were included in the findings section.

- ***Week five:*** The main goal in the last week of training is for teachers to write original context-based questions. For this purpose, we asked teachers to come prepared for this week and planned based on questions that teachers prepared or started to prepare during the lesson. The teachers then presented the questions they had prepared and discussed with the teachers whether the questions were context-based.

Data Collection Tools

In this study, we used two documents and an unstructured observation. Documents are forms consisting of national and international questions (such as questions, proficiency levels) and context-based open-ended questions prepared by teachers as data collection tools.

Document 1: Forms consisting of national and international questions (such as questions, proficiency levels)

As a data collection tool, we used a form consisting of national and international questions prepared by the researchers. We took the questions in the form from exams such as PISA, TIMSS and TEOG, mainly from PISA application. The main reason for this situation is that PISA application includes questions closer to scientific literacy. There are eighteen questions in the form. We asked teachers to answer this test, find competences in the questions, make comments according to the difficulty level of the questions, and so on. In the first week, the teachers are expected to answer the questions basically, in the second and third weeks they are expected to examine in terms of proficiency and in the fourth week, they are expected to classify these questions. In this context, we distributed four different forms ("understanding the questions-Form 1", "finding the skills/competences in the questions-Form 2", "choosing the skills/competences in the questions from the given skills/competences-Form 3", "recognize the scientific literacy/ context based questions-Form 4") to teachers to examine the same questions from different perspectives. The forms' application lasted for one hour each week. Five hours of theoretical content and activities with teachers took place. An average one hour is devoted to filling out these forms.

Unstructured observations

The trainings were carried out by the team of researchers and observations were made throughout the process (30 hours). We observed in the form of unstructured observations. Two researchers made observations each week and notes were taken on the process. But the main goal in the observations is to examine teachers in terms of scientific literacy and context-based question writing skills. In the observation notes, we basically took notes on these parts. We compared the grades we get each week and we have a consensus. We also took video recording during the process and used video recording at the required points.

Document 2: Context-based open-ended questions prepared by teachers

We asked teachers to write questions in the last two weeks. Since the main purpose of the study was to examine the teachers' context-based question writing skills, we used these questions as a data collection tool. At this stage, the original context based questions developed by the teachers were analyzed. In other words, the questions that the contexts of their own found were emphasized. Since each teacher wrote questions in different contexts, many contexts / topics and different grade levels have occurred. While examining these questions, the features specified by Elmas & Eryılmaz (2015) were taken into consideration (general title is given theoretical framework section). A rubric related to these features has been created and whether the questions were sufficient or not has been analyzed.

Data Analysis

Data on the first sub-problem “teachers' understanding of scientific literacy questions” were collected with the help of document 1 and observations. In document 1, the form of “understanding the questions” was used. The answers of the questions in this form were given by the relevant organizations (PISA, TIMSS etc.), and how many points should be given to which answer was also shown. Accordingly, in the study the answer keys of international exams were used in data analysis. In addition, observation data were also analyzed in accordance with the descriptive analysis and were used to support the form’s answers.

The second sub-problem is “How do science teachers analyze the skills/competences of a scientific literacy question?”. Data related to this problem was collected through "finding the skills/competences in the questions "with "choosing the skills/competences in the questions from the given skills/competences" forms in document 1 and observations. Since the skills/competences required by the questions in the form were expressed by the relevant organizations, analyzes were made based on these skills/competences. In the “finding the skills/competences in the questions” form, the teachers wrote the necessary skills/competences themselves. The skills/competences written by the teachers and were analyzed by the researchers. And analyzes were made regarding the suitability of the determined skills/competences. At this point, since the criteria are the skills/competences determined by the organizations, descriptive analysis, which is one of the analysis methods, was used. The second form, "choosing the skills/competences in the questions from the given skills/competences", was given related skills/competences, and teachers were asked to mark and explain these skills/competences’ rationale. These skills/competences are defined by PISA. In this context, analyzes continued similar to the other form. In addition, the data obtained from the observation were analyzed according to the descriptive analysis to support the data related to the second sub-problem.

The form prepared by the researchers was used to distinguish the third sub-problem, scientific literacy/context-based questions. Some of thequestions in the form were, scientific literacy/context-based questions and some were not. Teachers were expected to distinguish these questions and write their justifications. Whether these questions were context-based or not was determined by both relevant institutional data and discussing researchers. In addition, observation data were also analyzed descriptively to support this sub-problem.

Final research question is “How are the science teachers writing scientific literacy/context based questions?” Document 2 was used as the basis for finding an answer to this question. The teachers were asked to write questions during the last two weeks, and in the last week they were asked to write original questions by finding context. Within the scope of the study, we analyzed context-based open-ended questions prepared by the teachers in accordance with the document analysis. As Çepni (2019) states, document analysis is the process of collecting the existing records and documents related to the work to be performed and coding them according to the specific norm or system. In this study, we used the document analysis method because the questions posed by the teachers had an important place for the study. These questions were analyzed based on the criteria set by Elmas and Eryılmaz (2015). Here, the main focus is on whether the question involves a problem or context that concerns the society or the individual. The second criterion is whether the questioned concept of science is appropriately polled. It is also the last criterion whether the problem includes the thinking processes. The sub-dimensions of these three criteria are included in the relevant study. In parallel with these determined criteria, the questions developed by teachers were analyzed.

It can be said that descriptive analysis of qualitative data analysis methods were used for four sub-problems. We also included the images obtained from these forms in the findings section. In order to present the overall picture in a realistic way and to compare it with the results obtained from other data collection tools, we have combined the data obtained from the observations with the data obtained from other data collection tools. The analyzes were conducted jointly by three researchers who are also article authors. Analyzes were carried out after one week or two after the training process. Then the article was edited by a researcher during the writing process. At this point, in parallel with its analysis by more than one researcher, it was tried to provide reliability, i.e. coherence. In addition, since the analyzed data was shared and discussed with the participant teachers the following week, participant confirmations were provided and internal validity, namely persuasiveness, was supported. In addition, instead of a single data collection tool, two different types of data collection tools were preferred and this situation was tried to be supported. Finally, in the findings section, the data were tried to be described in detail and it was aimed to complete the external validity, ie the transferability.

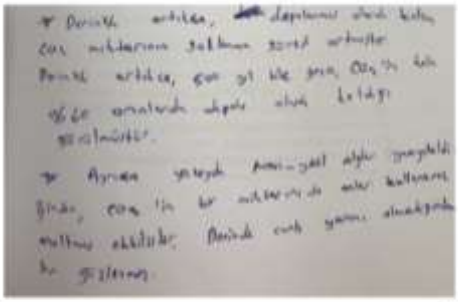
Findings

Findings Related to the Sub-Problem "How Do Science Teachers Understand Scientific Literacy Questionsin Literature?

According to the data obtained from the form 1 we collected from the teachers in our study, it was understood that the teachers answered almost all eighteen questions consisting of national and international exam questions correctly. Correct answers are those that get full points that are not recognized by the relevant organization (PISA, TIMSS etc.). In this context, we can say that teachers have been successful in answering context-based questions that serve scientific literacy. One of the most noteworthy issues in our observations is that teachers do not have any problems with the content knowledge necessary to solve the questions. Considering that the questions are prepared for the average age group of 15, it is desirable that teachers do not experience any problems. However, in our observations, we found that some teachers find it difficult to solve questions that require high-level thinking skills. For example, it was observed by researchers that teachers had difficulty in a question that requires interpreting and analyzing graphics. Photographs 2 and 3 for the answer of teachers' context-based questions are as follows.

In the Photograph 2, the teacher solved the question in detail about the fossil fuels question on graphic reading. In the Photograph 3, it is seen that the teacher answered the question on the variables correctly. Photograph 4 contains a question on how to read graphics and provide evidence. It is seen that the teacher provides evidence according to years. In this context, it can be stated that teachers are successful in solving context-based questions. At this point, it can be said that teachers are good at knowing the basic information necessary for scientific literacy.

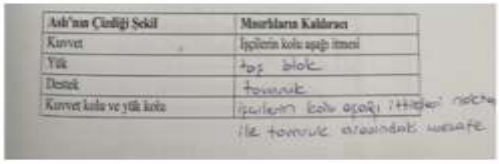
Fossil Fuel (3/4) (PISA 2015 Question)



* As the depth increased, the retention period of the amount of CO_2 remaining stored increased. As the depth increases, even after 500 years, CO_2 still remains 60% depot.
* In addition, since blue-green algae can survive on the surface, they may be reduced by using some of the CO_2. It is not observed since it does not have a deep life.

Photograph 2. Example of Teacher Answers 1

TIMSS 2007 Question (ID: S042244A)

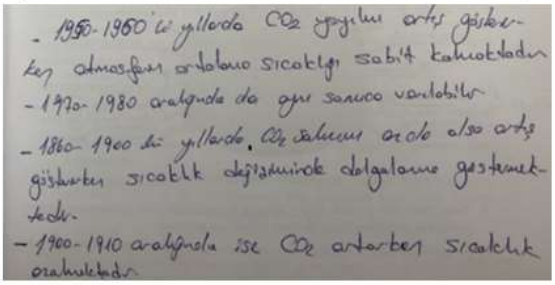


Ash'in Çizdiği Şekil	Mısırlıların Kullanımı
Kuvvet	İşçilerin kolu aşağı itmesi
Yük	taş blok
Destek	tomruk
Kuvvet kolu ve yük kolu	işçilerin kolu aşağı ittikleri nokta ile tomruk arasındaki mesafe

Ash's Figure	Leverage of the Egyptians
Force	Workers pushing the lever down
Load	Stone block
Support	Log
Force Lever and Load Lever	distance between the log and the point where the workers push the lever down

Photograph 3. Example of Teacher Answers 2

Greenhouse, Queston 1 (PISA 2006)



-In the 1950s and 1960s, CO_2 emissions increased, while the average atmosphere temperature remained constant.
-The same conclusion can be reached in the 1970s and1980s.
-In the 1860s and 1900s, CO_2 emissions increased, albeit slightly, and fluctuated in temperature changes.

Photograph 4. Example of Teacher Answers 3

Findings Related to the Sub-Problem "How Do Science Teachers Analyze Skills/Competences in Scientific Literacy Questions?"

In terms of knowing and applying the competences and skills required for scientific literacy, teachers are less successful than applying the content knowledge at this stage. In the activity with the teachers, context-based questions were given, and the skills/competences required in these questions were questioned. When the form 2 was examined, the most repeated skills/competences in teachers' answers were as follows:

"Interpretation, Graphical interpretation, Hypothesis building, having basic knowledge, defining variables, Analyzing, reading comprehension, evaluating data, Problem solving skills, Scientific process skills, Measuring skills"

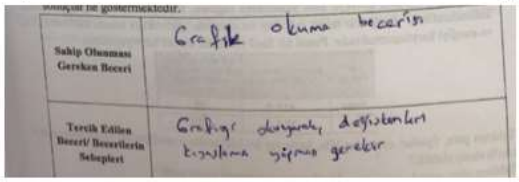
The teachers stated that they needed the most interpretation and graphic reading skills. In addition, skills such as hypothesis building, defining variables, and analysis are frequently repeated by teachers. Examples are given in Photographs 5 and 6.

Genetically Modified Crops, Queston 1 (PISA 2006)

Skill(s) to possess	Ability to recognize dependent-independent and controlled variable in the experiment and to interpret the result of the experiment
Reasons for preferred skill(s)	Can not solve the question without knowing the experimental method

Photograph 5. Example of Teacher Skills/Competences 1

Bee Colony Collapse Disorder, (4/5) (PISA 2015)



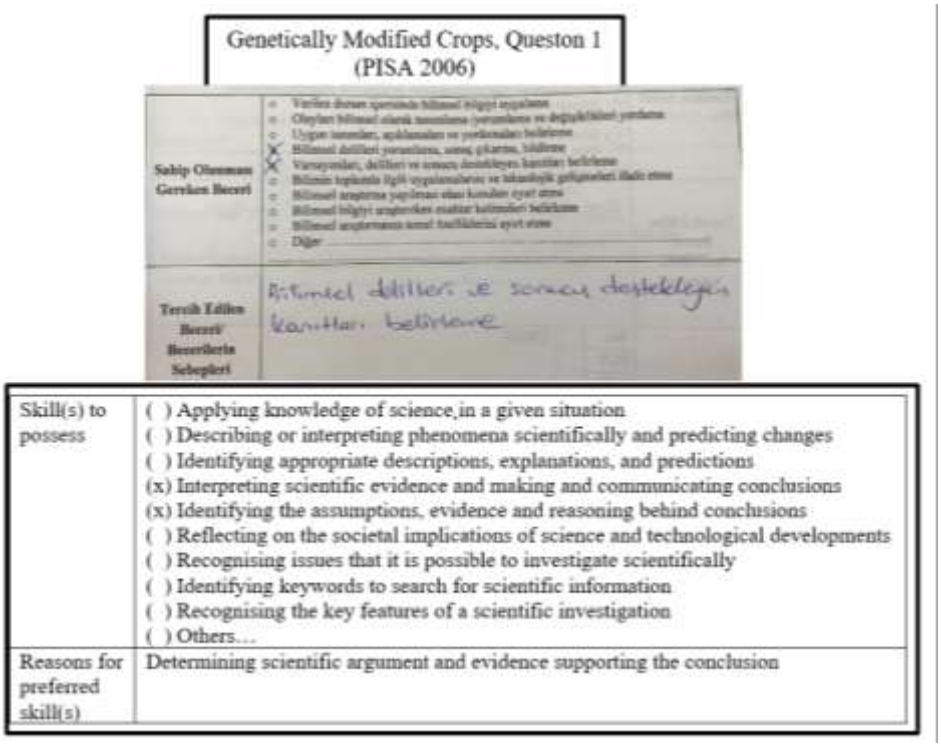
Skill(s) to possess	Ability to read graphics
Reasons for preferred skill(s)	By reading the graphic, it is necessary to compare the variables.

Photograph 6. Example of Teacher Skills/Competences 2

When the form 2 filled out by the teachers were examined, it was understood that although there were true statements, there were also false statements. In this context, it can be said that teachers have deficiencies in finding the necessary skills/competences for solving the problem. Observations also support this situation. In the observations, it was determined that teachers had problems in finding and defining skills/competences and in analyzing what the problem measures. A photograph of this process is included in Photograph 7.

Photograph 7. A moment from the Observation Process

In the second activity on identifying skills/competences (these skills/ competences are in the Photograph 8 which defined by PISA), the qualifications determined by PISA were given and teachers were asked to choose among these competencies and explain their reasons. Both documents and observations showed that teachers were more successful than the previous activity. An example of this is shown in Photograph 8. The most important mistake in this process is the desire of teachers to mark many skills/competences.



Genetically Modified Crops, Queston 1
(PISA 2006)

Sahip Olunması Gereken Beceri	○ Varılan durum içerisinde bilimsel bilgiyi uygulama ○ Olayları bilimsel olarak tanımlama (yorumlama ve değişiklikleri yordama ○ Uygun tanımları, açıklamaları ve yordamları belirleme X Bilimsel delilleri yorumlama, sonuç çıkarma, bildirme X Varsayımları, delilleri ve sonucu destekleyen kanıtları belirleme ○ Bilimin toplumla ilgili uygulamalarını ve teknolojik gelişmeleri ifade etme ○ Bilimsel araştırma yapılması olan konuları ayırt etme ○ Bilimsel bilgiyi araştırırken anahtar kelimeleri belirleme ○ Bilimsel araştırmanın temel özelliklerini ayırt etme ○ Diğer
Tercih Edilen Beceri/ Becerilerin Sebepleri	Bilimsel delilleri ve sonucu destekleyen kanıtları belirleme

Skill(s) to possess	( ) Applying knowledge of science,in a given situation ( ) Describing or interpreting phenomena scientifically and predicting changes ( ) Identifying appropriate descriptions, explanations, and predictions (x) Interpreting scientific evidence and making and communicating conclusions (x) Identifying the assumptions, evidence and reasoning behind conchusions ( ) Reflecting on the societal implications of science and technological developments ( ) Recognising issues that it is possible to investigate scientifically ( ) Identifying keywords to search for scientific information ( ) Recognising the key features of a scientific investigation ( ) Others…
Reasons for preferred skill(s)	Determining scientific argument and evidence supporting the conclusion

Photograph 8. Example of Teacher Skills/Competences 3

Findings Related to the Sub-Problem "How Do the Science Teachers Distinguish Scientific Literacy/Context Based Questions?"

In the next stage, the teachers were asked to select context-based questions about scientific literacy. Teachers generally misrepresented the cognitive level of the questions. Although this topic was discussed in the previous week and activities were conducted, it was observed that teachers had problems. Throughout this activity, it was determined that teachers selected almost all the given questions as context-based questions measuring scientific literacy (PISA, 2006). They stated the reasons for this from the very repetitive to the less repetitive as follows:

- Requires establishing a relationship between concepts
- Contains problems encountered in daily life
- Requires interpretation of graphics and tables
- Application oriented
- Requires conclusion
- Requires commenting
- Focusing on variables
- To be able to establish a cause-effect relationship
- Need to analyze the research results

When the reasons expressed by the teachers are examined, it is seen that the teachers correctly state the reasons of context-based question structures that measure scientific literacy. In addition, they stated that questions that do not measure scientific literacy contain the reasons "Requirement of book knowledge" and "It only requires remembering". When the reasons of teachers are examined, it can be understood that teachers are sufficient theoretically. However, it can be stated that teachers have some deficiencies at the point of application.

When we examine the observations made in applications and activities, the teachers are interested and participate in the activities throughout the education. With the activities, it was determined that teachers understand scientific literacy and life-based questions one more step each week. In this context, it is thought that teachers gradually learned the requirements of scientific literacy and the question structures that measure scientific literacy. A striking point in the process is that teachers are tired of solving questions even though they like applications more.

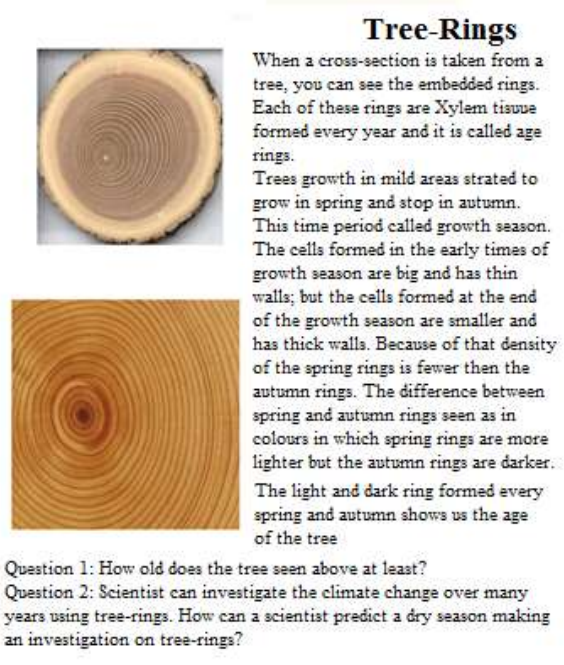
Findings Related to the Sub-Problem "How Do the Science Teachers Write Scientific Literacy/Context Based Questions?

As a result of these practices, teachers were asked to write context-based questions about scientific literacy. When we examine the questions prepared by the teachers, the general characteristics are as follows:

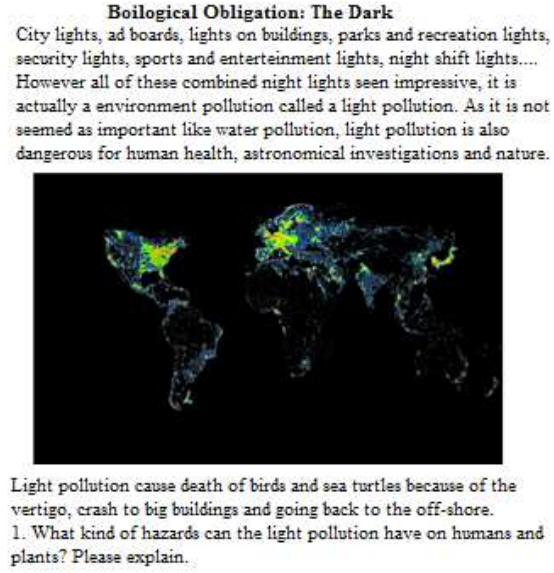
- Relationship with daily life in questions,
- There is a context in the questions, but generally there are problems in the relationship between the context and the item stem,
- The curriculum is not considered in the questions,
- The questions are usually close to the middle or upper cognitive level (such as comprehension, application, analysis).,
- The questions did not focus on high-level thinking skills.

When we examine context-based questions in terms of one of their characteristics, “it must contain a problem that concerns the individual or the community,” it can be stated that teachers are trying to relate them to a context or problem. However, it was found that the problem or context they started to construct was incomplete in some questions and that the relationship between the item stem and the context could not be fully established. In terms of another feature, “the concepts, formulas and laws of science should be in relation to context while the problem is being constructed”, it is understood that the questions are oriented towards a science concept. However, although it was stated that teachers were also asked to base a curriculum gain during the training period, it was determined that the questions ' relationship with the gain could not be fully established. When we look at the last feature, “the answer should come as a result of a thinking process rather than memorization”, teachers experience the most problems at this stage. When we look at the questions developed by teachers according to Bloom's taxonomy, they did not ask any questions at knowledge/remembering level, but the questions were generally at comprehension level. Some questions can be said to be at the higher level of application and analysis. However, the questions were found to be insufficient in terms of higher-level thinking skills. Given the importance of skills/competences in scientific literacy, this is a major shortcoming. Examples of questions posed by teachers are in Photographs 9, 10 and 11.

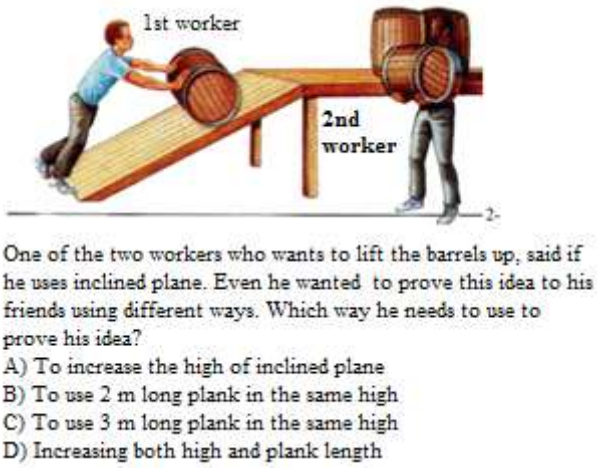
When the first example was examined, the teacher prepared a question about tree rings and gave information about it and entered a context. When the context is examined, some parts may be considered unnecessary, but generally related to daily life. However, it can be said that the context is not original and it is a known context in the literature. The questions were prepared in parallel with this context. The first question is a lower level and a calculation. When we look at the second question, it is seen that the teacher has more relationship with the context and tries to focus on a problem. However, one of the deficiencies in the question is that it is not directed towards the middle school curriculum. Although the question is about the concept of science, it is not appropriate for the scope of middle school. When we examine it in terms of skill/competence, it can be stated that although it includes interpretation and estimation processes, it is not a very comprehensive question in this respect. In the second example, a context for light pollution is established. However, it is also possible to solve the question by reading the root of the question without reading the context. In this context, it can be stated that the relationship between the question root and the context is not fully established. When the context in the question is examined, it is seen that it contains a problem from daily life. At this point, it can be said that the problem can be effective when a question containing context is prepared.



Photograph 9. Teacher I's Question



Photograph 10. Teacher R's Question



Photograph 11. Teacher M's Question

The third example is a context that can be encountered in everyday life with simple machines. However, context and item stem are not fully expressed, and parallel to this situation, the problem that context contains is not fully understood. When the question is studied at this point, it is thought that there may be context involving a problem from everyday life. When we examine the question structure, it can be said that it is parallel to the question structures asked in the transition exams to high schools in our country. It can be stated that the problem is compatible with the curriculum gains but there are important deficiencies in terms of high-level skills.

Discussion and Conclusion

According to the findings of the study, it was understood that teachers were able to solve context-based questions related to scientific literacy and they had difficulty in solving only the questions requiring some high-level skills. In this context, we can say that teachers are sufficient to know the basic concepts specific to the field required for scientific literacy. Considering that the participants are individuals who have been teaching for a long time, it is desirable that teachers do not have problems in their questions. Another finding obtained from teachers is that their students can do when they read these questions. However, students have perceptions about what they cannot do without reading context-based questions. Similar situation has been observed in some teachers. Güler (2013) found that as the main sources of difficulty for students to solve PISA questions, students do not trust themselves, do not fully read the problem, do not understand what they read and act carelessly. At this point, in addition to having knowledge in context-based questions, it is necessary to have full attitude and confidence about what it can do.

When we look at the findings related to the competences and skills necessary for scientific literacy, the most frequently mentioned skills are interpreting, graphical interpretation, hypothesis, defining variables, and analyzing. In PISA questions (OECD, 2013), it is thought that the highest number of interpretations and inferences from graphs is also in the study conducted in parallel. In the study conducted by Aktaş and Ceylan (2016), it was determined that pre-service science teachers' skills of defining and controlling variables, procedural defining skills were low, hypothesis-building skills were medium and research designing, graphics and data interpretation skills were high. It can be understood that teachers are more successful in interpreting data and graphics and are more effective in recognizing these skills. In general, it can be stated that teachers have knowledge in terms of necessary skills/competences, which is a dimension of scientific literacy, but this level is lower than knowledge dimension. Because the findings show that teachers have deficiencies in finding the necessary skills (such as identifying evidence, identifying fundamental features of the research) to solve the problem. However, it can be said that this situation will improve over time when teachers are more confronted with these skills or competences. Another finding obtained from the study is that teachers cannot prepare questions related to skills/competences such as interpretation and graphic reading in their own questions. In fact, although teachers found that they had interpretation and graphic reading skills in the questions they examined, they had problems integrating these skills into their own questions. At this point, it can be stated that teachers have problems in applying to the application dimension in parallel with their new encounter with these skills/competences. As they face these skills/competences, they are thought to include their own questions. However, considering the skill/competence dimension is important in comtext-based questions, it can be stated that it causes great deficiencies in the questions.

During the education process (Form 4), teachers were asked to choose context-based questions about scientific literacy. The main objective is to help teachers understand the structures of context-based questions for scientific literacy. The findings obtained in this context showed that teachers correctly selected scientific literacy questions. Teachers explained the reasons for this situation by using expressions such as the need to establish relations between concepts, the problems encountered in daily life, the need to interpret graphics and tables, and the need to apply them. In this context, it was understood that teachers theoretically knew the characteristics of context-based questions for scientific literacy. However, when the teachers themselves were

asked to write questions, that is, to use the theoretical knowledge they had towards the application, it was understood that they had some shortcomings.

When the findings from the questions prepared by the teachers are examined, the questions contain a context or problem from daily life. However, it was understood that the relationship between the problem or context and the root of the question that teachers began to construct could not be fully established. Similarly, as a result of their study in Ültay and Usta (2016), prospective teachers found that they were inadequate in choosing context from daily life. It can be said that teachers are expected to be challenged at this stage, as finding context or creating questions related to context requires a high level of skill in the question writing process. At this point, it is thought that as teachers prepare questions, that is, as they gain experience, this problem will disappear. In addition, since the exam system in our country includes a multiple choice question structure and the number of context-based questions is very few, teachers are not accustomed to these question styles. However, in recent years, the number of context-based questions has increased especially in high school entrence exams. In this context, teachers are increasingly used to context-based questions and believed to be more successful in writing this type of question. In the questions prepared by the teachers, it was determined that they were successful in establishing a relationship with the science concept or subject. It was understood that teachers had problems at the point that “questions involve a thinking process,” the final context-based feature. It has been determined that teachers ' questions are usually at a level of comprehension, but that the questions are lacking in terms of having a reasoning process. Similarly, in their study Özcan and Oluk (2007), they determined that the questions prepared by science teachers were largely at the level of knowledge and practice. Koray, Altunçekiç and Yaman (2002) found that the ability of science prospective teachers to ask questions was improved in the steps of "knowledge and comprehension", but that such skills were lower in the steps of "application, analysis, synthesis and evaluation", which included the use of learned knowledge and high-level thinking. This may be a positive development considering that the questions prepared in our study are not at the level of knowledge but at the level of understanding and higher level. However, we think that teachers need to improve this situation by writing more questions in order to include thinking skill processes in the questions.

As a result, teachers started to learn about scientific literacy requirements and context-based question structures that measure scientific literacy during the course. In this context, it can be stated that teachers' knowledge and competence in scientific literacy and context-based question writing gradually increase. In parallel with the education received, it is usual for science teachers to get better and better. Aslan (2011) stated that while a significant part of the questions prepared by the participants before the application was low, there was a significant increase in the percentage of the high-level questions after the application. With similar trainings, teachers can understand context-based questions and improve their context-based questions writing skills.

Suggestions

Some deficiencies were found in the results of the questions prepared by the teachers. In order to solve this problem, teachers need to prepare more context-based questions about their experience, namely scientific literacy. In addition, another way to increase the experience of teachers in this field is to increase the number of hands-on trainings for teachers. In this context, it may be suggested that the number of trainings to be given for scientific literacy and context-based question writing should be increased by similar content or by developing content.

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