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Research Article

Designing a science lesson: Developing pre-service teachers' lesson planning skills based on real-life context-based approach

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Abstract

In this study, it was aimed to support pre-service primary and science teachers' ability to implement real-life context-based course design in the 5E Model and to use current science education approaches in lesson designs. For this purpose, action research, one of the qualitative research types, was adopted. 13 pre-service primary and science teachers participated in the research. The data of the study were obtained from pre-post measurements, lesson plans developed by the pre-service teachers and observations made by the researchers as participant observers. The data were analyzed with descriptive and content analysis methods. The preliminary results show that pre-service teachers could not use basic teaching approaches such as the real-life contextual approach, nature of science, scientific reasoning, STEM activities, Web 2.0 tools, laboratory implementations. At the end of the trainings, pre-service teachers' competencies in preparing a science lesson plan based on context-based science teaching and in accordance with the current and basic science education paradigm increased significantly. This study supported the pre-service teachers' science self-efficacy for introducing current practices related to science teaching during their undergraduate education to become classroom and science teachers and to gain skills on how to reflect these practices in lesson plans. The findings indicate that there is a need for practical training in teacher training due to field studies in Turkey, and that pre-service teachers should adopt the 21st century science teaching approach.

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Introduction

Today's education systems are faced with the effort to develop the knowledge, skills, attitudes and values necessary to prepare individuals for rapid economic, environmental and social changes, jobs that have not yet been created, technologies that have not yet been invented, and solving unexpected social problems (Organisation for Economic Co-operation and Development [OECD], 2018). Science education is one of the main areas with effective importance in developing these knowledge, skills and attitudes that are necessary for today and the future. As a matter of fact, the importance of the value that societies attach to science education during the COVID-19 pandemic has once again come to light. For example, vaccine studies and vaccine hesitations (Kinali et al., 2022), individuals' conscious behavioral tendencies towards the pandemic and their reactions to scientific studies (Valladeres, 2021) are reflections of the science education that societies have. Thanks to science education, it is aimed to raise students as individuals who use scientific knowledge in their daily lives, comprehend science-technology-society and environmental relations, and perhaps most importantly, participate in the socio-scientific debates of the future informedly (Ağlarcı-Özdemir, 2020). Teachers play the most important role in fulfilling this clear goal. At this point, this study focuses on the education of pre-service teachers who have an active science teaching role in the basic education period. This is because the practicum in pre-service teacher curriculum is the longest and most intensive exposure to the teaching profession experienced by pre-service teachers (Cohen et al., 2013). From the perspective of Turkey, as a society with a population of approximately 23 million children (Turkish Statistical Institute, 2022) taking measures to ensure that this process is carried out effectively and efficiently is undoubtedly an important element in raising individuals who are better prepared for life. For this reason, developing qualified science teaching designs of pre-service teachers constitutes the main vision of the study.

One of the main issues in raising an individual who is better prepared for life with science education is to show the student that science is widely applicable in nature and life and in different aspects of life. When the national and international literature is examined (Badeli, 2017; Can, 2017; Gilbert, 2006; Hoşbaş, 2018; King, 2009; Konur & Ayas, 2010; Pilot & Bulte, 2006; Sak, 2018; Stolk et al., 2009) it is possible to see the findings that there is an isolation between science lessons and real life. Kwok (2018) states that science education at all levels of education is generally seen as abstract and irrelevant to real life, and that students think they cannot relate science discipline content and materials to the real world. When the research on science teaching programs from the past to the present is examined, it is often stated that the curriculum is intensive and intangible structure, and that there are instructional problems caused by teachers' inability to understand the curriculum sufficiently (Gilbert, 2006; Karaman & Karaman, 2016; King, 2009; Konur & Ayas, 2010; Özcan & Düzgünoğlu, 2017; Pilot & Bulte, 2006; Saraç & Yıldırım, 2019; Schwartz, 2006). Also, in the World Economic Forum's large-scale global research on the output of Education 4.0, when the curricula/working principles of the schools chosen as the schools of the future are examined, it is observed that they adopt a science teaching approach that has an answer to real-life problems (The World Economic Forum [WEF], 2020, pp. 12-20). Along with the necessity of transforming the knowledge gained through the science course into a skill in real life, the science education paradigm of nations is evolving into real-life context-based science education understanding (Bennett et al., 2006; De Jong, 2006; Eilks &

Hofstein; 2017; Kwok, 2018). In this context, the real-life approach in science teaching was chosen as the focal element in developing the lesson design.

The Real-life Context-Based Learning Approach is a learning-teaching approach based on shaping the teaching and assessment process with a context that includes real-life situations familiar to the student in which teaching is carried out based on the need to know (Bulte et al., 2006). In this approach, teaching starts with a context that the student is familiar with from his/her socio-cultural environment, concepts are taught within this selected context, and the effectiveness process is increased by associating the taught concepts with other contexts (Aydın-Ceran, 2018). The Real-life Context-Based Approach is a 21st century science teaching approach that offers a teaching environment focused on gaining science literacy (Gilbert, 2006), conceptual understanding skills (Aydın-Ceran, 2018; Akpınar, 2012; King, 2009), scientific process skills (Glynn & Koballa, 2005), STEM skills (Sevian, Dori, & Parchmann, 2018), understanding of nature of science (Duruk, 2017). As a matter of fact, the Program for International Student Assessment (PISA), which we can qualify as one indicator of international education and which is conducted by the OECD, associates students' science literacy with their success in daily life contexts. The science literacy term used in PISA evaluates students' ability to apply scientific knowledge to real life, as well as what they know in science (OECD, 2019). From this point of view, in this study, the issue of teacher training who teaches science in the context of real life and adopts the 21st century current science education approach is given importance.

When the literature is examined, studies focusing on the lesson plan development practices of pre-service teachers are encountered. Spooner et al. (2007) developed a Universal Design for Learning that can help teachers design an accessible lesson plan for all students. Jacops et al. (2008) developed and validated the Science Lesson Plan Analysis Instrument (SLPAI) for quantitative evaluation of teacher-generated multiday lesson plans. Goldstone et al. (2013) centered on the psychometric examination of the structure of an instrument, known as the 5E Lesson Plan (5E ILPv2) rubric for inquiry-based teaching. Srikoom (2020) has focused on the development of STEM integrated lesson plans. Also, there are also studies that examine the lesson plans developed by pre-service teachers according to various parameters. (Aşiroğlu & Koç-Akran, 2018; Canbazoglu-Bilici et al., 2016; Çolak & Yabaş, 2017; Kim & Bolger, 2017; Saraç & Uygun, 2020; Ültay et al., 2018). When the related literature is examined, it can be said that the lesson design trainings that deal with the current and basic dynamics of science teaching in teaching practice are limited. Therefore, in this study, the necessity of creating a multidimensional education package has been a driving force in developing lesson designs that include basic and current applications within the framework of the 21st century science education paradigm. In this context, real life element in science teaching was chosen as the focus in developing lesson design. With in this focus, a holistic and multidimensional design approach was tried to be developed with dynamics such as 5E, STEM, nature of science, scientific reasoning, web 2.0 tools, scientific inquiry and science laborotary.

Zeichner (2003) states that teaching is a clinical practice profession, just like clinical psychology and medicine. This view, which sees teaching as a clinical practice profession, attaches more importance to practical activities than theoretical knowledge. Pre-service teachers should be equipped with an appropriate academics curriculum and developed a policy for effective lesson plans (Hafiz et al., 2021; Terra et al., 2020). It is seen in the literature that science and primary teachers experience uncertainty about how they will contribute to the learning of

each child in science teaching, and that they have practice-oriented problems, especially in gaining field-specific skills (Çelik & Avcı, 2018; Kanat, 2018; Kubat, 2015; Loxley et al., 2016; Tatar & Ceyhan, 2018). For this reason, it is important that pre-service teachers in science lessons, which are based on experiment and observation but have many field-specific dynamics, have sufficient experience in terms of lesson plan development, implementation and evaluation context of 21st century current science education. Within the framework of all these, with the focus on transforming scientific knowledge into real life skills, the development of pre-service teachers' course design skills that include current and basic science teaching practices has a high value in terms of science teaching in the classrooms of the future. In this context, with this research, it was aimed to develop the skills of pre-service teachers in making holistic and multidimensional lesson design based on context-based science teaching. Within the framework of holistic and multidimensional lesson design approach, focused on the development of pre-service teachers' skills to use basic and contemporary approaches in lesson designs such as scientific inquiry, nature of science, STEM, Web 2.0 tools, and the 5E Model. In line with this general framework, the sub-objectives of the research are as follows:

1. What is the self-evaluation of pre-service teachers for designing a science lesson?
2. How do the trainings help pre-service teachers develop their lesson plans?
3. What is the self-evaluation of pre-service teachers in designing a post-education science course?

Methodology

Research model

In this study, the action research type of qualitative research method was adopted. Action research in education is research that teacher use to solve a problem they encounter in their classrooms, to improve the learning level of their students in any subject, and to increase their own professional performance (Creswell, 2012). According to Elliot (1991, p. 49), the main purpose of action research in education is “to develop practice rather than to produce knowledge”. For this reason, action research is focused on providing “change and development” (Gürgür, 2017, p. 39). In this research, it is aimed that pre-service teachers can develop lesson and activity plans in the 5E Model based on the context-based science teaching principles. The research was conducted according to the action research type of practice-oriented approach. The action research process followed in the research is visualized in Figure 1.

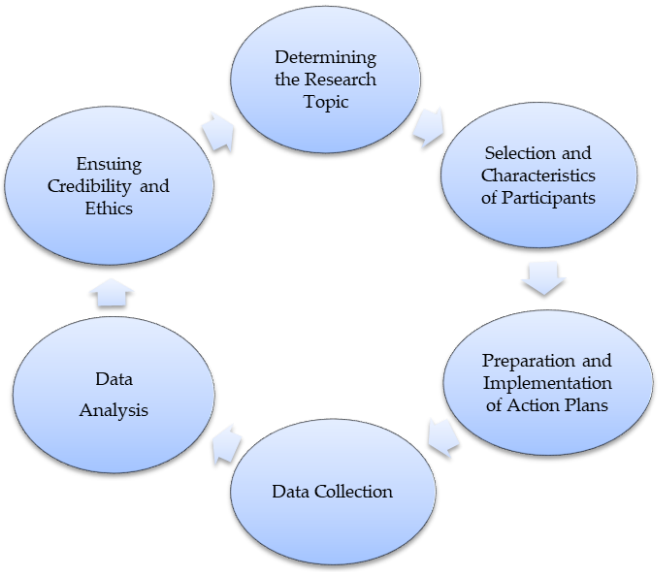

Figure 1. Research process

According to Figure 1, the studies carried out during the research process can be explained under the relevant headings as follows:

Determining the research topic

The subject of the study was determined during the scientific talking between first author who had many years of experience in science teaching, and the second author who had experience in classroom teaching. As a matter of fact, these observations cover the shortcomings of pre-service teachers in designing and developing science lessons, associating them with real life, and in making lesson designs based on the current and basic approach in science teaching. The researchers adopted a principal decision about the necessity of designing a lesson based on the learning needs of each student in classroom in line with their public school experiences and the observations of pre-service teachers on internship practices. Based on their experiences and observations, the researchers adopted an approach based on the real-life element in science teaching. Within the framework of this approach, they decided to use the 5E model, which is known for its usefulness and functionality, as a skeleton model in their lesson plans. In the lesson designs to be developed in the 5E Model based on real-life contexts, it is aimed that pre-service teachers adopt basic and current science teaching approaches and use them in their lesson plans. In the study, the nature of science, scientific reasoning, scientific process skills, STEM, laboratory applications and Web 2.0 tools were included in basic and current science teaching approaches. Thus, it was thought that the professional development of pre-service teacher can be strengthened and that teachers who are better equipped in science teaching will make significant contributions to future learning environments (Hafiz et. al., 2021; Terra et. al., 2020).

Participants

In the selection of the participants of the research, pre-service teachers at the education-teaching level, where the science course is carried out as an independent course, were determined as the target population. Criterion sampling and chain sampling techniques were used to reach the participants. According to this, the first participants who met the condition of

not having taken part in similar research before were reached among the pre-service primary school teachers who would actively conduct the science lesson at the 3rd and 4th grades and the pre-service science teachers. Then, other participants with similar characteristics were reached through the first participants and the study group of the research was expanded. Reaching people who meet the criteria by determining certain criteria and then expanding the sample by adding other people who meet the criteria to the study group with the guidance of the previous participant is a sampling technique suitable for the nature of qualitative research (Creswell, 2012; Patton, 2018). Pre-measurement was applied to 15 participants, of whom nine were pre-service primary teacher and six were pre-service science teachers selected under this technique. Since two of the participants did not give a voluntary participation statement, these pre-service teachers were not included in the research process. There were 13 pre-service teacher in the final study group. The most distinctive feature of the participants, obtained from the pre-tests, is that they considered themselves inadequate in developing an activity/lesson plan for lesson structuring, the real-life context-based science teaching principles and current science education approach. In addition, the other characteristics of the participants can be expressed in Table 1 as follows:

Table 1. Demographic characteristics of the participants

Branch	Gender	Grade	University
PST1	F	4	Gazi University
PST 2	F	3	Gazi University
PST 3	F	4	Karamanoglu Mehmetbey University
PST 4	M	3	Gazi University
PST 5	M	4	Necmettin Erbakan University
PST 6	F	3	Necmettin Erbakan University
PST 7	F	4	Gazi University
PST 8	M	4	Necmettin Erbakan University
PST 9	F	3	Necmettin Erbakan University
ST1	F	3	Necmettin Erbakan University
ST2	F	3	Necmettin Erbakan University
ST3	F	3	Necmettin Erbakan University
ST4	F	3	Necmettin Erbakan University

Note. In Table 1, the abbreviation PST indicates a pre-service primary teacher, and the abbreviation ST indicates a pre-service science teacher.

Action plans

A preliminary evaluation was made through Google forms to determine the current status of the pre-sevice teachers within the scope of the research topic. Then, the relevant literature was reviewed. In this context, topics that are considered important in terms of basic and current science education was determined based on real-life contextual approach. Because of the multidisciplinary nature of the science course in the trainings, attention was paid to include applications of concepts and achievements for all disciplines, such as physics, chemistry, biology, the environment, and health. In line with this plan, the action plans were implemented via an online platform for 33 lesson hours over a period of four days. Then, the process was completed by applying the post-tests to the pre-service teachers. In the research, 33 action plans, either theoretical or practical, were implemented in nine modules. The nine modules included

in the action plans are given in Table 2, and the detailed action plan table is given in the Appendix.

Table 2. Modules in action plans

Module Name	Duration of Implementation (min)
Daily Life and Scientific Reasoning: Developing Inquiry-Based Reasoning Skills	180
Elements of Daily Life in Chemistry Subjects; Event Design and Implementation Based on Real-Life Contexts	225
Activity Development for Daily Life Elements and Real-Life Problems in the Design of STEM Activities	180
The Place of Real-Life Context-Based Science Education in Curricula in the World and in Turkey According to International Education Indicators	90
How to Develop a Lesson Plan Based on Real-Life Contexts: How is it applied?	135
Cleaning Agents Used in Daily Life, Health Hazards and Safety Precautions	90
Context-Based Nature of Science Lesson Plan Development and Implementation	315
"Environmental Pollution" as a Real-Life Context: Developing and Implementing Activities Appropriate for Science Curriculum Outcomes	225
Use of Interactive Web 2.0 Tools in Science Teaching Based on Real-Life Contexts and Sample Practices	180
Total	1620

The developed action plans were implemented via an online platform within the scope of a program comprising 36 lesson hours (one lesson hour was calculated as 45 minutes) over a period of four days between 18.10.2021 and 21.10.2021. The responses of the participants to the preliminary measurements were effective in the creation of the action plans. In this direction, the first action plan drafts were prepared. The action plans were reviewed by both the researchers and the validity committee. After the revisions and changes were made to the action plans in line with the recommendations of the validity committee, each action plan was put into practice by academics who were experts in the subject.

Data collection tools

The data of the study were obtained from pre-post measurements, lesson plans developed by the pre-service teachers and observations made by the researchers as participant observers.

Pre- and post-measurements

Preliminary measurements of the research were made between 07.10.2021 and 17.10.2021 before implementing the action plans. A semi-structured interview form was used in the preliminary measurements. In the first part of the interview form, six closed-ended questions were included for some demographic information of the participants. In the second part, questions that aimed to evaluate their competence to structure lessons based on context-based science teaching principles and develop lesson-activity plans in accordance with current and basic science education dynamics were included. Some of these questions are as follows:

"How would you describe your ability to develop a lesson plan for a science lesson?",

"Do you have any information about the Life/Context-Based Teaching Approach? If the answer is 'yes', can you briefly explain what you know?",
"How would you explain the Nature of Science?"
"Can you create an idea for a context-based activity based on Scientific Reasoning?"
"How would you describe your ability to use the 5E Model in creating lesson plans?"

In addition, in order to better understand the proficiency status of pre-service teachers, guiding questions such as the following were included:

"When you started your profession, did you consider yourself competent to design a lesson plan about science teaching? What are the reasons for your answer?",
"Can you give examples of national and international practices related to teaching and assessment and evaluation approaches within the scope of life-based science education?",
"Do you consider yourself competent in integrating STEM with your lesson design? Can you explain why?"

The final measurements were made between 19.10.2021 and 29.10.2021 after implementation of the action plans was completed. In the last measurements, some questions asked to the pre-service teachers in order to determine the contribution of the education they received within the framework of the action plans are as follows:

"What are the subjects, concepts or practices that you have had the opportunity to learn for the first time in science education with this training?".
"How did this education contribute to your feeling ready for the teaching profession and improving your professional skills? ".

Lesson plans developed by pre-service teachers

In line with the action plans realized within the scope of the research, pre-service teachers were asked to design a lesson plan based on context-based science teaching principles and in the 5E Model for one of the science lesson curriculum topics or achievements. In addition, pre-service teachers were asked to integrate into their lesson plans at least one component (STEM, WEB 2.0, the Nature of Science, scientific reasoning, etc.) from the subjects they were trained in. The lesson plans of the pre-service teachers were checked by the researchers at regular intervals. During these checks, various pieces of feedback were given to the pre-service teachers. In line with this feedback, 13 lesson plans, which were completed by the pre-service teachers, were obtained.

Participant observation

Participatory observation helps the researcher to develop a good understanding of events by providing a holistic view of behaviors and interactions in a real context (Schoen, 2007). In this study, both researchers were participant observers at every stage of the research. The data obtained as a result of the participant observations were used to create the action plans and interpret the findings.

Data analysis

Descriptive and content analysis methods were used in the analysis of the data. For content analysis the researchers came together from time to time and compared their coding. In

this comparison process, common and different codes were determined. While the common codes were accepted by both researchers, re-evaluations were made on the differences. This process was carried out under the supervision of a different colleague. At the end of this process, 40 codes and 15 categories were created. The theme and code relationship is interpreted in detail under the relevant themes. Direct statements of pre-service teachers are also presented to show the basis of the theme and code formation processes. A code name such as "PST1" or "ST2" was used for each participant (PST1 shows the pre-service primary teacher who is the first participant, while ST2 shows the pre-service science teacher who is the second participant).

The presence of both researchers as participant observers during implementation of the action plans enabled the observations of the whole process to be evaluated from a different perspective. The results of these observations made it possible to make some determinations by mutually discussing issues such as the effectiveness of the applications made in the data analysis process, the shortcomings, the development of the participants, the suggestions of the participants, etc. In analysis of lesson plans, a descriptive analysis of the data obtained was made and the percentage and frequency values of the category/codes were determined. For this, both researchers analyzed the lesson plans prepared by the pre-service teachers after the training in line with 2 different criteria. These are the Real-life Context-Based Lesson Plan Criteria Table developed by Tekbıyık (2010) and revised by Aydın-Ceran (2018), the Stages Model of the Real-life Context-Based 5E Model developed by Aydın-Ceran (2018).

Credibility and ethics

Reliability in qualitative research is directly related to the reliability of the researcher's observation and the detailed presentation of each stage of the research (McMillan & Schumacher, 2010). By using more than one data collection method and technique together, a data triangulation approach is adopted and an attempt is made to minimize the possibility of the researcher making "systematic mistakes" (Yıldırım & Şimşek, 2008). In this study, an attempt was made to increase the validity and reliability of the research by using three types of data collection methods: interview, observation, and document review.

Another method used to increase credibility in qualitative research is peer debriefing (Holloway & Wheeler, 1996). All the action plans used in this study were examined by the validity committee made up of 8 academicians, including the researchers. As a result of these examinations, it was decided that the action plans can overcome the inadequacies in lesson structuring, lesson plan and activity development based on real-life context-based science teaching principles and can raise awareness current and basic science education dynamics. In addition, a pilot application of the pre- and post-measurement questions created to ensure credibility in the research was conducted on nine participants. The questions were examined by two academicians who are experts in the field.

Citations and stories are very important to establish the confirmability of a study. For this purpose, the findings should include the participants' own statements rather than the researcher's prejudices or opinions (Lincoln & Guba, 1985). In this research, direct quotations were made from the statements of the participants as the basis of the categories created by following a similar path. The Miles & Huberman (1994) coefficient of agreement was calculated for agreement between the researchers. This coefficient showed that there was 93% agreement between the researchers. At the beginning of the research process, a voluntary participation

statement was obtained from all participants. In addition, the identities of the participants were kept confidential by using codes such as "PST1" or "ST2" in the analysis processes for each participant.

Findings

Pre-service science and primary school teachers' self-evaluations on designing a science lesson

The data obtained from the interviews and observations with the 13 pre-service teachers were analyzed before the trainings. Based on these analyses, the categories related to pre-service teachers' self-evaluations on planning and designing a science lesson can be explained as follows:

In the "proficiency" category, a significant number of pre-service teachers (76%) stated that they did not consider themselves competent in developing a context-based lesson plan and designing lessons in accordance with the current and basic science teaching dynamics, that they needed support in this regard and that they did not have serious experience. This finding has been the launching pad for the creation of an education and training program by researchers. Some views of the pre-service teachers regarding the "proficiency" category are as follows:

> *"I have never had experience of preparing a science lesson plan in classroom teaching classes. But I can create a simple lesson plan based on the lesson plans we prepared in other lessons." PST6.*

> *"I don't think I gained the skill of preparing a lesson plan in the faculty. However, I am trying to prepare a lesson plan in line with the 5E plan with the lessons I took in the previous semesters." ST2.*

In the category of "focus in lesson design", the basic elements that pre-service teachers focused on in creating a course design were examined. It has been determined that the focal elements in this category are grouped under four different codes. These are "lesson plan preparation principles (47%)", "content selection (32%)", "teaching methods-techniques (%28)", and "student's affective characteristics (24%)". Focusing on the principles of lesson plan preparation in lesson design, the pre-service teachers focused on principles such as suitability for the level of the student and suitability for the subject. In the selection of content, it was seen that the pre-service teachers emphasized the necessity of the content to be real-life-based, multidisciplinary and simple. On the other hand, in the teaching methods and techniques code, it was seen that the pre-service teachers focused on the lesson plan being student-centered and based on active learning approaches. Some views on these categories and codes are as follows:

> *"The course should be prepared in accordance with its aims, objectives and gains. The lesson plan should be flexible and applicable, and should be prepared by paying attention to individual differences. A learner-centered course design should be created that will make the student active." PST3.*

> *"The lesson should be made interesting. It should be reconciled with daily life. It is important to teach at the level of any age group." ST2.*

In the category of "problems in the integration of basic dynamics", it was found that pre-service teachers had problems in using the elements that constitute the basic dynamics of science teaching in a lesson design, such as the nature of science, scientific reasoning, STEM, laboratory and Web 2.0. In addition, pre-service teachers stated that they did not consider themselves

competent in terms of these basic dynamics. Pre-service teachers stated that they could not receive adequate education in some science teaching practices in the faculty, especially that the trainings involving such subjects coincided with the distance education period in the COVID-19 pandemic, and therefore, that the courses were inefficient. This finding of the research has guided the researchers in the planning of trainings to integrate the dynamics expressed by the pre-service teachers into the context-based course design. Some of the pre-service teachers' opinions are as follows:

> *"I do not consider myself competent in areas such as STEM and the nature of science. I am familiar with these concepts, but I think I will have difficulty integrating them into course designs." PST8.*

> *"Unfortunately, I don't consider myself competent in how to use STEM, scientific reasoning, and life skills to develop a context-based lesson plan. Since it coincided with the COVID-19 pandemic process, I could not even take adequate laboratory courses in the 1st and 2nd grades. That's why I'm so deficient." ST2.*

In the category of "professional anxiety", pre-service teachers expressed concerns such as not being able to follow current developments in their teaching careers or not knowing the means of self-development. When this category is examined, there are two codes: "personal factors (56%)" and "external factors (51%)". When the personal factors code is examined, it can be said that the pre-service teachers emphasized the inadequacy of their own learning efforts or the need for more learning activities. The external factors code includes the problems in the structure of the undergraduate curriculum and the limitations of distance education in the COVID-19 period. Some opinions regarding this category are as follows:

> *"Sometimes I do not consider myself competent in teaching appropriately for raising scientifically literate individuals. Not performing the necessary practices and not being able to put my theoretical knowledge into practice are the reasons for this answer." PST3.*

> *"I search for experiments that can be done on the subjects in the curriculum so that my students can learn by experiencing as much as possible. However, I don't feel competent because I can't obtain the best results from distance education. I think I have a lot to learn." PST7.*

Lesson designs developed by pre-service teachers after the training

The lesson plans developed by the pre-service teachers were evaluated by the researchers according to 2 different criteria tables. A descriptive analysis of the data obtained in this process was made and the percentage and frequency values of the categories/codes are given in Table 3 and Table 4. The criteria given in Table 3 were scored by the researchers. Each criterion has a value between 1-4 points (totally adequate=4, highly adequate=3, partially adequate=2, inadequate=1). The highest score that can be obtained according to the criteria table is 44, and the lowest score is 11.

Before the values in the table were recorded, a separate scoring was made for each pre-service teacher's lesson plan, and the total mean scores of the 13 pre-service teachers from each criterion are reflected in Table 3.

Table 3. Analysis of pre-service teachers' lesson plans according to real-life context-based lesson plan criteria table

	X	Totally Adequate		Highly Adequate		Partially Adequate		Inadequate	
		f	%	f	%	f	%	f	%
1.The lesson begins with a context chosen from daily life that will interest the student.	3.61	8	61.53	3	23.07	2	15.8	-	
2.The context is such that it can be easily associated with science concepts.	3.53	8	61.53	4	30.76	1	7.69	-	
3.The context will increase the student's interest and motivation towards science.	3.53	7	53.84	6	46.15	-		-	
4.Guiding questions are asked to enable the student to establish a connection between the context and scientific knowledge and concepts.	3.23	6	46.15	6	46.15	1	7.69	-	
5. It makes students feel that learning scientific concepts is a necessity.	3.53	5	38.46	7	53.84	1	7.69	-	
6.Regarding the events that the student encounters in daily life, it enables them to find solutions by using scientific process skills, such as accessing information, interpreting information, analyzing information and making decisions.	3.07	5	38.46	5	38.46	2	15.38	1	7.69
7.It enables the student to find solutions to the events he/she encounters in daily life by using scientific knowledge.	3.07	5	38.46	5	38.46	2	15.38	1	7.69
8.It allows the student to relate the concept to the context (recognizing the connections between concepts and real-world applications).	3.53	6	46.15	5	38.46	2	15.38	-	
9. It allows the student to transfer the context to other concepts and contexts (transfer important links from one field to another).	3.23	6	46.15	5	38.46	1	7.69	1	7.69
10. It contains contextual assessment questions to determine whether the content is understood by students.	3.61	8	61.53	5	38.46	-		-	
11. It enables students to realize the social importance of science.	3.46	7	53.84	5	38.46	1	7.69	-	
Criteria Average	3.40		49.64		39.15		9.08		2.09

When the lesson plans prepared by the pre-service teachers are examined according to the life-based lesson plan criteria table, it is seen that the mean value of the lesson plans in the context of all criteria is 3.40. When this mean value is compared with the highest score that can be obtained, it can be said that the level of designing a lesson plan in accordance with the principles of a real-life context-based lesson plan is 85%. According to the real-life context-based lesson plan criteria of the lesson designs, on average, 49.64% were totally adequate, 39.15% were highly adequate, and 9.08% were partially adequate. However, it can be observed that a very low rate of the lesson plans, namely 2.09%, were not at an adequate level in terms of some criteria (6-7-9). If a detailed examination is made in the context of the criteria, it can be said that the

lesson plans were adequate in terms of criteria 1-2-3-5-8 and 10. However, pre-service teachers had difficulties in designing their lesson plans in terms of the 6th, 7th and 9th criteria.

Lesson plans were analyzed according to the stages of the Real-Life Context-Based 5E Model (Aydın Ceran, 2018) as presented in Table 4 within the framework of these criteria.

Table 4. Analysis of teacher pre-service teachers' lesson plans according to the stages of the real-life context-based 5E model

Stages	Criteria	Frequency	Percentage (%)
Engage	Guiding questions that invite students to question and making an introduction to the course with a context that attracts the student's interest and provides acceptance, and revealing students' questions (Beasley and Butler, 2002; King, 2009b).	12	92.30
Explore	Elaborating the context, framing the problem/hypothesis in context, need-to-know (Beasley and Butler, 2002).	10	76.92
	Student activities based on the scientific research process, including daily life situations on the basis of research and inquiry.		
Explain	Teaching knowledge and content on the basis of making learning a need (King, 2009).	10	84.61
Elaborate	Relating and transferring the concept and context (King, 2009b).	9	69.23
Evaluate	Exiting the real-life context; student's presentations or reports to implement knowledge, reflect and inform (Beasley & Butler, 2002; King, 2009b), life-based contextual questions and preparation for the next lesson.	10	76.92

The lesson plans of the pre-service teachers were examined according to the Real-Life Context-Based 5E Model and the 5E Model updated by Bybee in 2014. In line with this review, it can be said that pre-service teachers were quite successful in integrating the lesson plans, especially the engagement phase with context-based understanding. For example, PST3 used the context of "Bulb" in the lesson plan she prepared for the teaching of Simple Electrical Circuits in the 4th grade. PST3 started the lesson with a story called "My Brilliant Team" to attract students' attention to the lesson. Then, she asked guiding questions that made the students feel the relationship between the light bulb context and scientific concepts and invited the students to research and question. The design of PST3 at the introductory stage is as follows:

"1. The teacher reads the story "My Brilliant Team" to the students.

2. He/she asks the following questions to the students listening to the story:
• What problems would we have if we did not have bulbs and lights in our homes?
• What materials did the nano-bright bulb use to create its team?
• Can you give an example of the structures created by Nano in your environment?
• What did the nano-bright bulb use to run its team?" PST3.

In the exploration phase, some pre-service teachers (PST1, PST3, ST2) had difficulties in designing an inquiry-based activity that would enable students to make knowledge a need. For example, PST1 used the context of obesity in the teaching of our 4th grade food/healthy lifestyle

topic. With the videos and visuals that she showed at the stage of arousing curiosity, she created a desire to learn in the students and asked guiding questions that enabled them to associate scientific concepts related to healthy life and foods in the context of obesity. However, in the exploration phase, instead of designing an activity that would enable students to develop their scientific process skills and explore healthy living dynamics within the context of obesity, a nutrient matching study was carried out.

It has been observed that approximately 77% of the pre-service teachers were at the desired level in making a design that allows the student to make the first explanation during the explanation phase (Bybee, 2014). These pre-service teachers used an organization in their designs that guided them to explain the relationship between the student's exploratory experiences and the scientific concept and real-life context. However, some pre-service teachers (PST1, PST5, PST6) preferred a design that started with their own explanations rather than a design that allowed the student to explain before the explanation phase.

In the elaboration phase, approximately 70% of the pre-service teachers achieved the desired level of success in establishing a relationship between the context they used in the engagement phase and the concept and transferring it to other contexts. The problem observed in pre-service teachers who could not make the desired design in establishing this relationship was to move away from the real-life context used and to go to a new context configuration.

When examined according to the evaluation stage, it can be said that the course designs were at a good level, especially in creating real-life context-based questions. In the evaluation phase, pre-service teachers designed activities that enable the student to make inferences and reason by associating scientific concepts in line with the real-life context. It was found that pre-service teachers designed activities with the theme of completing the story, observing in nature, designing a STEM activity, concept map-caricature, scientific journal and newspaper news without breaking the relationship with the real-life context used in the elaboration phase.

Pre-service teachers' self-evaluations on designing a science lesson after the training

After the training given on the design of context-based science lessons, the data obtained from the interviews and observations with the 13 pre-service teachers were analyzed. Based on these analyses, the categories related to pre-service teachers' self-evaluations on planning and designing a science lesson can be explained as follows:

In the "lesson design approach" category, pre-service teachers focused on the impact of the trainings on developing a lesson design. This focus has been evaluated around two different codes. These are "implementation and comprehension (62%)" and "the connection between science and life (51%)". Regarding the implementation and comprehension code, the pre-service teachers stated that they were aware of the current and basic science teaching approaches, but that they understood this dynamics better in many aspects through the trainings. In addition, they stated that they gained skills in making implementations about 5E, Real-life Context Based Science Teaching, natue of science, STEM and web 2.0 tools. Also, they emphasized that they gained an understanding that the necessity of establishing the science-life connection is an important component of today's science education understanding. Some opinions regarding this category are as follows:

"It made me realize that there is an education that is intertwined with life outside of the traditional approach and that this education is more appropriate for our age." PST7.

"I understood the necessity of considering the basis of real-life in all course designs that I will make in science teaching. Of course, the effectiveness of a science education that is far from the real world will be very low." PST2.

"It gave me an important competence in integrating scientific process skill, nature of science and web 2.0 tools in science into a context-based course design." ST4.

The category of "21 st century teacher", pre-service teachers stated that they gained awareness about the characteristics that a teacher teaching science lessons should have today. In this category, the prominent findings are that a teacher has 21st century skills and gives students scientific reasoning, research and questioning skills. Also, pre-service teachers stated that a teacher should have a vision that integrates science with real life in science teaching. In addition, another prominent feature is that teachers should constantly improve their pedagogical, technological and professional knowledge-skills by following the current science education dynamics.

"A science teacher allows the student to explore and experience. While doing this, it should provide guidance on where to use science in daily life." ST3.

"A teacher should be an individual who can develop himself in line with constantly developing science and technology, besides his/her field and pedagogical knowledge, and who can question and make students question." PST2.

In the category of "contribution to professional skills", pre-service teachers emphasized the professional gains of the education they received. It can be said that there are five codes in this category. These are professional self-confidence, professional competence, technological-pedagogical content knowledge, activity-lesson design skills, and integration of science into real life. The pre-service teachers mentioned that the education they received increased their competence in designing a science course, improved their self-confidence, and improved their competence in transforming scientific knowledge and concepts into real-life skills. In addition, they stated that the trainings increased their knowledge and skills in technological-digital applications in science and provided support in feeling more ready for the profession. Some opinions about this category and codes are as follows:

"I knew the expectations of the 21st Century Science Education Understanding from the teachers before the project, but I had felt incompetent about how I should foster these skills in the students. There are serious tips from this education that I received. I will face my students with more confidence because a teacher with an effective lesson plan will reach the hearts and minds of their students more quickly." PST3.

Findings from participant observers' notes

In this study, both researchers were participant observers at every stage of the research. Participant observers' notes are discussed in three categories. These categories are before and at the beginning of the trainings, the training process, and the completion of the trainings.

In the category of "before and at the beginning of the trainings", the observers determined that the pre-service teachers could not give satisfactory answers to the questions posed on basic topics such as international and national education indicators, real-life context based science teaching, nature of science, scientific reasoning, and Web 2.0 tools used in science

education. It was observed that the pre-service teachers did not have enough self-confidence in these matters, and that they were shy in answering the questions, though they had more self-confidence in STEM and 5E subjects. However, in the pre-assessments and in the interviews about the lesson plans before the trainings, it was seen that there was wrong learning about the use of both STEM and 5E. Based on these findings, the action plans were shaped.

In the category of "the training process", it was observed that pre-service teachers were very interested, curious about education issues, took part actively, worked in cooperation, and asked questions to educators both in and outside the online classroom frequently. In the category of "completion of the trainings", it was observed that the pre-service teachers gave more confident and correct answers to the questions directed to them, were enthusiastic about performing different activities, and were highly motivated to improve themselves in science teaching.

Discussion, Conclusion, and Recommendations

With this research, it was aimed to develop the skills of pre-service teachers in making holistic and multidimensional lesson design based on context-based science teaching. In this context, revealing the existing knowledge, skills and ideas of pre-service teachers before the training was the first problem of the research. According to the results obtained from the first sub-problem of the research, it can be understood that the pre-service teachers did not consider themselves competent in preparing a science lesson plan based on the Context-Based Science Teaching approach. In addition, the participant observers findings show that pre-service teachers' prior knowledge and skills in context-based teaching, nature of science, scientific reasoning and international science education indicators in the first lessons were inadequate. Therefore, the preliminary results show that pre-service teachers could not use basic dynamics such as the nature of science, scientific reasoning, STEM activities, Web 2.0 tools, laboratory implementation that can be included in a holistic and multidimensional lesson design based on real-life context-based science teaching. When the national literature is examined, although this study was conducted with pre-service teachers, the results are in line with the studies conducted with in-service teachers. In fact, it is concluded in the literature that teachers cannot understand the context-based approach, cannot apply it in their lessons, have difficulties in time management of the implementation, do not have adequate skills in preparing/selecting the context, and interpret as only presenting examples from daily life (Ayvacı et al., 2013; Karamustafaoğlu & Tutar, 2020; Mete & Yıldırım, 2016; Topuz et al., 2013; Yıldırım & Gültekin, 2017). Also, Yıldırım (2018) found that teachers had difficulties in integrating STEM fields into their context-based lesson plans. In addition, the fact that pre-service teachers felt inadequate about their ability to design a holistic and multidimensional science lesson based on the Real-life Context-Based Science Teaching approach caused them to have professional anxiety. At this point, pre-service teachers believed that they had an openness to improvement in conducting future science lessons. This result was observed similarly in the results of previous studies. As a matter of fact, it is seen in the literature that science and primary teachers experience uncertainty about how they will contribute to the learning of each child in science teaching, and that they have practice-oriented problems (Goodnough, 2010; Kanat, 2018; Loxley et al., 2016). Based on these results, it is thought that the lack of these skills in pre-service teachers will cause problems in on-the-job science teaching.

According to the second problem situation of the research, it is seen that pre-service teachers were able to make lesson plans that meet the criteria of developing real-life context-based lesson plans according to 5E after their education. Pre-service teachers were able to develop an adequate level of lesson plans in accordance with criteria such as being able to choose a context from daily life, understanding the relationship between context and concept, increasing interest and motivation towards science and need to know scientific knowledge. When the lesson plans of the pre-service teachers are examined, it is observed that they are more successful especially in the engage, explore, explain and elaborate stages. In addition, it was observed that they used STEM, nature of science, laboratory applications and web 2.0 tools in the stages of 5E in line with the real life context they chose in their lesson plans.The least success was achieved in the elaboration phase. The efforts of the pre-service teachers to create a new context by breaking away from the initial context were effective in their failure to achieve the desired success at this stage. In addition, there were pre-service teachers who were able to transfer the real-life context to new concepts and contexts. In addition, they asked the educators questions about these issues both in the classroom and outside the classroom and shared them with the educators in the course by conducting in-depth research. These results of the research, which emerged at the point of integrating the 5E method and the context-based teaching approach, are important in terms of giving a unique perspective to the literature. When the studies in the field are examined, the studies on the teaching of context-based teaching practices to pre-service teachers are quite limited. In addition, studies have been found in which the training given to pre-service teachers was done with context-based teaching (Demircioğlu & Özdemir, 2019; Ültay & Usta, 2016). Ültay et al. (2018) discussed the comparison of primary teachers' lesson plans in accordance with the REACT and 5E Model. The results of this study, on the other hand, present a detailed education plan and a analysis of this action plan in terms of 5E, context-based teaching and current science education dynamics with lesson plans. In this context, this study is a pioneer in this field of study in terms of fostering the skills specified for pre-service teachers and increasing their competencies.

According to the third problem situation of the study, pre-service teachers' self-evaluation in preparing a science lesson plan based on context-based science teaching understanding and current science education dynamics significantly at the end of the trainings. Pre-service teachers stated that they improved in understanding, applying and awareness of current science education dynamics in the design of a science lesson plan. In addition, pre-service teachers realized that the nature of science, scientific reasoning, STEM, laboratory and Web 2.0 tools should be included in the lesson plans of activities that could enable the use of. At this point, the pre-service teachers emphasized the necessity of scientific reasoning, research and questioning, and the ability to recognize and know science in daily life and to transform it into a skills in real life for teachers with 21st century skills. In addition, the necessity of a teacher to be open to change and transformation from a professional point of view is among the other 21st century teacher qualifications that were emphasized. Finally, according to participant observers' notes and final evaluation data, pre-service teachers stated that they gained professional self-confidence and competence in the contribution of education to their professional skills, their technological-pedagogical content knowledge increased and they developed in activity planning. Based on this fact, it can be said that in raising science-literate individuals who can adapt to the new world order, there is a need for a teacher who can first establish the science-life bond himself

and reflect this bond in his/her lessons. It should not be forgotten that this understanding can be realized by teachers who are trained with a high level of awareness on this subject during the pre-vocational education stage, as seen in our research results. Therefore, it can be suggested that theoretical and applied contents be added to pre-vocational teacher training programs (especially at primary and secondary school level) based on real life and in the light of current 21st century science education dynamics. Küçük et al. (2013), in their study examining the science teaching self-efficacy of primary teachers, observed that the science teaching self-efficacy of new teachers (1-3 years' experience) was much higher than that of experienced primary teachers. The reason given for this was that the science courses taught at the faculty and the school practices yielded positive results (p. 62). Similarly, Güder and Demir (2018) found that as the age level of primary teachers increased, their self-confidence in technological and pedagogical content knowledge decreased. This study supported the pre-service teachers' science self-efficacy for introducing current practices related to science teaching during their undergraduate education to become primary and science teachers and for gaining skills on how to reflect these practices in lesson plans. These results suggest that the added value of quality science teaching practices to be offered in the pre-service period will be high in the coming years. In summary, the findings indicate that there is a need for practical training in teacher training due to field studies in Turkey.

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Appendix

Action plans and implementation times

Module Name	Action Plan	Duration of Implementation (min)
Daily Life and Scientific Reasoning: Developing Inquiry-Based Reasoning Skills	Developing Inquiry-Research-Based Reasoning Skills	45
	Fossil Footprints Mysterious Car Vanilla Ice Cream A Prediction Story: Mysterious Bones	45
	Prerequisites of Scientific Reasoning Scientific Reasoning and Some Professional Groups	90
Elements of Daily Life in Chemistry Subjects; Event	Elements of Daily Life, Activity Development and Application in Chemistry Subjects	45

Design and Implementation Based on Real-Life Contexts	Occupational Health-Safety and Chemistry Applications as a Daily Life Context	45
	Occupational Health-Safety and Chemistry Applications as a Daily Life Context	45
	Elements of Daily Life in Chemistry Subjects	45
	Elements of Daily Life in Chemistry Subjects -Solution Preparation	45
Activity Development for Daily Life Elements and Real-Life Problems in the Design of STEM Activities	STEM (Role of Sound in Hearing)	90
	STEM (Role of Sound in Hearing)	45
	Forest trip	45
The Place of Real-Life Context-Based Science Education in Curricula in the World and in Turkey According to International Education Indicators	A Perspective on Real-Life Context-Based Science Education in Turkey in the Light of Current Data	45
	A Global Perspective on Real-Life Context-Based Science Education in the Light of Current Data	45
How to Develop a Lesson Plan Based on Real-Life Contexts: How is it applied?	Context Selection and Integration of Context into the Lesson Plan Process	90
	Context Selection and Integration of Context into the Lesson Plan Process	90
Cleaning Agents Used in Daily Life, Health Hazards and Safety Precautions	Cleaning Agents Used in Daily Life, Health Hazards and Safety Precautions-1	45
	Cleaning Agents Used in Daily Life, Health Hazards and Safety Precautions-2	45
	Cleaning Agents Used in Daily Life, Health Hazards and Safety Precautions-3	45
Context-Based Nature of Science Lesson Plan Development and Implementation	What is the Nature of Science?	45
	Mysterious Footprints	45
	The Nature of Science and Scientific Inquiry	45
	Mysterious Bones Event	45
	The Nature of the Pedagogically-Based Science Lesson Plan Preparation Process	90

		Unconscious and Excessive Lighting, Do Not Cause Light Pollution!	45
"Environmental Pollution" as a Real-Life Context: Developing and Implementing Activities Appropriate for Science Curriculum Outcomes		Unconscious and Excessive Lighting, Do Not Cause Light Pollution!	45
		Give up plastic bags for a sustainable environment, choose cloth bags!	45
		Give up plastic bags for a sustainable environment, choose cloth bags!	45
Use of Interactive Web 2.0 Tools in Science Teaching Based on Real-Life Contexts and Sample Practices		Animaker	45
		Animaker	45
		Algodoo	45
		Algodoo	45
		Padlet & Edpuzzle	45
		Padlet & Edpuzzle	45
Total	9	33	1620