Effect of Cognitive Apprenticeship-Enriched Argument-Driven Inquiry Method on Pre-Service Teachers' Academic Achievement and Scientific Research Skills

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ABSTRACT

This study aimed to determine the effect of a cognitive apprenticeship-enriched argument-driven inquiry method on pre-service primary teachers' academic achievement and scientific research skills regarding environmental issues/problems. The study was conducted with 24 first-grade pre-service primary teachers from the Primary Teacher Department of a private university in Northern Cyprus. The study was conducted using a mixed-methods research design. The data collection tool used in this research is an academic achievement test, an open-ended question form for transferring knowledge to daily life, and students' videos/photos, reflective diary protocol, scientific research proposal-article-poster, and Moodle discussion contents. The research found that pre-service teachers' academic achievement and scientific research skills improved. According to this result, cognitive apprenticeship-enriched argument-driven inquiry improved pre-service teachers ' academic achievement related to the Environmental Education Course and their scientific research skills related to environmental topics and concepts.

Keywords:[1]
Cognitive apprenticeship, argument-driven inquiry, environmental education

INTRODUCTION

Rapid changes in science and technology affect individual and social needs, requiring new learning-teaching approaches and methods. Countries must re-evaluate their education systems and curricula on the basis of current global trends. Many countries, such as the US, Australia, New Zealand, Turkey, and OECD countries, have updated their science curricula. The main goal of these curricula is science literacy, which is crucial for society. Science literacy individuals are those who produce knowledge, apply this knowledge in daily life, find solutions to problems using scientific methods, think critically and creatively, are entrepreneurial, are able to make decisions, communicate, empathize, and respect social and cultural values (MNE, 2018). In other words, science literates are individuals who understand the nature of science, follow and understand scientific developments, have sufficient knowledge of science and engineering to participate in social debates on related issues, use scientific and technological knowledge effectively in daily life, continue to learn about science outside of school, and have the skills to enter careers of their choice, including careers in science, engineering, and technology (National Research Council [NRC] 2012; The Next Generation Science Standards (NGSS), 2013). Researchers including Duschl, Schweingruber, and Shouse (2007) and Duschl (2008) contend that science literacy comprises four connected components. First, one must be familiar with key scientific theories explaining the nature of reality, be able to apply existing theories to issues, and comprehend new theories in this light. In addition, one must be able to produce and assess scientific justifications and arguments. Third, to be literate in science, a person must comprehend the nature of science and how it has changed over time. Lastly, and perhaps most significantly, she/he requires a person to be able to engage in scientific practices (like designing and carrying out investigations, analyzing and interpreting data, and making arguments based on evidence) and to communicate in a way that adheres to the standards of the scientific community. An individual with science literacy can make decisions for themselves in the context of pertinent issues in daily life, participate in the relationship between society and culture, and use their understanding of science topics, scientific processes, and the epistemological aspects of science (developing epistemological beliefs) to work for economic productivity (Walker, 2011). In this context, science curricula in different countries include new teaching methods such as inquiry-based learning designed to help students develop science literacy and examples of the application of these methods. In parallel with this, just like the changing profile of science literacy individuals, expectations from teachers, who implement these science curricula and methods, have also changed.

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Science teachers are expected not only to help their students learn the basic facts and concepts of physics, chemistry, and biology but also to provide them with certain competencies. These competencies include asking questions and defining problems, developing and using models, planning and conducting investigations, analyzing and interpreting data, using mathematics and computational thinking, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information (Sampson et al., 2015). However, the role of teachers is crucial for the success of science curricula (El Nagdi, Leammukda, & Roehrig, 2018). One way to enhance teachers' skills is to offer them training before or during their service (Ayas & Özmen, 2002; Azar, 2011). This would enable them to foster science literacy among their students, such as the ability to think, research, create, socialize, assert, persist, communicate effectively, and contribute to society and culture (Jimenez-Aleixandre, Rodriguez, & Duschl, 2000; Kaçar, Ormancı, Özcan, Balım, & Urhan, 2022; Ormancı, Kaçar, Özcan, & Balım, 2020). Therefore, it is preferable to work with pre-service teachers in this study. This study aims to demonstrate to pre-service teachers how the argument-driven inquiry method can be used effectively in the learning-teaching process. In this context, the Environmental Education Course in the Classroom Teaching Undergraduate Program is chosen as an appropriate course to apply these methods. At this point, it is thought that it will be useful to briefly discuss the argument-driven inquiry and cognitive coaching-apprenticeship approaches that constitute the theoretical foundations of the learning-teaching (experimental application) process of this research.

Argument-Driven Inquiry Instructional

The argument-driven inquiry method was first described by Walker (2011), Walker, Sampson and Zimmerman (2011) and Sampson, Grooms, and Walker (2011). This method was developed as a reaction to undergraduate courses conducted according to the traditional (cookbook) laboratory approach. According to Walker, Sampson, and Zimmerman (2011), pre-service teachers who find undergraduate courses boring and unpleasant fail in the courses; they cannot comprehend what it means to do science because of laboratory activities that are based on the notion of verification. Therefore, they are not prepared to solve real science problems, make informed decisions about science-related issues, or teach science meaningfully. As a result, pre-service teachers graduate from universities without the competencies that teachers should have to educate science literacy students. To prevent this situation, Walker and colleagues developed a new learning-teaching method, argument-driven inquiry.

The argument-driven inquiry method is grounded in the constructivist approach. It includes a perfect harmony of argumentation and the inquiry method. In other words, it addresses the issues of argumentation and the inquiry process in the inquiry-based approach and the argumentation-based learning method, respectively. This teaching strategy is a lab-based approach that integrates research and inquiry and emphasizes the value of argumentation in science education (Walker et al., 2012). The argument-driven inquiry method attaches great importance not only to the experimental features of laboratories (questioning, method development) but also to the presentation of scientific claims (argumentation, writing) in developing students ' science literacy (Çetin & Eymur, 2018). In other words, this instructional method offers a broad perspective by combining argumentation with laboratory-based instruction (Walker & Sampson, 2013a; 2013b). This teaching strategy is intended to provide students with a more realistic and educational learning experience by providing them with the opportunity to conduct their own research, engage in argumentation, write scientific papers for an informed audience, participate in the peer review process, and revise their own papers in response to feedback (Sampson and Walker, 2012; Walker et al. 2010; 2012). According to Sampson et al. (2017), the argument-driven inquiry method fosters students' development and use of conceptual models, research design and implementation, explanation construction, idea sharing and critique, and other competencies that are essential for becoming science literate individuals. This method consists of eight stages, as shown in Figure 1.

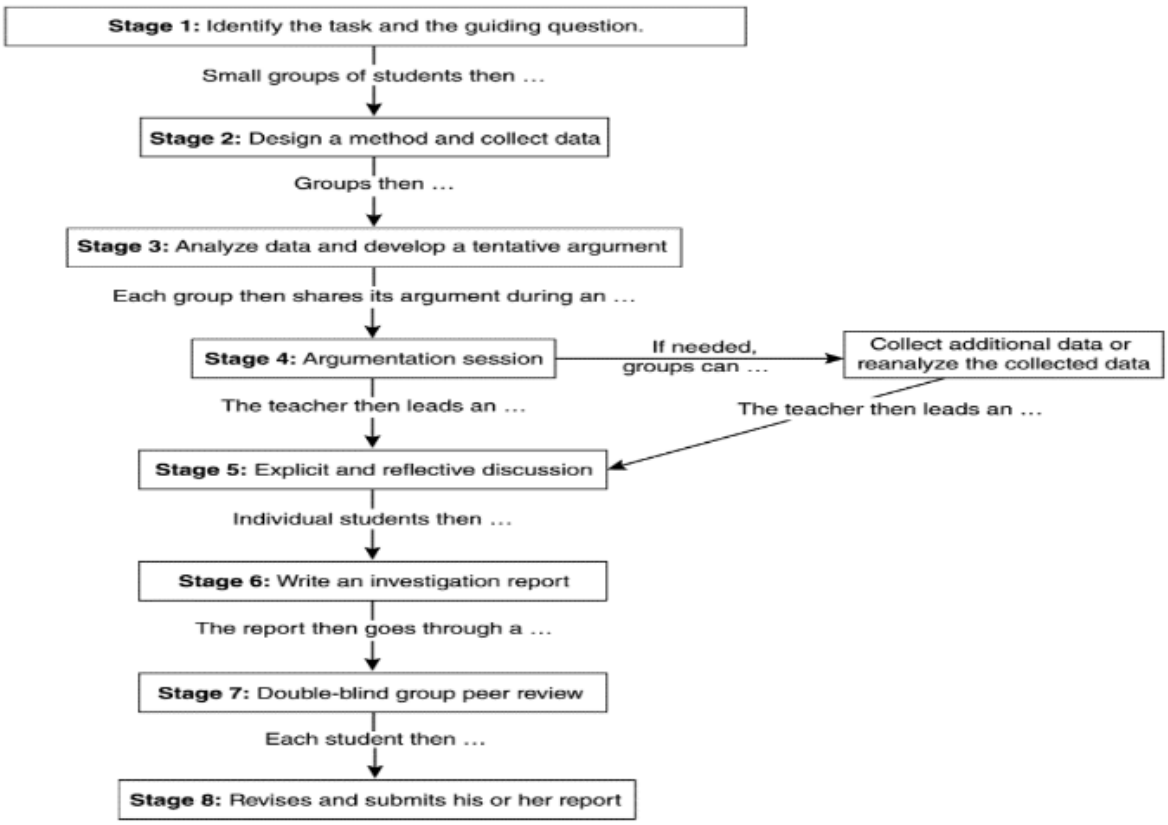


Figure 1. Stages of the Argument-Driven Inquiry Instructional Model (Grooms et al., 2016, pp.2, as cited in Kaçar ve Balım, 2021b, pp.818).

This learning method, as illustrated in Figure 1, emphasizes both the practical components of laboratory work (posing questions, designing methods) and the communication of scientific findings (reasoning, writing) to foster students' science literacy (Çetin & Eymur, 2018; Kaçar & Balım, 2018; 2021a). In other words, it integrates argumentation with laboratory-based teaching for a comprehensive view (Fakhriyah & Rusilowati, 2021; Walker & Sampson, 2013a; 2013b).

Cognitive Apprenticeship

Learning based on the coach-apprentice relationship is a learning-teaching approach that has been practiced in social structures for a very long time. In this method, a person specialized in a job or craft passes on his or her knowledge and skills to a less experienced person (apprentice). The coach provides both theoretical and practical training to the apprentice, directs, supervises, and evaluates him/her. The apprentice listens to the expert's instructions, imitates his or her actions, asks questions, and receives feedback. Thus, over time, the apprentice reaches the level of an expert (coach) and can train his or her own apprentices. For example, consider the woodworking job. A woodworker expert teaches his apprentice how to select, process, assemble, and paint wooden materials. The apprentice gains both theoretical and practical knowledge by working alongside the expert. The coach checks the apprentice's work, corrects mistakes, gives hints, and recognizes achievements. By observing the coach's work, the apprentice learns his techniques and subtleties. Thus, the apprentice becomes an expert in the carpentry profession and can then train his own apprentice. In this context, the cognitive apprenticeship approach is consistent with the views of researchers who advocate that in raising science literacy individuals, learning-teaching processes should be organized in a way that allows students to conduct scientific research and produce knowledge (Barab & Hay, 2001; Duschl, 2008; Duschl, Schweingruber & Shouse, 2007; Sampson & Walker, 2012).

Cognitive apprenticeship is a learning experience based on individuals being guided by experts in the process of developing cognitive and metacognitive skills related to a subject (Dennen & Burner, 2008). Cognitive apprenticeship is defined as a process of acquiring knowledge and experience that learners perform in accordance with the nature of science and scientific research in the working environments of expert researchers with their support (Bell, Blair, Crawford, & Lederman, 2003). An investigation is a broad approach

that involves the active participation of learners in authentic scientific inquiry, while apprenticeship is a more specific approach that places this inquiry within the framework of a particular scientist's research project. In this case, the apprentice works under the guidance of an expert, using the scientist's lab and equipment, doing the science that supports the scientist's work, and doing the science that the scientist (and possibly the apprentice) cares about (Barab ve Hay, 2001; Cooper, 2015). According to Chinn and Malhotra (2002), the expert helps the learner by showing them how to use their heuristics and strategies, guiding students to develop and justify their ideas, prompting them to express their knowledge and strategies, and offering a practice environment where students can use their knowledge, heuristics, and strategies in the context of authentic scientific tasks. This experience enables the learner to understand the social aspects of science and may help the learner adopt ways of thinking and acting that are aligned with those of real scientists. Thus, learners can conduct authentic research in a different cultural identity (e.g., scientist) under the guidance of expert researchers (e.g., laboratorian, technician, scientist, etc.) in mature application areas (e.g., laboratory environment, observation in nature, etc.) (Barab, 1999; Barab & Hay, 2001; Charney et al., 2007). Thus, learners recognize the value and meaning of acquiring knowledge skills. In light of this information, it is thought that the cognitive apprenticeship-enriched argument-driven inquiry will contribute to pre-service teachers' in-depth understanding of environmental issues such as population and ecosystem, developing their scientific research skills, and solving science-related problems.

When the related literature is examined, it is found that argument-driven inquiry increases learners' academic achievement (Arslan, Genç, & Durak, 2023; Kaçar & Balım, 2021b; Sampson & Gleim, 2009; Walker et al., 2012) and improves their scientific research skills (Fitri, Rusdi & Effendi-Hasibuan, 2022; Walker & Sampson, 2013). Moreover there are studies on the effects of cognitive apprenticeship on learners' scientific inquiry (Aydemir, Baksa, & Skinner, 2011), their understanding of the nature of science (Bell, Blair, Crawford, & Lederman, 2003), and their cognitive-personal and professional development (Hunter, Laursen, & Seymour, 2007). In parallel this study examines the effect of the cognitive apprenticeship-enriched argument-driven inquiry method on pre-service primary school teachers' academic achievement and their ability to conduct scientific research about environmental issues/problems.

In this context, the problem statement of the research is: "What is the effect of the cognitive apprenticeship-enriched argument-driven inquiry method on pre-service primary school teachers' academic achievements and their ability to scientifically research environmental issues/problems in the Environmental Education Course?" The sub-problems of this research are as follows:

- What is the effect of the cognitive apprenticeship-enriched the argument-driven inquiry method on pre-service primary school teachers' academic achievements in the Environmental Education Course?"
- What is the effect of the cognitive apprenticeship-enriched argument-driven inquiry method on pre-service primary school teachers' scientific research skills regarding environmental issues/problems in the Environmental Education Course?

METHOD

This study adopted a mixed-methods research design that integrates and aligns quantitative and qualitative data collection and analysis methods. In this design, the researcher can embed a qualitative phase within a quantitative phase, such as an experimental study, or a quantitative phase within a qualitative phase, such as a case study (Creswell, 2003; Creswell & Clark, 2017; Çepni, 2021; Greene, Caracelli, & Graham, 1989). In other words, a mixed research methodology involves combining, connecting, and validating techniques for collecting and analyzing both quantitative and qualitative data (Creswell & Clark, 2017; Fraenkel, Wallen & Hyun, 2012). In this study, a single-group experimental design was used for the quantitative phase and a case study was used for the qualitative phase.

Participants

The study group consists of 24 (nmale=8 and nfemale=16) pre-service teachers who were studying at a private university in Northern Cyprus in the 2022–2023 academic year. The pre-service teachers were studying in their first year at the Department of Primary Education. Participants with similar academic backgrounds took the same university entrance exam and were placed in the primary school teacher training program. The pre-service teachers graduated from Anatolian High School (78.3%), Vocational and Technical

Anatolian High School (8.7%), and Anatolian Imam Hatip High School (13%). Pre-service teachers graduated from high school with 78.3% equal weight (Turkish and Mathematics) and 21.7% in the Science Department.

Data Collection Tool

The data collection tools applicable to these research objectives are presented below.

Academic Achievement Test: This test was developed by the researcher to determine the academic achievements of pre-service teachers within the scope of "Environmental Education". The academic achievement test consists of forty multiple-choice questions.

The development of the academic achievement test focused on topics that are basic concepts related to environment and ecology, community ecology, population ecology, ecosystem ecology, biodiversity, problems threatening the environment, and environmental pollution. In the process of developing the academic achievement test, it was utilized questions from some exams conducted by the Measurement, Selection and Placement Center of the Republic of Turkey. These are the university entrance exam, undergraduate placement exam, and student selection exam. The questions in these exams were prepared by considering the learning outcomes in the high school biology course curriculum. Since the environmental topics and contents covered in this study are parallel to the environmental topics covered in the Biology Course, it was appropriate to choose among the questions in these exams.

Before the academic achievement test was developed, the learning outcomes of the Environmental Education course were written. Then, questions compatible with these learning outcomes were chosen from these exams. Initially, achievement tests were prepared 50 multiple-choice and five-choice achievement tests. To verify the questions in the prepared test, it was submitted to the opinions of three academicians who are experts in the field of biology and science education. After the expert opinions, 4 questions that were not thought to adequately measure the determined learning outcomes were removed from the test. After the expert opinion, a test consisting of 46 questions was administered to pre-service teachers who had completed the Environmental Education Course in the previous year, and the data obtained were analyzed. After the analysis, 6 questions with low elimination were removed from the test, and the achievement test was finalized. The Cronbach's alpha reliability coefficient of the test was calculated as 0.821. A test with a reliability coefficient of 0.70 is considered reliable (Büyüköztürk, 2011). The achievement test was applied to the pre-service teachers as a pre-test and post-test. The pretest and posttest points of the preservice teachers were compared with each other. Some examples of questions in the achievement test are shown in Figure 2.

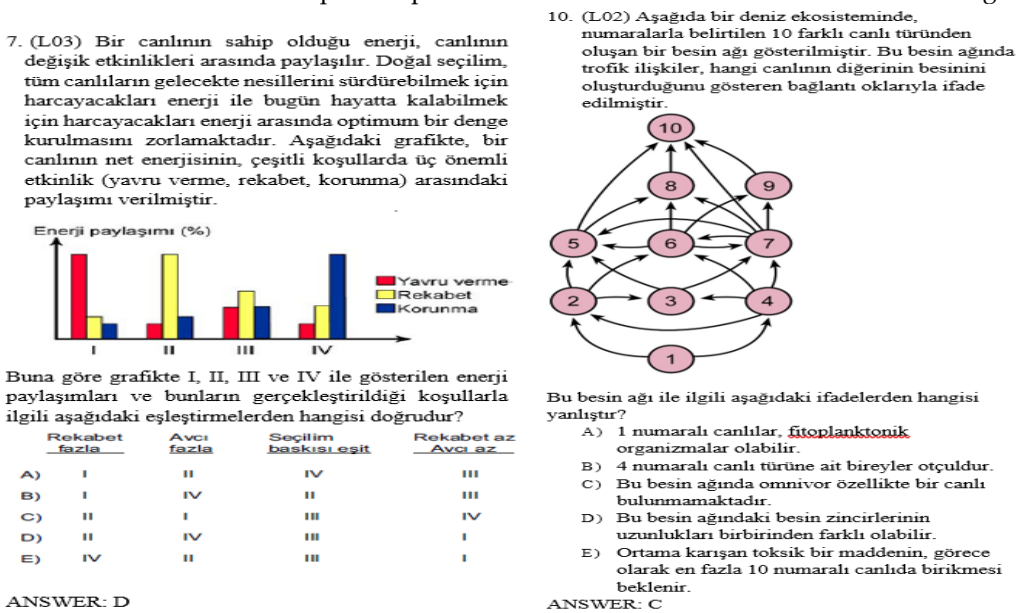


Figure 2. Examples of Questions in the Academic Achievement Test

Knowledge Transferring Knowledge to Daily Life Open-ended Question Form: When evaluating the academic achievement of pre-service teachers within the scope of the "Environmental Education" course, their ability to transfer knowledge to daily life was also considered. In this regard, pre-service teachers were asked five open-ended questions about environmental issues. First, the questions in the analytical thinking achievement test developed by Kocabaş (2021) were examined. Then, the questions in this test that were related to daily life and thought to be suitable for the level of pre-service teachers were determined. According

to these questions, the "Knowledge of Transferring Knowledge to Daily Life" question form was created by the researcher. Some examples of questions in this form are given below.

Sample Question 1:

Figure 3. Before and After Status of the Town

Mehmet, 12 years old, is very sad when he compares the picture of the town he lived in 20 years ago with the picture of the town today. The clean stream that used to flow through the trees is now very polluted. Juice boxes, food waste, and plastic bags are seen in it. Woodland and agricultural areas have been destroyed. What can Mehmet do to solve this problem? Explain.

Sample question 2: About 3% of the world 's water resources are freshwater resources. Some researchers predict that if the unconscious use of these resources continues, there will be a water shortage on Earth in the near future. How do you think this will affect living things?

Videos/Photos: These studies aim to improve the research skills of pre-service teachers. The pre-service teachers conducted scientific research by choosing a topic in which they were interested, such as environmental issues and problems. The pre-service teachers recorded each stage of their research using video or photographs. Thus, the researcher was able to evaluate the pre-service teachers' level of cooperation in groups, their ability to conduct research in accordance with scientific methods, write an article, and design a poster. Based on these videos and photographs, the research skills of the pre-service teachers were predicted. Figure 4 shows some examples of videos and photographs of the pre-service teachers' processes.

Figure 4. Video and Photo Examples of Preservice Teachers' Research Processes

Reflective Diary Protocol: The pre-service teachers wrote diaries reflecting the nature of their experiences during scientific research and reporting scientific research (writing articles and designing posters). These diaries were not structured in a way determined by the researcher. In other words, the diaries were not structured by the researcher. The pre-service teachers were expected to reflect on their own experiences using their creativity. In this way, the researcher objectively examined the pre-service teachers ' processes and the data collection process objectively and reliably. In this study, pre-service teachers worked in groups, and each group wrote a total of seven diaries.

Scientific Research Proposal and Article: This research aims to improve the scientific research skills of pre-service teachers. The pre-service teachers were asked to choose a topic related to environmental issues and problems, prepare a research proposal on this topic, conduct research, and write it as an article. For this purpose, the researcher first developed a research proposal form and a scientific article writing template. The research proposal covers the following components: what the research aims to investigate, what the expected outcome is, how the research will be conducted, what types of data will be collected, and how they will be analyzed. The article writing template provides guidance for pre-service teachers on how to write each section of their paper, such as the abstract, introduction, method, findings, conclusion and discussion, and references.

It also specifies the writing format that they should follow. This format and template were then shared with the pre-service teachers.

Scientific Research Poster: In this study, pre-service teachers were asked to design a poster reflecting their scientific research. For this purpose, a poster template was created by the researcher, similar to the research proposal format and the article template. The details of the template were explained to the pre-service teachers by the researcher.

Moodle: Another data collection tool used in this study was the analysis of the discussion content of the pre-service teachers on the Moodle platform. During this study, the pre-service teachers conducted each stage of the research process in collaboration with the group members through Moodle. Thus, pre-service teachers ' level of collaboration within the group and their ability to continue their research processes in accordance with scientific criteria were monitored and evaluated by the researcher through Moodle.

Data Collection and Analysis

In this study, the process of analyzing the data obtained using the data collection tool is explained in detail below.

Academic Achievement Test: This test consists of 40 multiple-choice questions with five options. Each question has a single answer. The academic achievement test was administered to pre-service teachers as a pre-test and post-test within the scope of the research. The answers given by the pre-service teachers were scored between the lowest zero and the highest one hundred points according to the answer key. Then, the researcher calculated the frequency and percentage values of the pre-service teachers who received points between the tens of point intervals such as 0-10 points, 11-20 points, 21-30 points, 91-100 points. In addition, the standard deviation and arithmetic mean values of the points obtained from the pre-service teachers from the test were calculated.

Knowledge of Transferring Knowledge to Daily Life Open-ended Question Form: This form was applied to pre-service teachers as a pre-test and post-test. The answers of the pre-service teachers were analyzed by considering the answers and scoring system in Kocabaş (2021) study. For example; "*Teacher: Recycling of solid waste is of great importance in terms of energy conversion. The contribution of energy saving to our country is not only economic. Energy saving means reducing environmental pollution. Because today* ……..…… ....……… *How do you expect the teacher to complete the above explanation? Explain with justifications."* The expected answers of the pre-service teachers to the question and the points they received according to these answers are given in Table 1.

Table 1. Score Distribution and Analysis of the Above Sample Question

Correct Answer: 4 points
This is explained in relation to the pollution caused by fossil fuels used in energy production. Example: Most energy sources harm the environment during production. By recycling and saving, less production is needed. In this way, reducing pollution is supported. Explains that recycling reduces the amount of waste left in the environment and less energy will be spent to dispose of less waste. Example: Living things are dying and global warming is occurring due to environmental pollution. Through recycling, less waste will be produced and the environment will be less polluted.
Partial Correct Answer: 3 points
The previous sentence was repeated differently. No reasoned explanation is given. Example: Our environment is very polluted due to a lack of energy savings. Without establishing the relationship between energy consumption and recycling, it is stated that environmental problems have increased, that they should be reduced, or that they are negative. Example: Because environmental pollution has increased significantly today. Recycling reduces this pollution.
Incorrect Answer: 2 points
Complete the rest of the sentence with sentences that have nothing to do with the paragraph. Example: Our country depends on foreign sources for energy production. The main source of all energy resources is solar energy.
Incorrect answers (deleted, scribbled, unreadable or off-topic): 1 score
No answer: 0 points

According to Table 1, the researcher gave 4 points to the correct answers, 3 to the partially correct answers, 2 to the incorrect answers, 1 to the deleted-scribbled-unreadable-off-topic answers, and 0 to the questions left unanswered. The process in Table 1 was followed in scoring the five open-ended questions in

the form. After the pre-service teachers' responses to the questions in this form were scored in both the pre-test and post-test, the number of pre-service teachers who scored between 0 and 4 points was expressed as a percentage.

Research Proposal, Scientific Research Article and Poster, Reflective Diary, and Moodle: The analysis focused on eight research proposals developed by different groups of pre-service teachers. The "research proposal evaluation rubric" developed by the researcher was used to analyze the research proposals. This rubric is shown in Figure 5.

RESEARCH PROPOSAL EVALUATION RUBRIC	Highest Score	Evaluation
1. ORIGINAL VALUE • It brings a scientific perspective to a local, national, or international problem. • It introduces a scientific or technological innovation in terms of method, theory, or knowledge. • It poses a new, different perspective and a complementary scientific question. • Its scientific consistency and integrity are emphasized with a literature review based on basic and current scientific sources and its relationship with other scientific studies is established.	40	( )
2. METHOD • The purpose of the research (problem/hypothesis) is clearly stated. • The research approach/model is introduced and appropriate for the purpose. • The scope of the research (group/material material) is explained. • The data collection methods and tools (and their development processes) are specified. • Data analysis techniques are appropriate for the purpose.	30	( )
3. FEASIBILITY OF THE PROJECT • The project team consists of the number of members required by the project. • The tasks assigned to the project team are explained with justifications. • The scope of the project (group/material/material) is well explained. • The purpose of the research (problem/hypothesis) is clearly stated. • Data collection methods and tools (development processes, if any) are specified.	20	( )
TOTAL	100	

Figure 5. Research Proposal Evaluation Rubric

According to Figure 5, the research proposals prepared by pre-service teachers were evaluated in three sections (original value, method, applicability of the project). According to this rubric, the highest score from the research proposal can be 100 (original value 40 points, method 30 points and the applicability of the project 20 points). The research proposals of the prospective teachers were scored between 0 and 100.

In this study, pre-service teachers were asked to report their scientific research processes in an article form. The analysis focused on eight research articles developed by different groups of pre-service teachers. The" scientific research article evaluation rubric" developed by the researcher was used to analyze the research proposals. This rubric is shown in Figure 6.

SCIENTIFIC RESEARCH ARTICLE EVALUATION RUBRIC	Highest Score	Evaluation
1. TITLE • Is the title of the article appropriate for the study (in terms of definition/generalization and length)?	3	( )
2.INTRODUCTION • Is the research topic explained based on related studies? • Has the importance/uniqueness of the research been demonstrated? • Is the purpose clearly stated?	12	( )
3.METHODS and METHODS • Is the type of research (survey, experimental, etc.) specified? • Is the place and time of the research specified? • Is the research population, sampling method (if necessary) and sample size specified? • Are the variables (dependent and independent) appropriate for the research hypotheses specified? • Are data collection methods (questionnaire, file review, scales, lab results, etc.) explained? • Is ethical information given (ethics committee approval, etc.)? • Are statistical analysis methods appropriate for the research hypotheses specified?	10	( )
4.FINDINGS • Are all results related to the research objectives included in the findings? • Are the results presented in an appropriate number of tables/graphs/pictures? • Are the content, organization and explanations of tables/graphs/pictures appropriate? • Are the results supported by statistical analysis?	10	( )
5.CONCLUSION • Are important conclusions drawn from the study in the light of the findings? • Are the findings briefly compared with other studies, if any? • Are recommendations made based on the results?	10	( )
6. MEDIA TOOLS • Are videos, photos, etc. shared that best reflect the research process (at least 3 media tools)?	10	( )
7. REFLECTIVE DIARIES • Are diaries written to reflect each step of the research process and shared on Moodle (at least 7 diaries get full points)?	15	
8. MOODLE • Was there a discussion in which at least 10 scientific articles related to the research topic were discussed? • Has a group discussion been held to determine the research topic? • Group discussion in which the research problem and hypothesis were determined? • Group discussion in which the research method was determined? • Group discussion in which the research sample was determined? • Was there a discussion on the process of collecting research data? • Was there a discussion on how to structure the research findings? • Was there a discussion on how to discuss the results of the research?	20	( )
9.CONTENT • Originality (The article being different from similar ones) (5 points) • Transferring the basic concepts and information about the environment covered in the Environmental Education course (5 points)	10	( )
TOTAL	100	( )

Figure 6. Scientific Research Article Evaluation Rubric

According to Figure 6, articles written by pre-service teachers were evaluated in nine sections. These are; title, introduction, method, findings, conclusion and discussion, media tools, reflective diary, Moodle, and content sections. The maximum score that could be obtained from the rubric was determined as 100 points: title 3 points, introduction 12 points, method 10 points, findings 10 points, conclusion and discussion 10 points, media tools 10 points, reflective diary 15 points, Moodle 20 points, and content 10 points. The pre-service teachers' articles were scored between 0 and 100.

In this study, pre-service teachers were asked to report their scientific research processes in the form of a poster, similar to an article. The analysis focused on eight posters developed by different groups of pre-service teachers. The "scientific poster evaluation rubric" developed by the researcher was used to analyze the research proposals. This rubric is shown in Figure 7.

SCIENTIFIC POSTER EVALUATION RUBRIC	Highest Score	Evaluation
1. TITLE • Is the poster title appropriate for the study (in terms of definition/generalization and length)?	5	( )
2.INTRODUCTION • Is the research topic explained based on related studies? • Has the importance/uniqueness of the research been demonstrated? • Is the purpose clearly stated?	10	( )
3.METHODS and METHODS • Is the type of research (survey, experimental, etc.) specified? • Is the place and time of the research specified? • Is the research population, sampling method (if necessary) and sample size specified? • Are the variables (dependent and independent) appropriate for the research hypotheses specified? • Are data collection methods (questionnaire, file review, scales, lab results, etc.) explained? • Is information about ethics given (ethics committee approval, etc.)? • Are statistical analysis methods appropriate to the research hypotheses specified?	10	( )
4.FINDINGS • Are all results related to the research objectives included in the findings? • Are the results presented in an appropriate number of tables/graphs/pictures? • Are the content, organization and explanations of tables/graphs/pictures appropriate? • Are the results supported by statistical analysis?	20	( )
5.CONCLUSION • Are important conclusions drawn from the study in the light of the findings? • Are the findings briefly compared with other studies, if any? • Are recommendations made based on the results?	10	( )
6. POSTER VISUALIZATION • Is the poster visually appropriate? • The title is striking and large enough, • Attractive and easy to read, Organized with appropriate headings, Sufficient free space • The choice of color, font and size is appropriate, • The way tables/charts/pictures are organized is appropriate/comprehensible	20	( )
7.CONTENT • Originality (Poster being different from similar ones) (10 points) • Transferring the basic concepts and information about the environment covered in the Environmental Education course (15 points)	25	( )
TOTAL	100	( )

Figure 7. Scientific Poster Evaluation Rubric

As shown in Figure 7, the posters designed by pre-service teachers were evaluated in seven sections. These are; title, introduction, method, findings, conclusion and discussion, visuality of the poster, and content. The maximum score that could be obtained from the rubric was determined as 100 points: title 5 points, introduction 10 points, method 10 points, findings 20 points, conclusion and discussion 10 points, visuality of the poster 20 points, and content 10 points. Pre-service teachers' posters were scored between 0 and 100 points.

After the research proposals, articles, and posters prepared by the pre-service teachers were analyzed according to the rubrics, each pre-service teacher 's score was tabulated. Then, pre-service teachers ' research skills were evaluated at 4 levels: 0-30 points as insufficient, 31-50 points as open to development, 51–75 points as sufficient (good), and 76–100 points as very successful.

Experimental Implementation Process

This study, excluding the pretest and posttest applications, lasted for 12 weeks. First, pre-tests were administered to the pre-service teachers. Then, they were informed about the tasks they had to perform within the course, the argument-driven inquiry, and the cognitive apprenticeship implementation. All the documents (presentations related to the course content, sample scientific research articles, research proposal form, etc.) that the pre-service teachers could benefit from within the Environmental Education course were shared with them via Moodle. Moreover, they were asked to form working groups of 2-4 people. How to form the groups and who would be the group members were left to the initiative of the pre-service teachers. In parallel with these groups, group discussion forums were opened on Moodle, and group members were added to this form. Then, the experimental application process was initiated.

The experimental application process was conducted in a face-to-face classroom environment according to cognitive apprenticeship-enriched argument-driven inquiry on topics such as basic concepts related to environment and ecology, community ecology, and population ecology. In this process, a scenario was presented to the pre-service teachers, which included a phenomenon example that addressed an environmental issue related to daily life. In this scenario, an environmental issue or problem was presented to the pre-service teachers. They were asked to define this problem in the scenario, produce possible hypotheses for the solution, determine the points they needed to research, list the data or evidence they needed, and conduct thought experiments for their solution suggestions. They performed these tasks in groups and then wrote their thoughts on the worksheets.

As the lessons continued in this way, it was stated that from the fourth week onwards, each group had to start preparing their own research proposals in parallel with the progress of the environmental issues explained. Pre-service teachers were given two weeks to develop their research proposals. They conducted research on the topics of "water pollution, soil pollution, Cyprus earthquake analysis, environmentally focused sustainable development, population growth and possible human and natural problems arising from it, and endemic species (plant and animal) specific to Cyprus" in the scientific research process. In addition to these topics, pre-service teachers were given research autonomy to investigate the environmental problem topics they wanted. They determined the environmental topic or problem they wanted to research. The researcher directed the teacher candidates to the discussion forums on Moodle to develop their research proposals collaboratively with their group mates. All stages related to the scientific research processes (from the development of the research proposal to the completion of the scientific poster development process) were conducted by the pre-service teachers on Moodle under the cognitive coaching of the researcher. In other words, they used Moodle effectively to communicate with their group mates and conduct scientific discussions in activities such as conducting research and writing articles in the implementation of the Environmental Education Course. Some examples reflecting the Moodle process are shown in Figure 8.

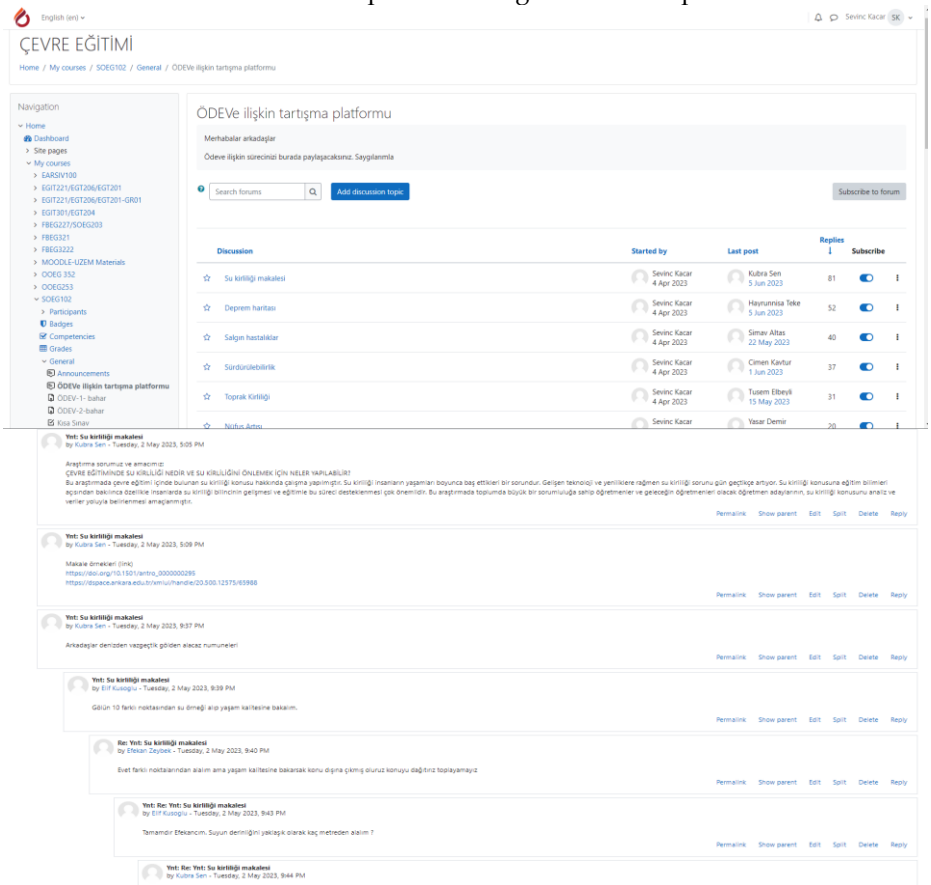


Figure 8. Example of Pre-Service Teachers' Group works in Moodle

While the stages of the scientific research process were conducted with the pre-service teachers via Moodle, face-to-face environmental courses were also continued.

To explain the experimental implementation process of the research through an example, a group of three pre-service teachers researched the topic of water pollution. The pre-service teachers first conducted literature research on topics such as "What is water pollution?", "Which substances cause pollution?", "How is water pollution analysis determined?". Considering the information they obtained they wrote a research proposal in which they explained the research question, hypothesis, and data collection processes. After completing this process, pre-service teachers began to implement scientific research proposals. At this stage, pre-service teachers went on a field trip to collect saltwater samples from the seas of the Kyrenia and Famagusta regions. The pre-service teachers took 5-6 tubes of water samples from different points of the seas in the regions they determined and analyzed these samples in the laboratories within the university under the supervision of an assistant/technician. Based on the analysis data obtained they wrote their research results on the water pollution status of the seas in Northern Cyprus in the form of a scientific article. They then

designed this article as a poster. While doing all these, the pre-service teachers continued face-to-face training. Simultaneously, the pre-service teachers had active discussions with their Moodle groupmates about the research processes, article writing, and poster designing stages. In parallel, the pre-service teachers wrote reflective diaries every week about their experiences in this research. Throughout all these phases, the researcher coached the pre-service teachers. The researcher followed the pre-service teachers' processes using Moodle. Through Moodle, the researcher provided feedback on the pre-service teachers ' processes or answered their questions.

After the completion of the experimental application, the data collection tools that were applied as a pre-test were applied to the pre-service teachers as a post-test .

FINDINGS

The findings of the study are explained in this section in parallel with the research questions.

Findings Related to the First Sub-Problem

In this research, the answer is sought to the question "What is the effect of the cognitive apprenticeship enriched argument-driven inquiry method on pre-service primary school teachers' academic achievement in the Environmental Education Course?" To find an answer to this question, an academic achievement test and the knowledge of transferring knowledge to daily life open-ended question form were applied as pre-test and post-test to the first grade pre-service teachers. The findings obtained from the academic achievement test are presented in Figure 9 and Figure 10.

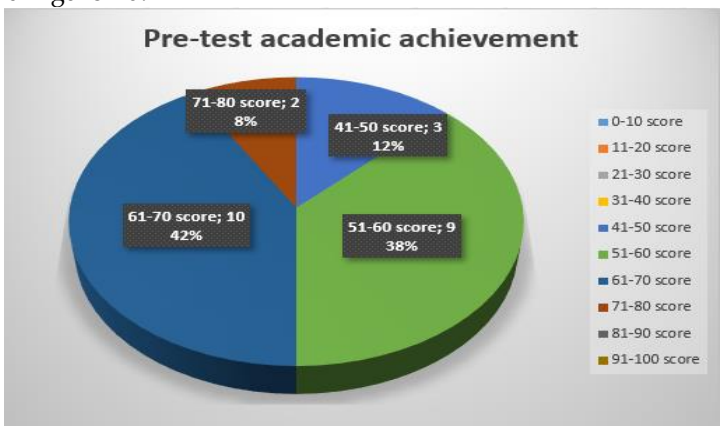


Figure 9. Graph for The Pre-Test Results of The Academic Achievement Test

According to Figure 9, the pre-test results of the academic achievement test showed that the pre-service teachers' points were distributed as follows: 12% scored between 41 and 50, 38% scored between 51 and 60, 42% scored between 61 and 70, and 8% scored between 71 and 80. A descriptive analysis of the pre-test points revealed that the mean score was 62.46 (St = 10.10), with a minimum of 50 and a maximum of 70.

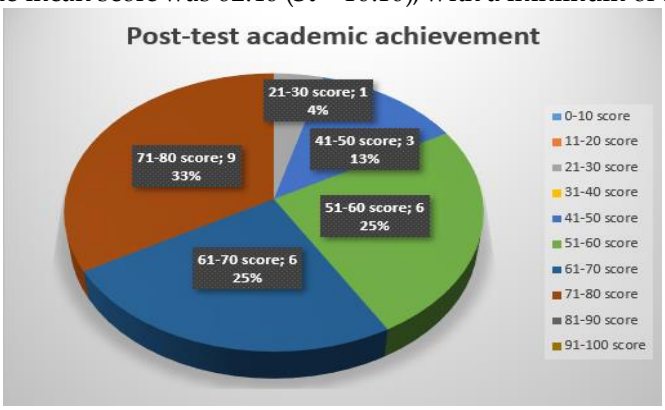


Figure 10. Graph for Post-Test Results of the Academic Achievement Test

According to Figure 10, the post-test results of the academic achievement test showed that the pre-service teachers' points were distributed as follows: 13% scored between 41 and 50, 25% scored between 51 and 60, 25% scored between 61 and 70, and 33% scored between 71 and 80. A descriptive analysis of the post-test points revealed that the mean score was 65.63 (St = 20.03), with a minimum of 45 and a maximum of 85. These findings reveal that pre-service teachers achieved higher academic achievement with the cognitive

apprenticeship-enriched the argument-driven inquiry method in the Environmental Education course. Since this method created a significant difference between pre-test and post-test grade averages and standard distributions of pre-service teachers, the cognitive apprenticeship-enriched argument-driven inquiry method is an effective method in environmental education.

In the study, to determine the academic achievement of pre-service teachers, an open-ended question form was also used to determine their knowledge of transferring knowledge to daily life. This form was applied to pre-service teachers as a pre-test and post-test. The findings related to the responses of the pre-service teachers to this form are presented in Table 2.

Table 2. Percentage Values of Pre-Service Teachers' Knowledge of Transferring Knowledge to Daily Life

Questions	Pre-test					Post-test				
	0 points	1 points	2 points	3 points	4 points	0 points	1 points	2 points	3 points	4 points
Question1a	54.17	-	4.17	12.50	25.93	38.46	-	26.92	23.08	11.54
Question1b	7.69	3.85	7.69	69.23	23.08	-	-	-	58.33	41.67
Questions2	-	3.85	30.77	53.85	11.54	4.17	-	8.33	41.67	45.83
Questions3		23.08		53.85	23.08	4.17	-	-	58.33	37.50
Questions4	-	7.69	26.92	46.15	19.23	4.17	-	29.17	37.50	29.17
Questions5	-	-	11.54	65.38	23.08	4.17	-	-	58.33	37.50

** 0 points: No answer, 1 points: Incorrect answers, 2 points: Incorrect answer, 3 points: The partially correct answer, 4 points: Correct answer*

*** The numbers of pre-service teachers in the table are expressed as percentages.*

**** The yellow indicates the highest score obtained from the open-ended questionnaire.*

***** The blue indicates the score value at which the pre-service teachers mostly gave answers in the open-ended question form*

According to Table 2, a comparison of the pre-test and post-test results for the first question reveals that the pre-service teachers struggled more with option A than option B. The percentage of incorrect answers for option A decreased from 54.14% in the pre-test to 38.46% in the post-test, but the percentage of correct answers also decreased from 25.93% to 11.54%. On the other hand, the percentage of partially correct answers for option B decreased from 69.23% in the pre-test to 58.33% in the post-test, whereas the percentage of correct answers increased from 23.08% to 41.67%.

Pre-service teachers gave partial correct answers to the second question with a frequency of 53.85% in the pre-tests, whereas they gave correct answers with a frequency of 45.83% in the post-test. Pre-service teachers gave partial correct answers to the third question with a frequency of 53.85% in the pre-tests and 58.33% in the post-test, whereas they gave correct answers with a frequency of 23.08% in the pre-tests and 37.50% in the post-test. Pre-service teachers gave partial correct answers to the fourth question with a frequency of 46.15% in the pre-tests and 37.50% in the post-test, whereas they gave correct answers with a frequency of 19.23% in the pre-tests and 29.17% in the post-test. Pre-service teachers gave partially correct answers to the fifth question with a frequency of 65.38% in the pre-tests and 58.33% in the post-test, whereas they gave correct answers with a frequency of 23.08% in the pre-tests and 37.50% in the post-test. These findings indicate that pre-service teachers could answer most of the questions partially correctly, but they had difficulty answering them fully correctly. In other words, compared with the pre-tests, the rate of correct answers increased and the rate of partially correct answers decreased in the post-tests. This also reveals that pre-service teachers ' knowledge level of environmental topics and concepts is increased and that the cognitive apprenticeship-enriched argument-driven inquiry method is a successful teaching method in this area.

Findings Related to the Second Sub-Problem

The second sub-problem of the research is the question "What is the effect of the cognitive apprenticeship-enriched argument-driven inquiry method on pre-service primary school teachers' scientific research skills about environmental issues/problems in the Environmental Education Course?". For this purpose, the pre-service teachers were asked to write research proposals and scientific articles, design a poster covering the context of the Environmental Education Course, participate in discussions on Moodle related to this topic, and keep reflective diaries. The data obtained from this study were analyzed. In parallel the research

proposals developed by pre-service teachers were first analyzed, and the findings related to this are given in Table 3.

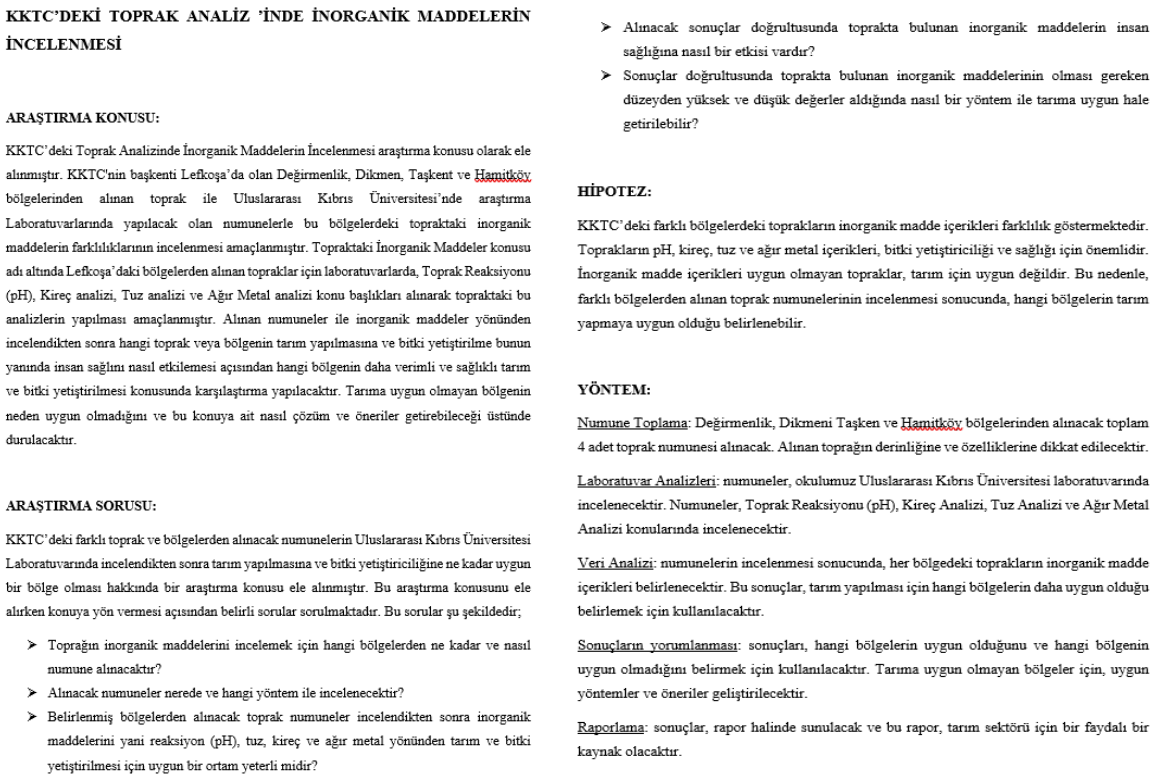
Table 3. Findings Related to Pre-Service Teachers' Points on the Rubric for Evaluating Scientific Research Proposals

Groups	Pre-service Teacher	Scientific Research Proposal Evaluation Rubric Sections			Maximum Score	Pre-service Teacher Score	Skill Level
		Original Value	Method	Conductability of the Research			
1. Group	PST1	2	2	2	100	6	Insufficient
2. Group	PST 2	20	15	10	100	45	Open to Development
	PST 3	20	15	10	100	45	
3. Group	PST 4	10	15	10	100	35	Open to Development
	PST5	10	15	10	100	35	
4. Group	PST6	25	20	15	100	60	Sufficient
	PST7	25	20	15	100	60	
	PST8	25	20	15	100	60	
	PST9	2	2	2	100	6	
5. Group	PST10	30	18	12	100	60	Sufficient
	PST11	30	18	12	100	60	
	PST12	30	18	12	100	60	
	PST13	30	18	12	100	60	
6. Group	PST14	40	20	10	100	70	Sufficient
	PST15	40	20	10	100	70	
	PST16	40	20	8	100	68	
	PST17	40	20	10	100	70	
7. Group	PST18	40	15	10	100	65	Sufficient
	PST19	40	15	10	100	65	
	PST20	40	15	10	100	65	
8. Group	PST21	15	15	12	100	42	Open to Development
	PST22	15	15	12	100	42	
	PST23	15	15	12	100	42	
	PST24	15	15	12	100	42	

**0-30 points: insufficient, 31–50 points: open to development, 51–75 points: sufficient (good), 76–100 points: very successful*

*** The values in the table reflect values in the range of 0-100 points.*

The findings given in Table 3 are based on the evaluation of the pre-service teachers' ability to develop a research proposal. According to these findings, a large majority of the pre-service teachers (n=14) have a sufficient (good) level of skills in the range of 51–75 points, while some pre-service teachers (n=8) have open to development in the range of 31-50 points. In addition, according to the research proposal evaluation rubric, only the pre-service teacher with the code PST1 scored 6 points and showed an insufficient level of skills. This result can be attributed to the lack of sufficient knowledge and experience of the pre-service teachers about the scientific research process or their inability to appropriately determine their research topics. An example of the research proposals developed by the pre-service teachers is shown in Figure 11.



KKTC'DEKİ TOPRAK ANALİZ 'İNDE İNORGANİK MADDELERİN İNCELENMESİ

ARAŞTIRMA KONUSU:

KKTC'deki Toprak Analizinde İnorganik Maddelerin İncelenmesi araştırma konusu olarak ele alınmıştır. KKTC'nin başkenti Lefkoşa'da olan Değirmenlik, Dikmen, Taşkent ve Hamitköy bölgelerinden alınan toprak ile Uluslararası Kıbrıs Üniversitesi'nde araştırma Laboratuvarlarında yapılacak olan numunelerle bu bölgelerdeki topraktaki inorganik maddelerin farklılıklarının incelenmesi amaçlanmıştır. Topraktaki İnorganik Maddeler konusu adı altında Lefkoşa'daki bölgelerden alınan topraklar için laboratuvarlarda, Toprak Reaksiyonu (pH), Kireç analizi, Tuz analizi ve Ağır Metal analizi konu başlıkları alınarak topraktaki bu analizlerin yapılması amaçlanmıştır. Alınan numuneler ile inorganik maddeler yönünden incelendikten sonra hangi toprak veya bölgenin tarım yapılmasına ve bitki yetiştirilme bunun yanında insan sağlını nasıl etkilemesi açısından hangi bölgenin daha verimli ve sağlıklı tarım ve bitki yetiştirilmesi konusunda karşılaştırma yapılacaktır. Tarıma uygun olmayan bölgenin neden uygun olmadığını ve bu konuya ait nasıl çözüm ve öneriler getirebileceği üstünde durulacaktır.

ARAŞTIRMA SORUSU:

KKTC'deki farklı toprak ve bölgelerden alınacak numunelerin Uluslararası Kıbrıs Üniversitesi Laboratuvarında incelendikten sonra tarım yapılmasına ve bitki yetiştiriciliğine ne kadar uygun bir bölge olması hakkında bir araştırma konusu ele alınmıştır. Bu araştırma konusunu ele alırken konuya yön vermesi açısından belirli sorular sorulmaktadır. Bu sorular şu şekildedir;

- Toprağın inorganik maddelerini incelemek için hangi bölgelerden ne kadar ve nasıl numune alınacaktır?
- Alınacak numuneler nerede ve hangi yöntem ile incelenecektir?
- Belirlenmiş bölgelerden alınacak toprak numuneler incelendikten sonra inorganik maddelerini yani reaksiyon (pH), tuz, kireç ve ağır metal yönünden tarım ve bitki yetiştirilmesi için uygun bir ortam yeterli midir?
- Alınacak sonuçlar doğrultusunda toprakta bulunan inorganik maddelerin insan sağlığına nasıl bir etkisi vardır?
- Sonuçlar doğrultusunda toprakta bulunan inorganik maddelerinin olması gereken düzeyden yüksek ve düşük değerler aldığında nasıl bir yöntem ile tarıma uygun hale getirilebilir?

HİPOTEZ:

KKTC'deki farklı bölgelerdeki toprakların inorganik madde içerikleri farklılık göstermektedir. Toprakların pH, kireç, tuz ve ağır metal içerikleri, bitki yetiştiriciliği ve sağlığı için önemlidir. İnorganik madde içerikleri uygun olmayan topraklar, tarım için uygun değildir. Bu nedenle, farklı bölgelerden alınan toprak numunelerinin incelenmesi sonucunda, hangi bölgelerin tarım yapmaya uygun olduğu belirlenebilir.

YÖNTEM:

Numune Toplama: Değirmenlik, Dikmeni Taşken ve Hamitköy bölgelerinden alınacak toplam 4 adet toprak numunesi alınacak. Alınan toprağın derinliğine ve özelliklerine dikkat edilecektir.

Laboratuvar Analizleri: numuneler, okulumuz Uluslararası Kıbrıs Üniversitesi laboratuvarında incelenecektir. Numuneler, Toprak Reaksiyonu (pH), Kireç Analizi, Tuz Analizi ve Ağır Metal Analizi konularında incelenecektir.

Veri Analizi: numunelerin incelenmesi sonucunda, her bölgedeki toprakların inorganik madde içerikleri belirlenecektir. Bu sonuçlar, tarım yapılması için hangi bölgelerin daha uygun olduğu belirlemek için kullanılacaktır.

Sonuçların yorumlanması: sonuçları, hangi bölgelerin uygun olduğunu ve hangi bölgenin uygun olmadığını belirmek için kullanılacaktır. Tarıma uygun olmayan bölgeler için, uygun yöntemler ve öneriler geliştirilecektir.

Raporlama: sonuçlar, rapor halinde sunulacak ve bu rapor, tarım sektörü için bir faydalı bir kaynak olacaktır.

Figure 11. Examples of Pre-Service Teachers' Research Proposals

In this study, to evaluate the pre-service teachers' scientific research skills, we also analyze the scientific research articles they wrote. These articles were analyzed with reference to the scientific research article evaluation rubric. The findings related to the results of this analysis are presented in Table 4.

Table 4. Findings Related to Pre-Service Teachers' Points from the Scientific Research Article Evaluation Rubric

Groups	Pre-service Teacher	Scientific Research Article Evaluation Rubric Sections									Maximum Score	Pre-service Teacher Score	Skill Level
		1	2	3	4	5	6	7	8	9			
1. Group	PST1	3	2	0	0	0	0	0	1	2	100	8	Insufficient
2. Group	PST2	3	8	10	10	10	5	8	15	10	100	79	Very sufficient
	PST3	3	8	10	10	10	5	8	20	10	100	84	
3. Group	PST4	0	2	5	5	0	5	10	10	10	100	47	Open to Development
	PST5	0	2	5	5	0	5	10	5	10	100	42	
4. Group	PST6	3	6	10	5	10	5	11	7	10	100	67	Sufficient
	PST7	3	6	10	5	10	5	11	10	10	100	70	
	PST8	3	6	10	5	10	5	11	10	10	100	70	
	PST9	2	0	0	0	0	2	0	5	0	100	9	Insufficient
5. Group	PST10	3	6	10	10	5	10	15	15	10	100	84	Very sufficient
	PST11	3	6	10	10	5	10	15	7	10	100	76	
	PST12	3	6	10	10	5	10	15	7	10	100	76	
	PST13	3	6	10	10	5	10	15	10	10	100	79	
6. Group	PST14	3	12	10	10	10	10	15	20	10	100	100	Very sufficient
	PST15	3	12	10	10	10	10	15	20	10	100	100	
	PST16	3	12	10	10	10	10	15	15	10	100	95	
	PST17	3	12	10	10	10	10	15	20	10	100	100	
7. Group	PST18	3	8	8	8	8	10	15	20	10	100	90	Very sufficient
	PST20	3	8	8	8	8	10	15	20	10	100	90	
	PST19	3	8	8	8	8	5	15	7	10	100	72	Sufficient
8. Group	PST21	3	2	2	5	0	5	8	1	10	100	36	Open to Development
	PST22	3	2	2	5	0	5	8	7	10	100	42	
	PST23	3	2	2	5	0	5	8	5	10	100	40	
	PST24	3	2	2	5	0	5	8	1	10	100	36	

**0-30 points: insufficient, 31–50 points: open to development, 51-75 points: sufficient (good), 76-100 points: very successful*

*** The values in the table reflect values in the range of 0-100 points.*

****Sections of Scientific Research Article Evaluation Rubric: 1-Title, 2-Introduction, 3-Methods, 4-Findings, 5-Conclusion and Discussion, 6-Media Tools, 7-Reflective Diaries, 8-Moodle, 9-Content*

When the findings in Table 4 are examined, it is determined that the pre-service teachers can write scientific articles at very successful (n=12) in the range of 76-100 points, sufficient (good) (n=4) in the range of 51–75 points, and open to development (n=9) in the range of 31–50 points. The findings above also show that there are pre-service teachers with different competency levels from their group mates, despite being in the same group. For example, pre-service teachers with PST6, PST7, and PST8 codes in the fourth group have sufficient research skills according to the scientific research article evaluation rubric, whereas the pre-service teacher with PST9 code in the same group has insufficient skills. Therefore, the scientific research and article writing processes related to the fourth group were examined in depth.

The participation of pre-service teachers in the research process was examined using reflective dairies and group discussions in Moodle. According to the data obtained here, it was understood that the pre-service teacher with the code PST9 collaborated with his/her group mates in the first stage of the research process, but withdrew from the group work in the following stages. It was determined that PST9's name was not included in the article written by Group Four. The reason for this is that he/she did not support his/her group mates during the article writing the process. The reason why PST19 that was in Group Seven had a different skill level from his/her group mates was similar to the situation of PST9. However, when the findings in Table 4 were evaluated in general, it was stated that the cognitive apprenticeship enriched the argument-driven inquiry method for the pre-service teachers to have sufficient skills in conducting scientific research and writing it in article form on the environmental issue/problem. However, the fact that some of the pre-service teachers were at sufficient or open to improvement levels indicated that this method was not equally functional for everyone or that some students needed more support. An example of the scientific research articles written by the pre-service teachers is shown in Figure 12.

GİRNE DENİZİ ve MAĞUSA DENİZİNDE BAKTERİ ANALİZİNİN YAPILMASI

ÖZ

Su kirliliği insanların yaşamlarını devam ettirebilmesi için belli başlı sorumluluk alması gereken evrensel bir sorundur. Teknolojinin olumsuz etkisi ve bilinçsiz su kirliliğinin artması sonucunda ne yazık ki dünyamızda su kirliliğinin önüne geçmekte zorlanılmaktadır. Su kirliliği konusunun önüne geçmekte eğitimin çok büyük oranda bir katkısı olacaktır. Araştırmanın sonucunda değerli öğretmen ve öğretmen adayları üzerine düşen sorumluluk fazlalaşmıştır. Bu sorumluluk üzerine öğretmen adayları olarak KKTC'de bulunan Girne yat limanından ve Mağusa'da bulunan Glapsides plajından örnek alınarak laboratuvar yardımı ile denizlerde yaşayan bakterileri öğrenmek ve pH değerlerini ölçmek amaçlanmıştır. Bu denizlerden numune alma nedenimiz ise konum olarak yakın olmasıdır. Aynı zamanda denizlerin yüz ölçümünün büyük olması ve su alabileceğimiz kıyının güvenli olması bu denizleri seçme nedenimiz olmuştur. Son olarak bu denizleri seçme sebeplerimizden biri de bir denizin Girne yat limanında bulunan denizin KKTC'nin en pis denizi konumunda olması diğer deniz Mağusa' da bulunan Glapsides plajının en temiz deniz konumunda olması seçmemizin en ana sebebidir. İki deniz analizinde bulunan bakteri farkına bakılarak karşılaştırma yapılacaktır. Çalışmamızda nitel ve nicel gözlemlere yer verilmesi planlanmıştır. Çalışmamız 3 farklı uygulama ile incelenmiş ve sonuç olarak bir poster oluşturulmuştur. Uygulamalarımız metafor çalışması, öğretmen kontrolünde bireysel ve grupsal tartışma ortamı ve analiz-tarama yönünde hazırlanmıştır. Metafor çalışmamızda "Bakteri miktarı pH değerine göre____azdır/çoktur. Çünkü……." şeklinde sorulara yer verilmesi kararlaştırılmıştır. Grup görüşmelerinde araştırılacak denizler belirlenmiş hangi bakterilerin bakılacağına karar verilmiştir. Analiz-Tarama yönteminde ise denizin kıyısından, 1metre ilerisinden 0,3-0,5 metre derinliğinden iki farklı denizden örnek alınması planlanmıştır. Bu planın sonucunda denizleri kendi içerisinde de kıyı ve 1 metre ilerisi de kıyaslanacaktır. Araştırma sonrası edinilecek nitel ve nicel veriler ele alınarak incelenmiştir. Konum, tablo, grafik olarak sunulmuştur. Bu çalışma sonucunda öğretmen adaylarının su kirliliği konusunda bilinçlenmesi ve bilinçlendirmesi amaçlanmıştır. Evrensel sorun olan su kirliliğinin önüne geçilmesi ya da dikkat edilmesi üzerine bu çalışmanın katkı sağlayacağını düşünmekteyiz.

GİRİŞ

Su canlı yaşamı için çok kritik bir öneme sahiptir. Vücudumuzdaki yaşamsal fonksiyonları sürdürebilmemiz için suya ihtiyacımız vardır. Suyun olduğu yerde hayat vardır. Su sayesinde vücudumuzun pH dengesi korunur, besin maddeleri taşınır. Yeryüzündeki sular güneşin verdiği enerji sayesinde bir döngü halindedir. Canlılar da bu döngü su ihtiyaçlarını bu döngü sayesinde karşılar ve harcadıkları bu suyu aynı döngüyle tekrardan geri verirler. Bu süreçte suyun içine karışan birçok madde suyun kimyasal, fiziksel ve biyolojik özelliklerini değiştirerek su kirliliğini ortaya çıkarır. Su kirliliği, gelen su kaynağının fiziksel, kimyasal ve ekolojik özelliklerini olumsuz yönde etkiler. Su kirliliği olarak isimlendirdiğimiz özelliği değişen sularda yaşayan birçok canlı da olumsuz yönde etkilenir. Bundan dolayı suyun kirlenmesi suya bağlı olan ekosistemlerin de olumsuz etkilenip dengelerinin bozulmasına neden olur. Dünyada suyun büyük çoğunluğunu okyanuslar ve denizler oluşturur.

Çevre kirliliği denildiğinde akla su, toprak ve hava kirliliği gelir. Bunların arasından çok kolay ve çok çabuk kirlenen sudur. Çünkü herhangi bir kirlenme durumunda suya başvururuz.

Su kirliliğini önleyebilmek için su kaynaklarında ortaya çıkan fiziksel, kimyasal ve biyolojik değişimler tespit edilmeli ve bu tespitlerin sonuçları değerlendirilmelidir. Su kirliliğinin önüne geçebilmek için su kaynaklarının korunması için gerekli çalışmalar yürütülmelidir.

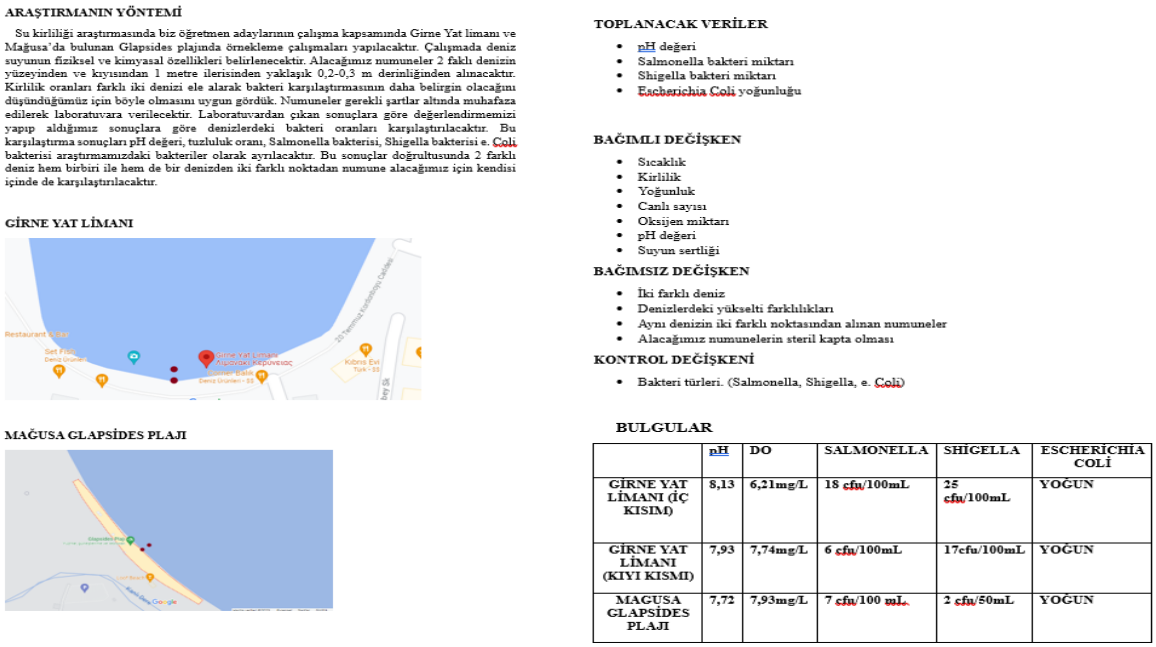
Su kirliği ve sebepleri:

- Ağır metallerin su kaynaklarına karışmasıyla meydana gelen su kirliliği; boşaltım, sindirim ve dolaşım bozuklukları, kusma, mide rahatsızlığı gibi hastalıkları ortaya çıkarır.
- Evsel atıkların su kaynaklarına karışmasıyla meydana gelen su kirliliği arıtılmadığından dolayı su havzalarının kirlenmesine sebep olur.
- Su kirliliği canlılara ve çevreye zarar veren bir durumdur.
- Su kirliliğini ortaya çıkaran etkenler; tarımda kullanılan kimyasallar, dengesiz nüfus artışı, endüstri alanında meydana gelen gelişmeler, plansız yapılaşma, sanayi atıkları, biyolojik, fizyolojik ve kimyasal kirlilikler, hayvansal atıklar gibi çevresel faktörlerdir.
- Su kirliliğini azaltmak için; tedbirler alınmalı, sular düzenli olarak analiz ve kontrol edilmeli, atık maddeler suya katılmadan önce geri dönüştürülmeli ve arıtılmalı, atık suların arıtılması için elverişli tesisler kurulmalı, kanalizasyon alt yapı sistemleri geliştirilmeli, temizlik malzemelerinin aşırı kullanımı azaltılmalı ve bu tarz önlemler alınmalıdır.

GİRNE VE MAGUSA DENİZLERİNDE BULUNAN BAKTERİLER

Projemizin konusu olan KKTC'de bulunan Girne ve Mağusa denizlerindeki bakterilerin incelenmesi hem denize giren insanların bilinçlenmesi hem de kirli ve temiz deniz arasında bulunan seçtiğimiz bakterilerin arasındaki farkı tespit etmek amaçlandı. Bu bakteriler Salmonella, Shigella ve Escherichia coli olarak belirlenmiştir.

Salmonella: Salmonella bakterisi, insan ve hayvanlar için patojen olan bakteri cinsinden biridir. Özellikle intestinal sisteme yerleşip enfeksiyon yaratan, vücutta ciddi etkileri olan bu bakteri için en sık görülen bulaş yolu hayvanlar ve kontamine yiyeceklerdir. Salmonella, insanlarda şiddetli ishal ve ateşe sebebiyet veren oldukça zararlı bir bakteridir. (Baron, medical microbiology, 1996)



ARAŞTIRMANIN YÖNTEMİ

Su kirliliği araştırmasında biz öğretmen adaylarının çalışma kapsamında Girne Yat limanı ve Mağusa'da bulunan Glapsides plajında örnekleme çalışmaları yapılacaktır. Çalışmada deniz suyunun fiziksel ve kimyasal özellikleri belirlenecektir. Alacağımız numuneler 2 faklı denizin yüzeyinden ve kıyısından 1 metre ilerisinden yaklaşık 0,2-0,3 m derinliğinden alınacaktır. Kirlilik oranları farklı iki denizi ele alarak bakteri karşılaştırmasının daha belirgin olacağını düşündüğümüz için böyle olmasını uygun gördük. Numuneler gerekli şartlar altında muhafaza edilerek laboratuvara verilecektir. Laboratuvardan çıkan sonuçlara göre değerlendirmemizi yapıp aldığımız sonuçlara göre denizlerdeki bakteri oranları karşılaştırılacaktır. Bu karşılaştırma sonuçları pH değeri, tuzluluk oranı, Salmonella bakterisi, Shigella bakterisi e. Coli bakterisi araştırmamızdaki bakteriler olarak ayrılacaktır. Bu sonuçlar doğrultusunda 2 farklı deniz hem birbiri ile hem de bir denizden iki farklı noktadan numune alacağımız için kendisi içinde de karşılaştırılacaktır.

GİRNE YAT LİMANI

MAĞUSA GLAPSİDES PLAJI

TOPLANACAK VERİLER

- pH değeri
- Salmonella bakteri miktarı
- Shigella bakteri miktarı
- Escherichia Coli yoğunluğu

BAĞIMLI DEĞİŞKEN

- Sıcaklık
- Kirlilik
- Yoğunluk
- Canlı sayısı
- Oksijen miktarı
- pH değeri
- Suyun sertliği

BAĞIMSIZ DEĞİŞKEN

- İki farklı deniz
- Denizlerdeki yükselti farklılıkları
- Aynı denizin iki farklı noktasından alınan numuneler
- Alacağımız numunelerin steril kapta olması

KONTROL DEĞİŞKENİ

- Bakteri türleri. (Salmonella, Shigella, e. Coli)

BULGULAR

	pH	DO	SALMONELLA	SHİGELLA	ESCHERİCHİA COLİ
GİRNE YAT LİMANI (İÇ KISIM)	8,13	6,21mg/L	18 cfu/100mL	25 cfu/100mL	YOĞUN
GİRNE YAT LİMANI (KIYI KISMI)	7,93	7,74mg/L	6 cfu/100mL	17cfu/100mL	YOĞUN
MAGUSA GLAPSİDES PLAJI	7,72	7,93mg/L	7 cfu/100 mL	2 cfu/50mL	YOĞUN

Figure 12. A Sample of Preservice Teachers' Scientific Articles

In this study, in the evaluation of pre-service teachers' scientific research skills, the scientific posters they developed were also analyzed. These posters were analyzed with reference to the scientific poster evaluation rubric. The findings related to the results of this analysis are presented in Table 5.

Table 5. Pre-Service Teachers' Points from The Scientific Poster Evaluation Rubric

Groups	Pre-service Teacher	Scientific Research Poster Evaluation Rubric Sections							Maximum Score	Pre-service Teacher Score	Skill Level
		1	2	3	4	5	6	7			
1. Group	PST1	0	0	0	0	0	0	0	100	0	Insufficient
2. Group	PST2	5	10	10	20	10	20	25	100	100	Very sufficient
	PST3	5	10	10	20	10	20	25	100	100	
3. Group	PST4	3	5	5	10	5	10	10	100	48	Open to Development
	PST5	3	5	5	10	5	10	10	100	48	
4. Group	PST6	5	10	10	20	10	20	25	100	100	Very sufficient
	PST7	5	10	10	20	10	20	25	100	100	
	PST8	5	10	10	20	10	20	25	100	100	
	PST9	0	0	0	0	0	0	0	100	0	Insufficient
5. Group	PST10	5	10	10	20	10	15	20	100	90	Very sufficient
	PST11	5	10	10	20	10	15	20	100	90	
	PST12	5	10	10	20	10	15	20	100	90	
	PST13	5	10	10	20	10	15	20	100	90	
6. Group	PST14	5	10	10	20	10	20	25	100	100	Very sufficient
	PST15	5	10	10	20	10	20	25	100	100	
	PST16	5	10	10	20	10	20	25	100	100	
	PST17	5	10	10	20	10	20	25	100	100	
7. Group	PST18	5	10	10	10	0	20	25	100	80	Very sufficient
	PST19	5	10	10	10	0	20	25	100	80	
	PST20	5	10	10	10	0	20	25	100	80	
8. Group	PST21	5	5	5	10	5	10	10	100	50	Sufficient
	PST22	5	5	5	10	5	10	10	100	50	
	PST23	5	5	5	10	5	10	10	100	50	
	PST24	5	5	5	10	5	10	10	100	50	

0-30 points: insufficient, 31–50 points: open to development, 51-75 points: sufficient (good), 76-100 points: very successful
** The values in the table reflect values in the range of 0-100 points.*
****Sections of the Scientific Research Poster Evaluation Rubric: 1-Title, 2-Introduction, 3-Methods, 4-Findings, 5-Conclusion and Discussion, 6-Poster Visuality, 7-Content*

When the findings in Table 5 are examined, it is understood that the majority of the pre-service teachers can develop scientific research posters at a very sufficient level in the range of 79-100 points (n=16) and at a level open to development in the range of 31-50 points (n=6) on environmental problems topics. As a result, in light of these findings, it can be said that pre-service teachers' ability to prepare scientific research posters on environmental problems is high. An example of the scientific research posters designed by the pre-service teachers is shown in Figure 13.

Figure 13. Examples of Pre-Service Teachers' Scientific Posters

RESULTS, DISCUSSION, and SUGGESTIONS

This study aimed to examine the effect of the cognitive apprenticeship-enriched argument-driven inquiry method in the Environmental Education Course on (1) academic achievement and (2) the ability to investigate environmental issues/problems of first-grade pre-service primary education teachers. The results of the study are given below.

This study aimed to examine the effects of the cognitive apprenticeship-enriched the argument-driven inquiry method on pre-service teachers' academic achievement. As a result of this study, it is understood that

pre-service teachers' academic achievement related to environmental concepts and topics increased. In parallel when the related literature is examined, there are not many studies examining the effect of cognitive apprenticeship-enriched argument-driven inquiry on learners' academic achievement or conceptual understanding. However, De La Paz, Levin, and Butler (2023) developed an argumentation-based learning method integrated with cognitive apprenticeship that promises to improve the ability of students with disabilities to write scientific arguments. As a result of the implementation of this model, they stated that students' scientific arguments writing skills improved. In another study, Antonio and Prudente (2021) investigated the effect of a metacognitively enriched argument-driven inquiry method on pre-service biology teachers' learning of antimicrobial resistance. As a result of the study, they reported that this method significantly improved pre-service teachers' conceptual understanding. In another study, Eymur, Yeşildağ-Hasançebi, and Çetin (2022) investigated the effect of the argument-driven inquiry method supported by the nature of science on pre-service science teachers' conceptual learning about evolution. As a result of this study, they stated that this method increased pre-service teachers' knowledge and reduced their misconceptions. Based on these results, it can be said that this study is supported by the findings in the literature.

Moreover, when the relevant literature is examined, studies emphasizing that the argument-driven inquiry method has positive effects on learners' academic achievement and conceptual understanding are found (Antonio & Prudente, 2021; Bidwell, 2016; Çetin, Eymur, Southerland, Walker & Whittington, 2018; Demirci-Celep, 2015; Demircioğlu & Uçar, 2015; Myers, 2015; Ping, Halim & Osman, 2020; Sampson & Gleim, 2009; Strimaitis, Southerland, Sampson, Enderle & Grooms 2017). In their study, Salsabila, Wijaya, Winarno, and Hanif (2019) investigated the effect of the argument-driven inquiry method on middle school students' concepts in learning about global warming and found that argument-driven inquiry has a better effect on improving students' concept understanding. Myers (2015) stated that the argument-driven inquiry method increased high school students' academic achievement in biology courses. Arslan, Genç and Durak (2023) applied the argument-driven inquiry method to experiments in physics, chemistry and biology in the Science Laboratory Practices course. This study investigates how the argument-driven inquiry method affects pre-service science teachers' academic achievement in science laboratories. The results of this study indicate that the argument-driven inquiry method increased pre-service science teachers' academic achievement in science laboratories. In a study carried out by Demircioğlu and Uçar (2015), argument-driven inquiry methods and traditional laboratory methods were compared in physics laboratory courses. Because of the study, it was found that the argument-driven inquiry method increased pre-service teachers' physics achievements more than the traditional method. Based on these results, it can be said that this research is supported by the findings in the literature. As a result, the argument-driven inquiry learning method enables pre-service teachers to answer research questions by designing experiments. With this method, pre-service teachers can overcome their lack of knowledge about the subject, share information with group members, and defend their ideas. In addition, by examining the research of other groups, they see different solutions, correct their mistakes, and improve their learning and ideas through discussion. When alternative perspectives are presented, scientific knowledge increases because individuals question the reasons for true and false explanations. Moreover, pre-service teachers gain first-hand experience in the process of research on environmental issues and problems under the guidance of experts and have the opportunity to correct their misconceptions in light of the correct information provided by experts. This, in turn, improves pre-service teachers' learning of environmental issues and concepts and increases their academic achievement.

This study also examined the effect of cognitive apprenticeship-enriched on argument-driven inquiry pre-service teachers' scientific research skills regarding environmental issues and problems. Because of the research, it is concluded that cognitive apprenticeship enriched argument-driven inquiry and improved pre-service teachers' scientific research skills. When the related literature was reviewed, some research results showed that cognitive apprenticeship improved learners' views and understandings of scientific research. For example, Charney et al. (2007) examined the experiences of high school students who interned with expert scientists in a study on current questions in molecular genetics. As a result of this study, it is emphasized that students have sophisticated beliefs about the nature of science and their scientific inquiry skills have improved. Another study was conducted by Roth and Bowen (1995). Roth and Bowen (1995) examined how eighth-grade students participated in science processes using a learning model in which cognitive apprenticeship and open inquiry methods were used together. In this study, it is observed that as students participated in inquiry activities, their skills in identifying research questions, developing data collection

methods, and interpreting results increased and their views about science and scientific inquiry changed. Unlike previous studies, Metin-Peten (2021) found that the argument-driven inquiry method improved pre-service teachers' understanding of the nature of scientific research. This result is consistent with the literature. In fact, it is not surprising that cognitive apprenticeship enriched the argument-driven inquiry method and enhanced pre-service teachers' research skills. Pre-service teachers conducted scientific research on an environmental topic or issue of their choice under the guidance of an expert in the field with their peers. In this process, each pre-service teacher group first developed a research proposal and then conducted research following the scientific research steps considering this proposal. During their research, pre-service teachers benefited from different laboratories at our university and received support from experts there. Throughout this process, both the researcher and the experts in the laboratory provided them with cognitive coaching (supervisor) to enable them to conduct research like a scientist. The pre-service teachers provided scientific explanations about the environmental issue/problem by discussing the scientific data and evidence they obtained during their research with their peers and experts. They then report their processes and explanations in the form of scientific articles and posters and share them with other learners. Thus, they conduct research in accordance with both argument-driven inquiry and cognitive apprenticeship. In other words, while the pre-service teachers research a problem or a topic they are curious about, they both present evidence to support their own views and critically evaluate the views of others. Thus, pre-services develop argumentation skills that play an important role in the formation of scientific knowledge. In addition, the pre-service teachers receive feedback from experts (cognitive coaches) throughout their research process and improve their research with their guidance. This also enables pre-service teachers to learn from more experienced people, as in the cognitive apprenticeship model. In this way, the pre-service teachers have a experience similar to the research conducted by scientists and develop scientific research skills.

As a result, for future research;

- Studies based on comparative research with larger groups can be conducted on the effect of cognitive apprenticeship-enriched argument-driven inquiry on academic achievement and research skills. Similar studies can be conducted for longer periods of time, such as longitudinal research, or research can be repeated in other subjects in science education (physics, chemistry and biology).

- The effect of cognitive apprenticeship-enriched argument-driven inquiry on different variables (e.g. epistemological beliefs, metacognition) can be investigated.

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