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COMPARISON OF TURKISH PRE-SERVICE SCIENCE TEACHERS AND SECONDARY SCHOOL STUDENTS WITHIN THE SCOPE OF NATURAL HISTORY TOPICS

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Abstract: Natural history includes the period from the formation of the Earth to recent times and all the changes it has gone through throughout this vast period. The biggest challenge in understanding natural history is the age of the Earth. Even though natural history is quite difficult to understand, pre-service science teachers are expected to be knowledgeable about this matter to a fundamental degree. Therefore, this study aims to determine the knowledge levels of secandary school students and pre-service science teachers on some natural history topics and compare compare these two groups in this context. . To conduct such research in which a qualitative-natured case study design was used, the data obtained through 15 open-ended questions were analyzed through content analysis. As a result, percentages of correct answers regarding the time perception component were quite low both for secaondary students and pre-service science teachers. While both groups were close in the component of the transformation of the Earth, it was founden that students answered more questions correctly. As expected, pre-service teachers correctly answered more questions regarding the component of diversity of living things than the students.

Key words: Natural history education, teacher education, teacher knowledge

1. Introduction

Nature is an entity that involves everything from quarks, regarded as the smallest particle of matter, to the universe that is assumed to contain at least two hundred billion galaxies, and living and non-living beings (Khann, 1999). This entity includes various living and non-living elements, processes, and mechanisms; it can affect and be affected, can change, and be changed, can be renewed; it has no certain boundaries, and it is an open system that has come to exist outside the human impact (Kocataş, 2006). These changes that nature has experienced in living and non-living things over time give rise to natural history. Fleischner (2001, 2005) defined natural history as a practice that is guided by truth and honesty and deliberately focuses on the increased human attention and power of perception. What was meant with practice is the ability of humankind to use survival skills in nature since the dawn of time. Furthermore, Gilligan (2009) presented a comprehensive description of natural history: natural history is a fieldwork-based science that uses comparative and descriptive methods to understand and interpret the biotic and abiotic components of the natural world and their relationships, and how they have evolved in time. As an attempt to understand a long process, natural history can also be referred to as the story of nature (Hampton & Wheeler, 2012). This story accounts for the origin, evolution, and behaviors of the organisms as well as the observation of their relationship with one another (Wilcove & Eisner, 2000). To Arnold (2003), the history of nature helped the generation of many sciences such as astronomy, geology, paleontology, biology, ecology, ethology, geography, systematics, and genetics.

As mentioned above, knowing the natural history, which includes many sciences, both conceptually and learning the changes that nature has undergone over millions of years will enable us to get to know nature closely. Thus, people will be more willing to protect nature, taking sustainability into account. However, children and youth of today suffer from nature deficit syndrome that stems from the distancing from nature (Louv, 2008). While this detachment with the distancing negatively affects

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their awareness of nature, interests, attitudes, and desires to know, it causes them to be less active in the individual precautions that could be taken to protect nature (Pyle, 1993; Kahn, 2002). Therefore, the first step to protect nature is to get to know it closely and to learn natural history through systematically applied teaching programs. Natural history can provide students with a wealth of experience in learning experimental processes, developing the skills of active and competent observation that they are far from today, and the imaginative use of circumstantial evidence and a good natural history education lays a solid foundation for learning other disciplines that have a lot in common, such as ecology (Disney, 1968). It can also help facilitate overcoming difficulties in education that result from a lack of first-hand experience with the living world outside the classroom (Pyle, 2001). Knowing natural history constitutes the first step of providing more willing and participatory individuals in the protection of nature, as stated in the objectives of environmental education in the 1977 Tbilisi declaration. In addition, it is important to know natural history to reduce their prejudices against evolution and facilitate their understanding (Dobzhansky 1973; Mayr, 1982).

However, studies have shown that natural history teaching is gradually losing its place in curricula at all levels of education (Noss, 1996). For example, in a study in which the programs were evaluated according to the states in the USA, it was seen that the teaching of natural history subjects differed both in content and grade levels (Lerner, 2000). In ten states grouped in his A grade, such as California, substantial attention is devoted to the history of the earth and to mechanisms such as plate tectonics and continental drift, usually in the early or middle grades. It is stated that the other forty states do not have topics and achievements on this subject. In Turkey, natural history subjects are covered in the eleventh- grade general biology textbook of 1935 (Esen, 1935) and in another biology textbook in 1939 (Binal, 1939). However, in the study conducted by Öz Aydın and Şahin in 2017, in which he examined the status of natural history in terms of the achievements in secondary school science, secondary school biology, physics, chemistry and geography courses and taking part in the activities in the textbooks, it is seen that the subjects of paleontology and anthropology, which are natural history subjects, are not included. Finally, the percentages of natural history subjects in the curriculum of the relevant courses in terms of achievements; 0.86% in physics, 3.66% in biology, 1.42% in geography, and 2.77% in secondary school science. Researchers have stated that natural history subjects and the number of achievements are not sufficient to understand and explain natural history correctly. Pyle (2001) goes further and argues that schools without natural history are reduced as an intention to destroy experience for teachers and students. Due to the prevalence of nature study curricula adopted by program makers in previous years, students and teachers were in regular and direct contact with the plants, animals, and natural features of their local environment (Gruenewald, 2003).

As a quality, natural history teaching should not only transfer one-way knowledge from the teacher to the student, but also should activate individuals to think about nature, common sense, and emotions (Chipeniuk, 2014). Regarding the quality of a natural history program in terms of subject content, it was stated that in the principles put forward by Kolan and Poleman (2009), the holism and relationality of the subjects should be emphasized. Similarly, Shen et al. (2016) state that a holistic understanding is required in the perception of natural history, since the phenomenon of time is very large-scale in earth sciences, which is one of the sciences that reveal natural history.

Based on the holistic perspective necessary for the instruction of geology science, this study focused on natural history aligned with the topics of time, the early world, and biodiversity. In the context of natural history, the concept of time is a topic that is quite challenging to understand. According to Cheek (2012), competencies that support the comprehensibility of geological time are the ability to put geological phenomena in sequential order and understanding and visualizing the processes taking place at a slow pace. However, contrary to possessing this competency, many students do not know the structure of the earth at the early stages of formation, having unscientific ideas such as believing that there was life on its surface (Libarkin et al., 2005). Another crucial element of geology is the comprehension of the geological structures and systems (Dodick & Orion, 2003a) and the diversity of living things throughout this vast period. Harlen (2010) addresses biodiversity as the result of the organisms that had lived because of evolution and the organisms that had gone extinct. In accordance with the International Biodiversity agreement, biodiversity is the collection of all living beings that

filled the earth as a consequence of evolution (CBD, 1993). The trouble with the concept of biodiversity and its protection is the difficulty of teaching it in the school context due to the complexity and abstract nature of the topic (Bermudez, Longhi & Gavidia, 2016).

When considered in terms of natural history teaching, especially secondary school science and biology teachers are expected to have basic knowledge on this subject. Similarly, Krupa (2000) stated that the most crucial thing for natural scientists and teachers is to be willing to include natural history in instruction while the second most important matter is to know about natural history. However, formal education programs are not sufficient to enable them to understand environmental education, evolution and natural history (Öz Aydın et al., 2022). However, as stated above, since the natural history content is not sufficiently included in the curriculum, it is thought that there is no expected difference in the knowledge levels of teachers and students in these subjects. In literature, there are some studies comparing the characteristics such as interests, attitudes and beliefs between prospective teachers and students in different subjects (Murphy et al., 2004; Yavetz et al., 2010). However, there are few studies that directly compare their knowledge levels, such as Boon (2016)'s study comparing the knowledge levels of secondary school students and teacher candidates on climate change. Therefore, this study aimed to determine and compare the knowledge levels of the students and pre-service science teachers who will be teachers in the future in terms of time perception, the early world characteristics, and the diversity of the living subjects.

2. Method

The research is a descriptive study designed with qualitative research methods as it aims to portray the existing state of knowledge levels of secondary school students and pre-service science teachers in terms of certain fields of natural history (Büyüköztürk et al., 2020). In this model, a situation that has happened or is still existent is described, and the phenomenon, individual, object, or a circumstance in the focus of the study is defined in their conditions, and the research does not attempt to change or influence the situation in any way (Karasar, 2002).

2. 1. Study Group

The research was conducted with the secondary school students and pre-service teachers who voluntarily participated in the TUBITAK 4004 project entitled “Nature Education and Science Schools Support Program” during the 2018-2019 academic year. These projects aimed to meet science with society through dissemination, offering knowledge with as much visualization as possible through interactive practice. In addition, the other goals were to promote learners’ curiosity, and willingness to research, question, and learn by making them notice scientific phenomena (TUBITAK, 2022). The project titled “Merge the Sciences, Beautify the Nature” under which this study was conducted aimed to merge different science branches to get familiar with nature better. The participants of the study were 34 third-year pre-service science teachers from various universities and 34 sixth grade secondary school students who studied in different types of schools. The preservice teachers who participated in the project and the parents of the 6th grade students signed a consent document stating that their students allowed the studies made from the project to be used in scientific publications. Participant information was presented in detail in Table 1.

2. 2. Research Instrument

In this study, 15 open-ended questions that measured the basic knowledge level of natural history were asked. The questionnaire was applied to determine the existing situations before the natural history activities were held. Forty-five minutes were given to answer the questions. The questions were prepared under three components as time perception (questions 1, 2, 3, 4), the early earth that inquired about the changed geological structure from the formation of the earth to today and the change in the climate (questions 5, 6, 7), and diversity of the living things inquiring the living species in the past and today (questions 8, 9, 10, 11, 12, 13, 14, 15). A biology education specialist, a biology teacher, and a

science teacher were consulted about whether the questions were in the correct component categories to ensure the question form's reliability. The grouping done by the researchers and the results of the consultation were compared to be finalized with Miles and Huberman's (1994) reliability calculation formula (Reliability = $\frac{\text{Consensus}}{\text{Consensus+Disagreement}} \times 100)$ in terms of harmony. In qualitative research, harmony level of 70% or above between the consulted experts and the researcher is recommended (Miles & Huberman, 1994). In the case of this research, the reliability score forthe first expert was found to be 80.30%, 96.97% forthe second expert, and 100% forthe third expert. Finally, the harmonizing mean of the three experts were calculated as 92.42%. This outcome indicated a desirable level for the reliability of the study.

Following the expert opinions, the question forms were piloted with the sixth-grade secondaryschool students and third-grade pre-service science teachers. In piloting, the items were evaluated in terms of font, character intelligibility, comprehensibility, and the time allocated for answering each item. In the end, the form regarded as adequate concerning these criteria was administered.

In qualitative studies, the detailed presentation of the data analysis process is recommended as a way to ensure the validity of the data analysis results (Yıldırım & Şimşek, 2005). Regarding this study, a three-phase data analysis process including sorting out the papers, coding, and marking the questions as correct or incorrect were presented to ensure validity.

2. 2. Data Analysis

The analysis of the data was done through the content analysis of the answers given by the participants. Stages of the data analysis process are as follows:

2. 2. 1. Sorting out the papers

Prior to the data analysis, it was decided that any papers with unanswered, irrelevant, and meaningless items would be omitted. Thus, it was agreed that there were no papers to exclude from the study.

2. 2. 2. Coding the papers

Papers were coded in accordance with the rules predetermined by the researchers. The rules for coding were presented in Table 1.

Table 1. ***Participant Information and Coding Rules***

Secondary School Students A				**Pre-service Teachers B**			
	Letter	Number	%		Letter	Number	%
District Boarding School	a	8	23.52	Aksaray Uni.	a	3	8.82
Village School	b	13	38.23	Balıkesir Uni.	b	23	67.64
City School	c	10	29.41	Celal Bayar Uni.	c	3	8.82
Private School	d	3	8.82	İstanbul Uni.	d	1	2.94
Sorting from number 1				Osmangazi Uni.	e	3	8.82
Example: Paper with the code A.a.1; secondary school student, district boarding school, student number 1				Sıtkı Koçman Uni.	f	1	2.94
				Sorting from number 1			
				Example: Paper with the code B.a.1; pre-service teacher, Aksaray University, student number 1			

2. 2. 3. Marking the answers as correct or incorrect

An answer key was constructed by the researchers who determined the correct answers for the questions. The answers differing from the predetermined correct answers were marked as incorrect. The papers were independently marked by the researchers, and the answers were classified as correct and incorrect. The independent markings of the researchers were compared and no disagreements regarding the classification of the answers as correct or incorrect were detected, which generated a 100% harmony level. In comparing the knowledge levels of secondary school students and pre-service teachers, the number of correct answers given to each question was used as a reference.

3. Findings

The findings of the study consist primarily in the comparisons between the number and percentage of correct answers provided by the pre-service teachers and secondary students in Table 2.

Table 2. *Number and Percentage of Correct Answers by Secondary Students and Pre-service Teachers*

QUESTIONS	Secondary Student Correct Answer Number/Percentage		Pre-service Teacher Correct Answer Number/Percentage	
1. How old do you think the oldest tree is?	-		-	
2. How old are the ruins of ancient cities inhabited by the people of old?	-		2	5,88%
3. How old are the dinosaurs?	2	5.8%	6	17,64%
4. How old is the earth?	2	5.8%	2	5.8%
5. Was there an atmosphere in the early ages of the earth?	12	35,29%	14	41,17%
6. Was there water in the early ages of the earth?	18	52,94%	10	29,41%
7. Has the shape of the earth (state of the continents) been the same since the early ages of the earth?	30	88,23%	34	100%
8. Are there any alive dinosaurs?	31	91,17%	32	94,11%
9. How do we know dinosaurs were alive once?	26	76,47%	32	94,11%
10. Do you think there were living things on earth before humans?	23	67,64%	32	94,11%
11. Have all the living things on the earth been alive all the time?	30	88,23%	32	94,11%
12. How many of the plant and animal species in nature do you know of?	4	11,76%	11	32,35%
13. Do you know about the platypus? Where do you think it lives?	10	29,41%	12	35,29%
14. Do you think there are any extinct living beings?	34	100%	34	100%
15. Do you think dinosaurs and humans lived at the same time? How do we know that?	17	50%	12	35,29%

According to Table 2, the number of correct answers given by the pre-service teachers and secondary school students was equal in two questions, which were the 4th and the 14th questions. As for the 2nd, 3rd, 5th, 7th, 8th, 9th, 10th, 11th, 12th, and 13th questions, ten items were given more correct answers by the pre-service teachers whereas, in two questions (the 6th and the 15th), students gave more correct answers than their pre-service teacher counterparts. The more detailed findings regarding this aspect were presented in Table 3.

Table 3. *Comparison of Correct Items by Secondary Students and Pre-service Teachers*

	Questions	Number of Questions
Equally correct answers	4th and 14th questions	2
More correct answers by pre-service teachers	2nd,3rd, 5th, 7th, 8th, 9th, 10th, 11th, 12th, and 13th questions	10
More correct answers by secondary students	6th and 15th questions	2
No correct answers in both groups	1st question	1
Total		15

According to Table 3 10 out of 15 questions (66.7%) were answered correctly by the pre-service teachers more frequently than the secondary school students. Two questions, which were about the early earth and the diversity of the living components, were given more correct answers by the secondary schoolers.

Aligned with the purpose of the study, the comparison of the correct and incorrect answers given regarding to the knowledge levels of pre-service teachers and secondaryschool students in time perception, the early earth, and the diversity of the living dimensions arepresented in Table 4. This comparison was made in accordance with the correct answer percentages.

Table 4. *Correct Answers Based on the Question Dimensions*

	Secondary School Students		Pre-service Teachers	
Question Dimension	Number of Correct Answers	Percentage of Correct Answers	Number of Correct Answers	Percentage of Correct Answers
Time perception Questions 1, 2, 3, 4	4	2.94%	10	7.35%
Early earth Questions 5, 6, 7	60	58.82%	58	56.82%
Diversity of the living Questions 8, 9, 10, 11, 12, 13, 14, 15	173	63.60%	197	72.42%

Table 4 allows for a comparison of percentages of the correct answers given by the pre-service teachers and secondary school students. The difference in correct answer percentages for the questions in the time perception dimension between pre-service teachers and secondary school students was 4.41% while the difference in the percentages regarding the diversity of the living dimension was 8.82%. Pre-service teachers, despite the little difference in percentages, gave more correct answers to the questions in these two dimensions. However, considering the early earth dimension questions, secondary school students gave more correct answers by 2%.

To elaborate on the topic and to support the aforementioned data in the study, some samples of the answers provided by students and teachers that are considered to best represent the general perspective have been presented in Table 5.. To simplify the interpretation, answers given by the pre-service teachers and students were compared in a tabulated form together with the questions.

Table 5. *Sample Answers*

Question	**Sample Student Answer**	**Sample Pre-Service Teacher Answer**
1. How old do you think the oldest tree is?	*A.a.7 It might be 452 years old.*	*B.a.2. 200 years old.*
2. How old are the ruins of ancient cities inhabited by the people of old?	*A.b.14 100 years old.*	*B.b.18 3000 years old.*
3. How old are the dinosaurs?	*A.c.25 There are no dinosaurs.*	*B.b.1 I can't know the age of*

		something that doesn't live because there are no dinosaurs on earth.
4. How old is the earth?	*A.d.32 800.000 years old.*	*B.d.1 2 million years old.*
5. Was there an atmosphere in the early ages of the earth?	*A.c.28 Maybe.*	*B.c.3 No, because if there was, there would be some life or bacteria.*
6. Was there water in the early ages of the earth?	*A.b.17 I suppose there was.* *A.c.25 there was only lava back then.* *A.d.32 there wasn't. There was only lava or something.*	*B.b.19 No. There are theories about how the water came to earth.* *B.b.1 Only as salty and acidic.*
7. Has the shape of the earth (state of the continents) been the same since the early ages of the earth?	*A.c.25 No, continents separated due to an earthquake occurring later.* *A.c.31. "No. Because with global warming, glaciers sink underwater."*	*B.c.3 No, because external factors, wind, rains, etc. caused changes.* *B.b.12 No. There were shifts.*
8. Are there any alive dinosaurs?	*A.a. 9 No, because they got extinct.* *A.b.21. Yes, alligators.*	*B.b.7 It may live as an evolved species.*
9. How do we know dinosaurs were alive once?	*A.b.10 Because there are bones in museums.* *A.c.28 From history books and fossils.*	*B.b.10 Science fiction journals.* *B.b.11. Archeological studies, remains, research and investigations.* *B.b.20 "Fossils mentioned in documentaries."* *B.a.1, B.b.6, B.e.2, Archeological excavations.*
10. Do you think there were living things on earth before humans?	*A.a.4 No.* *A.b.11 Yes, dinosaurs.* *A.c.25. Yes, microscopic organisms.*	*B.b.3 Yes, there were aquatic organisms, bacteria, etc.* *B.b.1 There were prokaryotic beings.*
11. Have all the living things on the earth been alive all the time?	*A.c.31 If they had, humans and dinosaurs would've lived at the same time.*	*B.b.22 No, because the extinction of a being can give an opportunity for another to live.*
12. How many of the plant and animal species in nature do you know of?	*A.c.26 25%* *A.a.5 70%. Because we go to science class a lot.* *A.b.14 90%*	*B.b.4 2%* *B.a.3 50%* *B.e.3 10% or lesser. I think there are still undiscovered species in nature.*
13. Do you know about the platypus? Where do you think it lives?	*A.a.8, A.b.12 I don't know.* *A.c.30 I know. I saw it in a cartoon, then I looked it up if it was real.* *A.c.29 I know platypus from cartoons but I don't know where they live.* *A.c.26 Yes, I do, but I don't know where they live. I saw it on TV and in books.*	*B.b.6, B.e.1, I don't know.* *B.e.2 I do. I know they sometimes climb trees to feed.* *B.b.10 No, I don't, but I feel they might've lived during the dinosaur era.* *B.b.13. Platypus is a beaked mammal is all I know.*
14. Do you think there are any extinct living beings?	*A.c.25 Yes, for example, Dodo bird.* *A.b.15 Yes there are. For example, dinosaurs.* *A.a.5 Yes there is because there was an extinction topic in the science lesson.*	*B.f.1 There are. Dinosaurs and bacteria.* *B.c.3 Yes, species living in glaciers and some birds might go extinct in time.*
15. Do you think dinosaurs and	*A.a.3 They didn't, because dinosaurs*	*B.b.1 They did, because both*

humans have lived at the same time? How do we know that?	*would've killed them.* *A.c.25 No, humans have been here for almost 2-3 million years. Dinosaurs went extinct 65 million years ago.* *A.b.21 No. If they'd lived together, dinosaurs would've eaten them.*	*species are eukaryotic.* *B.b.5 Yes, they have. We know it from historical remains.* *B.b.11 Yes, they have. We can know it from dinosaurs or human remains.* *B.b.19 They haven't. There are no fossils belonging to the same years.*

In Table 5, except for the one about the age of the dinosaurs, the sample answers given by the students and pre-service teachers for the questions under the time perception group included numbers very far from the correct answers. Regarding the sample answers for the early earth questions, it is seen that students responded with more correct answers. When it comes to living diversity questions, the question with the most incorrect answers from both pre-service teachers and students inquiring about how many of the plants and animals in the nature they knew indicated that they thought themselves aware of many types of species due to taking frequent science classes. This finding is noteworthy in a way that it shows students felt a linear relationship between the number of classes and learning the content more effectively. Additionally, students generally made inferences through scientific arguments for the questions about the diversity of the living component.

4. Discussion and Conclusion

It is a necessary and expected situation for pre-service teachers to give more correct answers than secondary school students by having more knowledge about the time perception, early earth and the diversity of living things.

Time Perception

The fact that the vast amount of time that has passed since the Earth's existence is very long compared to human life makes it difficult to perceive. (Ault, 1998; Libarkin et al., 2005; King, 2008). The knowledge levels of pre-service teachers and students are similar regarding the age of the world, which is related to time perception. As seen in Table 3, only two correct answers were given to this question in both groups. This number is quite low for teacher candidates. Similar to this result, in a study examining the pedagogical content knowledge of pre-service biology teachers about the age and beginning of the Earth, it was determined that the pre-service teachers did not have sufficient knowledge on this subject (Tekkaya & Kılıç, 2012). This study also points out that the most difficult part of understanding natural history is understanding the length of time from the formation of the earth to today. The most possible reason for the lack of knowledge in this subject might be that the curriculum does not include activities to ease the understanding of the learning outcomes and a time concept that is difficult to comprehend. In addition, difficulties with understanding millions and billions as mathematical numbers led to this problem (Libarkin et al., 2005).

In the time perception section, none of the pre-service teachers and students gave a correct answer to the question in which the age of the oldest tree was asked. One of the reasons for this result may be that it is difficult to detect the age of other living species, whose lifespan is longer than that of humans. Another reason is that such a subject or achievement is not included in the curricula. The importance of perceiving the length of time will contribute to the learning of both nature conservation issues and evolution by enabling people to understand that they are a part of nature. Thus, it is important to teaching techniques and materials that could help simplify the comprehension of the time length (O'Brien, 2000; Taşkın, 2011) in natural history education. Understanding the amount of this wide time window must be the sole focus of geology teaching (King, 2008). According to Alpagut (2002), this can be improved and implemented by higher education institutions and natural history museums that emphasize the importance and necessity of preserving the environment by portraying the natural disasters, natural vitality, and biological diversity of the living things and their relationships with each other. Natural history museums represent current and historical records of living and extinct organisms, entire ecosystems, and Earth's geological and physical properties and are important for

students to learn about natural history. Therefore, the lack or scarcity of these museums may cause difficulties in the learning process (Castro et. al, 2021). The Ministry of National Education (MNE) places great importance on museum education in elementary school curricula (MNE, 2018). Considering the results from the answers given to time perception questions, the hardest part to understand in natural history is the length of the period since the formation of the earth. Since it is difficult to comprehend this period, it makes it challenging to understand the changes in the earth's geological and diversity-related changes over this period.

Early Earth

When asked whether there were seas and oceans when the world was first formed, it is a striking result that the knowledge level of the pre-service teachers was lower than that of the students, according to the answers received. The reason why pre-service teachers have less knowledge about the structure of the Earth in the first place; As Taş (2005) stated in a study on geography education, it can be said that the geography lesson hours in Türkiye are less, the curriculum has a more complex structure compared to other countries, and yet it is not prepared in detail. Related to the earth's geological structure, a study on the concept of plate tectonics revealed that elementary students had misconceptions and were confused about the forming of the earth (Mills et al., 2016). Moreover, teachers valuing geology so little and paying little attention to the topic results in students having a negative attitude towards the issue, thusly, learning it less (Betzner & Maker, 2014; King, 2001). Another reason for secondary students to give more correct answers to this question might be that children of this age group are more interested in the earth's structure than pre-service teachers. Since no learning outcome can be found regarding this topic in the curriculum, it is probable that students who gave correct answers to this item must have learned it outside the school environment. For instance, it is speculated that visual media used by children as a source of information and science fiction movies in which these matters are mentioned might be another reason for this type of result. In this context, studies point out that science fiction movies can be used as a learning tool in teaching and learning environments (Köse Biber & Kubaş, 2017). In this study, as seen in Table 5, students coded A.c.26, A.c.29 and A.c.30 expressed this.

One of the questions in the early earth group is whether the atmosphere was in the beginning. Students have more information on this subject than pre-service teachers albeit by a small margin. Moreover, these results were obtained from this item since the transformation of the earth was not presented from an evolutionary perspective in the curricula in Türkiye. Considering the countries that met international standards in teaching science, it is seen that natural history instruction has been performed based on the framework of the evolution of nature and life (Kaya, 2013).

When asked if the location of the continents has been the same since the beginning of the earth, all the pre-service teachers and most of the students gave a correct answer. In the other two questions in this group, the reason why teacher candidates know that the shape of the earth has changed is that this subject is included in secondary education programs (Öz Aydın & Şahin, 2017).

Diversity of Living Things

The topic that both teacher candidates and students know best is whether there is an endangered species. The reason for this is that since these subjects are included in the science and biology curriculum, they frequently encounter these subjects and examples at many grade levels (MEB Science Program, 20018; MEB Biology Education Program, 20018).

The second question for which secondary school students gave more correct answers was the 15th question related to time perception in which they were asked if dinosaurs and humans have lived together. In this question, time perception was handled with the consideration of the era during which dinosaurs lived. The reason for the secondary students' high percentage of correct answers was interpreted as the use of dinosaurs in the question. Dinosaurs are an extinct species that are quite popular, lovable, and eye-catching, and they are frequently used in movies and the entertainment business. Thus, it is thought that by being more familiar with the animal, students probably did more research and are more knowledgeable about them. In addition, the fact that educational materials for

children such as books, magazines, and movies are richer in recent years and that dinosaurs are frequently used in these media might have affected this result. In a similar vein to the result that answers given to this question by the teacher candidates were low in percentage, Taşkın (2011) stated in a study that pre-service science teachers thought that prehistoric humans and dinosaurs lived in the same historical era.

It is thought that one of the reasons why the misinformation that dinosaurs and humans lived at the same time is more common among teachers stems from the idea of creationism. Because, according to creationism, all living things came into existence at the same time. In a survey conducted by Eurobarometer (2005) among European Union member or candidate countries, "Did dinosaurs and humans live at the same time?" The question was asked and Turkey was the country that gave the most wrong answers among 32 countries. According to Table 3, the rate of correct answers to the question similarly asked in this research was 50% in students while it was 35.29% in pre-service teachers. Moreover, it can be seen from the explanations given by the students that some gave knowledge-based (*A.c.25 No, humans have been here for almost 2-3 million years. Dinosaurs went extinct 65 million years ago.*) answers whereas some reached the answer through inquisition (*A.a.3 They didn't, because dinosaurs would've killed them. A.b.21 No. If they'd lived together, dinosaurs would've eaten them.*). As referenced from this result, in teaching such topics, organizing activities that directly give information or channel students to become inquisitive can ensure permanent learning. In addition, it is quite clear that this topic offers opportunities for researching and questioning which are desired to be cultivated in students (Fang, 2021). In addition, there are scientifically alarming answers among the wrong answers given by the pre-service teachers. For example, *"yes they did, because they are both eukaryotes."*

Regarding the results of the questions in the diversity component, it can be noted that both groups were more successful in terms of knowledge level as opposed to their performance in time and early earth parts. In a study conducted by Öz Aydın and Şahin (2017) in which the state of inclusion of natural history in elementary and high school course books was examined, elementary science, high school biology, physics, chemistry, and geography course books and curricula were reviewed, and it was revealed that the highest rate of natural history outcomes within the whole sets of learning outcomes was the biology lesson. It can be stated that in the Turkish curricula, natural history occupies more space in biology, which, in essence, is a science of living things, than the field of geology. This result indicates the reason why living diversity questions were answered more successfully than the questions in the geological structure. The most striking result of the question within the same group regarding the diversity of the living in the past, "How do we know dinosaurs were alive once?" is the answer that the fossil records were used to know about them. It was seen that students and pre-service teachers considered the soundness of the arguments they used in deciding what to accept out of all explanations and the evidence that would support those arguments, just as scientists would do (Driver et al., 2000). It was revealed that both students and pre-service teachers used results obtained through scientific methods about a subject involving tangible knowledge without any guidance. This result is highly important in terms of revealing that students tended to use scientific data while making deductions.

A striking result of the study was that secondary school students gave more correct answers to the 6th and 15th questions in comparison with pre-service teachers. It is unacceptable for pre-service teachers to be less knowledgeable than students on science-related issues. In this case, as stated in Boon (2010)'s study, two options emerge for pre-service teachers. First, pre-service teachers will spend extra time learning these topics, create additional teaching materials, benefit from teachers who are in the profession, and the second option will skip teaching these topics, as in the findings of Howitt (2007). One of these two questions, which the students answered correctly more than the pre-service teachers, is about geography and the other is about biology. Although the subjects of natural history are covered in these courses, it can be said that their knowledge level is low because there is no connection between the courses. In addition, it is thought that the source of the incorrect information that the Earth was covered with water when it was formed may have originated from various mythological stories (Erhat, 1993).

Extending the place of natural history as a multidisciplinary field in the curricula and teaching it from a broader perspective are likely to ease the difficulties of learning evolution topics. As Lerner (2000) reported in a study, the states where evolution is taught best handle the topic within the framework of natural history. Some of the reasons for the difficulties in the evolution topicare the challenges to understanding it due to being a very lengthy phenomenon and the lack of knowledge (Cheek, 2012; Cotner et al., 2010 Stenlund & Thibell, 2019). It has been stated that there is difficulty in perceiving the concepts and processes regarding the geological structure, especially in the change of the early earth (Dodick & Orion, 2003). Therefore, as it was addressed in this study, a good understanding of one of the dimensions referred to as the change in the diversity of the living and geological structure, and time makes the comprehension of the other dimension. For instance, understanding geological time makes understanding the fields of biology such as ecology, cosmology, and evolutionary biology (Dodick & Orion, 2003a).

Lack of knowledge on natural history issues hinders protecting the environment and biodiversity and learning about evolution. Therefore, for an effective natural history education, teachers should also know these obstacles and should know the teaching methods that will remove them. It is not enough for teachers to know only, and programs should also cover this issue in depth. As in the result reached in this study, the students answered completely correctly in the 14th question since it was included in the curriculum, and the 4th question was not included in the curriculum, so both the pre-service teachers and students gave very few correct answers. In terms of curricula, this study also provides a foresight about the curricula of other countries, although it was conducted in Turkey. For example, discourses in Turkey against evolutionary issues related to natural history show patterns similar to those in America (Edis, 1999), and as a reflection of this situation in Turkey, education programs and practices are affected in terms of evolution teaching (Yalçınoğlu, 2009).

Researchers, in a holistic perspective, look at natural history as a whole that contains both structural and organismic changes over a very long timeline, that is, from the formation of the earth to our time. This approach should be included in secondary school, high school and teacher training programs in countries with weak programs in evolution teaching and environmental education. As discussed in this study, if natural history programs are prepared with the themes of time, the world, and biodiversity first, they will be jumping points for evolution teaching. However, as a reflection of the fact that it is not included in the existing curriculum in this way, as seen in the result of this study, the participants had non-scientific knowledge on some subjects and secondary school students gave better answers than pre-service teacher on some subjects related to natural history. Finally, there is no literacy scale for natural history subjects in the literature. It is recommended to develop a natural history literacy scale in this area.

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