DINAMIKA ILMU
Vol. 22 No. 2, 2022
P-ISSN: 1411-3031; E-ISSN: 2442-9651
doi: http://doi.org/10.21093/di.v22i2.5046

An Investigation of Secondary School Students' Biodiversity Literacy Level

Hülya Aslan Efe
Dicle University, Department of Science Education, Turkey
e-mail: hulyaefe@dicle.edu.tr

Rıfat Efe
Dicle University, Department of Science Education, Turkey
e-mail: rifatefe@dicle.edu.tr

Abstract

The quality of life sustained by human beings is largely possible thanks to the opportunities offered by the biodiversity resources in nature. It is widely accepted that the continuation of this lifestyle largely depends on the sustainable use of consumed and destroyed natural resources. Therefore, teaching biodiversity becomes an important element of science teaching. In this context, it is important to reveal the biodiversity literacy levels of the new generation. This study aims to investigate secondary school students' biodiversity literacy levels. The descriptive survey method, one of the quantitative research methods, was used in the research. A total of 787 secondary school students studying at state schools during 2021-2022 academic year participated in the research. "Biodiversity Literacy Assessment Instrument" was used as a data collection tool in the study. Independent t-test was used to compare gender scores while one-way ANOVA was used to compare student scores based on their grades, students' feelings about studying biodiversity, and understanding problems related to biodiversity. Tukey HSD test was used to determine the direction of significance in multiple comparisons. The findings revealed that while secondary school students' scores for attitudes toward biodiversity were high, their biodiversity knowledge levels were low. Also, female students gained higher scores for "the conservation and importance of biodiversity", "ethics and biodiversity" and "sustainability and biodiversity" sub-dimensions of biodiversity literacy scale in comparison to male students. Additionally, the study found that participant students' biodiversity

literacy scale scores differed based on students' years of study. The study has implications for teaching biodiversity that include activities to help students take responsibility for the protection of biodiversity and the place of biodiversity in the national curriculum.

Keywords: biodiversity literacy, environmental issues, science education, secondary school students

A. Introduction

Biodiversity is defined as the diversity of life on earth, including plants, animals, fungi and micro-organisms, and the habitats in which these life forms live (Cardinale et al., 2012). In recent years, the world has focused on studies for the protection of biodiversity (European Commission, 2020). Because biodiversity is the source of basic human needs, from clean food to drinkable water and clean air. However, it is reported that biodiversity is decreasing day by day due to unsustainable human activities (WWF, 2020). Leakey (1996) claims that the rate of species extinction today exceeds the extinction rate that occurred after the meteor impact that led to the extinction of the dinosaurs. The World Wildlife Fund (WWF), which monitors the amount of 21,000 vertebrate populations around the world, revealed in its 2020 report that there was an average of 68% decrease in monitored mammal, bird, amphibian, reptile, and fish populations from 1970 to 2016 (WWF, 2020). According to the report, freshwater biodiversity is declining much faster than the biodiversity in our seas or forests. In addition, the report emphasizes that since 1700, approximately 90% of global wetlands have been lost, millions of kilometres of rivers have changed, and because of these changes, freshwater biodiversity has been deeply affected, and there has been a sharp decline in the population trends of freshwater species. The American continent, which is one of the sources of ecological biodiversity, has a 94% reduction curve due to factors such as the transformation of lands in its tropical regions, overuse of species, climate change, and alien species. It is reported that the number of extinct plant species is double the total number of extinct mammals, birds, and amphibians combined to date (Humphreys, Govaerts, Ficinski, NicLughadha & Vorontsova, 2019), and one-fifth (22%) of existing plant species are threatened with extinction (Brummitt, Bachman, Griffiths-Lee, Lutz, Moat, et al. 2015). Also, insect monitoring programs conducted in Europe and America have recently revealed surprisingly rapid and sustained declines in insect numbers, distributions or total weight (biomass) (WWF, 2020). The 2017-2020 report of the International Union for Conservation of Nature and Natural Resources (IUCN) reveals the grim reality of ecological degradation on Earth. It is stated that out of 15 589 threatened species of biodiversity in the world, 7,266 are animal and 8,323 are plant species. It is estimated that one in four mammals and one in eight birds may become extinct in the near future (IUCN, 2020).

It is reported that the geography of Turkey is very rich in terms of biodiversity, with 161 mammals, 480 bird species, 141 reptiles, and 300 fish species (National Biodiversity

Strategy and Action Plan, 2007). In the same report, 23 mammals, 17 birds, 50 fish, 10 reptiles, and frog species are reported to be in danger of extinction. Although Turkey is very rich in terms of endemic plants, some of these species that make up the richness are faced with serious threats. According to the criteria of the International Union for Conservation of Nature (IUCN 2001), approximately 600 endemic species in Turkey are in the "Very Endangered CR" category and 700 of them are in the "Endangered EN" category. According to the OECD (2012) Environment Forecast Report by 2050, forests in Turkey, which are rich in biodiversity, will decrease as a result of widespread commercial forestry activities and human interventions. Although many positive economic and structural changes have been made in Turkey over the last 10 years, and great efforts have been made to protect biological diversity and solve environmental problems, it is still early to say that all components of sustainable development are integrated with nature conservation and environmental management, especially the protection of biological diversity. For example; with a worldwide accepted approach, it is recommended that the ratio of protected areas be at least five percent of the country's surface area, while in Turkey this ratio reaches one percent of the country's surface area (Demirayak, 2002). The extinction of living species, in other words, biodiversity has reached dangerous dimensions and has become a global problem (Menzel & Bogeholz, 2010). Biodiversity is based on increasingly strong evidence showing its incalculable importance to many aspects of our lives, including our health, well-being, food supply, wealth, and security. It is necessary to protect biological diversity in order to meet the needs of today and transfer this diversity to future generations (Convention on Biological Diversity. 2010).

In times of climate change and the dramatic loss of biodiversity, there is a potential risk of raising a generation that does not pay enough attention for protecting animals, plants, and landscapes. Nature plays a minor role in the daily life of the younger generation (Brämer 2010), their free time is often spent in front of computers by playing games, watching television and other multimedia (Kaşıkçı et al., 2014). It is emphasized that the young generation lacks knowledge and interest in the concept of biodiversity as a result of life disconnected from nature ((Menzel & Bogeholz, 2009). Drissner et al. (2011) in their study emphasize that people tend to protect what they know (and love). This is also true for learning and protecting biodiversity. It is now widely accepted that the loss of biodiversity and the collapse of the ecosystem are among the most important threats that humanity will face in the next decade (World Economic Forum, 2020). Therefore, there is an urgent need for biodiversity teaching programs that increase knowledge and attitude towards biodiversity and eliminate negative feelings such as dislike for species (Drissner et al. 2011). The study conducted by the European Commission (2013) revealed that only 44% of the 26,000 people participating in the research could define biodiversity, which is not at the desired level. In a study conducted in Switzerland, it is emphasized that individuals most frequently refer to species diversity and associate biodiversity with ecological concepts when describing biodiversity (Lindemann-Matthies and Bose, 2008). This result shows that the elements that make up biodiversity are missing while defining biodiversity. In addition, the results of the research conducted by the European Commission (2013)

emphasize that the attitudes of the participants who are conscious about biodiversity towards protecting biodiversity are closely related to their knowledge levels. In this context, it is important to restructure science education to increase environmental awareness and educate students as biodiversity literate (Barker & Elliot, 2000; Schaal, Matt, & Grübmeyer, 2012). Biodiversity literacy covers the fundamental processes of biodiversity awareness (Moss, Jensen & Gusset, 2014). Biodiversity literacy is defined as both the ability to understand and comprehend the concept of biodiversity and the ability to have knowledge about specific actions that lead to biodiversity conservation (Hooykaas et al. 2019; Schneiderhan-Opel & Bogner 2020). It is stated in the literature that secondary school students define the concept of biodiversity incompletely (Kılınç et al., 2003; Menzel & Bogeholzl, 2009; Fiebelkorn & Menzel, 2013). Kılınç et al. (2013) asked 245 secondary school students about the definition of the concept of biodiversity using the interview method. The research revealed that the participant students could not make a scientific-based definition of the concept of biodiversity, and they defined the word biodiversity as "species diversity". Similarly, students participating in Menzel and Bogeholz (2009) studies explained the concept of biodiversity as plant and animal diversity. In the study of Bermudez and Lindemann-Matthies (2020), it is seen that high school students define biodiversity in relation to the concepts of species, species diversity, and interspecies relationship. In the same study, they stated that some students ignore the necessity of protecting the elements of biodiversity, which significantly affects the development of biodiversity literacy. Schneiderhan-Opel and Bogner (2020) point out that biodiversity literacy is within the scope of environmental literacy under the umbrella of science literacy. It is stated that the subject of biodiversity has a special place in environmental education (Weelie & Wals, 2002). Basically, the aim of environmental education is to raise individuals who are sensitive and knowledgeable about environmental problems and play an active role in solving these problems (Hsu, 2004). Because only individuals who are raised knowing how to take responsibility can make the right decisions in the conscious use and consumption of environmental resources and in making important decisions (Korhonen & Lappalainen, 2004). Biodiversity enables people to continue their lives in wealth. Insufficient awareness of biodiversity conservation leads to the rapid extinction of species on earth and humans will be severely affected by its consequences (Jalil & Sharif, 2018). Therefore, it is important to reveal the biodiversity literacy levels of the young generations. Examining secondary school students' biodiversity literacy levels constitutes the main starting point of this research. To achieve this aim, the following research questions were sought:

1. What is the biodiversity literacy mean scores of participant secondary school students?
2. Is there a statistically significant difference between the participant students' biodiversity literacy levels based on gender variables?
3. Is there a statistically significant difference between the participant students' biodiversity literacy levels based on students' grades?

4. Are there statistically significant differences among the participant students' biodiversity literacy levels according to students' feelings about studying biodiversity?
5. Are there statistically significant differences among the participant students' biodiversity literacy levels according to students' views of the understanding of environmental problems in comparison to their peers?

B. Research Methodology

1. Research Design

The survey, one of the quantitative research designs, was used in this study. The survey method examines individuals, groups, institutions, methods, and materials in order to identify, compare, contrast, classify, analyse and interpret the entities and events that make up the different dimensions of the research (Cohen, Manion, & Morrison, 2018).

2. Participants of the Study

The sample of the study consisted of 787 middle school students who voluntarily agreed to participate in the research. In the study, the participants were determined by using the cluster sampling method. Cluster sampling is a method in which researchers divide the entire population into sections or clusters that represent a population. First of all, schools in Diyarbakir province districts are clustered. Then, the school was selected from each cluster and the data were collected. Participant secondary school students' demographic information is provided in table 1.

Table 1. Secondary school students' demographic information

		N
Gender	Female	378
	Male	409
Grade	6^{th}	180
	7^{th}	134
	8^{th}	473
		204
Compared to other subjects you study, how do you feel about studying environmental topics?	Less interested	
	About the same	324
	More interested	259
		93
Compared with other students of your age, how well do you understand problems related to the environment?	Below average	
	Average	468
	Above average	226
Attendance of environmental project	Yes	311
	No	476
Total		787

3. Instruments

In the research, the "Biodiversity Literacy Assessment Instrument" developed by the Wisconsin Environmental Education Centre financed by the World Wildlife Fund (WWF) in 1996 was used as the data collection tool. The scale was adapted to the Turkish language by the researchers. The instrument consists of three parts: demographic information, attitude scale items, and a multiple-choice test. The attitude scale is a 4-point Likert type. The "Biodiversity Literacy Assessment Instrument" used in the study consists of 6 dimensions and 27 items. The scale has 5 items in "conservation and importance of biodiversity (CIB)", 5 items in "ethics and biodiversity (EB)", 3 items in "sustainability and biodiversity (SB)", 4 items in "taking action to protect biodiversity (TAPB)", 4 items in "biodiversity and utility (BU)" and 6 items in "conservation and importance of species (CIS)" dimension. The Cronbach alpha coefficient of the scale used in the study was calculated as .726 for the CIB dimension, .764 for the EB dimension, .706 for the SB dimension, .704 for the TAPB dimension, .710 for the BU dimension, .852 for the CIS dimension and .892 for the entire scale. The multiple-choice part of the scale consists of 30 questions that measure the level of biodiversity knowledge. The Spearman-Brown test was used to determine the value of multiple-choice questions. The reliability value was calculated as .822 for the whole test.

4. Data Analysis Techniques

SPSS 28 was used to analyze the data collected for the study. Independent t-test was used to compare gender scores while one-way ANOVA was used to compare student scores based on their grades, students' feelings about studying biodiversity, and understanding problems related to biodiversity. Tukey HSD test was used to determine the direction of significance in multiple comparisons. Means for the items were calculated. The intervals used to interpret the means for the scale used in the research are given below.

Completely agree (very significant): 3,25-4,00

Agree (significant): 2,50-3,24

Disagree (less significant): 1,75-2,49

Completely disagree (not significant): 1,00-1,74

C. Findings and Discussions

In this section, statistical data regarding the answers to the research questions are provided and discussed.

RQ1. What is the biodiversity literacy mean scores of the participant secondary school students?

For each item in the six dimensions of the scale part of the instrument, the mean scores from the participant student responses are provided in table 2.

Table 2. Participant students' mean scores for the scale items

Dimension	Item	Mean
CIB	A plant or animal can be important just because it is interesting to watch	2.52
CIB	If I wanted to. I could help get a law passed to protect plants and animals.	2.91
CIB	I could convince my classmates to protect plants and animals.	2.79
CIB	If I do things like planting trees and putting up nesting boxes. this can help animals that are in danger of becoming threatened or extinct.	2.91
CIB	The things I do every day show how I protect the environment.	2.70
EB	An important reason for studying about the diversity of plants. animals. and ecosystems is because**;** I want to know what I can do to help protect them	2.90
EB	An important reason for studying about the diversity of plants. animals. and ecosystems is because**;** There are many interesting jobs relating to these things.	2.84
EB	An important reason for studying about the diversity of plants. animals. and ecosystems is because**;** Some of the species may be gone by the time I am an adult.	2.90
EB	An important reason for studying about the diversity of plants. animals. and ecosystems is because**;** We use many species for food and medicine.	2.84
EB	An important reason for studying about the diversity of plants. animals. and ecosystems is because**;** My future. as well as future generations. depend on healthy ecosystems.	2.90
SB	I think it is my responsibility to let people know how the things they buy can affect the environment.	2.61
SB	It is my responsibility to try to get my school to do things like recycle and use less paper.	2.57
SB	I think that it's my responsibility to help protect species.	2.61
TAPB	We should limit the use of bicycles. boats. and other vehicles if they harm the environment.	2.67
TAPB	I believe that my friends need to make changes in their lives to protect the environment.	2.82
TAPB	I think that people like scientists and engineers can solve most of the world's environmental problems.	2.61
TAPB	Most people I know should change how they live to help solve environmental problems.	2.74
BU	How important do you think the protection of biodiversity should be for scientists?	3.26
BU	How important do you think the protection of biodiversity should be for kids your age?	3.03
BU	How important do you think the protection of biodiversity should be for people who live in Africa?	3.05
BU	How important do you think the protection of biodiversity should be for people who live in the country?	3.12
CIS	How important do you think it is to protect Hummingbirds	2.94
CIS	How important do you think it is to protect Frogs	3.08
CIS	How important do you think it is to protect Worms	3.14
CIS	How important do you think it is to protect Vultures	3.10
CIS	How important do you think it is to protect Fungi	3.13
CIS	How important do you think it is to protect Bats	2.85

The participant students' mean scores for their responses to the items in the CIB, PE, SB, and TAPB dimensions were at the level of "agree" (Table 2). The mean of the first item in the BU dimension was "very significant" based on the interpretation of the scores for assessment. On the other hand, the other items in the BU dimension and the item averages in the CIS dimension were at the "significant" level. These results are important as developing knowledge and behaviour to protect biodiversity is seen among the important elements of biodiversity literacy (Moss, Jensen & Gusset, 2014). The findings are also supportive of the finding of the study by The Schneiderhan-Opel and Bogner (2020)

that reported Grade 10 students' high motivation to protect biodiversity. Similarly, the study by Nisiforou and Charalambides (2012) found that university students participating in the research expressed a positive attitude towards biodiversity, but were reluctant to engage in environmental behaviours. Chandrasekar, Sundavadivelan, and Selvan (2012), also, found a high level of biodiversity awareness among school students. In the study examining biodiversity literacy of pre-service science teachers, it is stated that pre-service science teachers have high averages in terms of "the importance of biodiversity" (Çavuş Güngören & Özdemir, 2020). In a study examining awareness of biodiversity in Switzerland, it was determined that the majority of school students were unfamiliar with the term biodiversity. In the same study, only 16% of students identified the school as a source of information on biodiversity (Lindemann-Matthies & Bose, 2008). Similarly, in our study, the average of secondary school students' responses to the biodiversity knowledge test was calculated as 10.32. Considering that there are 30 questions in the biodiversity knowledge test, it can be said that this figure is quite low. Again, the results of many studies conducted in different countries reveal that primary and secondary school students demonstrated deficiency in terms of biodiversity knowledge (Huxham et. al., 2006; Torkar, 2016; Köksal & Gebelek, 2019; Hooykass, et all, 2021). According to Buijs et al., (2008), determining students' biodiversity knowledge levels should be considered important as it determines their ways of taking responsibility for the environment. In addition, the level of knowledge affects the construction process of students in creating new knowledge (Hailikari, Nevgi, & Lindblom-Ylänne, 2007). Therefore, it is important for students to have a high level of biodiversity knowledge.

RQ2 Is there a statistically significant difference between the participant students' biodiversity literacy levels based on gender variable?

This research question investigated whether gender was an affective variable in students' approaches to biodiversity. The findings related to students' scores based on their genders are provided in table 3.

Table 3. Comparison of participant secondary school students' biodiversity literacy levels based on gender

Dimension	Variable	N	Mean	SD	df	t	p
CIB	Female	378	2.8243	.62081	785	2.476	.014*
	Male	409	2.7105	.66547			
EB	Female	378	2.9259	.66533	785	1.902	.058*
	Male	409	2.8308	.73253			
SB	Female	378	3.1640	.68074	785	1.944	.052*
	Male	409	3.0709	.66226			
TAPB	Female	378	2.6138	1.05876	785	1.233	.218
	Male	409	2.5330	.76585			
BU	Female	378	2.6199	.71520	785	.795	.427
	Male	409	2.5786	.74013			
CIS	Female	378	3.0926	.88381	785	1.380	.168
	Male	409	3.0069	.85703			

BK	Female	378	10.52	5.356	785	.963	.336
	Male	409	10.15	5.391			

When Table 3 is examined, it is seen that the mean scores of female students in CIB (t:2.476, p<.05), EB (t:1.902, p<.05), and SB (t:1.944, p<.05) dimensions are significantly different from those of male students. This is in line with the findings of Derman, Çakmak, and Gürbüz (2012) that reported the mean of female students in the dimension of the importance of biodiversity was significantly higher than that of male students. Similarly, Güleş, Uzel, and Gül (2020) obtained significant results in favour of female students in the dimension of the importance of biodiversity. Özbaş (2016), also, emphasizes in his study that female students have a higher means of protecting biodiversity than male students. Again, Özdemir (2020) found that female undergraduate students' attitudes toward biodiversity loss were significantly higher than male students' attitudes. Biodiversity literacy of TAPB (t:1.233, p>.05), BU (t:.795, p>.05), CIS (t:1.380, p>.05) and BK (t:.963, p>.05) dimensions did not reveal any statistically significant result between female and male students' mean scores. Uç and Gül (2021), in their study in which they examined the level of attitude towards biodiversity of undergraduate students, point out that attitudes towards reducing biodiversity and preventing biodiversity do not differ significantly according to the gender variable. Akkaya and Benzer (2019) examined the biodiversity literacy levels of pre-service teachers and concluded that the biodiversity literacy levels of female and male students were similar. In the same vain, Chandrasekar, Sundavadivelan, and Selvan (2012) revealed that the biodiversity awareness of female and male students studying at the high school level is similar in the Vilathikulam region. When the literature is examined, it is seen that there are studies that found the level of biodiversity knowledge differs according to the gender variable (Yüce & Doğru,2018; Özdemir, 2020) and there are also studies that did not find any significant difference between male and female students scores (Turan & Common, 2014). Özbaş (2016) reports that there is no significant difference between students' biodiversity knowledge levels according to the gender variable. But in the present study, female students' mean scores were higher than male students' scores in all dimensions. Nunes and Clorez (2017), in their study examining the environmental literacy of high school students, found that the environmental knowledge levels of female students were higher than that of male students, although it was not significant. According to Davidson and Freudenberg (1996), girls are more concerned with environmental risks than boys because girls describe themselves as part of the environment, but boys do not see themselves as part of the environment.

RQ3 Is there a statistically significant difference between the participant students' biodiversity literacy levels based on students' grades?

The 3rd research question of the study investigated whether the year of study was an important predictor for the participant students' biodiversity literacy level.

Table 4. Comparison of participant secondary school students' biodiversity literacy levels based on grades

Descriptive					ANOVA Results					
Dimension		N	Mean	Std. Deviation		Sum of Squares	df	Mean Square	F	Sig.
CIB	6th grade	180	2.80	.81937	Between Groups	13.959	2	6.980	10.174	.000*
	7th grade	134	3.01	.84446	Within Groups	537.820	784	.686		
	8th grade	473	3.13	.82698	Total	551.779	786			
	Total	787	3.03	.83786						
EB	6th grade	180	2.69	.70924	Between Groups	4.619	2	2.309	5.589	.004*
	7th grade	134	2.64	.70733	Within Groups	323.907	784	.413		
	8th grade	473	2.82	.59540	Total	328.526	786			
	Total	787	2.76	.64651						
SB	6th grade	180	2.70	.69071	Between Groups	8.307	2	4.154	8.586	.000*
	7th grade	134	2.83	.76784	Within Groups	379.288	784	.484		
	8th grade	473	2.95	.67566	Total	387.595	786			
	Total	787	2.87	.70223						
TAPB	6th grade	180	2.99	.71716	Between Groups	3.360	2	1.680	3.742	.024*
	7th grade	134	3.11	.72009	Within Groups	351.993	784	.449		
	8th grade	473	3.15	.63607	Total	355.353	786			
	Total	787	3.11	.67239						
BU	6th grade	180	2.55	.78061	Between Groups	.535	2	.267	.504	.604
	7th grade	134	2.63	.75488	Within Groups	416.139	784	.531		
	8th grade	473	2.60	.70000	Total	416.674	786			
	Total	787	2.59	.72809						
CIS	6th grade	180	2.61	.74389	Between Groups	2.040	2	1.020	2.367	.094
	7th grade	134	2.71	.68541	Within Groups	337.826	784	.431		
	8th grade	473	2.74	.61114	Total	339.866	786			
	Total	787	2.70	.65757						
BK	6th grade	180	11.13	5.62357	Between Groups	239.763	2	119.882	4.185	.016*
	7th grade	134	9.37	5.44787	Within Groups	22458.613	784	28.646		
	8th grade	473	10.28	5.21781	Total	22698.376	786			
	Total	787	10.32	5.37386						

Table 4 shows the analysis of the participant secondary school students' biodiversity literacy levels based on students' studying years. There are statistically significant differences in CIB ($F_{(2\text{-}784)} = 10.174$, $p<.05$), EB ($F_{(2\text{-}784)} = 5.589$, $p<.05$), SB ($F_{(2\text{-}784)}= 8.586$, $p<.05$), TAPB ($F_{(2\text{-}784)}= 3.742$, $p<.05$) and BK ($F_{(2\text{-}784)}= 4.185$, $p<.05$) dimensions of

biodiversity literacy levels based on student grades (Table 4). Tukey HSD analysis revealed the significant difference in the CIB (p=.000), SB (p=.000), and TAPB (p=.018) dimensions is between 8th and 6th-grade students and that the 8th-grade participant students mean scores in these dimensions are higher than the 6th-grade students mean scores. In the same vain, Tukey HSD analysis was conducted to determine the direction of significance in the EB (p=.009) dimension of biodiversity literacy scale disclosed that this significance stem from the differences between 8th and 7th-grade students, albeit in favour of 8th-grade students. Pedro and Pedro (2010) point out the importance of environmental education for the development of environmental attitudes. Similarly, Dervişoğlu (2007) reported that the tendency to protect biodiversity increases when students receive biodiversity education. As a matter of fact, it is not surprising that 8th-grade students in our study have higher mean scores in terms of protecting and considering biodiversity as important, given that they take more environmental courses within the scope of science education. The analysis, also, showed that the significant difference in the BK (p=0.011) dimension was between the 7th and 6th grades and in favour of the 6th-grade participant students. This result can be evaluated with the environmental education given within the scope of science education in Turkey. In Turkey, the biodiversity unit is covered within the scope of the "human and environment" unit, which is the last unit of the 5th grade at the secondary school level. Therefore, it is possible for 6th-grade students to remember their knowledge about biodiversity more easily. While there is not any environmental education unit in the 6th and 7th-grade science curriculum, there is an "Energy transformations and Environmental Science" unit in the 8th-grade science curriculum. In this respect, the mean scores of biodiversity knowledge obtained as a result of the research are seen as relevantly significant. Özbaş (2016), in their study examining high school students' biodiversity knowledge according to the grade variable, concluded that the level of knowledge enhances as the grade level increases. Similarly, Nisiforou and Charalambides (2012) found that the level of biodiversity knowledge of university students in the 2nd year was significantly higher than that of the 1st year students. In contrast, there was not any statistically significant difference in students' attitudes towards biodiversity. Therefore, the results may also reflect the differences in students' socio-economic backgrounds (living in the countryside or the city) and receiving training from teachers who have different biodiversity teaching approaches. In the present study, the findings did not reveal any statistically significant difference in students' mean scores for the BU ($F_{(2\text{-}784)} = .504$, $p>.05$) and CIS ($F_{(2\text{-}784)} = 2.367$, $p>.05$) dimensions based on students' year of study.

RQ4 Are there statistically significant differences among the participant students' biodiversity literacy levels according to students' feelings about studying biodiversity?

This research question investigated whether students' feelings about studying environmental topics compared to the other science topics was an important factor for their biodiversity literacy scores.

Table 5. Comparison of participant secondary school students' biodiversity literacy levels based on feelings about studying environmental topics

Dimension		N	Mean	SD	F	Sig.
CIB	Less interested	204	2.67	.64428	2.720	.067
	About the same	324	2.81	.61578		
	More interested	259	2.77	.68063		
	Total	787	2.76	.64651		
EB	Less interested	204	2.86	.66510	.376	.687
	About the same	324	2.90	.68860		
	More interested	259	2.85	.74777		
	Total	787	2.87	.70223		
SB	Less interested	204	3.03	.67365	2.207	.111
	About the same	324	3.14	.66812		
	More interested	259	3.14	.67359		
	Total	787	3.11	.67239		
TAPB	Less interested	204	2.54	.75270	.085	.919
	About the same	324	2.57	.76036		
	More interested	259	2.58	1.18338		
	Total	787	2.57	.91856		
BU	Less interested	204	2.51	.73040	3.089	.046*
	About the same	324	2.66	.70454		
	More interested	259	2.57	.74913		
	Total	787	2.59	.72809		
CIS	Less interested	204	3.08	.88817	1.285	.277
	About the same	324	2.98	.83165		
	More interested	259	3.09	.90244		
	Total	787	3.04	.87049		
BK	Less interested	204	9.82	4.888	1.233	.292
	About the same	324	10.44	5.660		
	More interested	259	10.57	5.366		
	Total	787	10.32	5.374		

Table 5. displays that there is a statistically significant difference ($F_{(2-784)}$ =3.089, p<.05) in the BU dimension of the biodiversity literacy scale based on students' feelings about studying environmental topics compared to other topics. Tukey HSD analysis, which was conducted to determine the direction of significance in the BU (p=.046) dimension of biodiversity literacy, shows that the averages of students who study environmental issues "almost the same" are significantly higher than those of "less concerned" students. It is not surprising that students studying environmental issues have high averages in the BU dimension. When the literature is examined, the results of many studies reveal that students' approaches to nature are more utilitarian (Grace and Ratcliffe, 2002; Dervişoğlu and Kılıç, 2013). The results of a study conducted in England revealed that high school students see the reason for the conservation of biodiversity as utilitarian, aesthetic, and economically important rather than ecological reasons (Grace and Ratcliffe, 2002). Similarly, Dervişoğlu and Kılıç (2013) emphasize that university students have the most common utilitarian value orientation towards nature. In the remaining dimensions, including CIB ($F_{(2-784)}$=2.720, p>.05), EB ($F_{(2-784)}$=.0376, p>.05), SB ($F_{(2-784)}$=2.207, p>.05), TAPB ($F_{(2-784)}$=.085, p>.05), CIS ($F_{(2-784)}$=1.285, p>.05) and BK ($F_{(2-784)}$=1.233, p>.05), there is not any statistically significant difference when student feelings for studying environmental topics is considered. This might be due to the insufficiency of environmental topics in the curriculum, the instructional methods that shape the learning

process, or the lack of awareness of the environment. It is thought that the fact that out-of-school learning is not included in the program and that students examine environmental issues detached from nature may negatively affect their processes of making sense of environmental issues.

RQ5 Are there statistically significant differences among the participant students' biodiversity literacy levels according to students' views of the understanding of environmental problems in comparison to their peers?

This research question investigated the participant students' biodiversity literacy scores based on their understanding of environmental issues.

Table 6. Comparison of participant secondary school students' biodiversity literacy levels based on the understanding of environmental problems

		N	Mean	SD	F	Sig.
CIB	Above average	226	2.76	.72050	1.191	.305
	Average	468	2.78	.58465		
	Below average	93	2.67	.74530		
	Total	787	2.76	.64651		
EB	Above average	226	2.89	.71754	.558	.572
	Average	468	2.85	.67069		
	Below average	93	2.93	.81516		
	Total	787	2.87	.70223		
SB	Above average	226	3.14	.66448	2.395	.092
	Average	468	3.13	.64460		
	Below average	93	2.97	.80628		
	Total	787	3.11	.67239		
TAPB	Above average	226	2.72	.73843	.353	.702
	Average	468	2.71	.61326		
	Below average	93	2.65	.66952		
	Total	787	2.70	.65757		
BU	Above average	226	2.66	.75261	1.360	.257
	Average	468	2.56	.68346		
	Below average	93	2.58	.87006		
	Total	787	2.59	.72809		
CIS	Above average	226	3.14	.84761	3.010	.05*
	Average	468	3.00	.79804		
	Below average	93	2.93	.98080		
	Total	787	3.03	.83786		
BK	Above average	226	9.81	5.21289	1.436	.239
	Average	468	10.51	5.34162		
	Below average	93	10.59	5.87596		
	Total	787	10.32	5.37386		

Table 6 displays the analysis of data based on the participant secondary students' understanding of environmental issues. The analysis reveals a statistically significant difference in student responses in the CIS ($F_{(2-784)}$ =3.010, p<.05). In contrast, students' responses to their understanding of environmental issues do not differ in the CIB ($F_{(2-784)}$=1.191, p>.05), the EB ($F_{(2-784)}$=.558, p>.05), the SB ($F_{(2-784)}$=2.395, p>.05), the TAPB ($F_{(2-784)}$=.353, p>.05), the CIS ($F_{(2-784)}$=1.360, p>.05) and BK ($F_{(2-784)}$=1.436, p>.05) dimensions of biodiversity literacy scale. This might be due to the insufficient number of learning outcomes and the time allocated for teaching the related units framed in the national

curriculum (MoNE, 2018). Therefore, it is not surprising to see relatively low mean scores for the participant students understanding of environmental issues. Cebesoy and Şahin (2010) found that biological diversity and its importance for the country are included in the science curriculum, but this importance is not emphasized enough. However, it is necessary to increase the diversity protection sensitivity of individuals who grow up in a developing country like Turkey (Yörek, 2009). Ozdemir (2010) claims that only the economic value of biological diversity related to human needs is included in the textbooks and the knowledge about the protection of biodiversity is generally superficial while mostly ignoring the self-value. This is why the biodiversity literacy levels of the students do not differ as the participant secondary school students cannot fully understand the environmental problems. Ergazaki and Ampatzidis (2012) state in their study that university students cannot understand the depth of their environmental problems. In their study, the scenarios were established that if the environment is protected by people, the environmental destruction will be eliminated and the environmental balance can be as before.

E. Conclusion

In this study, secondary school students' biodiversity literacy levels were investigated. The study revealed that the students' displayed a high attitude towards biodiversity but their knowledge level of biodiversity was low. The study also showed that female participant students' attitudes towards biodiversity were higher than male participant students in the CIB, PE, and SB dimensions of biodiversity literacy scale. In the same vain, participant students' grade levels had a positive correlation with students' attitudes toward biodiversity as students' years of study increased their attitude towards biodiversity and also showed an increase in CIB, EB, SB, TAPB dimensions. In this context; extra content, activities, and learning outcomes for biodiversity should be included in the national science curriculum. Also, the textbooks should be reviewed to include all elements of biodiversity education.

BIBLIOGRAPHY

Akkaya, M. M. & Benzer, S. (2019). Comparison of the views of science and primary school teacher candidates on the subject of biodiversity. Şahin, H. &Avcı-Akbay, B.,(Eds)., *Academic Researches in Educational Sciences*. ISBN 978-9940-540-74-6, Ivpe publishing.1-16.

Barker, S., & Elliot, P. (2000). Planning a skills-based resource for biodiversity education. *Journal of Biological Education, 34*(3), 123–27.

Bastı, K. , Doğan, N. , Bahar, M. & Nartgün, Z. (2016). Investigation of primary school 4th, 5th and 6th grade students' awareness of biodiversity according to various variables: The case of Bolu province. *Journal of Abant İzzet Baysal Üniversitesi Education Faculty*, *11*(2), 239-256,

Bermudez & Lindemann-Matiz (2020). "What matters is species richness"—High school students' understanding of the components of biodiversity, *Research in Science Education,* 50:2159–2187

Brämer, Rainer (2008): Grün tut uns gut. Daten und fakten zur renaturierung des hightech-menschen. Natur subjektiv studien zur natur-beziehung in der hightech-welt. Retrieved May 1, 2022 from http://www.wanderforschung.de/files/gruentutgut125803228 9.pdf

Buijs, A.E., Fischer, A., Rink, D. & Young, J.C., (2008). Looking beyond superficial knowledge gaps: Understanding public representations of biodiversity*. Int. J. Biodivers. Sci. Manag*. *4*(2), 65–80.

Brummitt, N. A., Bachman, S. P., Griffiths-Lee, J., Lutz, M., Moat, J. F., Farjon, A., … Nic Lughadha, E.M. (2015). Green plants in the red: A baseline global assessment for the IUCN Sampled Red List Index for plants. *PLOS ONE* **10**:e0135152.

Cardinale, B.J., Duffy, J.E., Gonzalez, A., Hooper, D.U., Perrings, C., Venail, P., et al. (2012). Biodiversity loss and its impact on humanity. *Nature*, *486*, 59-67.

Chandrasekar, S., Sundaravadivelan, C. and Selvan, A. (2012). Awareness on biodiversity among higher secondary students in Vilathikulam area. *International Journal of Physical and Social Sciences*, *2*(9), 305-313.

Cohen, L., Manion, L., & Morrison, K. (2018). *Research Methods in Education* (8th ed.). London: Routledge

Convention on Biological Diversity (2010). *Global Biodiversity Outlook 2*. Retrieved Janruary 3, 2022, from https://www.cbd.int/doc/gbo/gbo2/cbd-gbo2-en.pdf.

Davidson, D. & Freudenberg ,W. (1996). Gender and environmental risk concerns: A Review of available research. *Environment and Behavior*, 28, 302–339.

Demirayak, F. (2002). *Biodiversity-nature conservation and sustainable development.* TUBITAK VİZYON 2023., 1-30. Retrieved March 12,2022 from https://www.tubitak.gov.tr/tubitak_content_files/vizyon2023/csk/EK-14.pdf

Derman, M., Çakmak, M. & Gürbüz, H. (2012). Investigation of pre-service teachers' biodiversity literacy, *International Journal of Social Science, 5*(7), 279-289.

Dervişoğlu, S. (2007). *Pre-Learning conditions for education biodiversity conservation.* Unpublished Doctoral Thesis, Hacettepe University, Institute of Science, Ankara.

Dervişoğlu, S. & Kılıç, D.S. (2013). Young people's value orientation and preferences of nature. *Journal of Research in Education and Teaching*, *2*(1), 92-99

Drissner, J., Haase, H. Martin, Nikolajek, M., & Hille, K., (2011). Environmental education in a 'green classroom'. *Resonance.*180-187.

Ergazaki, M., & Ampatzidis, G. (2012). Students' Reasoning about the future of disturbed or protected ecosystems & The idea of the 'balance of nature'. *Research in Science Education*, 42, 511–530.

European Commission (2013). *Attitudes toward biodiversity. flash eurobarometer 379- TNS Political & Social.* Retrieved April 13, 2022 from http://ec.europa.eu/commfrontoffice/publicopinion/flash/fl_379_en.pdf.

European Commission (2020). *Biodiversity strategy for 2030*. Retrieved May 22,2022 from https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en

Fiebelkorn,F., Menzel, S.(2013). Student teachers' understanding of the terminology, distribution, and loss of biodiversity: perspectives from a biodiversity hotspot and an industrialized country. *Res. Sci. Educ.*, *43*(4), 1593–1615.

Hailikari T, Nevgi A. & Lindblom-Ylänne S. (2007). Exploring alternative ways of assessing prior knowledge, its components and their relation to student achievement: a mathematics-based case study. *Studies in Educational Evaluation, 33*(4), 320–337.

Hooykaas, M.J.D., Schilthuizena, M., Aten, C., Hemelaar, E., Albers, C., Smeets, I. (2019). Identification skills in biodiversity professionals and lay people: A gap in species literacy. *Biological Conservation, 238,* 108-202.

Hooykaas, M.J.D., Aten, C., Hemelaar, E., Albers, C., Schilthuizena, M., Smeets, I. (2021). Children's species literacy as estimated and desired by biodiversity communicators: A mismatch with the actual level, *bioRxiv*. Retrived from https://www.biorxiv.org/content/10.1101/2021.11.10.466733v1.full

Humphreys, A. M., Govaerts, R., Ficinski, S. Z., Nic Lughadha, E., & Vorontsova, M. S. (2019). Global dataset shows geography and life form predict modern plant extinction and rediscovery. *Nature Ecology & Evolution,* **3,**1043-1047.

Huxham , M. Welsh, A, Berry, A. & Templeton, S. (2006). Factors influencing primary school children's knowledge of wildlife, *Journal of Biological Education*, *41*(1), 9-12.

Hsu, S. J. (2004). The effects of an environmental education program on responsible environmental behavior and associated environmental literacy variables in Taiwanese college students. *The Journal of Environmental Education*, *35*(2), 37-48.

IUCN. (2001). *IUCN Red List Categories and Criteria: Version 3.1.* IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. ii + 30 pp.

IUCN (2020). *IUCN Red List 2017–2020 Report.* Retrieved May 2, 2021, from https://5wf.org/wp-content/uploads/2021/09/IUCN_red_list_quadrennial_report_2017-2020.pdf.

Jalil, N.J. & Sharif, Z.M. (2018). Factors affecting the awareness of biodiversity conservation among students in Malaysia private university. *International Journal of Engineering & Technology*, *7*(4.35), 791-795.

Grace, M. & Ratcliffe, M. (2002). The science and values that young people draw upon to make decisions about biological conservation issues. *International Journal of Science Education, 24*, 1157-1169.

Güleşir, T., Uzel, N. & Gül, A. (2020). *Comparison of biodiversity literacy levels of pre-service teachers,* Zahal, O., (Eds.) *Academic Studies in Educational Science-II*, Gece Publishing.

Kaşıkçı, D.N., Çağıltay, K., Karakuş, T., Kurşun, E.& Ogan, C. (2014). Internet habits and safe internet use of children in Turkey and Europe. *Education and Science*, 39, 230-243.

Kılınç, A., Yeşiltas¸, N. K., Kartal, T., Demiral, U., & Eroğlu, B. (2013). School students' conceptions about biodiversity loss: Definitions, reasons, results and solutions. *Research in Science Education*, *43*, 1–31.

Korhonen, K., & Lappalainen, A. (2004). Examining the environmental awareness of children and adolescents in the Ranomafana region Madagascar. *Environmental Education Research*. *10 (*2), 195-216.

Köksal, E.A. & Gebelek, Z. (2019). Knowledge and perceptions of seventh grade students about plant and animal species, *Eurasscience Journals*, *7*(2), 1-13.

Leakey R.R.B. (1996). Definition of agroforestry revisited. *Agroforestry Today 8*(1), 5–6

Lindemann-Matthies, P. & Bose, E. (2008). How many species are there? Public understanding and awareness of biodiversity in Switzerland. *Hum. Ecol*., 36, 731–742.

Menzel, S., & Bogeholz, S. (2009). The loss of biodiversity as a challenge for sustainable development: How do pupils in Chile and Germany perceive resource dilemmas? *Research on Science education, 39*, 429-447.

Menzel, S.& Bogeholz, S. (2010). Values, beliefs and norms that foster Chilean and German pupils' commitment to protect biodiversity. *International Journal of Environmental & Science Education*, 5, 31-49.

Moss, A., Jensen, E., & Gusset, M. (2014). *A global evaluation of biodiversity literacy in zoo and aquarium visitor.* Gland: word association of zoos and aquariums executive office.

MoNE (2018). *Science teaching curriculum. National Ministry of Education* Retrieved March 19, 2022 from http://mufredat.meb.gov.tr/Dosyalar/201812312311937-FEN%20B%C4%B0L%C4%B0MLER%C4%B0%20%C3%96%C4%9ERET%C4%B0M%20PROGRAMI2018.pdf

National Biodiversity Strategy and Action Plan (2007). Retrieved January 4,2021 from http://www.nuhungemisi.gov.tr/Content/Documents/ubsep-turkce.pdf

Nisiforou, O., & Charalambides, A. G. (2012). Assessing undergraduate university students' level of knowledge, attitudes and behaviour towards biodiversity: A case study in Cyprus. *International Journal of Science Education,* 34, 1027–1051.

Nunez, M.B. & Clorez, M.A. (2017). Environmental literacy of k–10 student completers, *International Journal of Environmental & Science Education*, *12*(5), 1195-1215

OECD (2012). *Oecd environmental outlook to 2050: The consequences of inaction* Retrieved May 18,2021 from https://www.oecd.org/env/indicators-modelling-outlooks/49846090.pdf

Özbaş, S. (2016). High school students' knowledge and attitudes related to biological diversity, *Hitit University Journal of Social Sciences Institute*, *9*(2), 793-808

Özdemir, A. M. (2020). Investigation of primary school candidates' views on biodiversity, *International Journal of Eurasian Education and Culture, Issue*: 10, 1145-1165.

Pedro, S. A. & Pedro, M. V. (2010). Developing sustainable environmental behavior in secondary education students (12-16) analysis of a didactic strategy, *Procedia Social and Behavioral Sciences* 2, 3568–3574.

Schaal, S., Matt, M., & Grübmeyer, S. (2012). mobile learning and biodiversity - bridging the gap between outdoor and inquiry learning in pre-service science teacher education. *Procedia - Social and Behavioral Sciences,* 46, 2327-2333

Schneiderhan-Opel, J. & Bogner, F. (2020). The relation between knowledge acquisition and environmental values within the scope of a biodiversity learning module. *Sustainability*, 12, 2036, 2-19

Torkar, G., (2016). Young Slovenian learners' knowledge about animal diversity on different continents. *Int. J. Biol. Educ*. *5* (1), 1–11.

Turan, İ. & Yangın, S. (2014). The possible reasons and alternative understandings of university student teachers in different program about "biodiversity" concept. *Electronic Journal of Social Sciences, 13*(49), 84-103.

Uç, H. & Gül, A. (2021). Researching the biodiversity attitudes of vocational school students, *journal of Anatolian cultural research, 5*(3), 212-227.

Van Weelie, D. & Wals, A. (2002) Making biodiversity meaningful through environmental education, *International Journal of Science Education, 24*(11), 1143-1156.

World Economic Forum (2020). *The global risks report 2020*. Retrieved April 22, 2021 from https://www3.weforum.org/docs/WEF_Global_Risk_Report_2020.pdf

WWF (2020). *Living planet report 2020* - Bending the Curve of Biodiversity Loss. Almond, R.E.A., Grooten M. and Petersen, T. (Eds). WWF, Gland, Switzerland.

Yüce, M. & Doğru, M. (2018). Level of plant recognition in immediate vicinity of science teacher candidates, *Ihlara Journal of Educational Research, 3*(1), 15-35.