Educational Policy Analysis and Strategic Research, V17, N3, 2022

Determining Secondary School Students' Knowledge Levels on Ecosystem, Biodiversity, and Environmental Problems

Emine AYDIN[1]
MoNE, 15 Temmuz Şehitleri Secondary School
Mahmut SELVİ [2]
Gazi University
Elvan İNCE AKA [3]
Gazi University
Mustafa SARIKAYA[4]
Gazi University

Abstract

The present study aimed to determine the knowledge levels secondary school students have on ecosystem, biodiversity, and environmental problems within the context of a science class and to identify the relationship between their knowledge levels on these subjects according to gender and science course grades. The study applied the survey design, a quantitative research method. The participants for the study included 400 eighth-grade students from a public secondary school in Ankara, Turkey during the 2018–2019 academic year. The Ecosystem, Biodiversity, and Environmental Problems Achievement Test (EBET) was used to collect the study data, and SPPS 17 software was used for data analysis. The students' responses to EBET were evaluated based on Bloom's Original taxonomy. The results revealed that the students had no difficulty in answering knowledge and comprehension questions, partial difficulty in answering application questions, and great difficulty in answering analysis questions. There was a positive, moderately significant relationship between the students' science course grades and their scores on the knowledge and comprehension questions; however, no significant relationship was found between their science course grades and their scores on application and analysis questions. Regression analysis was performed to determine the predictive value of science course grades on the knowledge levels of ecosystem, biodiversity and environmental problems. The students' knowledge and comprehension scores varied significantly by gender in favor of the female students, whereas their application and analysis scores did not vary significantly by gender.

Keywords: Ecosystem, biodiversity, environmental problems, Bloom's taxonomy, secondary school students

DOI: 10.29329/epasr.2022.461.4

[1] Teacher, Emine Aydın, MoNE, 15 Temmuz Şehitleri Secondary School, Ankara, Turkey, ORCID:0000-0002-6098-6241 Email: eminemrcn@gmail.com
[2] Prof.Dr. Mahmut Selvi, Gazi University, Gazi Faculty of Education, Ankara, Turkey, ORCID:0000-0002-9704-1591 Email: mselvi@gazi.edu.tr
[3]Associate Prof. Dr., Elvan İnce Aka, Gazi University, Gazi Faculty of Education, Ankara, Turkey, ORCID: 0000-0003-2013-1035
Correspondence: elvanince@gazi.edu.tr
[4]Prof.Dr. Mustafa Sarıkaya, Gazi University, Gazi Faculty of Education, Ankara, Turkey, ORCID:0000-0002-5917-0237 Email:sarikaya@gazi.edu.tr

Introduction

Environmental problems pose one of the greatest challenges faced by today's world. The main reasons behind the emergence of environmental problems are people's unconscious behavior, negative attitudes and ignorance towards the environment. In order to protect the environment, emphasis has been placed on developing and/or improving value judgements concerning natural assets and habitats, and their sustainability in human-environment and human-nature relationships (Özkan, 2008). The many disciplines that address the natural environment, including biology, chemistry, geography, and economics, has resulted in the emergence of a wide range of approaches to environmental education. In some cases, environmental education is delivered as a separate course, while in others it is delivered as part of a course, like biology or geography, or designed as a separate theme and interspersed among different courses. Environmental education at the secondary education level in Turkey is delivered in different courses, like science, life sciences, and social sciences. The concepts of ecosystem, biodiversity, and environmental problems cannot be considered as separate from one another, as changes in one affect the others. These concepts should therefore not be evaluated through a human-based perspective alone but rather, by considering all the elements that form an ecosystem. With this in mind, the present study addresses ecosystem, biodiversity, and environmental problems together. A limited number of the studies in the related literature have reported that students have a moderate level of knowledge regarding environmental concepts and environmental problems (e.g., Yurttaş & Sülün, 2010). A far greater number of studies, on the other hand, have found that students have an insufficient level of knowledge on these subjects (e.g., Atasoy & Ertürk, 2008; Erduran Avcı & Darçın, 2009; Karakaş, Doğan & Sarıkaya, 2016; Gökdere, 2005; Morrone, Mancl & Carr 2001; Uluçınar et al., 2008). Students' participation in environmental actions, their awareness of environmental problems, and their suggestions for the elimination of these problems have also been reported to be insufficient (Uluçınar et al., 2008).

It is important to carry out alternative assessment and evaluation methods to identify the cognitive levels that individuals have for any given topic, including environmental issues (Öksüz & Güven-Demir, 2019; Samaie & Khosravian, 2014). In the study by Leeming, Dwyer, and Brecken (1995), secondary school student's Environmental Attitude and Knowledge Scale (CHEAKS) was developed and applied. There are many studies in the related literature involving the development of achievement tests in multiple-choice formats (e.g., Aydın & Selvi, 2020; Akbulut & Çepni, 2013; Dumanoğlu & Akçay, 2018; Güneş & Serdaroğlu, 2018; Keçeci, et al., 2019; Nacaroğlu et al., 2020; Özcan et al., 2019; Özkan & Eryılmaz Muştu, 2018; Saraç, 2018; Sontay & Karamustafaoğlu, 2017; Sontay & Karamustafaoğlu, 2020; Şener & Taş, 2017; Türkoğlu & Uzunkoca, 2017).

In a comparison of the 2005 and 2013 science curricula in terms of environmental issues, it was found that there were only minor changes, like redistribution of environmental topics according to grade level and changes in the allotted time for these topics, in the environmental issues addressed in the 2013 science curriculum. According to the Ministry of National Education (MoNE, 2018), when performing assessments and evaluations, the objectives and explanations included in the related curriculum should be considered, and attention should be given to ensuring that they are compatible with all components of the curriculum. Assessment and evaluation processes are not restricted to written-oral exams performed by teachers but rather, are conducted for all exams administered by educational institutions (Uzoğlu et al., 2013). The most common of all taxonomies that determine the knowledge and skills that students want to gain and facilitate the mental process is the Original Bloom Taxonomy (OBT) (Bloom, 1956; Bümen, 2006; Grounlund, 1998; Johnson & Fuller, 2006). OBT was refurbished by Anderson and Krathwohl (2001) as a result of innovations in learning (Bümen, 2006; Krathwohl, 2002; Zimmerman & Schunk, 2003). Bloom's taxonomy is a model used to rank the levels of questions in measurement tools applied to determine students' cognitive levels (Güleryüz & Erdoğan, 2018). In Bloom's taxonomy, skills are ranked in hierarchical order according to their complexity and specificity (Demir, 2011). The cognitive domains of the taxonomy include six levels: knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom, 1956).

A literature review showed that there are many studies on Bloom's taxonomy in the field of science. The subject area, target school level, and the focus of the study of some of the science research studies conducted on this taxonomy are presented in Table 1.

Table 1. Bloom's Taxonomy of Science Studies in Turkey

Subject Area	Target school level	Focus of the study	Reference
Science	Secondary school	LGS and TEOG exam questions	Akyürek (2019)
Science	Primary school	Primary school, third-grade science textbook unit questions.	Dündar (2019)
Science	Primary school	Objectives of third- and fourth-grade science courses in primary school curricula.	Yolcu (2019)
Science	Secondary school	Questions in science and technology curriculum	Güven and Aydın (2017)
Science	Secondary school	Questions in a science and technology textbook	İlhan and Gezer (2017)
Science	Secondary school	Questions in a science and technology textbook	Güven (2014)
Science	Secondary school	Unit questions in science textbooks	Kahramanoğlu (2013)
Science	High School	Unit questions in 9^{th}–12^{th}-grade science textbooks	Davila and Talanquer (2009)
Science	Teacher	Science course exam questions prepared by 5^{th}-grade science teachers	Dindar and Demir (2006)
Science	Undergraduate	Exam questions prepared by preservice teachers	Koray et al. (2004)

As can be seen in Table 1, the studies on Bloom's taxonomy differed in terms of the age and educational level of their target audience. The classification of the questions provided by the taxonomy enables teachers to form questions at the targeted cognitive level and eliminates concerns over asking questions that are at the same cognitive level; in applying this system of classification, teachers can develop their question formation skills (Büyükalan, 2004). Posing questions to students that encourage them to use their knowledge and to effectively engage in problem solving with their knowledge, rather than simply memorizing and recalling, can enhance students' high-level thinking skills. High-level cognitive questions will enable students to establish a connection between new knowledge they will learn and the current knowledge they have and thereby improve their levels of achievement (Çimer, 2007). Machanick (1998) suggests that OBT should be taken as a basis for a more comprehensive review of the topics taught in the curriculum. When literature is reviewed it is a common occurrence to find studies in which the Original Taxonomy is taken as a reference in the evaluation of coursebooks (Assaly & Smadi, 2015; Bıkmaz, 2002; Çepni & Azar, 1998; Eber & Parker, 2007; Gierl, 1997; Jideani & Jideani, 2012; Mizbani & Chalak, 2017; Seo et.al., 2010). There are also studies examining the learning outcomes of the science program, examining the curriculum and assessment tools (Lee, Kim & Yoon, 2015; Green, 2011). While the literature shows that Bloom's taxonomy has been used in studies to classify and determine the content validity of exams/written exam questions, objectives in the curriculum, questions in textbooks/workbooks, and unit questions in textbooks and questions in workbooks; there were no studies specifically evaluating achievement tests, that is, students' current cognitive levels, according to Bloom's taxonomy. In addition, in the Science curriculum, students related to the environment; it is aimed that they can explain the ecosystem and related concepts, question the causes and consequences of environmental problems, gain knowledge and skills for biodiversity, endangered and endangered creatures and what needs to be done to protect these species (MoNE, 2018). In this respect, it was necessary to determine the learning levels of secondary school students regarding the "ecosystem, biodiversity and environmental problems" in the science course curriculum. In this respect, considering the importance of increasing students' current cognitive knowledge levels, studies that focus on determining these levels in students for the purpose of identifying any weaknesses in this area would fill the existing gap on this subject in the science education literature.

Research Aim and Research Questions

The present study aimed to determine secondary science students' knowledge levels on ecosystem, biodiversity, and environmental problems within a science course and to examine the relationship between the students' knowledge levels and their science course grades and gender.

The question of the research is this: Do the knowledge, comprehension, application, and analysis scores of secondary school students have an effect on their science course grades?

The following sub-problems associated with the aforementioned problem were developed to guide the study:

What is the level of the students' knowledge, comprehension, application, and analysis scores?

Is there a significant relationship between the students' science course grades and their knowledge, comprehension, application, and analysis scores?

Are the students' knowledge, comprehension, application, and analysis scores a significant predictor of their science course grades?

Do the students' knowledge, comprehension, application, and analysis scores significantly differ by gender?

Method

Research Methodology

The present study used a survey design, a quantitative research approach. Survey studies focus on determining participants' characteristics, such as their views, interests, or attitudes, regarding a certain topic or event and facilitate the use of larger samples compared to those of other research designs (Büyüköztürk, 2008).

Participants

Participants for the present study were determined using the cluster sampling technique, a probability sampling method. With this method, groups, rather than individuals, are sampled. In this study, 10% of the students in the province where the study was conducted were reached to ensure that the results could be generalized to the accessible universe (Büyüköztürk et al., 2014). A total of 400 eighth-grade students from a public secondary school in Ankara, Turkey during the 2018–2019 academic year constituted the study sample. According to Tavşancıl (2010), the sample to be selected must be at least five times the number of items in the scale and tests to be applied. The student sample of the study was determined by taking the EBÇT test with 30 questions into consideration. Accordingly, 400 students were found to be sufficient for the sample. 212 of the participants were female, and 188 were male. In terms of percentages, these numbers corresponded to 53% female and 47% male.

Instrument and Procedures

Ecosystem, Biodiversity, and Environmental Problems Achievement Test

In the study, the EBET, developed by Aydın and Selvi (2020), was applied to determine the secondary school students' knowledge levels on ecosystem, biodiversity, and environmental problems. The test consists of 30 multiple-choice questions, each with four response options. The KR-20 value of the test was .71, the average discrimination power was .38; and the average item difficulty index was .56, indicating that the test items were at a medium difficulty level and had high discrimination power.

Data Analysis

It took approximately 45 mins for each student to complete the test. Each correct answer was scored one point and each incorrect answer, zero points. To compare the students' scores at different cognitive levels, the equivalents of the scores were calculated as percentages, and the data collected were analyzed using SPSS 17 and Microsoft Excel software. The Pearson correlation coefficient was used to determine the relationship between the students' science course grades and their knowledge, comprehension, application, and analysis level scores. Independent samples t-test was conducted to determine whether the students' knowledge, comprehension, application, and analysis level scores significantly differed by gender.

Results

Findings Regarding the First Sub-problem

Descriptive analysis results regarding the students' knowledge, comprehension, application, and analysis scores are given below in Table 2.

Table 2. Descriptive Statistics Results for Bloom's Taxonomy

Bloom's taxonomy level	N	M	SD	Mode	Median
Knowledge	400	71.36	25.54	87	75
Comprehension	400	71.36	23.00	87	68
Application	400	51.40	30.67	66	66
Analysis	400	31.10	26.54	33	33

Examining the mean (M), median, and mode values of the students' scores given in Table 3, it can be seen that since the mean value is lower than the median value, the scores are skewed to the left. Moreover, the mean and median values were close to each other, which indicates that the related data are normally distributed (Büyüköztürk, 2008). In evaluating the scores out of 100, it was found that on the knowledge and comprehension questions, the students' answers were good; on the application questions, their answers were at the medium level, and on the analysis questions, their answers were unsuccessful.

Findings Regarding the Second Sub-problem

Results of the Pearson correlation analysis conducted to determine the relationship between the students' science course grades and their knowledge, comprehension, application, and analysis scores are presented below in Table 4.

Table 4. Relationship between Science Course Grades and Knowledge, Comprehension, Application, and Analysis Scores

Variables		Knowledge	Comprehension	Application	Analysis
Science course	r	.445	.460	.276	.040
grade	p	.000	.000	.000	.426
	N	400	400	400	400

A positive, moderately significant relationship was found between the students' science course grades and their scores on the knowledge and comprehension questions but a low-level positive relationship between their science course grades and their scores on application and analysis questions. The correlation with knowledge, comprehension, and application scores and science course grades were significant, as indicated by $p < .05$, whereas the correlation with analysis scores was not significant, as indicated by $p > .05$.

Findings Regarding the Third Sub-problem

Regression analysis was conducted to determine whether the students' knowledge, comprehension, application, and analysis scores were a significant predictor of their science course scores. In a regression analysis, it is necessary to check for any outlier variables, as the existence of outliers makes it difficult to satisfy the "linearity" assumption in a regression analysis. A plot chart, presented in Figure 1 below, was developed to identify any outliers.

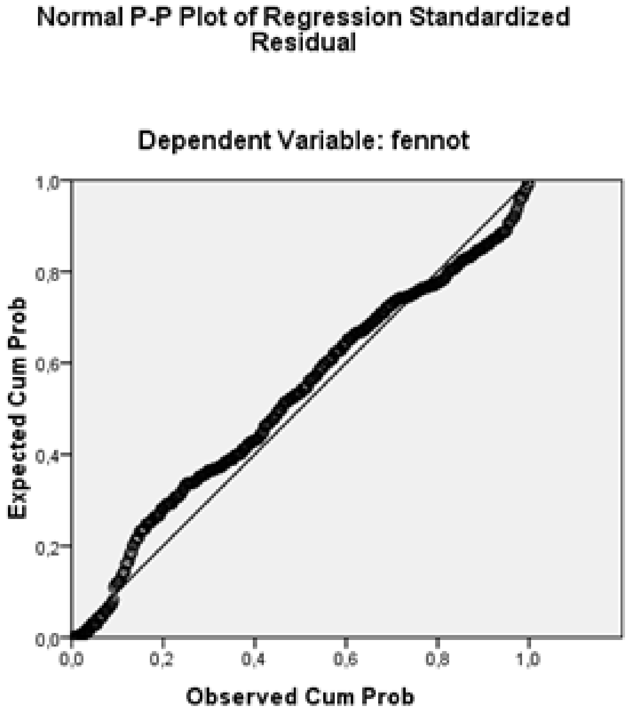

Figure 1. Correlation between the Students' Science Course Grades and Their Knowledge, Comprehension, Application, and Analysis Scores

The plot graph in Figure 1 also presents the correlation between the predictor variable and the dependent variable (predicted, criterion), which shows a positive moderate level relationship between the students' science course grades and their knowledge, comprehension, application, and analysis scores.

Upon meeting the assumptions of linearity and normality, a multiple regression analysis was performed to determine whether the students' knowledge, comprehension, application, and analysis scores predicted their science course grades. The related results are given below in Table 5.

Table 5. Multiple Regression Analysis Results on Whether Knowledge, Comprehension, Application, and Analysis Scores Predict Science Course Grades

Variable	B	Standard Error $_B$	β	t	p	Paired r	Partial r
Constant	56.39	2.20	-	25.65	.000	-	-
Knowledge	0.13	0.04	.21	3.22	.001	0.45	0.16
Comprehension	0.18	0.04	.28	4.13	.000	0.46	0.20
Application	0.50	0.02	.10	2.02	.045	0.28	0.10
Analysis	-0.03	0.03	-.05	-1.19	.236	0.04	-0.06
R =0.50, R^2=0.25							
$F_{(4, 395)}$= 32.15, p< .05							

Regarding the paired and partial correlations between the predictor variables and the dependent variable (predicted, criterion) in Table 5, a positive moderate level relationship was found between knowledge scores and science course grades (r=.45); when the other variables were controlled, the correlation between these two variables was found to be r=.16. A positive moderate level relationship was found between comprehension scores and science course grades (r=.46); when the other variables were controlled, the correlation between these two variables was found to be r=.20. The relationship between application scores and science course grades was found to be positive and close to a moderate level (r=.28); when the other variables were controlled, the correlation between these two variables was found to be r=.10. Finally, the relationship between analysis scores and science course grades was found to be positive but at a low-level (r=.04); when the other variables were controlled, the correlation between these two variables was found to be negative and low-level (r=-.06).

A moderate level positive relationship was found between the students' knowledge, comprehension, application, and analysis scores and their science course grades (R =.50, R2=.25, p <.05). The students' knowledge, comprehension, application, and analysis scores taken together explained 25% of the total variance in science course grades.

According to the standardized regression coefficient (β), the relative importance order of the predictor variables on the students' science course grades was: comprehension, knowledge, application, and analysis scores. Considering the t-test results on the significance of the regression coefficients, the knowledge, comprehension, and application scores were significant predictors of the students' science course grades, while the analysis scores were not a significant predictor of science course grades (p<.05 for knowledge, p<.05 for comprehension, p = .045 <.05 for application, and p= .236 for analysis).

From the results of the regression analysis, the following regression equation (mathematical model) for the prediction of science course grades was developed:

Science course grade=56.39 + 0.13 (Knowledge) + 0.18(Comprehension) + 0.05(Application) – 0.03 (Analysis)

Findings Regarding the Fourth Sub-problem

Independent samples t-test was performed to determine whether the students' knowledge, comprehension, application, and analysis scores differed by gender.

Table 6. Independent Samples t-Test Results for the Students' Knowledge, Comprehension, and Analysis Scores by Gender

	Gender	N	$\overline{X}$	s	sd	t	p
Knowledge	Female	212	73.70	24.78	398	2.01	.045
	Male	188	68.64	26.17			
Comprehension	Female	212	69.01	20.45	398	3.75	.000
	Male	188	60.54	24.87			
Application	Female	212	53.10	30.81	398	1.18	.238
	Male	188	49.47	30.48			
Analysis	Female	212	28.81	25.30	398	-1.80	.073
	Male	188	33.57	27.73			

As seen in Table 6, the students' knowledge and comprehension scores differed significantly by gender (t(398)= 2.01, pKnowledge=.045 <.05, and t(398)= 3.75, pComprehension=.000<.05); whereas their application and analysis scores did not significantly differ by gender (t(398)=1.18, pApplication=.238>.05, and t(398)= -1.80, pAnalysis=.073>.05). The female students were found to have higher knowledge and comprehension scores than those of the male students (Knowledge=73.70 and Comprehension=69.01), which indicates that the female students responded better to the knowledge, comprehension, and application questions. In addition, the results in students' comprehension scores indicated an effect size such as $\eta 2$ = 0.19. In other words, 0.19% of the reason for the students' comprehension score variability can be attributed to the gender of the students.

Discussion and Conclusion

The present study aimed to determine secondary science students' knowledge levels on ecosystem, biodiversity, and environmental problems in a science course and to examine the relationship between the students' knowledge levels and their science course grades and gender. In a study by Jeffries, Stanisstreet, and Boyes (2001), first-year undergraduate students' thoughts on global warming -Which is one of the most important environmental issues-, and their thoughts on the causes and consequences of global warming were examined. According to the results of the research, it was determined that the students lack the required knowledge and they also had misconceptions regarding environmental problems. In a similar fashion, in another study by Morrone, Mancl, and Carr (2001) it was revealed that the participants had insufficient knowledge regarding environment and environmental problems. A review of the literature on this subject showed that no study evaluated achievement tests according to Bloom's taxonomy.

The present study investigated whether there was a significant relationship between the students' science course grades and their knowledge, comprehension, application, and analysis scores. The results revealed that the students did not have any difficulty in answering knowledge and comprehension questions, had partial difficulty in answering application questions, and had great difficulty in answering analysis questions. Related studies on behaviors and attitudes towards environmental sustainability (Belen, 2020; Buldur & Ömeroğlu, 2018) found a weak relationship between attitude and behavior and achievement. Çavuşoğlu et al. (2017), in their study, evaluated primary school students' knowledge and attitudes regarding environment and reported a positive but weak relationship between students' knowledge scores and attitude scores. Studies reporting similar results (Derman, 2013; Makki et al., 2003; Uzun, 2007) were found in the literature. These studies found there to be a positive medium level relationship between students' environmental awareness and their learning levels on ecosystem topics. Affective behaviors have been shown to explain 25% of academic achievement (Bloom, 2012). However, in the review, there were studies that used Bloom's taxonomy to investigate exam questions of different courses. For example, Güleryüz and Erdoğan (2018) conducted a study on exam questions of a science course and found that of the questions investigated, 59.5% were at the knowledge level, 20.4% were at the comprehension level, 13.4% were at the application level, 5.2% were at the analysis level, and 1.5% were at the synthesis level, but that none were at the evaluation level. In another study that examines elementary science classroom learning outcomes based on cognitive processes; It is observed that in countries like Singapore and South Korea all learning outcomes are gathered under the umbrella of cognitive processes such as Knowledge, Comprehension, and Application. A lack of learning outcomes was observed in subcategories like Analysis, and Synthesis Evaluation (Lee, Kim & Yoon, 2015). In his doctoral study which investigates teaching strategies of the music classroom and the National Standards of Music Education according to Bloom's Taxonomy, Coleman (2013) suggests that the teachers' usage of metacognitive teaching methods in classroom activities, improved students' Cognitive, Affective and Physical skills. Increasing the number of objectives that correspond to higher cognitive levels could improve the quality of evaluation questions, as well as improve students' higher-level thinking skills. The inability to predict students' science course grades based on their application and analysis cognitive scores suggests that science course grades are not issued according to higher cognitive levels. This may stem from the assessment and evaluation methods used by the teacher or from the low level of the objectives specific to the curriculum.

The present study investigated whether the students' knowledge, comprehension, application, and analysis scores were a significant predictor of their science course grades. The results revealed there to be a significant relationship between the students' science course grades and their knowledge and comprehension scores but no significant relationship between their science course grades and their application and analysis scores. Studies in the related literature showed that questions are mostly gathered under lower stages of the cognitive domain (Altun, 2016; Assaly & Smadi, 2015; Ardahanlı, 2018; Cangüven et al., 2017; Dalak, 2015), and that students who can solve analysis questions are expected to have a good science course grade. Given this information, it was surprising that in the present study, a negative relationship was observed, that is, the students' answers to analysis questions did not significantly predict their science course grades. There are many studies in the literature that applied Bloom's taxonomy to investigate the learning outcomes of curricula and the exam questions developed by teachers and MoNE. In studies whose aim was to investigate curriculum objectives of different disciplines according to Bloom's taxonomy, it was reported that the objectives were mostly at the lower stages of the taxonomy (Cangüven et al., 2017; Yılmaz & Keray, 2012; Zorluoğlu et al., 2017). There are also numerous studies in the literature that examined the content validity of science questions in TEOG, SBS, and LGS (Coşar, 2011; Şenses, 2008).

The present study investigated whether the students' knowledge, comprehension, application, and analysis scores significantly differed by gender. The results revealed that the students' knowledge and comprehension scores differed significantly by gender, whereas their application and analysis scores did not significantly differ by gender. The knowledge and comprehension scores were found to be higher in the female students, which suggests that the female students, compared to the male students, are more successful in the lower stages of Bloom's taxonomy, such as in knowledge and comprehension. On the other hand, no significant difference was found for the higher stages. In the literature review, there was no study found evaluating an achievement test or scale according to Bloom's taxonomy. However, there were studies examining differences in the learning of environmental issues by gender, and the results reported in these studies were similar to those observed in the present study. In a study by Azapagic, Perdan, and Shallcross (2005), it was determined that gender has no role in the scores of teacher candidates in the achievement test for sustainable environment. Çavuşoğlu et al. (2017), in their study, evaluated primary students' environmental knowledge and attitudes and found there to be a significant difference between environmental knowledge and attitudes in favor of female students and a significant difference in students' environmental knowledge scores in favor of eighth-grade students, compared to their peers. In a study by Çelikbaş (2016), students' awareness about environmental problems, in terms of gender, environmental behaviors, attitudes towards environment, attitudes on environmental sustainability, water footprint, and ecological footprint were determined to be similar before receiving environmental education, yet after receiving environmental education, the female students were reported to have significantly higher awareness about environmental problems, while the male students had significantly more positive environmental attitudes. Sönmez and Yerlikaya (2017), in their study, found that female students, compared to male students, scored significantly higher on both knowledge and attitude levels regarding environmental topics. The present study observed that the female students, compared to the male students, scored higher on the lower cognitive stages, which could mean that female students have more cognitive competence.

Recommendations

The following recommendations are made in light of the findings obtained from the present study:

Further studies should be conducted using qualitative data collection methods to corroborate the quantitative data found in the present study, and students' cognitive levels, as well as their affective levels, in the related topics should be investigated.

Considering that in this study the students' achievement levels were collected at the lower levels of Bloom's taxonomy, these levels should be raised to higher levels by including in-class and extra-curricular teaching activities to activate higher level cognitive skills.

Since the objectives in the current curriculum mostly correspond to the lower levels of Bloom's taxonomy, these objectives should be revised so that they correspond to the higher stages of the taxonomy.

Attention-grabbing supplementary activities should be planned in related topics to increase students' knowledge and comprehension levels.

Acknowledgements or Notes

This study was taken from the first author's doctoral dissertation conducted under the supervision of the second author.

References

Akbulut, H. İ., & Çepni, S. (2013). Bir üniteye yönelik başarı testi nasıl geliştirilir? İlköğretim 7. sınıf kuvvet ve hareket ünitesine yönelik bir çalışma [How to develop an achievement test for a unit? A study on primary school 7th grade force and motion unit.] *Amasya Üniversitesi Eğitim Fakültesi Dergisi, 2*(1), 18-44.

Akyürek, G. (2019). *LGS ve TEOG sınavlarının fen bilimleri dersi öğretim programı ve yenilenmiş Bloom taksonomisine göre incelenmesi [Examination of LGS and TEOG exams according to science course curriculum and revised Bloom taxonomy]* [Master's Thesis, Necmettin Erbakan University]. Ulusal Tez Merkezi. https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp

Altun, H. (2016). *TEOG sınavı matematik soruları hakkında öğretmen görüşlerinin incelenmesi ve yenilenmiş Bloom Taksonomisi'ne göre sınıflandırılması [Examination of teachers' views on TEOG exam mathematics questions and classification according to the revised Bloom's Taxonomy.*] [Master's Thesis, Ondokuz Mayıs University]. Ondokuz Mayıs Kurumsal Akademik Arşiv. http://libra.omu.edu.tr/tezler/92714.pdf

Ardahanlı, Ö. (2018). *TEOG sınavı matematik soruları ile 8.sınıf matematik yazılı sınav sorularının yenilenmiş Bloom Taksonomisi'ne göre incelenmesi [Examination of TEOG exam math questions and 8th grade math written exam questions according to the revised Bloom's Taxonomy.]* [Unpublished Master's Thesis]. Eskişehir Osmangazi University.

Atasoy, E., & Ertürk, H. (2008). İlköğretim öğrencilerinin çevresel tutum ve çevre bilgisi üzerine bir alan araştırması (A field study on the environmental attitude and environmental knowledge of primary school students.) *Erzincan Eğitim Fakültesi Dergisi, 10*(1), 105-122.

Aydın, E., & Selvi, M. (2020). Ortaokul öğrencilerine yönelik ekosistem, biyolojik çeşitlilik ve çevre sorunları başarı testinin geliştirilmesi (Development of achievement test for ecosystem, biodiversity and environmental problems for secondary school students.) *Eğitim ve Toplum Araştırmaları Dergisi, 7*(2), 661-682.

Azapagic, A., Perdan, S., & Shallcross, D. (2005). How much do engineering students knowabout sustainable development? The findings of an international survey and possible implications for the engineering curriculum. *European Journal of Engineering Education, 30*(1), 1–19.

Belen, B. (2020). *Ortaöğretim öğrencilerinin sürdürülebilir çevre hakkındaki bilgi, tutum ve davranışlarının belirlenmesi [Determining the knowledge, attitude and behavior of secondary school students about sustainable environment.*] [Master's Thesis, Gazi University]. Ulusal Tez Merkezi. https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp

Bıkmaz, F. H. (2002). Analysis of the written exam questions of the science education course of 4th and 5th grades of primary schools in terms of learning levels and types. *Eurasian Journal of Educational Research, 8*, 74-85.

Bloom, B. S. (2012). *İnsan nitelikleri ve okulda öğrenme [Human qualities and learning at school.]* (2. Baskı) (D.A. Özçelik, Trans.). Pegem (Orijinal work published 1976).

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H. & Krathwohl, D. R. (1956). *Taxonomy of educational objectives: the classification of educational goals*. Handbook I: Cognitive Domain. David McKay Company Inc.

Bloom, B. S. (1956). *Taxonomy of educational objectives: The classification of educational goals*. Handbook I: The Cognitive Domain. David Mckay Company Inc.

Buldur, A., & Ömeroğlu, E. (2018). An examination of the relationship between pre-school children's and their teachers' attitudes and awareness towards the environment. *Journal of Education and Learning, 7*(2), 221-229.

Bümen, N.T. (2006). Program geliştirmede bir dönüm noktası: Yenilenmiş Bloom taksonomisi. *Eğitim ve Bilim, 31*(142), 3-14.

Büyükalan F. S. (2004). *Öğretmenler için soru sorma sanatı [The art of asking questions for teachers*]. Asil.

Büyüköztürk, Ş. (2008). *Sosyal bilimler için veri analizi el kitabı [Manual of data analysis for social sciences.]* (9. Press). Pegem A.

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, O. E., Karadeniz, S. & Demirel, F. (2014). *Bilimsel araştırma yöntemleri. [Scientific research methods.]* (16. Press). Pegem Akademi.

Cangüven, H. D., Öz, O., Binzet, G., & Avcı, G. (2017). Milli Eğitim Bakanlığı 2017 fen bilimleri taslak programının yenilenmiş Bloom taksonomisine göre incelenmesi. [Examination of the Ministry of National Education 2017 science draft program according to the revised Bloom taxonomy.] *International Journal of Eurasian Education and Culture, 2*(2), 62-80.

Çavuşoğlu, F., Altay, B., Nuriyeva, G. & Öngör, B. (2017). İlköğretim öğrencilerinin çevre bilgi ve tutumlarının değerlendirilmesi [Evaluation of primary school students' environmental knowledge and attitudes.] *Anadolu Hemşirelik ve Sağlık Bilimleri Dergisi, 20* (4), 254-259.

Çelikbaş, A. (2016). *Sürdürülebilirliği temel alan çevre eğitiminin ortaokul öğrencilerinin çevresel davranışlarına ve sürdürülebilir çevre tutumlarına etkisi [The effect of sustainability-based environmental education on secondary school students' environmental behavior and sustainable environmental attitudes.]* [Master's Thesis, Mersin University]. Ulusal Tez Merkezi. https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp

Çepni, S., & Azar, A. (1998, September). Analysis of the questions asked in high school physics exams. Proposal Presented at the *III. National Science Teaching Symposium*. Karadeniz Technical University, Trabzon.

Çimer, A. (2007). Effective teaching in science: A review of literature. *Journal of Turkish Science Education, 4* (1), 20-44.

Coleman, V. M. (2013). *National music education standards and adherence to bloom's revised taxonomy* [Doktoral Thesis, Walden University] ProQuest Dissertations and Theses.

Coşar, Y. (2011). *İlköğretim altıncı sınıf matematik dersi çalışma kitabındaki soruların kapsam geçerlik ve yenilenmiş Bloom taksonomisinin bilişsel süreç boyutuna göre analizi [Analysis of the questions in the primary school sixth grade mathematics lesson workbook according to the content validity and cognitive process dimension of the revised Bloom's taxonomy.]* [Master's Thesis, Atatürk University]. Ulusal Tez Merkezi. https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp

Dalak, O. (2015). *TEOG sınav soruları ile 8. sınıf öğretim programlarındaki ilgili kazanımları yenilenmiş Bloom Taksonomisine göre incelenmesi [Examination of TEOG exam questions and related gains in 8th grade curriculum according to the revised Bloom Taxonomy.]* [Master's Thesis, Gaziantep University]. Yükseköğretim Kurulu Açıkbilim. https://acikbilim.yok.gov.tr/handle/20.500.12812/130164

Davila, K., & Talanquer, V. (2009). Classinfying end-of-chapter questions and problems for selected general chemistry textbooks used in the United States. *Journal of Chemical Education, 87* (1), 97-101.

Demir, M. (2011). 5. ve 6. Sınıf Fen ve Teknoloji Ders Sınav Sorularının Bloom Taksonomisine Göre Değerlendirilmesi [Evaluation of 5th and 6th Grade Science and Technology Course Exam Questions According to Bloom's Taxonomy.] *Milli Eğitim Dergisi, 41* (189), 131–143.

Derman, İ. (2013). *Farklı başarı düzeylerindeki okullarda 9 ve 12. sınıf öğrencilerinin ekosisteme ilişkin öğrenme düzeyleri ve sürdürülebilir çevre bilinci ile ilişkisi [The relationship of 9th and 12th grade students with ecosystem-related learning levels and sustainable environmental awareness in schools with different success levels.]* [Master's Thesis, Hacettepe University]. Ulusal Tez Merkezi. https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp

Dindar, H., & Demir, M. (2006). Beşinci sınıf öğretmenlerinin fen bilgisi dersi sınav sorularının bloom taksonomisine göre değerlendirilmesi [Evaluation of fifth grade teachers' science course exam questions according to bloom's taxonomy.] *Gazi Eğitim Fakültesi Dergisi, 26*(3), 87-96.

Dumanoğlu, F., & Bezir Akçay, B. (2018). Elektrik enerjisi başarı testinin geliştirilmesi [Development of electrical energy success test.] *E-Kafkas Eğitim Araştırmaları Dergisi, 5* (2), 20-39. https://doi.org/10.30900/kafkasegt.422251

Dündar, H. (2019). *İlkokul üçüncü sınıf fen bilimleri ders kitabındaki ünite sonu değerlendirme sorularının revize edilmiş Bloom taksonomisi bağlamında kapsam geçerliği. [Content validity of the end-of-unit assessment questions in the primary school third grade science textbook in the context of the revised Bloom's taxonomy.]* [Master's Thesis] Giresun University. Ulusal Tez Merkezi. https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp

Eber, P. A. & Parker, T.S. (2007). Assessing Student Learning: Applying Bloom's Taxonomy. *Journal of Human Service Education, 27* (1), 45-53.

Erduran A., D., & Darçın E. S. (2009). Investigation of eight grade students' knowledge level about global environmental problems. *Eurasian Journal of Physics and Chemistry Education, 1*(2), 93-98.

Gierl, M. J. (1997). Comparing the Cognitive Representations of Test Developers and Students on a Mathematics Achievement Test Using Bloom's Taxonomy. *Journal of Educational Research, 91*(1), 26–32. https://doi.org/10.1080/00220679709597517

Gökdere, M. (2005). A study on environmental knowledge level of primary students in Turkey. *Asia-Pacific Forum on Science Learning and Teaching, 6*(2), 1-13. Retrived from https://www.ied.edu.hk/apfslt/download/v6_issue2_files/gokdere.pdf

Green, K. H. (2011). Matching Functions and Graphs at Multiple Levels of Bloom's Revised Taxonomy. PRIMUS: *Problems, Resources, and Issues in Mathematics Undergraduate Studies, 20(*3), 204–216. https://doi.org/10.1080/10511970802207212.

Grounlund, N.E. (1998). *Assessment of Student Achievement*. Boston: Allyn and Bacon.

Güleryüz, H., & Erdoğan, İ. (2018). Ortaokul fen bilimleri dersi sınav sorularının Bloom'un bilişsel alan taksonomisine göre değerlendirilmesi: Muş İli Örneği [Evaluation of middle school science course exam questions according to Bloom's cognitive domain taxonomy: The Case of Muş Province.] *Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi, 6*(1), 43–49. https://doi.org/10.18506/anemon.354846.

Güneş, M. H., & Serdaroğlu, C. (2018). Bitki ve hayvanlarda üreme, büyüme ve gelişme ünitesinde geliştirilen başarı testinin geçerliliği ve güvenirliği [Validity and reliability of the success test developed in the reproduction, growth and development unit in plants and animals.] *Bilim, Eğitim, Sanat ve Teknoloji Dergisi, 2*(1), 35-40.

Güven, Ç. (2014). *6, 7, 8. sınıflar fen ve teknoloji dersi öğretim programındaki soruların yenilenmiş Bloom taksonomisine göre incelenmesi [Examining the questions in the 6th, 7th and 8th grades science and technology curriculum according to the revised Bloom's taxonomy.]* [Unpublished Master's Thesis] Ahi Evran University.

Güven, Ç., & Aydın, A. (2017). Yedinci sınıf fen ve teknoloji dersi öğretim programı sorularının yenilenmiş bloom taksonomisi bakımından analizi ve değerlendirilmesi [Analysis and evaluation of seventh grade science and technology course curriculum questions in terms of renewed bloom taxonomy.] *Atatürk Üniversitesi Kazım Karabekir Eğitim Fakültesi Dergisi, 35*(1), 223-233.

İlhan, M., & Gezer, M. (2017). A content analysis of the wh-questions in the efl textbook of horizons. *International Education Studies, 6*(7), 200-224.

Johnson, C.G., & Fuller, U. (2006) *Is Bloom's Taxonomy Appropriate for Computer Science.* Berglund, A. (Ed.), 6th Baltic Sea Conference on Computing Education Research: Koli Calling 2006 (pp. 115-118). Koli National Park.

Jideani, V. A., & Jideani, I, A. (2012). Alignment of Assessment Objectives with Instructional Objectives Using Revised Bloom's taxonomy. The Case for Food Science and Technology Education. *Journal of Food Science Education 11* (3). Wiley Online Library: 34–42.

Kahramanoğlu, E. (2013). *İlköğretim fen ve teknoloji ders kitaplarının Bloom taksonomisi açısından değerlendirilmesi [Evaluation of primary school science and technology textbooks in terms of Bloom's taxonomy.]* [Unpublished Master's Thesis]. İstanbul University.

Karakaş, H., Doğan, A., & Sarıkaya, R. (2016). Etkinlik temelli eğitimin üstün yetenekli öğrencilerin ekolojik ayak izi farkındalığına etkisi. *Turkish Studies*, *11*(3), 1365-1386.

Keçeci, G., Yıldırım, P., & Kırbağ Zengin, F. (2019). Sistemler akademik başarı testi: geçerlik ve güvenirlik çalışması [Systems academic achievement test: validity and reliability study.] *Ulusal Eğitim Akademisi Dergisi*, *3*(1), 96-114.

Koray Ö., Altunçekiç A., & Yaman S. (2004). Fen bilgisi öğretmen adaylarının soru sorma becerilerinin bloom taksonomisine göre değerlendirilmesi [Evaluation of science teacher candidates' questioning skills according to bloom taxonomy.] *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, *17*(17), 33-39.

Krathwohl, D.R. (2002). A revision of Bloom's Taxonomy: An Overview. *Theory into Practice, 41*(4), 212-218.

Leeming, F. C. , Dwyer. W. O. and Bracken, B. A. (1995). Children's Enviromental Attitude And Knowledge Scale: Construction and Validation, *Journal of Envronmental Education. Spring (26*)3.

Machanick, P. (1998). *The skills hierarchy and curriculum*. In Proceedings of the SAICSIT_98 (pp. 54-62). Gordon's Bay.

Makki, M. H., Abd-El-Khalick, F., & Boujaoude, S. (2003). Lebanese secondary school students' environmental knowledge and attitudes. *Environmental Education Research, 9*(1), 21-33. http://doi.org:/10.1080/1350462030346821-33

Morrone, M., Mancl, K. & Carr, K. (2001). Development of a metric to test group differences in ecological knowledge as one component of environmental literacy. *Journal of Environmental Education,* 32(4), 33-42.

Ministry of National Education of Turkey [MoNE]. (2018). *Science curriculum (3rd-8th grades)*. Board of Education.

Mizbani, M. & Chalak, A. (2017). Analyzing reading and writing activities of ıranian efl textbook prospect 3 based on bloom's revised taxonomy. *Journal of Applied Linguistics and Language Research 4*(2), 2017, 13-27.

Nacaroğlu, O., Bektaş, O., & Kızkapan, O. (2020). Madde döngüleri ve çevre sorunları konusunda başarı testi geliştirme: geçerlik ve güvenirlik çalışması [Developing a success test on item loops and environmental problems: A validity and reliability study.] *Kastamonu Eğitim Dergisi, 28*(1), 36-51. http://doi.org:/10.24106/kefdergi.3374

Öksüz, Y., & Güven Demir, E. (2019). Açık uçlu ve çoktan seçmeli başarı testlerinin psikometrik özellikleri ve öğrenci performansı açısından karşılaştırılması [Comparison of open-ended and multiple-choice achievement tests in terms of psychometric properties and student performance.] *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 34*(1), 259-282.

Özcan, H., Koca, E., & Söğüt, M. (2019). Ortaokul öğrencilerinin basınç kavramıyla ilgili anlayışlarını ölçmeye yönelik bir test geliştirme çalışması [A test development study to measure middle school students' understanding of the concept of pressure.] *Eğitim ve Toplum Araştırmaları Dergisi, 6*(1), 130-144.

Özkan, E., & Eryılmaz Muştu, Ö. (2018). 8. sınıf basit makineler ünitesine yönelik başarı testi geliştirme: Geçerlik ve güvenirlik çalışması [Developing achievement test for 8th grade simple machines unit: Validity and reliability study.] *Hitit Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 11*(1), 737-754.

Özkan, M. (2008). *Biyolojik, ekolojik, genetik çeşitlilik ve doğa eğitimi [Biological, ecological, genetic diversity and nature education.]* Uludağ Milli Parkı, Bursa ve Çevresinde Ekoloji Temelli Doğa Eğitimi-III Sonuç Raporu. Proje No: 108B027, s.4-29. Bursa.

Samaie, M., & Khosravian, F. (2014). Achievement test development and validation: A measure of reading comprehension strategies for Iranian learners of English. *International Journal of Linguistics, 6*(2), 12-22.

Saraç, H. (2018). Fen Bilimleri dersi “maddenin değişimi” ünitesi ile ilgili başarı testi geliştirme: Geçerlik ve güvenirlik çalışması [Developing an achievement test for the "change of matter" unit in the Science course: a validity and reliability study.] *Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi, 18*(1), 416-445.

Seo, Y. J., Kim, H. S,, & Chae, H. K. J. (2010). Analysis of the end-of-chapter questions in chemistry ii according to revised bloom`s taxonomy of educational objectives. *Korean. Chem. Soc. 54*(3), 329.

Şener, N., & Taş, E. (2017). Developing achievement test: A research for assessment of 5th grade biology subject. *Journal of Educationand Learning, 6*(2), 254-271.

Şenses, A. (2008). *İlköğretim 6. sınıf sosyal bilgiler ders kitaplarındaki soruların kapsam geçerlilik ve Bloom Taksonomisi'ne göre analizi [Analysis of questions in primary school 6th grade social studies textbooks according to content validity and Bloom's Taxonomy.]* [Unpublished Master's Thesis, Gaziosmanpaşa University].

Sönmez, E., & Yerlikaya, Z. (2017). Ortaokul öğrencilerinin çevresel bilgi düzeyleri ve çevreye yönelik tutumları üzerine bir alan araştırması: Kastamonu ili örneği [A field study on the environmental knowledge levels of secondary school students and their attitudes towards environment: Kastamonu province.] *Kastamonu Eğitim Dergisi, 25*(3), 1239-1249.

Sontay, G., & Karamustafaoğlu, O. (2020). Fen bilimleri dersi "Güneş, Dünya ve Ay" ünitesine yönelik başarı testinin geliştirilmesi [Developing an achievement test for the science lesson "Sun, Earth and Moon" unit.] *Gazi Eğitim Fakültesi Dergisi, 40*(2), 511-551.

Sontay, G., & Karamustafaoğlu, S. (2017). 5. sınıf fen bilimleri dersi "yer kabuğunun gizemi" ünitesine yönelik başarı testi geliştirme çalışması [Success test development study for the "mystery of the crust" unit of the 5th grade science lesson.] *Fen Bilimleri Öğretimi Dergisi, 5*(1), 62-86.

Tavşancıl, E. (2010). *Tutumların ölçülmesi ve SPSS ile veri analizi.* Ankara: Nobel.

Türkoğlu, İ., & Uzunkoca, F. (2017). İlköğretim 7. sınıflarda ekosistem konusunun öğretiminde geleneksel ve bilgisayar destekli öğretim yöntemlerinin öğrenci başarısına etkisinin karşılaştırılması [Comparison of the effects of traditional and computer-aided teaching methods on student achievement in teaching the ecosystem subject in 7th grades of primary education.] *Turkish Journal of Educational Studies, 4*(2), 78-102.

Uluçınar Sağır, Ş., Aslan, O., & Cansaran, A. (2008). İlköğretim öğrencilerinin çevre bilgisi ve çevre tutumlarının farklı değişkenler açısından incelenmesi [Investigation of primary school students' environmental knowledge and environmental attitudes in terms of different variables.] *İlköğretim Online, 7*(2), 496-511.

Uzoğlu, M., Cengiz, E., & Daşdemir, İ. (2013). Fen ve teknoloji öğretmenlerinin seviye belirleme sınavı (sbs)'nda yapılan değişiklikler ile ilgili görüşlerinin incelenmesi [Examining the opinions of science and technology teachers about the changes made in the placement test (sbs).] *Mersin Üniversitesi Eğitim Fakültesi Dergisi, 9*(3), 77–86.

Uzun, N. (2007). *Ortaöğretim öğrencilerinin çevreye yönelik bilgi ve tutumları üzerine bir çalışma [A study on the knowledge and attitudes of secondary school students towards the environment.]* [Doctoral dissertation, Hacettepe University]. Ulusal Tez Merkezi. https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp

Yılmaz, E., & Keray, B. (2012). Söyleşi metinleri yoluyla sekizinci sınıf öğrencilerinin soru sorma becerilerinin yenilenmiş Bloom Taksonomisi'ne göre incelenmesi [Examining the questioning skills of eighth grade students according to the revised Bloom Taxonomy through interview texts.] *Sakarya University Journal of Education, 2*(2), 20–31.

Yolcu, H. (2019). İlkokul öğretim programı 3 ve 4. sınıf fen bilimleri dersi kazanımlarının revize edilmiş bloom taksonomisi açısından analizi ve değerlendirilmesi [Analysis and Evaluation of Primary School Curriculum 3rd and 4th Grade Science Course Outcomes in Terms of Revised Bloom's Taxonomy.] *Elementary Education Online, 18*(1), 253-262. http://ilkogretim-online.org.tr doi: /ilkonline.2019.527214

Yurttaş, G. D., & Sülün, Y. (2010). What are the most important environmental problems according to the second grade primary school students? *Procedia-Social and Behavioral Sciences, 2*(2), 1605-1609.

Zimmerman, B.J., & Schunk, D.H. (2003). *Educational Psychology: A Century of Contributions*. Lawrence Erlbaum Associates.

Zorluoğlu, S. L., Şahintürk, A. & Bağrıyanık, K. E. (2017). 2013 yılı fen bilimleri öğretim programı kazanımlarının yenilenmiş Bloom Taksonomisi'ne göre analizi ve değerlendirilmesi [Analysis and evaluation of the achievements of the 2013 science curriculum according to the revised Bloom Taxonomy]. *Bartın Üniversitesi Eğitim Fakültesi Dergisi, 6*(1), 1–15.