OPEN ACCESS

Volume: 12

Special Issue: 1

Month: June

Year: 2024

E-ISSN: 2582-1334

Received: 12.02.2024

Accepted: 20.05.2024

Published: 29.06.2024

Citation:
Arslan, K., & Ari, A. G. (2024). Development of Ecology Achievement Test for Secondary School Students. *Shanlax International Journal of Education, 12*(S1), 166–79.

DOI:
https://doi.org/10.34293/education.v12iS1-June.7195

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# Development of Ecology Achievement Test for Secondary School Students

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**Abstract**
*This study aimed to develop a valid and reliable multiple-choice achievement test for the subject area of ecology. The study was conducted within the framework of exploratory sequential design based on mixed research methods, and the study group consisted of a total of 250 middle school students studying at the sixth and seventh grade level. In the process of preparing the question pool, the level and scope of the questions in the pool were shaped by taking into account the achievements of science, environmental education and climate change courses. A question pool consisting of questions obtained as a result of the literature review and prepared by the researcher was created. The pool of 41 questions was reduced to 29 questions in line with expert opinions. The 29-question multiple-choice test, whose language comprehensibility was examined and necessary arrangements were made, was made ready for implementation. The draft form of the achievement test, which was piloted, was applied to 250 students. Item difficulty indices and item discrimination indices of the test answers obtained from the students were calculated. After the item analysis, a total of 4 questions were removed from the test. As a result of the analyses, the average difficulty value of the test was calculated as 0.58 and the average discrimination value was calculated as 0.60. The KR-20 reliability coefficient of the developed test was 0.85 and Cronbach alpha reliability coefficient was 0.88. As a result of the research, a valid and reliable ecology achievement test was developed.*

**Keywords: Ecology, Environment, Achievement Test, Secondary School**

## Introduction

The rapid development of technology and industry, irregular urbanization process, unmet energy needs, changing consumption habits, unconscious consumption of resources and the scattering of wastes into the environment increase the pressure of individuals on the environment day by day. The serious pressures reflected by individuals on the environment cause environmental problems that affect sustainable life such as pollution of air, water and soil elements, and play the role of disrupting nature and ecological balance (Akyüz, 2019; Aznar-Díaz et al., 2019; Karalar & Kiracı, 2011; Neves et al., 2020). These environmental problems have become one of the biggest global problems today, threatening humanity and the ecological order (Arık & Yılmaz, 2017). Environmental problems are a widespread problem of all developed and developing countries and are the focus of much debate worldwide (Rahman & Alam, 2021).

In the 21st century, the world has become unable to protect against major environmental problems such as global climate change, pollution, and damage to ecosystems (Ali & Khan, 2017). Global warming, various environmental pollution, extinction of various species of living things, damage to natural assets, which today's world faces, means the deterioration of the ecological balance.

The deterioration of the ecological balance has reached a dimension that threatens world life and has made it necessary to take measures (Akgün & Atmaca, 2015). Living in safe and healthy environmental conditions in countless countries has required a challenging process (Bhavya et al., 2021). When the ecological environment is threatened by serious ecological degradation, it weakens the flow of life and makes the scarcity of resources inevitable (Song & Hu, 2018; Ukaogo et al., 2020). Therefore, damage to the ecological environment means a decrease in the quality of life.

Environmental problems increasing with anthropogenic activities carried out without taking into account the carrying capacity of the planet cause permanent damage to the ecological balance by damaging nature and threaten biotic forms (Bhavya et al., 2021; Demirel, 2022; Mızık & Yiğit Avdan, 2020). Although there are many reasons for the damage to the ecological balance, it is possible to state that the factor linked to all causes is human and human activities. Güngör and Kalburan (2022) stated that individuals play a role in each environmental problem that triggers the deterioration of the ecological balance. Unfortunately, people drag the world into a dead end with their actions day by day. Solid wastes generated after the daily life activities of individuals create serious pollution. Human activities with serious negative effects on the natural environment, including but not limited to the negative impact on biodiversity, damage to the ozone layer, accumulation of greenhouse gases, climate change waste management, deforestation, are faced with (Gedik, 2020). The widespread use of fossil fuels (Aydın & Çamur, 2017; Özsoy & Dinç, 2016), uncontrolled waste generation based on population growth (Gürlük, 2010) will lead to more pollution. In particular, widely used fossil fuels act as a catalyst and directly cause climate change (Shepardson et al., 2011). Industrial solid wastes, plastic wastes disposed of in water, carbon dioxide emission, burning of biomass and agricultural products have negative impacts on air, water and soil (Cai et al., 2018; Debrah et al., 2021; Shams et al., 2022; Singh et al., 2020; Song et al., 2015). The improper disposal of unused plastic waste is the agent of environmental pollution (Chae & An, 2018).

The world's ecosystem services are under serious threat (Yang et al., 2018), facing the consequences of human activities. It has difficulty in ensuring the protection and management of its ecosystems. Since the rate of self-renewal of nature cannot keep up with the rate of consumption of natural resources (Ballı, 2019), it will be inevitable that natural resources will face depletion (Tokur, 2023). In addition, the disruption of the ecological order may lead to natural disasters. Sezer and Öner Armağan (2023) states that there has been a noticeable increase in the number of natural disasters such as high temperatures, floods, forest fires and droughts in recent years. There is also concern about the lack of fresh water resources (Farahbod, 2021). Due to global warming, glaciers are melting 2-3 times faster than in previous centuries. In a report published by the World Wide Fund for Nature (WWF), it was announced that the population of vertebrate species worldwide has declined by two-thirds as a result of the negative effects of factors such as habitat loss, overuse of resources, invasive alien species, pollution, and climate change (WWF, 2022). Ecological problems undoubtedly affect biodiversity negatively, as they may lead to irreversible biodiversity losses (Gürlük, 2010). Disruptions in ecological balance pose a risk to human health and can even lead to deaths (Aydın & Çamur, 2017; Khan et al., 2019; Sharma et al., 2019; Ukaogo et al., 2020). In addition, when evaluated as a whole, it is not possible to ignore the irreversible repercussions on the economy for countries (Neves et al., 2020).

Uncontrolled destruction of the environment, excessive consumption of natural resources and disruption of the ecological balance have directly and indirectly put living life at risk (Akyüz, 2019; Kaypak, 2013). There have been disruptions and disruptions in the functioning of environmental elements. The fact that the world's resources are limited means that the destruction of nature cannot be repaired and has the potential to turn into a growing ecological crisis (Maltaş, 2015). Assuming that ecosystem capacities are limited, environmental integrity is threatened by population growth, overconsumption, increasing pollution and depletion of natural resources (Gedik, 2020). The increasing environmental problems and the deteriorating ecological order turning into

a situation that harms living things have increased the focus of individuals on the science of ecology (Karaer et al., 2023). Countries around the world have shifted their focus towards protecting ecological balances and combating environmental problems (Rahman & Alam, 2021). Environmental pollution and deterioration in natural functioning have become a matter of sensitization of countries towards the protection of the natural environment and awareness of its effects (Menteşe, 2017). At this point, taking measures to control, strengthen and protect the ecological order has gained momentum. The study of the morphology of collective life with its static and dynamic aspects can be expressed as ecology (Hawley, 2017). The science of ecology is uniquely equipped to solve environmental problems in a rapidly changing and developing world. It is in a guiding position in understanding local and global environmental problems (Lewinsohn et al., 2015). The fact that ecology explains the existing relationship of living things with each other and their environment is proof that it has a key role in the biological interpretation of living life. It can be stated that the value given to the science of ecology can greatly contribute to preventing environmental problems and ensuring the sustainability of life. Focusing on the field of ecology can be shown as an important breakthrough in controlling environmental problems.

Although humans have been the source of ecological problems, they can play the role of preventing ecological problems with their actions towards the sustainability of ecology. It is highly desirable for individuals to take measures for a healthier and sustainable environment (Liu et al., 2019; Wang et al., 2020). Ha et al. (2021) associate the integrity of the relationship between humans and nature with an understanding of the ecosystems in which life is sustained and their working methods. Individuals need to exhibit behaviors parallel to the laws of nature to solve environmental problems (Sönmez, 2022). Individuals should build their ecological identity (Williams & Chawla, 2016), which expresses their relationship with the environment and their individual process related to their experiences, in a positive way. The ecological footprint, which numerically expresses our damage to nature, should be kept as small as possible and lifestyles should be revised to be compatible with the environment (Güleç & Orhan, 2022). Indeed, considering the starting point of environmental problems, waste separation based on recycling can be shown as one of the main actions that individuals can exhibit.

Building a sustainable society where environmental sustainability is achieved and the ecological system is protected should be one of the leading goals (Liang et al., 2019; Lu et al., 2015). It is only through effective education that each member of the society can be environmentally compatible and develop a positive ecological identity. With the aim of increasing the value that society will give to the environment, it is necessary to provide individuals with the knowledge and skills they can have for the environment. It is a known fact that individuals with education and sensitivity will play an active role in solving environmental problems (Alfianto et al., 2019; Aydın & Çamur, 2017; Özbuğutu et al., 2014). Desmarais (2023) points out that education has a collective task that can contribute to individuals making sense of ecological systems. An effective environmental education should be shaped around the goals of protecting the environment, improving the quality of life, making individuals aware of their role in the environment they belong to, informing them ecologically and making them exhibit responsible behaviors (Anufrieva et al., 2020; Boehnert, 2013; Güler, 2010; Monroe et al., 2008).

Studies emphasize that the education provided is generally superficial in terms of learning about ecology and that students are not given enough opportunity to use ecological concepts in a practical way (Inoue, 2020; Lewinsohn et al., 2015). At this point, it is inevitable to focus on how environmental education can be planned and defined at a time when ecological balance is being disrupted. It should be clearly defined what students should learn in order to develop a grounded understanding of ecology (Persson et al., 2022). Taylor & Pacini-Ketchabaw (2015) argue that current education should be delivered from early childhood and that children need to interact frequently to understand their place in the ecosystem. It is important for children to be aware of the importance of living in a healthy and

safe environment, finding solutions to environmental problems and protecting their environment. Therefore, it is necessary to design an education in which students are made aware of ecology issues, their existing deficiencies are eliminated and correct information is provided. At this point, knowing the readiness of students and their level of knowledge about the subject can be guiding in shaping education. Therefore, the most important step that can be taken is to reveal students' knowledge. In this direction, the development of an effective measurement tool can play an important role in meeting the existing need. The idea that an achievement test that can be developed can make a great contribution to the literature has shaped the purpose of this study. At this point, this study aimed to develop a valid and reliable 'Ecology' achievement test for middle school students. With this aim in mind, does the 'Ecology Achievement Test' provide valid and reliable results? research question was sought to be answered in this study.

## Method

### Research Design

The study was conducted based on the exploratory sequential design, one of the mixed research methods, which is the process of starting with the qualitative phase and then moving on to the quantitative phase. In the development of a measurement tool for a subject area, it is recommended to conduct the study based on the exploratory sequential design (Creswell & Creswell, 2021). Within the framework of the research; in the first stage, qualitative data were collected and analyzed, and an item question pool for the achievement test was created based on the literature. The draft form of the measurement tool was prepared within the scope of the question pool. The draft form of the achievement test was applied to the students and quantitative data were collected. The data set obtained from the students was transferred to the statistics program and analyzed. Item analysis calculations were used in the analysis process. The reliability of the achievement test was evaluated by calculating the KR-20 and Cronbach alpha internal consistency coefficient.

The study group of the research consists of 250 sixth and seventh grade middle school students studying in a public middle school in Istanbul in the 2022-2023 academic year. 140 of the students are female and 110 of them are male. The study group was determined based on the convenience sampling method. Yıldırım & Şimşek (2018) state that convenience sampling aims to provide speed and practicality to the research. In the test development process, it is recommended to work with a sample that is five times the number of items in the test (Bryman & Cramer, 2001; Seçer, 2018). From this point of view, it is understood that a sufficient study group was reached when the number of questions (29) included in the achievement test draft is taken into consideration.

### Test Development Process

The process steps followed in the process of developing the ecology achievement test developed in the study were explained (Bano et al., 2021; Malay et al., 2023; Şener & Taş, 2017).

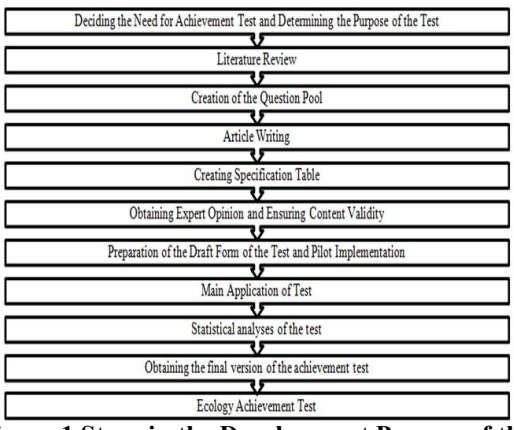


**Figure 1 Steps in the Development Process of the Achievement Test**

After the literature review, the need for a development knowledge test for the subject area of ecology was revealed and it was decided to develop an ecology achievement test. In the process of preparing the questions of the test, the achievements of the 2018 MEB science and 2022 environmental education and climate change courses and the achievements shaped by expert researchers were taken as the basis. In the process of preparing the question pool, knowledge tests, science textbooks, achievement assessment tests, basic skills questions, and central exam questions that may be suitable for

the achievements and subject area were examined in detail. After the examinations, a pool of 50 to 80 questions was obtained by combining some sample questions from the literature and the questions created by the researcher. From the pool of 50 questions, a new pool of 41 questions was created by eliminating similar questions. The 41-question pool was examined in detail, the questions were checked, read by the researchers, and final arrangements were made by making changes again. It is understood that the test includes 10 different achievements belonging to the achievements of science and environment courses that can be included in the scope of sustainability subject area and the achievements created by the researcher. It is seen that the test includes questions at knowledge, comprehension, analysis, synthesis and evaluation stages and at least 3 questions are included for each outcome (Table 1).

**Table 1 Specification Table for the Sustainability Achievement Test**

| Subject Area | Gain | Question No | Source | Step |
|---|---|---|---|---|
| Ecological Problems | F.5.6.2.1.Expresses the importance of the interaction between human and environment. | S1 | Researcher | Analysis |
| | | S2 | Researcher | Analysis |
| | | S3 | Researcher | Evaluation |
| | | S4 | Researcher | Evaluation |
| | Discusses the positive and negative aspects of the interaction between human and nature. | S5 | Researcher | Grip |
| | | S6 | Researcher | Analysis |
| | | S7 | Researcher | Grip |
| | Gives examples of continuous interaction between living and non-living things in the environment he/she lives in. | S8 | Literature | Grip |
| | | S9 | Literature | Grip |
| | | S10 | Researcher | Analysis |
| | Recognizes that waste and garbage cause air, water, soil pollution and radioactive pollution. | S11 | Researcher | Information |
| | | S12 | Researcher | Information |
| | | S13 | Researcher | Information |
| | | S14 | Researcher | Information |
| | Explains local and global environmental problems with examples. | S15 | Researcher | Information |
| | | S16 | Researcher | Information |
| | | S17 | Researcher | Information |
| | | S18 | Researcher | Analysis |
| | | S19 | Researcher | Information |
| | | S20 | Researcher | Information |
| | | S21 | Literature | Evaluation |
| | Explains the problems arising due to environmental pollution and the effects of these problems on human life. | S22 | Researcher | Evaluation |
| | | S23 | Researcher | Information |
| | | S24 | Researcher | Information |
| | F.5.6.2.3. Makes predictions about the environmental problems that may occur in the future as a result of human activities. | S25 | Researcher | Information |
| | | S26 | Researcher | Information |
| | | S27 | Researcher | Information |
| | | S28 | Literature | Information |
| | | S29 | Researcher | Analysis |

| | | | | |
|---|---|---|---|---|
| Ecological Problems | Provides suggestions for solving the ecological problems they face in their lives. | S30 | Researcher | Grip |
| | | S31 | Literature | Information |
| | | S32 | Researcher | Analysis |
| | | S33 | Researcher | Analysis |
| | | S34 | Literature | Information |
| | | S35 | Researcher | Information |
| | | S36 | Researcher | Grip |
| Human and Environment | Designs a project that will create social awareness for the protection of natural balance. | S37 | Researcher | Information |
| | | S38 | Researcher | Application |
| | | S39 | Researcher | Application |
| | It assumes a willing role in gaining awareness in the field of ecology. | S40 | Researcher | Application |
| | | S41 | Researcher | Grip |

The draft form was examined by 8 experts, including 2 science teachers, 2 social studies teachers, 2 faculty members specialized in science, 1 faculty member specialized in social sciences and 1 faculty member specialized in environmental education. In addition, the appropriateness of the test in terms of language and expression was checked by 2 linguists. Necessary arrangements were made by taking into consideration the suggestions in the context of the opinions. KGO is expressed as an item statistic based on content validity regarding the presence or absence of items in the scale (Ayre & Scally, 2014; Yurdugül, 2005). After the KGO calculations, 12 questions that did not provide sufficient value for 8 experts based on the KGO value were removed from the test. As a result of the arrangements made in the last stage, a 29-question multiple-choice test was drafted. In the context of expert opinions, a directive was added to the draft form consisting of 29 questions, in which the purpose of the achievement test was briefly and concisely explained. In the next stage, the pilot application of the test was carried out by applying it to 30 middle school students who had the qualifications to meet the target audience. The draft form of the ecology achievement test consisting of 29 questions was applied to 250 sixth and seventh grade students and the main application phase was completed. The data set obtained from the students was transferred to statistical programs and item analysis and reliability analysis were carried out. In addition, the reliability internal consistency coefficient values of the achievement test were also calculated. A valid and reliable ecology achievement test was made ready for use.

**Data Collection Tool and Data Collection Process**

The study data were collected using a multiple-choice ecology achievement test draft consisting of 29 questions, which was created by going through certain stages. The process of obtaining the study data was completed face-to-face with the participating middle school students in a classroom environment. Before the implementation of the form, the students were given the necessary explanations and information about filling out the form.

**Data Analysis**

The answers obtained from the students were reviewed at the first stage, checked and transferred to the statistical programs. The correct answers given by the students to the multiple-choice questions were entered into the program as 1 point; incorrect answers and questions left blank were entered into the program as 0 points. SPSS and Excel statistical programs were used in the data analysis process. Before the analysis, the total scores of the students' answers to the questions in the test were calculated and the score values were ranked from the highest to the lowest. After the ranking of the scores, the upper group of 27% and the lower group of 27% were determined. The group of 250 students was formed as upper (n=68) and lower (n=68) groups with correct answers. In the next stage, item difficulty (Pj) and item discrimination (Rjx) values of the question items were calculated. In addition, KR-20 and Cronbach alpha coefficient values were calculated to ensure the reliability of the achievement test. In this item analysis, it was examined whether the

difference between the averages of the two groups was significant or not, independent groups t-test was applied and since there was a significant difference, it was deemed appropriate to remain in the test. The mean, standard deviation and item-total correlation values of the items were determined.

### Ethical Processes in Research

Secondary school students who participated in the study were clearly explained the purpose of the study, the reason for the study and where their answers would be used. The students were informed that their answers to the test would be kept confidential and would only be used for scientific research. In addition, student names and surnames were kept confidential and coding method was used. The necessary legal permissions were obtained for the research conducted.

## Findings

### Findings Regarding the Content Validity of the Achievement Test

In the development stages of the achievement test, the content validity of the test was ensured. In order to ensure content validity, a specification table was created for the questions. At least 3 questions were written for each achievement in the test. The prepared questions were presented to 8 field experts. In addition, the KGO values of the content validity of the test were calculated in line with the expert opinions. The 12 questions that did not meet sufficient CSR values for 8 experts were removed from the test. It was understood that the CSR value obtained for each remaining question provided sufficient value (CSR>0.750) for 8 experts (Ayre & Scally, 2014; Lawshe, 1975).

### Findings Related to Item Analysis of Achievement Test

The group of 250 students to whom the draft of the ecology achievement test was applied was divided into two groups: the upper group (n=68) and the lower group (n=68) who answered the questions correctly. Item analyses were conducted in line with the answers given by both groups. Based on the results of the item analyses, the number of correct answers in the upper group, the number of correct answers in the lower group, item difficulty index values, item discrimination index values and the decisions regarding the questions in the test are presented in Table 2.

**Table 2 Findings of Item Analysis Results of the Developed Achievement**

| Question No | Du | Da | Pj | Rjx | Decision (Evaluation) |
|---|---|---|---|---|---|
| 1 | 62 | 44 | 0,78 | 0,26 | Very Weak |
| 2 | 63 | 27 | 0,66 | 0,53 | Very good |
| 3* | 68 | 24 | 0,68 | 0,65 | Very good |
| 4* | 42 | 27 | 0,51 | 0,22 | Very Weak |
| 5 | 63 | 18 | 0,60 | 0,66 | Very good |
| 6 | 66 | 21 | 0,64 | 0,66 | Very good |
| 7* | 61 | 15 | 0,56 | 0,68 | Very good |
| 8 | 47 | 33 | 0,59 | 0,21 | Very Weak |
| 9 | 68 | 24 | 0,68 | 0,65 | Very good |
| 10* | 68 | 24 | 0,66 | 0,62 | Very good |
| 11* | 49 | 35 | 0,62 | 0,21 | Very Weak |
| 12 | 65 | 23 | 0,65 | 0,62 | Very good |
| 13 | 57 | 19 | 0,56 | 0,56 | Very good |
| 14* | 58 | 16 | 0,54 | 0,62 | Very good |
| 15 | 56 | 16 | 0,53 | 0,59 | Very good |
| 16 | 60 | 18 | 0,57 | 0,62 | Very good |
| 17 | 62 | 18 | 0,59 | 0,65 | Very good |
| 18 | 60 | 21 | 0,60 | 0,57 | Very good |
| 19* | 57 | 17 | 0,54 | 0,59 | Very good |
| 20 | 56 | 13 | 0,51 | 0,63 | Very good |
| 21 | 55 | 17 | 0,53 | 0,56 | Very good |
| 22* | 64 | 22 | 0,63 | 0,62 | Very good |

Du: number of correct answers belonging to the upper group; Da: number of correct answers belonging to the lower group; Pj: item difficulty index values; Rjx: item discrimination index values; *questions that should be removed from the test

Table 2 shows the results of the item analysis of the achievement test. The number of lower and upper group students who answered each question in the test is also seen. It is understood from the table that the questions with item difficulty index values and item discrimination index values above 0.40 remained in the test and the questions with values below 0.40 were removed from the test. The item analysis values of all questions remaining in the test were above 0.40. After the item analyses, 4 questions

that were not suitable as a result of the item analyses were removed from the 29-question achievement test draft form. After the item analyses, the average difficulty index value of all items remaining in the test was 0.58 and the average discrimination value was 0.60. The mean, standard deviation, item-total correlation and t-values of the questions in the achievement test are given in Table 3.

**Table 3 Independent t-Test Analysis Results for Ecology Achievement Test**

| Article | Group | Average | Standard Deviation | Item Total Correlation | t-Value | Significance (p) |
|---|---|---|---|---|---|---|
| S1 | Top | ,9265 | ,26294 | 0,319 | 7,814 | ,000 |
| | Low | ,3971 | ,49293 | | | |
| S2 | Top | 1,0000 | ,00000 | 0,407 | 11,083 | ,000 |
| | Low | ,3529 | ,48144 | | | |
| S3 | Top | ,9265 | ,26294 | 0,598 | 10,567 | ,000 |
| | Low | ,2647 | ,44446 | | | |
| S4 | Top | ,9706 | ,17021 | 0,587 | 11,011 | ,000 |
| | Low | ,3088 | ,46544 | | | |
| S5 | Top | ,8971 | ,30614 | 0,416 | 10,771 | ,000 |
| | Low | ,2206 | ,41773 | | | |
| S6 | Top | 1,0000 | ,00000 | 0,490 | 11,083 | ,000 |
| | Low | ,3529 | ,48144 | | | |
| S7 | Top | 1,0000 | ,00000 | 0,427 | 11,083 | ,000 |
| | Low | ,3529 | ,48144 | | | |
| S8 | Top | ,9559 | ,20688 | 0,458 | 9,802 | ,000 |
| | Low | ,3382 | ,47663 | | | |
| S9 | Top | ,8382 | ,37097 | 0,437 | 7,880 | ,000 |
| | Low | ,2794 | ,45205 | | | |
| S10 | Top | ,8529 | ,35680 | 0,471 | 9,149 | ,000 |
| | Low | ,2353 | ,42734 | | | |
| S11 | Top | ,8235 | ,38405 | 0,302 | 8,443 | ,000 |
| | Low | ,2353 | ,42734 | | | |
| S12 | Top | ,8824 | ,32459 | 0,571 | 9,254 | ,000 |
| | Low | ,2647 | ,44446 | | | |
| S13 | Top | ,9118 | ,28575 | 0,539 | 10,098 | ,000 |
| | Low | ,2647 | ,44446 | | | |
| S14 | Top | ,8824 | ,32459 | 0,460 | 8,335 | ,000 |
| | Low | ,3088 | ,46544 | | | |
| S15 | Top | ,8382 | ,37097 | 0,508 | 8,471 | ,000 |
| | Low | ,2500 | ,43623 | | | |
| S16 | Top | ,8235 | ,38405 | 0,571 | 9,451 | ,000 |
| | Low | ,1912 | ,39615 | | | |
| S17 | Top | ,8088 | ,39615 | 0,509 | 7,820 | ,000 |
| | Low | ,2500 | ,43623 | | | |
| S18 | Top | ,9412 | ,23704 | 0,511 | 9,654 | ,000 |
| | Low | ,3235 | ,47130 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| S19 | Top | ,8824 | ,32459 | 0,372 | 8,628 | ,000 |
| | Low | ,2941 | ,45903 | | | |
| S20 | Top | ,8529 | ,35680 | 0,431 | 7,385 | ,000 |
| | Low | ,3235 | ,47130 | | | |
| S21 | Top | ,8676 | ,34139 | 0,360 | 8,267 | ,000 |
| | Low | ,2941 | ,45903 | | | |
| S22 | Top | ,8382 | ,37097 | 0,394 | 7,602 | ,000 |
| | Low | ,2941 | ,45903 | | | |
| S23 | Top | ,7353 | ,44446 | 0,404 | 7,241 | ,000 |
| | Low | ,2059 | ,40735 | | | |
| S24 | Top | ,7353 | ,44446 | 0,437 | 9,254 | ,000 |
| | Low | ,1176 | ,32459 | | | |
| S25 | Top | ,7794 | ,41773 | 0,303 | 8,426 | ,000 |
| | Low | ,1912 | ,39615 | | | |

Table 3 shows the item-total correlation values of each item in the achievement test, t-values showing the differences between the item scores of the upper and lower 27% groups, and the mean and standard deviation values of the items. The item-total correlation values of the items in the scale are above 0.30 and these values are between 0.303 and 0.598. In addition, there is a significant difference between the means of the lower and upper groups of each item in the scale (p:0,000<0,05).

**Findings Related to the Reliability of the Achievement Test**

After the item analysis, the reliability values of the achievement test, which was reduced to 25 items, were calculated. KR-20 and Cronbach alpha internal consistency coefficients were determined to determine the internal consistency coefficients of the test. Based on the results of the reliability analyses, the reliability internal consistency coefficient values of the achievement test are presented in Table 4.

**Table 4 Reliability Analysis Results of the Developed Achievement Test**

| Reliability Internal Consistency Coefficients | Internal Consistency Coefficient Values |
|---|---|
| KR-20 | 0,85 |
| Cronbach Alpha | 0,88 |

Table 4 shows the KR-20 and Cronbach alpha internal consistency coefficient values of the achievement test. It is understood that the KR-20 internal consistency coefficient of the achievement test is 0.85 and the Cronbach alpha internal consistency coefficient is 0.88. It is understood that both reliability coefficients of the achievement test are above 0.80.

**Discussion, Conclusion and Recommendations**

The study aimed to develop a valid and reliable multiple-choice ecology-achievement test for middle school students. In the process of developing the test, expert opinions were consulted to ensure content validity and the content validity condition of the test was met (Yeşilyurt & Çapraz, 2018). In the study, Lawshe (1975) technique was utilized to ensure content validity based on expert opinion. The fact that 8 field experts were consulted for the test developed based on this technique indicates that the number of experts is sufficient to obtain objective results. In addition, the fact that the CSR values obtained for the questions in the test were 0.750 and above indicates that it meets a sufficient value for 8 experts (Ayre & Scally, 2014; Wilson et al., 2012; Yurdugül, 2005).

Considering the calculated difficulty and discrimination indices of the questions in the measurement tool, it was found that the item difficulty index values and item discrimination index values of the questions in the test were above 0.40. Item difficulty index and item discrimination index values can take values between -1 and +1, indicating the degree to which a question in the test

distinguishes successful and unsuccessful students (Ayvacı & Durmuş, 2016). It is stated that the value of each item between 0.40 and 0.60 is interpreted as medium difficulty (Akbulut & Çepni, 2013; İlhan & Hoşgören, 2015; Tosun & Taşkesenligil, 2011). It is emphasized that the average difficulty index of a test should be around 0.50 (Erkan & Gömleksiz, 2022; Tekin, 2010). From this point of view, it can be inferred that the questions in the test can distinguish the level of the students and have a moderate difficulty.

The reliability values of the sustainability achievement test developed in the current study were found to be 0.85 for the KR-20 internal consistency coefficient and 0.88 for the Cronbach alpha internal consistency coefficient. A measurement tool with a reliability internal consistency coefficient of 0.70 and above means that it is highly reliable (Can, 2022; Pallant, 2020). Therefore, the fact that the reliability internal consistency coefficients of the sustainability achievement test developed in the study are above 0.80 reveals that the measurement tool is highly reliable.

The fact that all of the item-total correlation values for the questions in the sustainable achievement test were above 0.30 is another evidence for the discrimination of the items (Büyüköztürk, 2019). On the other hand, after the t-test comparison process of the upper and lower groups, a significant difference was found in the mean scores of the questions (p:,000; <0.05), and it can be inferred that students who exhibit the target behavior and students who do not exhibit the target behavior can distinguish (Can, 2022).

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