

5th Grade Science Course “Living World” Unit Related Academic Achievement Test Development and Implementation

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Abstract: The aim of this study is to develop a valid and reliable achievement test for the “Living World” unit within the scope of the 5th grade science course. For this purpose, the following steps were carried out in the research in which the screening method was used. The purpose and scope of the test were determined; literature review was conducted and test questions were determined; expert opinions were obtained for the draft of the achievement test and it was applied to 86 5th grade students studying in a state school in Turkey, the steps of analyzing the items and finally creating the test were followed. As a result, the achievement test consisting of a total of 24 questions with an average difficulty of 0.68, an average discrimination of 0.54 and a KR-20 reliability coefficient of 0.75 covering the curriculum content framework took its final form. When the findings are evaluated in general, it can be said that the test is a valid and reliable test in measuring the students’ success in the relevant subject.

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Introduction

SCIENCE education is an important learning area that aims to help students understand nature, make observations and gain scientific thinking skills. It is of great importance in terms of individuals recognizing living and non-living things in their environment, understanding natural events and developing scientific thinking skills. One of the main objectives of science courses at the primary school level is to enable students to make inferences based on scientific knowledge. In this context, the “World of Living Things” unit in the 5th grade curriculum plays a critical role in helping students learn basic biology concepts such as recognizing living things, classifying them and understanding their common characteristics. First of all, this unit allows students to structure basic biology concepts. Basic topics such as the distinction between living and non-living things, the classification of animals and plants, and life processes support the development of students’ mental schemas regarding biology. These concepts form a basic infrastructure for more complex biological topics that they will encounter in the following years. In addition, the “Living World” unit provides an important opportunity for students to develop their scientific process skills. Skills such as observation, classification, comparison and relationship-making are supported with practical activities within this unit. In this way, students not only acquire knowledge, but also learn to think with the scientific method.

The unit also enables students to gain awareness of the environment. Topics such as the diversity of living things, their interactions with nature and the conditions necessary for life contribute to students’ development as environmentally sensitive individuals. This is also important in terms of achieving the affective goals of science education. For these reasons, the “Living World” unit is a basic learning area that not only provides knowledge in science teaching, but also contributes significantly to the processes of scientific thinking, environmental awareness and cognitive development.

Research shows that primary school students may have various misconceptions about living things and life processes (Çalık & Ayas, 2005). In this context, the “World of Living Things” unit helps students correct these misconceptions with accurate scientific information.

One of the most effective ways to determine the extent to which learning has taken place in the educational process is through measurement and evaluation practices. Achievement tests, in particular, are important tools in terms of objectively revealing students’ knowledge levels on a subject and guiding the teaching process (Turgut & Baykul, 2012). Achievement tests are structured measurement tools designed to evaluate students’ knowledge, comprehension, application and analysis levels on a particular subject or unit.

These tests have important functions in terms of teachers monitoring the teaching process, determining students’ learning deficiencies and evaluating teaching methods. Especially in courses with high conceptual intensity such as science, structured tests with validity and reliability studies are needed to measure students’ learning levels (Çepni, 2005). However, the tests to be developed must meet scientific criteria in terms of validity and reliability. Most of the ready-made tests used in educational environments may be pedagogically inadequate or may not be suitable for the conceptual development levels of the students. In addition, the limited resources that teachers have in preparing measurement tools based on scientific foundations is also an important problem. Especially when preparing multiple-choice tests, it is of great importance that the questions are appropriate to the cognitive level, written in a clear and understandable language, misleading expressions are avoided and the statistical properties of the test are examined through item analysis. Test development studies carried out within this framework both increase the quality of measurement tools and contribute to the scientific basis of decision-making processes in the education system. In particular, multiple-choice tests are preferred due to their advantages such as breadth of scope, objectivity and ease of scoring. Accordingly, the development of a structured and scientifically based achievement test for the “World of Living Things” unit for 5th grade students will both contribute to teachers’ measurement and evaluations processes and allow for a more accurate analysis of students’ achievement levels. In addition, the “World of Living Things” unit aims to provide students with information about the classification of living things, common and different aspects of plants and animals, and basic life processes. However, research has shown that students may have misconceptions about basic biological concepts such as the classification of living things and the distinction between living and nonliving things (Çalık & Ayas, 2005). Therefore, qualified measurement tools are needed to determine whether the information acquired in this unit has been learned correctly and permanently. Although various studies have been conducted in the literature on the development of achievement tests specific to science units (Özsevgeç 2007; Taşdemir & Demirbaş, 2010), the number of tests specific to the “World of Living Things” unit and appropriate for the 5th grade level is quite limited. Regarding the subject, Gül et al. (2021) conducted an achievement test development study for the subject area of journey to the world of living things. However, this study was developed for primary school 3rd grade students and is not at a level that can measure the academic success of upper grades. Again, regarding the same subject, Sağırkaya (2017) developed the achievement test for living awareness and common characteristics of living things, and this test was also developed for primary school 4th grade students and does not cover the diversity of living things in detail in terms of

content. In summary, this situation reveals that the validity of the measurement can be questioned, as there are deficiencies and inconsistencies in the applicability of the tests in existing studies, their inadequacy and inconsistency in terms of their scientific validity and their compatibility with the cognitive level of the students, and this study will help meet the existing need and emphasize innovation.

Therefore, there is a need for an achievement test that can objectively evaluate the extent to which 5th grade students have achieved the achievements in the “Living World” unit and that meets scientific validity and reliability criteria. This study aims to develop an achievement test specific to the unit in question in a way that will meet this need.

Purpose of the Study

The purpose of this study is to develop a valid and reliable achievement test for the “Living World” unit within the scope of the 5th grade science course. In this context, the stages followed in the development process of the test will be discussed in detail.

In line with this general purpose, the following sub-goals are aimed to be achieved:

1. Creating multiple-choice test items in line with the achievements related to the “Living World” unit.
2. Examining the created item pool in terms of validity based on expert opinions.
3. Conducting item analyses (item difficulty and discrimination) of the test items through pilot application.
4. Determining the reliability of the test through KR-20.
5. Creating the final form of the test and evaluating its usability in educational environments.

Method

This research was conducted using the screening method. The screening method is a research method generally conducted on larger samples. This method allows in-depth examination of the participants’ qualities such as interests, skills, opinions, and abilities regarding a subject or event (Fraenkel & Wallen, 2006). In the research, an achievement test was prepared to measure what they learned about the Living World unit in the 5th grade science course.

Working Group

The researcher works in an urban state secondary school located in the center of Turkey. The researcher formed the study group from his own school in order to be easily accessible. The convenience sampling method was used in the study. This type of sampling was used based on the knowledge that the groups are accessible and easy to include in the process (Ekiz, 2009). The researcher collects data from a sample that he can easily reach. The sample of the study consists of 86 students (46 girls, 40 boys) studying in the 5th grade of the 2023-2024 academic year at this school. In addition, the test was applied to a different group of 50 students (27 girls, 23 boys) from the same school for the reliability analysis of the achievement test, which was finalized after the item analysis. The students are between the ages of 11-12, the gender ratios are close to each other and they show a homogeneous distribution.

Development Process of the Achievement Test for the World of Living Things Unit

The development process of the achievement test was carried out based on the test development steps suggested in the literature. The process followed in this study was structured similarly to the test development stages suggested by Haladyna (1997) and Kızıkan and Bektaş (2018). Accordingly, the stages followed and the procedures performed for the development of the achievement test are explained below:

Determining the Purpose and Scope of the Test

The main purpose of the achievement test developed in this study is to measure the academic success levels of students regarding the “World of Living Things” unit within the scope of the 5th grade science course. In the Science Course Curriculum published by the Ministry of National Education (MEB, 2023), there is only one outcome related to the “World of Living Things” unit and the content of the outcome is as follows:

Gives examples of living things and classifies them according to their similarities and differences.

- Microscopic living things
- Fungi
- Plants
- Animals

The test items developed in line with this achievement have been carefully structured to cover the content in question and have been prepared to measure students’ knowledge levels on these topics in a valid and reliable manner.

Literature Review and Determination of Test Questions

The scope of the test to be developed was determined by examining the 5th Grade Science Course Curriculum (MEB, 2023) and then a comprehensive literature review was conducted by the researchers. The questions published on the page accessible only to teachers via the EBA platform of the Ministry of National Education were also examined. In this process, achievement tests previously developed on the subject of “World of Living Things” at the 5th grade level were carefully examined. As a result, when the studies conducted are examined, the purpose of developing a new achievement test in the current study is the need for an up-to-date, comprehensive and pedagogically appropriate assessment tool to measure students’ academic achievements in the “World of Living Things” unit within the scope of the 5th grade Biology course in a valid and reliable manner. When achievement tests developed by different researchers in the literature are examined, it is seen that these tests attract attention with their different content structures, application samples and reliability levels. However, due to reasons such as the fact that most of these tests have a limited number of questions and do not fully overlap with the curriculum, a new achievement test was needed.

Development Process of Achievement Test: Draft Preparation and Expert Opinions

In the study, the “World of Living Things Achievement Test” (CDBT) was prepared by examining the relevant literature and containing 25 multiple-choice questions, each consisting of four options, in accordance with the content framework of the “World of Living Things” unit in the 5th grade science course curriculum. In order to ensure validity in scientific research, it is a common and accepted practice to seek the opinions of experts in the field (Aydın & Selvi, 2020; Gönen et al., 2011; İlhan & Hoşgören, 2017; Şen & Eryılmaz, 2011). In this direction, the draft form of the achievement test consisting of 25 multiple-choice items with four options was presented to the evaluation of three academicians competent in field knowledge and measurement-evaluation and one experienced science teacher. For this purpose, experts were given a form where they could write their opinions. The questions were listed from 1 to 25 in the form and for each item, experts were asked to write their justifications, corrections and suggestions regarding the suitability of the questions for the outcome, whether the expressions and options were appropriate. Some items were corrected considering the suggestions received. According to the feedback received, they stated that the test represented the subject and was suitable for the 5th grade level in terms of content adequacy and scope validity. Grammar and spelling

Table 1. Values Obtained as a Result of ABT Application.

Variable	Values
Number of Participants	86
Total Score	25
Minimum	0.000
Maximum	25.000 = 100
Median	19.000 = 76
Mean	17.186 = 68.7
Standard Deviation	6.109
Variance	37.314
Skewness	-1.144
Kurtosis	0.683
Number of Items Removed	0
Number of Items Analyzed	25
Average Item Difficulty	0.687
Average Discriminant Coefficient	0.546
Average Point Biserial	0.562
Average Adjusted Point Biserial	0.511
KR20 (Alpha)	0.906
KR21	0.892
ÖSH (KR20)	1.877
Upper Group Minimum Score (n=34)	2.000
Lower Group Maximum Score (n=23)	14.000

corrections were made in a few questions and options. Accordingly, the test items were rearranged according to grammar and spelling rules and given their final form.

Findings

Data obtained from the 25-question test applied to 86 students were analyzed in IBM SPSS 26 software. The KR-20 reliability value of the test, the average difficulty of the items, and the average point biserial discrimination coefficient were calculated (**Table 1**).

The Kuder Richardson-20 (KR-20) reliability value of the test was calculated as 0.906. The reliability of the scores obtained in an achievement test can be calculated statistically using different techniques. The KR-20 statistical method is one of them. The KR-20 statistical method is used in tests where a score of (1,0) is given. Özçelik (1997) states that the test reliability should be above 0.80 in the decision-making process. It can be stated that the reliability of this test, which has a KR-20 reliability value of 0.906, is high. The average difficulty of the items in the test was calculated as 0.687, and the average point biserial discrimination coefficient was

Table 2. Item Analysis Results for ABT.

Item No.	Difficulty	Lower-Upper Group Discrimination	Bi-Series Discrimination
I-1	0.80	0.39	0.58
I-2	0.73	0.43	0.42
I-3	0.78	0.46	0.54
I-4	0.78	0.62	0.58
I-5	0.78	0.35	0.49
I-6	0.93	0.19	0.49
I-7	0.87	0.43	0.62
I-8	0.48	0.85	0.65
I-9	0.88	0.39	0.69
I-10	0.74	0.51	0.59
I-11	0.78	0.59	0.69
I-12	0.58	0.75	0.57
I-13	0.52	0.47	0.38
I-14	0.66	0.33	0.38
I-15	0.51	0.63	0.54
I-16	0.43	0.59	0.48
I-17	0.69	0.56	0.54
I-18	0.67	0.56	0.54
I-19	0.62	0.71	0.58
I-20	0.76	0.62	0.66
I-21	0.84	0.48	0.66
I-22	0.73	0.55	0.59
I-23	0.69	0.80	0.71
I-24	0.45	0.69	0.52
I-25	0.48	0.68	0.54

calculated as 0.562. The item difficulty takes a value between 0 and 1. As the difficulty index approaches 1, the item becomes easier, and as it approaches 0, the item becomes more difficult (Gömleksiz & Erkan, 2010). It can be stated that this test, in which the average difficulty of the items was measured as 0.687, is a test consisting of easy items on average in terms of difficulty (**Table 2**).

Discriminativeness is the measure of the items' ability to distinguish between individuals who know and those who do not know about the measured feature. Discriminativeness has a value between (-1) and (+1). Questions with an item discrimination index of 0.40 and above have high discrimination, those between 0.20-0.39 have medium discrimination, and those with 0.19 and below have low discrimination. According to Büyüköztürk (2012), if the item discrimination index is between .20-.29, that item should be corrected, and if this value is 0.19 and below, that item should be removed from the test. The higher the discrimination value of a

Table 3. Content Framework of the 9th Grade Organic Matter Topic and the Questions It Covers.

Subject Coverage	Items
Microscopic organisms	1-4
Fungi	5- 7
Plants	8- 15
Animals	16-24

test, the higher its reliability and validity (Kavaklı, 2016). When the test was examined according to average discrimination, it was found that discrimination was high. Difficulty and discrimination results on an item basis are given in **Table 2**.

When Table 2 is examined, it is seen that the difficulty of the items varies between 0.45 and 0.93. The discrimination coefficients calculated according to the lower-upper group are between 0.19 and 0.85. According to the point biserial discrimination coefficient, the discrimination values vary between 0.38 and 0.71. The discrimination coefficient of item 6 is low according to the lower-upper group. In addition, the item is very easy. Therefore, it was decided to remove item 6 from the test.

According to these findings, 1 question was deemed not to serve the purpose and was removed from the test. The subject of the World of Living Things, which is included in the MEB (2023) science program, and the content framework of this subject were taken as basis in the development of the test. The prepared test included more than one question covering all subheadings of the subject. Since there was more than one question in the test, the removal of the inappropriate question did not pose a problem in terms of content validity. The distribution of the 24 questions in the final test according to the content framework is shown in **Table 3**.

Discussion and Conclusion

In this study, it was aimed to develop a valid and reliable achievement test in accordance with the content framework of the subject “The world of living things” in the 5th Grade Science Curriculum of the 2023-2024 academic year. The test, whose content validity was provided in line with the opinions of field experts, was analyzed with the data obtained as a result of the pilot application. As a result of the item analyses, it was determined that the majority of the questions in the test had an appropriate difficulty level and a high discrimination coefficient.

As a result, after the item analyses, the achievement test consisting of a total of 24 questions covering the curriculum content framework took its final form. The average difficulty of the test was calculated as 0.68 and the average discrimination was calculated as 0.54. In this final form, the test was applied to a different group of 50 students for reliability analysis and the KR-20 reliability coefficient was found to be 0.75, demonstrating that the test was reliable. These results show that the developed achievement test can be used as an effective tool in measuring the knowledge levels of students regarding the "The world of living things" unit.

The findings obtained in the study support the previous test development studies in the literature (Özsevgeç, 2007; Taşdemir & Demirbaş, 2010). In these studies, the systematically followed item writing, expert opinion, pilot application and statistical analysis stages were applied in a similar way in the developed tests and valid/reliable test forms were obtained. This situation shows that effective and functional measurement tools can be obtained when the test development process is carried out within the framework of a standard scientific method. The fact that both the content validity and statistical reliability levels of the developed test are high shows that items at the appropriate cognitive level and in line with the curriculum were created for 5th grade students. This situation indicates that the test can be used safely by teachers in in-class measurement-evaluation activities. In addition, concepts related to the "World of Living Things" unit can often cause misconceptions in students. Therefore, revealing the correct knowledge levels of students with structured test items related to such concepts is quite valuable in terms of directing the teaching process.

However, retesting the validity and reliability of the test by applying it to student groups with different socio-economic levels will increase the generalizability of the test. In addition, developing similar measurement tools for other units of the science course will ensure that measurement-evaluation practices gain a holistic structure.

As a result, this study provides teachers and educators with a concrete measurement tool as well as a scientific model for the measurement tool development process. Future studies can make deeper contributions to science education by examining the effect of the test on long-term academic success or its power in detecting misconceptions.

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