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Construction and Validation of Biology Assessment Test (BAT) for Junior High School Students

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Abstract:

This test development study aims to develop and validate an achievement test in Biology designed for junior high school completers. Test items were pooled from selected lessons in Biology. The researchers prepared a table of specification (TOS) and subjected the102- item multiple choice type of examination to validation by experts. After the initial validation, the test had 88 items that were pilot tested among 172 grade 11 students at a private university. The researcher did item analysis which classified 67 items as "average," 21 as "hard," none as" easy," 10 as "very good", 12 as "good," 19 as "fair" and 47 as "poor." Consistency and reliability were obtained using Kuder-Richardson (KR) 20. A total of 22 items were retained of the 88 based on validation and item analysis. Three items that were initially classified as "fair" and with "marginal" difficulty index were revised to produce a 25-item final version of the Biology Achievement Test.

Keywords: *test, assessment, biology, construction, validation.*

Introduction

Biology is a broad field of knowledge that requires the acquisition of knowledge within and outside of classroom environments. On the other hand, it is a subject that is least preferred by high school students (Kubiatko et al., 2017). Furthermore, some topics in biology were found to be boring for students, such as systems, tissues, and power transformation (Derman, 2017). However, biology has been providing essential innovations in human lives through studies of its branches of microbiology; biotechnology; molecular biology; genetics, and many more (Köksal & Yaman, 2013). Hence, biology is undeniably part of progress of the quality of life, making it one of the essential subjects in basic education.

In the Philippines, the curriculum shift to K to 12 is one of the most significant challenges in education (Casina, 2018; Hernando-Malipot, 2018a; Luci-Atienza, 2019). The curriculum shows excellent potential for graduates (Hernando-Malipot, 2018b; Hernando-Malipot, 2018c). The K to 12 Science curriculum is anchored on learner-centered and inquiry-based approaches. It aims to equip students with

competencies necessary for employment and future higher education. Furthermore, this provides learners with a full range of understanding of society. It also follows a spiral approach from grades 3 to 10. Each grade level is divided into four main domains: Matter; Living things and their environment; Force, motion and Energy; and Earth and space (DepEd, 2016). Living things and their environment are where the life sciences and biology are integrated.

Additionally, the K-12 Science curriculum is viewed as a setting that prepares students' aptitudes (Cabansag, 2014). The shift from the common traditional science education to the spiral approach is one of the key features of the K to 12 science curriculum. Learners recognize this shift in science education, as it positively influences their acquisition of science concepts, skills, and attitudes (Montebon, 2015). Moreover, learning science, specifically Biology, requires more than a shift in pedagogical models. However, classroom conditions, the role of the teacher, and the learners themselves are parts of the learning process. Therefore, in addition to improving the teaching and learning process, learning assessment should also be considered (Utari & Djukri, 2017).

One of the fundamental measures of student learning is through assessment. A functional assessment is part of teaching practice and evidence that allows educators to assess students' learning progress (Edwards, 2013). One assessment that teachers can use to assess students' learning progress is the use of an achievement test. An achievement test is related to academic growth and advancement (Singh & Yadav, 2018). Therefore, constructing and validating an achievement test gives a clear picture of students' performance, specifically in Biology subject in K-12 curriculum. With this goal in mind, the researchers aim to develop an achievement test on topics in grades 7-10 or junior high school. This test development focuses on measuring junior high school achievement levels about concepts as indicated in the competencies in living things and their environment. The development of the achievement test is an attempt to provide a clear picture of students' accomplishments, especially in biology.

Materials and Methods

The entire process of constructing the Biology Achievement Test (BAT) includes (a) preparation, (b) development of the BAT, and (c) validation.

Preparation

The K-12 Basic Education Curriculum Guide in Science (DepEd, 2016) was used as the main guide when considering the scope of the achievement test. Two reference materials from grades 7 to 10 were also used as a source of questions. These books were developed and are being used in private schools. In the study, no reference materials published before 2017 were used.

Development of BAT

Based on the curriculum guide set by the Department of Education, the biology part of spiral Science includes the following components: animal parts and function, inheritance and variation, biodiversity and evolution, and ecosystems. Given the broad scope of the curriculum guide, the researchers developed a table of specifications or TOS (Appendix 3) for ten questions on each component of each level of the year.

Validation

The validation of the test material was done by four seasoned junior high school science teachers. The validators evaluated the content and construction of each question. The researchers requested the validators to mark the items as acceptable or not. Items that were marked as "acceptable" by at least two validators were retained. Suggestions like changing the options, the format of the stem, and the arrangement of options were also considered. After revision, the researchers administered the test to grade 11 students from a private school. These grade 11 students were enrolled in Technology, Vocational, and Livelihood Track, Science and Technology Engineering and

Mathematics Strand, Accountancy and Business Management Track and General Academic Strand during the school year 2018 to 2019.

Item analysis, particularly the difficulty index (DI), and Index of discrimination (ID), was done using the method developed by Arevalo and Ignacio (2018). Internal reliability was achieved using the Kuder-Richardson formula 20 (KR20) in Microsoft Excel. Items that had 0.30 or better ID were retained, while those with 0.29 or lower ID were either revised or rejected.

Results and Discussion

Experts' Evaluation

Four evaluators were tasked with evaluating the 102-item multiple choice test (Appendix 1). Three of the four evaluators are master's degree holders and teaching science subjects in senior high school during the study, while the other one was in the thesis proposal phase. Face validation was done by checking the construction of the test, grammar, options given, and even the length of the questions.

Of the 102 items, 88 were retained after a round of validation from the evaluators. Some items were deleted due to broad scope, ambiguous stems, repeated concepts, and items deemed very easy. After revision, the researchers administered the 88-item exam (Appendix 1) to 172 grade 11 students in a private school in Pampanga.

Test Administration and Checking

The exam was administered per class. The proctor explained the general instructions through a pre-examination orientation which included directors on how to answer, the time required to finish the examination and, most importantly, the nature of the examination (Figure 1). The examination was answered by shading the letter that corresponds to the right answer. Changing the answer was discouraged because the answer sheet was machine-checked, specifically by an optical media reader (OMR).

Item Analysis

The researchers analyzed the elements using a spreadsheet developed by Arevalo and Ignacio (2018). The item analysis for the 88 biology achievement test (BAT) included the index of difficulty (ID) and the discrimination index (DI). Both indices served as the basis for rejecting, revising, or accepting the item for the BAT (Appendix Table 2).

The difficulty was computed using the responses of the upper and lower 27% of the total of the exam (N=172). Ninety-two, 46 in the upper class and 46 in the lower class, were considered in the calculation of the item analysis. The more students who gave correct responses to an item, the less difficult that item was. Items with ID of 0.25-0.75 were considered average or moderately difficult, while those with ID of above 0.756 to 1.0 and below 0.25 were deemed too easy or difficult, respectively (Keley, 1939).

Table 1 shows the summary of ID of BAT. The majority of the items, 67 out of 88, had an ID between 0.25 and 0.75, and were considered average. Twenty-one were considered difficult. No items were considered easy. Items considered easy often discriminate poorly, unlike difficult test items considered good discriminators (Hingorjo & Jaleel, 2012).

Table1. Summary of the Index of Difficulty (ID)

Index of Difficulty	Frequency	Item No.	Interpretation
Above 0.75	0	---	Easy
Between 0.25 and 0.75	67	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 17, 18, 19, 21, 22, 23, 24, 25, 27, 28, 29, 30, 31, 33, 34, 37, 38, 40, 42, 43, 45, 46, 47, 48, 49, 50, 53, 55, 56, 57, 58, 59, 60, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 74, 75, 76, 77, 78, 79, 81, 82, 83, 84, 85, 88	Average
Below 0.25	21	11, 13, 15, 16, 20, 26, 32, 35, 36, 39, 41, 44, 51, 52, 54, 61, 62, 73, 80, 86, 87,	Difficult

In Table 2, DI shows 47 items regarded as poor items. Sharma (2018) reported that items with 0.30 – 0.39 DI have less or no revision required, while items with DI of 0.40 – 0.90 are satisfactory. In total, 22 items were initially considered for the final version of the BAT.

Table 2. Summary of Discrimination Index (DI)

Discrimination Index	Frequency	Item No.	Interpretation
0.40 -0.90	10	18, 42, 65, 66, 71, 75, 76, 83, 84	Very good items
0.30 – 0.39	12	8, 24, 31, 33, 37, 50, 55, 59, 70, 72, 78, 82	Good items
0.20 – 0.29	19	12, 17, 19, 28, 29, 35, 45, 46, 47, 48, 49, 62, 69, 74, 77, 79, 81, 85, 88	Fair items
0.19 and below	47	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 13, 14, 15, 16, 20, 21, 22, 23, 25, 26, 27, 30, 32, 34, 36, 38, 39, 40, 41, 43, 44, 51, 52, 53, 54, 56, 57, 58, 60, 61, 63, 64, 67, 73, 80, 86, 87	Poor items

Reliability

Internal consistency and reliability were measured using Kuder-Richardson (KR) 20. This reliability test measures the inter-item consistency (Patock, 2004). It is based on assumed test items that are equal or closely related (Sarmah & Hazarika, 2012). The KR 20 was calculated using the proportion of correct and wrong answers and the variance of the wrong scores.

The mean score of 172 students was 32.06, with a standard deviation of 7.26 (Appendix Table 3). Calculating the KR20 reliability of the 88-item BAT, the researcher was able to deduce the KR20 to 0.65. The ideal value for KR20 is 1.00, while the acceptable range is 0.60 or higher (Zimmaro, 2016). Thus, the BAT shows acceptable reliability in terms of KR20.

Final Version of BAT

The final version of the BAT is made up of 22 items that were deemed acceptable based on item analysis (Table 3). Three more items were reconsidered to complete a total of 25-item Biology achievement test for junior high school.

Table 3. Item Analysis of the Final Version of Biology Achievement Test (BAT)

Item No.	Question	ID	DI
8	Which describes a population?	0.47	0.35
18	Which of the following happen after mitosis?	0.52	0.46
24	Which correctly describes hepatitis?	0.49	0.31
31	What is the primary function of blood?	0.65	0.33
33	What are the tiny sacs in the lungs through which the exchange of oxygen and carbon dioxide takes place?	0.41	0.35
37	Thyroxine is to thyroid, while insulin is to _____.	0.45	0.40
42	What do you call the highly condensed form of DNA?	0.48	0.50
50	Which of the following branches of science deals with the study of genes and how the traits are passed from one generation to another?	0.43	0.35
55	A homozygous red-flowered plant was crossed with a homozygous white-flowered plant and resulted in an offspring with red flowers. Which of the following pattern of inheritance is illustrated?	0.36	0.35
59	The strand is chemically a(n) _____.	0.41	0.35
65	Which is true about mutations in DNA?	0.45	0.44
66	These organisms are genetically altered to produce bigger, better and more nutritious products.	0.45	0.48
68	Which of the following basis is used in classifying organisms?	0.54	0.54
70	What refers to specialist organisms that feed on resources from hosts?	0.47	0.31

71	What fishing practice drives fishes out of the coral reef due to the pounding of the corals using heavy objects such as stones?	0.43	0.48
72	The breakdown of glucose in produce energy results to the following waste(s):	0.42	0.33
75	An endangered species is a(n) _____.	0.61	0.48
76	When the same species or different species are after for the same resource such as food and space _____ may result.	0.56	0.46
78	Which among the ecological relationships is considered neutral?	0.44	0.38
82	If there are 24 pyruvic acids after glycolysis, how many glucose molecules were broken down?	0.53	0.31
83	Planktons are the food producers of the sea while rice plants are food producers on land. What characteristics are common to planktons and rice plants that enable them to carry out photosynthesis?	0.45	0.44
84	Evolution is evidenced by the following EXCEPT	0.42	0.42
17*	An organism's scientific name is composed of _____ and _____.	0.44	0.29
69*	What process describes the conversion of carbon dioxide and water to energy in the form of glucose?	0.44	0.29
81*	Which BEST describes an autotroph?	0.38	0.29

Note: ID- Index of difficulty; DI=Discrimination index; * reconsidered item

Conclusion

This test development project aimed to develop and validate an achievement test in Biology (BAT). The test was designed to assess the achievement of junior high school completers, the Grade 11 senior high school, in biology concepts. The BAT possesses a reliability of 0.65 based on KR20. In the Philippine setting, implementing a new curriculum is a challenge for teachers. The effectiveness of the new curriculum is dependent on exploration through experiments. Thus, developing a valid and reliable examination is one of the main goals in describing the effects of the curriculum on the students.

Recommendations

The results suggest that there is a need for the BAT to be validated by more experts who have higher educational attainment and richer experience in teaching biology and to revalidate the BAT with more respondents from both public and private schools and more locales. Another round of validation will improve the content of BAT, specifically on concepts and the alignment of the items with the required competencies by the Department of Biology for senior high schools.

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Conflict of interests

No conflict of interest.

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