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Development and Validation of Organismal Classification Achievement Test (OCAT): Basis for Implementation and Standardization for Test Construction in Junior Science High School

Berame JS[1]*, Lawsin NLP[2], Gacosta H[3], Yadao M[4] and Orleans AV[5]

[1]*Caraga State University-Main Campus, Butuan City, Philippines*
[2]*Navotas Polytechnic, Manila, Philippines*
[3]*Mayamot National High School, Manila, Philippines*
[4]*University of San Jose-Recoletos, Cebu City, Philippines*
[5]*Philippine Normal University-Manila, Philippines*

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***Corresponding author:**
Berame JS
Caraga State University
Butuan City
Philippines
E-mail: Janveel@yahoo.com

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Abstract

This study aimed to develop, validate and administer an achievement test in organismal classification for grade 8 junior science high school. In the development stage, the researchers followed the aligned topics in the K to 12 curriculum guide for grade 8 science that focused on taxonomy and systematics and these were the basis for the development of the achievement test. The developed Organismal Classification Achievement Test (OCAT) was validated by content experts in biology. The initial version of the instrument is 60-item test which was administered to grade 8 high school students. Reliability coefficient, (KR20), difficulty index and discrimination index were used to select which items were retained, revised or rejected. Result of pilot-testing retained 40 items in which 19 items were described as average to excellent items (x > 0.20) while 21 questions were described as items subject for revision (between 0.10 and 0.20) for discrimination index.

Keywords: Achievement test; Organismal classification; Taxonomy; Junior science high school

Introduction

Taxonomy and systematics are the branches of biology that deals with naming and classification of organisms based on their phylogenetic relationship. Rules and principles in naming and classifying organisms make these branches difficult to learn. Natural EnvironmentResearch Council [1] revealed that taxonomy is less importantin many of the sciences in the country. Recently, taxonomic research may have seemed less difficult, involving a more degree of bias, encountered in other biological sciences taught in the school. Both areas were acquired the least attention inside the classroom taken by teachers who recognized low level ofimportance to fieldwork. [2]. These areas, handled bynovice or uninterestedbiologyteachers, had least self-confidence and this activity received the least importance as a result.

The school of science postulated that taxonomy is one of the competencies in biology with numerous misconceptions and low conceptual understanding as perceived by in-service biology teachers [3]. Related problems also exist in same education levels. There is a

toughform of view in junior high school education that promotes the escaping of taxonomy and systematics as subjects, yet compulsory among the students [4]. This approach seems questionable set the natural inquisitiveness of students that most science teachers now agree that some basictraining in taxonomy, by thematured secondary students [5].

Meanwhile, adoption of the K to 12 science curriculum re-introduces the teaching of taxonomy, or identification methods at least, into many classrooms in the school [6]. However, these competencies are supposedly discussed in the last quarter of the school year making it difficult to be taught due to possible lack of instructional time allotment for the school year in the event of emerging special holidays or "no class" periods [7]. Therefore, assessing the content of the students' achievement always suffers.

In addition, there are two main categories which teachers need to consider to these existing problems in the school. First, the mainconcern is the traditional approach to the teaching used of systematics and identification. Much emphasis is being put on achieving the names, instead of giving thought to the aims or objectives, principles, and methods include [8, 9]. The teaching method of taxonomy should not involve rote learning as long lists of names and taxonomically significant structures, yet an overdependence on rote learning.

Second, there is lack of insufficient resource materials for students and teachers. Much dependence is placed on poorly designed or inappropriate resource materials and there is a need for a comprehensive range of instructional materials [10].

With this, the researchers, being the science teacher themselves, were motivated to develop a validated achievement test in organismal classification focusing on Philippine biodiversity suited for the 8th grade high school students to help assess their Organismal Classification Achievement Test **(**OCAT) deficiencies.

Methodology

Research design

Developmental design was used in this study. The study developed an achievement test for organismal classification, have it validated with content-expert and pilot-tested to the 100 Grade 8 high school students of Rizal province.

Research instruments

Organismal Classification Achievement Test (OCAT) was the primary instrument in this study. Comments and suggestions of the content-validators were immediately written on this instrument and were used to further improve the content of this instrument.

Sampling and participants

This study used two groups of participants. The first group is composed of 3 content-expert validators. They are all doctorate biology students who are teaching biology subjects in junior high school or tertiary education. The second group is composed of 100 students from the Department of Education (DepEd)high school of Rizal Province, Philippines. The 100 students were all from two heterogeneous classes of the school. There were 66 males and 34 females in this set of sample. They were evaluated after three weeks of implementing the organismal topics in the classroom.

Research procedure

Input-Process-Output (IPO) Model served as the guide in the development of this achievement test. Figure 1 shows the flowchart of the procedure in this study.

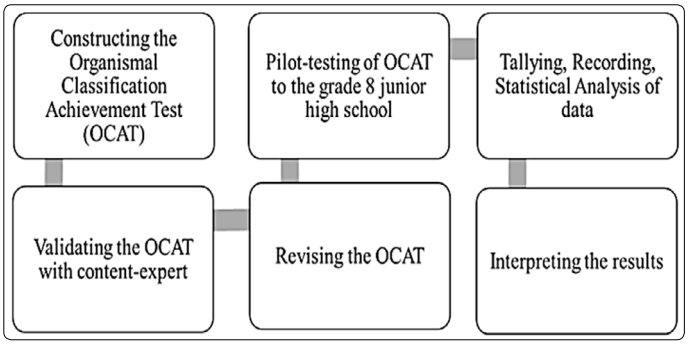

Figure 1. Flowchart of the study

The analysis of the content from the curriculum guide in science was served as the basis in the development of the Table of Specification (TOS) and OCAT. The number of hours in teaching the competency was considered. After the development of the OCAT, it underwent content validation of the 3 biology experts. Comments and suggestions were gathered and followed in revising the OCAT. The instrument has 50-item test prior to the pilot-testing. The validated OCAT was administered to the 100 junior high school students. Students' responses were checked, tallied and subjected to item analysis. After analysing which items to be retained, revised and/or disposed, the table of specifications (TOS) OCAT and answer sheets were finalized through removing the items that were not passed the criteria in distractor analysis.

Quantitative evaluation and statistical treatment

This study used only descriptive statistics derived from the pilot-testing and these are as follows:

Frequency (R_U& R_L)

It is used to determine the students who got the correct answer per item in the upper 27 percent and lower 27 percent of the sample respectively.

Mean

It is used to determine the average scores per student and per item.

Reliability Coefficient (KR20)

Test reliability is an indication of the consistency of the test construction.Upper test reliability indicates that the test measures whatsoever it measures in a consistent way.

Difficulty Indexd

Measure of the proportion of respondent who respond to an item correctly.

Discrimination index

This shows the extent to which an item has discriminated amongst the high scorers and low scorers on the test.

Item analysis

It is used to assess which test items to be rejected, revised or retained in order to improve the reliability of the instrument.

After the test was administered to 100 Grade 8 biology student-respondents, the item analysis of the test construction was carried out in calculating the difficulty and discrimination indices for each test items, validity and reliability survey of the testwas done. Inappropriate questions wereomitted; KR-20 reliability coefficient was calculated until the test achieved its final form.

The test items in the study were evaluated based on its difficulty levels [11] provided in Table 1 and discrimination power [12] presented in Table 1.

Table 1. Difficulty index (p)

Difficulty Index (p)	Interpretation
0.75-1.0	Easy
0.25-0.75	Average
0.25 or below	Hard

The subsequent rules for determining the quality of the item constructed in the test in terms of the discrimination index (d) is shownin Table 2 with the ***d*** values and their corresponding interpretation[12].

Table 2. Discrimination index (d)

Range	Remarks	Recommendations
> 0.39	Excellent	Preserve
0.30 - 0.39	Good	Possibilities for enhancement
		Need to review/verify
		Reject of review in-depth
0.20-29	Average	(Items having good difficultyvalue but discrimination
0.00-0.19	Poor	indexup to 0.10 is considered forrevision and finally included inthe test)
< -0.01	Worst	Remove

Findings

Development and validation results

Content experts gave comments and suggestions to improve the quality of OCAT as an assessment tool in systematics-taxonomy, the summary of their comments and suggestions areto use contextualized examples of organisms that can be found in the Philippines,rephrase some items and apply the knowledge in situation cases so students will gain more knowledge as their read the content of the test item, give more descriptions on words that are highly technical, fuse some items that measure almost the same competencies, alphabetized the options and/or arrange them in increasing and decreasing order, andremove repetitive words in the choices or distractors [13].

Item analysis

After the administration of the OCAT to the intended respondents, the answer sheets were checked.Each student's letter answers were recorded per test item.The scores were ranked from highest to lowest scores where the upper and lower 27 scores were separated for item analysis.In each item, the frequency of correct scores for upper 27 and lower 27 were recorded as basis for computing the item difficulty and item discrimination indices computed as follows:

difficulty index, $p = \frac{R_u + R_L}{54}$

discrimination index, $d = \frac{Ru - R_L}{27}$

All the calculations were done with the use of MS Excel 2010, i.e., the descriptive statistics and the item analysis. The result of the item analysis together with the recommended action is presented in Table 3.

Test of reliability

As an important element of a constructed test, the test of reliability was calculated using Kuder-Richardson formula 20 (KR-20).The resulting reliability coefficient marked 0.725 for the 60-item test.Table 4 shows the descriptive statistics for the developed test questionnaire.

Table 3. Descriptive values of the data

Descriptive Values		
Number of Items		60
Descriptive Values		
Number of Items	60	
Sample size	100	
Sample Mean	29.02	
Standard Deviation	52.14	

Discussion

As presented in Table 4, the distractor analysis of the test suggests revision on particular choice of answer. The table contains the item number and newly designated item. Distractor analyses considered the upper and lower 27% of the respondents and tallied their responses per item in order to determine which items need to be retained, revised or disposed.

Based on the results, the following 40 item test were retained and/or revised from the original OCAT questionnaire. They are items *1, 2, 6, 7, 8, 11, 12, 14, 15, 17, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 34, 36, 37, 39, 40, 42, 43, 44, 45, 46, 50, 51, 53, 54, 56, 58, and 59*.Initially, there were 9 items that are functioning as intended in such a way that they can completely distract or discriminate several items while 31 item testwere required revisions of one option and revising the option per item was required sincethe 31 item test had good difficulty index yet the discrimination index for two options was not fully discriminated by the upper and lower 27% of the population.

Furthermore, as presented in Table 4, majority of the test items need revision based on the discrimination index even the OCAT was validated by experts. This indicates that majority of the student-participants have lacked prior knowledge in the subject contents based on the result of the discrimination index. The options of the test basically on their level of standard but the result were very low.

This tends to revised 31 test item based on the low results of their scores. This leads to re-structuring their lessons and instruction in the classrooms. Evidently, students with do not have enough basic knowledge in the previous levels; they really performed less in the test since Philippine education is newly adopted the new curriculum in the country. The curriculum is significantly affects the academic performance as focused on outcomes-based performance.

Table 4. Distractor analysis of the items

Item No.	Previous No.	LEVEL	OPTION FREQUENCIES					REMARKS
			A	B	C	D	Total	
1	1	UPPER	2	24	0	1	27	all distractors are functioning as intended
		LOWER	3	15	4	5	27	
2	2	UPPER	4	2	18	3	27	revise option A
		LOWER	4	4	15	4	27	
3	6	UPPER	6	15	4	2	27	revise option B
		LOWER	5	11	9	2	27	
4	7	UPPER	3	2	5	17	27	revise option B
		LOWER	7	1	5	14	27	
5	8	UPPER	4	2	6	15	27	all distractors are functioning as intended
		LOWER	5	7	7	8	27	
6	11	UPPER	13	8	3	3	27	revise option B
		LOWER	18	5	0	4	27	
7	12	UPPER	7	13	4	3	27	revise option A
		LOWER	4	10	7	6	27	
8	14	UPPER	2	4	14	7	27	revise option B
		LOWER	8	4	13	2	27	
9	15	UPPER	9	7	9	2	27	revise option C
		LOWER	17	0	4	6	27	
10	17	UPPER	1	7	8	11	27	revise option A
		LOWER	0	17	0	10	27	
11	20	UPPER	4	1	3	19	27	revise option C
		LOWER	7	5	0	15	27	
12	21	UPPER	5	0	22	0	27	revise option D
		LOWER	9	2	16	0	27	
13	22	UPPER	21	3	3	0	27	revise option D
		LOWER	11	8	8	0	27	
14	23	UPPER	3	1	17	6	27	revise option C
		LOWER	6	0	14	7	27	
15	24	UPPER	4	2	5	16	27	revise option B
		LOWER	8	2	4	13	27	
16	25	UPPER	3	0	23	1	27	all distractors are functioning as intended
		LOWER	4	10	8	5	27	
17	26	UPPER	25	2	0	0	27	revise option C
		LOWER	19	6	0	2	27	
18	27	UPPER	1	7	17	2	27	revise option A
		LOWER	1	4	20	2	27	
19	28	UPPER	1	5	7	14	27	revise option B
		LOWER	4	4	3	16	27	
20	29	UPPER	5	9	6	7	27	revise option C
		LOWER	2	10	5	10	27	
21	30	UPPER	4	22	1	0	27	revise option D
		LOWER	8	17	2	0	27	
22	31	UPPER	3	4	18	2	27	revise option D
		LOWER	6	8	11	2	27	
23	32	UPPER	20	2	0	5	27	revise option B
		LOWER	17	2	2	6	27	
24	34	UPPER	1	0	6	20	27	revise option C
		LOWER	6	6	2	13	27	
25	36	UPPER	10	0	5	12	27	revise option A
		LOWER	1	3	2	21	27	
26	37	UPPER	8	4	11	4	27	revise option B
		LOWER	13	3	8	3	27	
27	39	UPPER	0	20	3	4	27	all distractors are functioning as intended
		LOWER	9	6	6	6	27	
28	40	UPPER	3	3	20	1	27	all distractors are functioning as intended
		LOWER	9	4	6	8	27	
29	42	UPPER	20	2	5	0	27	revise option C
		LOWER	17	4	3	3	27	
30	43	UPPER	25	1	0	1	27	all distractors are functioning as intended
		LOWER	18	2	2	5	27	
31	44	UPPER	4	0	23	0	27	all distractors are functioning as intended
		LOWER	8	4	14	1	27	
32	45	UPPER	2	6	3	16	27	revise option B
		LOWER	8	4	4	11	27	
33	46	UPPER	4	20	3	0	27	revise option C
		LOWER	7	14	2	4	27	
34	50	UPPER	7	0	0	20	27	revise option A
		LOWER	4	9	14	0	27	
35	51	UPPER	2	20	1	4	27	revise option B
		LOWER	3	15	5	4	27	
36	53	UPPER	5	0	2	20	27	revise option B
		LOWER	16	0	0	11	27	
37	54	UPPER	8	11	2	6	27	revise option A
		LOWER	6	17	4	0	27	
38	56	UPPER	4	0	20	3	27	revise option A
		LOWER	4	0	8	15	27	
39	58	UPPER	4	0	20	3	27	all distractors are functioning as intended
		LOWER	7	3	12	5	27	
40	59	UPPER	9	2	2	14	27	revise option B
		LOWER	16	1	0	10	27	

Conclusion

To conclude, Philippine education at present tends to adapt, validate, and improve the present curriculum which is new in the school teachers. The full implementation only happens this year, in short, this curriculum is on its experimental set-up whether to become effective or not. Teachers at present are trying to venture this new curriculum. So, this study trying to develop and help improve their test construction of OCAT on Philippine biodiversity (taxonomy and/or systematics) in order to assess the students' knowledge toward organismal classification since some standardized tests are using their own organisms that are present in their locality which seemed to be unfamiliar to students. Content-experts agreed that emphasizing Philippine biodiversity can assess actual learning since students were able to imagine the species that were asked in the test items.

Recommendations

The researchers highly recommend other science teachers to re-validate this instrument to other sample of the students in order to further increase and establish its validity and reliability as andeveloping and validating OCAT assessment tool in taxonomy and/or systematics.

Lastly, developing OCAT instrument will become more reliable and standardize to re-consult K to 12 science curriculum makers and biology teachers to become more suitable for science high school students.

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Declaration

The researchers declare that all works are authentic and this research paper has not been published in any journals.

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