Research Article

Development and Validation of Mathematics Achievement Test

Nora V. Marasigan

Associate Professor, College of Teacher Education, Batangas State University, JPLPC-Malvar, Philippines Email: yayi marasigan@yahoo.com

Received: Mar 19, 2019	Accepted: Mar 26, 2019	Published: Mar 30, 2019
-------------------------------	------------------------	--------------------------------

Abstract: The paper described the development and validation of Mathematics Achievement Test for pre-service teachers. A multiple choice test of 125 items covering topics from different strands in Grades 7-10 Mathematics was considered. Data were obtained from 39 first year students from the College of Teacher Education at Batangas State University JPLPC-Malvar. The test was subjected to content-validation by three Mathematics teachers based on the table of specifications. After the content validation, a 100-item test was formed. Validity and reliability were determined using Upper-Lower Formula, Pearson's r and Chi-Square Formula. Results showed that the mean score and standard error measurement of 51.846 and 3.259, respectively, were obtained. Based on reliability analysis, a reliability coefficient of 0.913 was determined. Moreover, 60 items have discrimination index of greater than 0.2 and 78 items have difficulty index in the range of 0.3 to 0.7. Hence, 53 items were retained, 7 items were revised and 40 items were rejected. From these findings, it was concluded that the items in the Mathematics Achievement Test for pre-service teachers are relevant based on experts' judgment. Based on the indices of discrimination, difficulty and reliability, the developed Mathematics Achievement Test is valid and reliable. With the conclusions drawn from the study, the researcher suggested the following recommendations: An item-biased analysis of the Mathematics Achievement Test may be performed to further validate the Mathematics Achievement Test. A more comprehensive validation process may be applied to fully validate the developed Mathematics achievement test. For the standardization of the test, the sample size may also be increased covering a wide range of sample from different Campuses.

Keywords: Difficulty index, Discrimination index, Mathematics achievement test, Validity, Reliability.

Introduction

Mathematics has long been a part of the human search for understanding. Mathematical discoveries have come both from the attempt to describe the natural world and from the desire to arrive at a form of unpreventable truth from careful reasoning. These remain fruitful and important motivations for mathematical thinking. The sheer complexity of mathematics makes it unique in the continued occurrence of different innovation and discoveries since the dawn of time. Today, mathematics as a mode of thought and expression is more valuable than ever before.

Mathematics is an important school subject because it is associated with more academic and or career opportunities. Since the beginning of recorded history, mathematic discovery has been at the forefront of every civilized society, and in use in even the most primitive of cultures. The needs of mathematics arose based on the wants of society. The more complex a society, the more complex the mathematical needs. Primitive tribes needed little more than the ability to count, but also relied on math to calculate the position of the sun and the physics of hunting (Akinsola and Tella, 2003). Furthermore, the different mathematical patterns have paved a way in building the society itself due to different patterns that were continuously observed in the real world across varying circumstances that possibly lead to another discovery. Mathematics as a school subject has crossed various horizons in terms of guidance, application, and innovations.

The importance of a solid mathematics education goes much beyond the current conversation of improved proficiency on test scores. Studying mathematics not only will develop more engineers and scientists, but also produce more citizens who can learn and think critically and creatively. The competencies that mathematics provides develops the logical and abstract reasoning one may possess. It enables them to see what is not clearly seen and provide unbiased and fundamentally correct answers. Mathematics provides a clear and wide perspective about the fundamental concepts and supply logical reasoning based on criticallyanalyzed data.

A test of educational achievement is a test designed to measure knowledge, understanding, and skills in a specified subject or group of subjects. This test is a successful means of determining to what extent the student has attained a certain degree of progress toward a desired goal. Achievement test scores are often used in an educational system to determine the level of instruction for which a student is prepared (Freeman, 2010).

An achievement test is one designed to measure a student's grasp of some body of knowledge or his proficiency in certain skills. Standardized tests are considered important because they serve as a sampling of where students are in their learning and whether or not they are "on track" to hit the achievement milestones that have been set for them. Standardized achievement tests, according to those who are proponents, are valuable and useful information (Ebel, 2005).

Achievement tests provide an avenue for students to assess their own learning capabilities and identify their own competencies based on test scores. These results identify the mental capacities of the students when it comes to a certain subject and their intellectual capacities as well. Achievement tests are well-provided test formats that have been validated on certain levels which ensures accurate measurement of a student's capabilities.

Achievement tests in Mathematics are used to measure the knowledge and skills of a student in different aspects since Mathematics is used in a lot of different areas. In the Enhanced K to 12 Basic Education Curriculum, it is expected that the necessary competencies and skills of graduates for productive work or entrepreneurship must be developed. Educational assessment then is in a great compromise to monitor and verify the realization of the curriculum's objectives (Mariňo, 2014).

Assessment literacy is a professional obligation. Hence, it is a major responsibility of those in the academe to construct a valid, reliable and bias-free achievement or performance tests as a commonly used type of assessment tool. It is also regarded as a likely target for teachers' professional development (Popham 2009).

A carefully validated and developed mathematics achievement test is essential to measure a student's capabilities on the mathematics subject. It also fills the discrepancy between

different curriculums applied in each school year that enables it to gather a more accurate and precise result. Henceforth, a study regarding the development and validation of mathematics achievement test is deemed important in assessing the mental and intellectual capabilities of a student.

Objective of the Study

The main purpose of this study was to develop and validate an achievement test in Mathematics intended for pre-service teachers. Specifically, this study sought answers to the following questions: What is the content validity of the test items in the Mathematics Achievement Test? and, What are the indices of difficulty, discrimination and reliability of the developed Mathematics achievement test?

Methodology

This study made use of the descriptive method of research, a fact-finding method, through the use of achievement test questionnaire. The achievement test questionnaire was developed based on the competencies prescribed in the K-12 Mathematics Curriculum for Grades 7-10. The test objectives were first formulated and table of specification was crafted.

The developed items were then subjected to content validation by experts in the field of Mathematics. Improvement of the items based on experts' suggestions was also done. The improved test was then tried out and administered to first year students to ascertain the level of difficulty and discrimination of each item through item analysis. Reliability test was also performed using Guttman Reliability.

Results and Discussion

This presents the data gathered together with the corresponding analysis and interpretation. The data are presented in tabular form organized in a sequential manner, following the order of the specific problems posed at the beginning of the study.

1. Content Validity of Mathematics Achievement Test

In order to ascertain the content validity of the Mathematics Achievement Test, the items were reviewed by three subject matter experts. One of them was a Mathematics instructor from CABEIHM Department, the other was a Mathematics Trainer and the last was a Master Teacher.

Number of Items	Numbers and Number Sense	Measurement	Patterns and Algebra	Geometry	Statistics and Probability
125	15	10	30	30	40
100	10	5	25	25	35

Table 1. Content Validity of Mathematics Achievement Test

The table shows the number of items per strand in the K to 12 Mathematics Curriculum of the Mathematics Achievement Test. From 125 items initially developed, 25 items were deleted based on experts' judgment.

The relevance of the items to the table of specifications was also considered. There were 10 items in Numbers and Number Sense, 5 items in Measurement, 25 items in Patterns and Algebra, 25 items in Geometry and 35 items in Statistics and Probability.

2. Discrimination, Difficulty and Reliability Indices of Mathematics Achievement Test

To be able to determine the discrimination index and difficulty index, item analysis was conducted. Guttman Reliability was also utilized to determine the reliability coefficient of the developed Mathematics Achievement Test.

	lest								
Mean	SD	SEM	Discrimin- ation Index >.2	Difficulty Index .3 to .7	Retained	Revised	Rejected	Total	Reliability Index
51. 846	3. 259	16. 622	60	78	53	7	40	100	0.913

 Table 2. Discrimination, Difficulty and Reliability Indices of Mathematics Achievement

 Tast

Table 2 shows the discrimination index, difficulty index and reliability index of Mathematics achievement test. It can be gleaned from the table that the mean was 51.846 while the standard error measurement was 16.622. The reliability coefficient of 0.913 was above 0.90, which is the accepted reliability coefficient for a standardized test such as those used for achievement test (Spearman, 1904). Statistical analysis also shows that that there were 60 items that satisfy the guidelines that items with discrimination index of greater than 0.20 are the only acceptable items (Ebel, 1979). Additionally, 78 items have difficulty index that range from 0.30 to 0.70 which are the ideal items (Brown, 1996). Hence 53 items were retained, 7 items were revised and 40 items were rejected.

Conclusion and Recommendation

This study revealed the mean score and standard error measurement of 51.846 and 3.259, respectively. Based on reliability analysis, a reliability coefficient of 0.913 was determined. Moreover, 60 items have discrimination index of greater than 0.2 and 78 items have difficulty index in the range of 0.3 to 0.7. Hence, 53 items were retained, 7 items were revised and 40 items were rejected. From these findings, it was concluded that the items in the Mathematics Achievement Test for pre-service teachers are relevant based on experts' judgment. Based on the indices of discrimination, difficulty and reliability, the developed Mathematics Achievement Test is valid and reliable.

With the conclusions drawn from the study, the researcher suggested the following recommendations: An item-biased analysis of the Mathematics Achievement Test may be performed to further validate the Mathematics Achievement Test. A more comprehensive validation process may be applied to fully validate the developed Mathematics achievement test. For the standardization of the test, the sample size may also be increased covering a wide range of sample from different Campuses.

Conflicts of interest: The author declares no conflicts of interest.

References

- 1. Akinsola, M.K. and Tella, A. 2003. Effectiveness of individualistic and cooperative teaching strategies in learning geometry and problem solving in Mathematics among junior secondary schools in Nigeria. Personality Study and Group Behaviuor, 23: 95-105.
- 2. Brown, J.D. 1996. Testing in Language Programs. Upper Saddle River, NJ: Prentice Hall.
- 3. Ebel, R.L. 1983. The Practical Validation of Tests of Ability. Educational Measurement: Issues and Practice, 2(2): 7-10.

- 4. Freeman, F.S. 2010. Theory and Practice of Psychological Testing, Third Edition.
- 5. Mariňo, N.T. 2014. Validity, Reliability and Item-Bias Analysis of KPUP-Based Test in Science for Grade 7 Students.
- Popham, W.J. 2009. Classroom assessment: What teachers need to know? Allyn & Bacon, A Viacom Company, 160 Gould St., Needham Heights, MA 02194; World Wide Web: http://www.abacon.com.
- 7. Spearman, C. 1904. General Intelligence objectively determined and measured. The American Journal of Psychology, 15(2): 201-292.

Test	Discrimination	I Verbal Difficulty Verbal			
Item	Index	Interpretation	Index	Interpretation	Decision
No		•		1	
1	0.38	Good	0.58	Average	Retained
2	0.31	Good	0.38	Average	Retained
3	0.31	Good	0.23	Difficult	Revised
4	0.62	Good	0.46	Average	Retained
5	0.15	Poor	0.54	Average	Rejected
6	0.46	Good	0.54	Average	Retained
7	0.00	Poor	0.85	Easy	Rejected
8	-0.15	Poor	0.54	Average	Rejected
9	0.38	Good	0.58	Average	Retained
10	0.15	Poor	0.46	Average	Rejected
11	-0.15	Poor	0.46	Average	Rejected
12	0.69	Good	0.50	Average	Retained
13	0.38	Good	0.50	Average	Retained
14	0.62	Good	0.54	Average	Retained
15	0.08	Poor	0.50	Average	Rejected
16	-0.15	Poor	0.62	Average	Rejected
17	0.08	Poor	0.58	Average	Rejected
18	0.00	Poor	1.00	Easy	Rejected
19	0.15	Poor	0.23	Difficult	Rejected
20	0.77	Good	0.54	Average	Retained
21	0.54	Good	0.58	Average	Retained
22	0.08	Poor	0.27	Difficult	Rejected
23	0.31	Good	0.31	Average	Retained
24	0.46	Good	0.54	Average	Retained
25	0.31	Good	0.62	Average	Retained
26	0.08	Poor	0.04	Difficult	Rejected
27	0.62	Good	0.62	Average	Retained
28	0.46	Good	0.46	Average	Retained
29	0.54	Good	0.50	Average	Retained
30	0.62	Good	0.54	Average	Retained
31	0.77	Good	0.38	Average	Retained
32	0.00	Poor	0.15	Difficult	Rejected
33	0.15	Poor	0.08	Difficult	Rejected
34	0.46	Good	0.46	Average	Retained

Discrimination and Difficulty Indices

Volume-3, Issue-3, March-2019: 262-268 International Journal of Recent Innovations in Academic Research

35	-0.08	Poor	0.65	Average	Rejected
36	0.08	Poor	0.96	Easy	Rejected
37	0.62	Good	0.46	Average	Retained
38	0.54	Good	0.50	Average	Retained
39	0.00	Poor	1.00	Easy	Rejected
40	0.77	Good	0.46	Average	Retained
41	0.38	Good	0.50	Average	Retained
42	0.54	Good	0.50	Average	Retained
43	0.08	Poor	0.58	Average	Rejected
44	0.15	Poor	0.62	Average	Rejected
45	0.54	Good	0.50	Average	Retained
46	0.38	Good	0.50	Average	Retained
47	0.15	Poor	0.69	Average	Rejected
48	0.31	Good	0.46	Average	Retained
49	0.38	Good	0.42	Average	Retained
50	0.54	Good	0.50	Average	Retained
51	0.38	Good	0.42	Average	Retained
52	0.54	Good	0.58	Average	Retained
53	0.23	Good	0.27	Difficult	Revised
54	0.46	Good	0.46	Average	Retained
55	0.31	Good	0.69	Average	Retained
56	0.15	Poor	0.77	Easy	Rejected
57	0.08	Poor	0.58	Average	Rejected
58	0.31	Good	0.54	Average	Retained
59	0.15	Poor	0.31	Average	Rejected
60	0.31	Good	0.77	Easy	Revised
61	0.38	Good	0.58	Average	Retained
62	0.31	Good	0.38	Average	Retained
63	0.15	Poor	0.62	Average	Rejected
64	0.08	Poor	0.04	Difficult	Rejected
65	0.15	Poor	0.54	Average	Rejected
66	0.77	Good	0.46	Average	Retained
67	0.00	Poor	0.85	Easy	Rejected
68	0.23	Good	0.65	Average	Retained
69	0.54	Good	0.50	Average	Retained
70	0.77	Good	0.54	Average	Retained
71	0.38	Good	0.81	Easy	Revised
72	0.08	Poor	0.73	Easy	Rejected
73	0.31	Good	0.62	Average	Retained
74	0.15	Poor	0.92	Easy	Rejected
75	-0.15	Poor	0.23	Difficult	Rejected
76	-0.15	Poor	0.62	Average	Rejected
77	0.38	Good	0.58	Average	Retained
78	0.15	Poor	0.69	Average	Rejected
79	0.00	Poor	0.23	Difficult	Rejected
80	0.77	Good	0.54	Average	Retained
81	0.15	Poor	0.62	Average	Rejected
82	0.23	Good	0.73	Easy	Revised

Volume-3, Issue-3, March-2019: 262-268 International Journal of Recent Innovations in Academic Research

83	0.23	Good	0.27	Difficult	Revised
84	0.00	Poor	0.38	Average	Rejected
85	-0.08	Poor	0.35	Average	Rejected
86	0.00	Poor	0.31	Average	Rejected
87	0.15	Poor	0.62	Average	Rejected
88	0.54	Good	0.50	Average	Retained
89	0.23	Good	0.42	Average	Retained
90	0.08	Poor	0.58	Average	Rejected
91	0.00	Poor	0.62	Average	Rejected
92	0.54	Good	0.58	Average	Retained
93	0.31	Good	0.46	Average	Retained
94	0.23	Good	0.27	Difficult	Revised
95	0.54	Good	0.50	Average	Retained
96	0.77	Good	0.46	Average	Retained
97	0.38	Good	0.50	Average	Retained
98	0.62	Good	0.46	Average	Retained
99	0.38	Good	0.65	Average	Retained
100	0.62	Good	0.62	Average	Retained

Reliability Statistics

Cronbach's Alpha	Dout 1	Value	.879	
	Part I	N of Items	50 ^a	
	Dout 1	Value	.854	
	raiti	N of Items	50 ^b	
	Total N of Items		100	
Correlation Between Forms				
Spearman-Brown Coefficient	Equal Length		.914	
Unequal Length		.914		
Guttman Split-Half Coefficient				

Descriptive Statistics

	Ν	Minimum	Maximum	Mean		Std.
						Deviation
	Statistic	Statistic	Statistic	Statistic	Std.	Statistic
					Error	
Score	26	28.00	73.00	51.8462	3.259 87	16.62214
Valid N (Listwise)	26					

Citation: Nora V. Marasigan. 2019. Development and Validation of Mathematics Achievement Test. International Journal of Recent Innovations in Academic Research, 3(3): 262-268.

Copyright: ©2019 Nora V. Marasigan. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.