



Construction and Standardization of Achievement Test for Numeracy Skills (ATNS)

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Abstract

The main purpose of assessment of students is to collect evidences about their level of achievement in a specific subject area. On the basis of those evidences, one can make inferences to determine the students' knowledge and skill acquisition, proficiency and know whether curriculum standards are being met or not. The paper presents the details of the construction and standardization of the achievement test for numeracy skills for Grade III students. The items were prepared from the content of the mathematics textbooks of standard III. The test initially consisted of 112 items and was given to subject experts for their valuable suggestions to ensure its content validity. Item analysis was done by calculating the difficulty index level and discriminative power for each of the items. Based on the analysis, 73 items were retained and those items were selected for the final draft. The split-half method was used to establish the reliability of the tool and it was found to be 0.921.

Key Words- Achievement, Numeracy skills, Construction and Standardization

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I. Introduction

Assessment is an important tool for evaluation which needs to be matched with the objectives of the content taught. Assessment helps in identifying students who are not understanding the concepts and thus, improving the teaching-learning process. Appropriately constructed assessment tools have the potential to have a significant effect on the policies of education. Assessments are used to help teachers, administrators and parents to make effective decisions about the progress of the child in a particular area and planning instructional programmes accordingly (Salvia, et.al., 2010). Nature of mathematics is abstract. While learning mathematics, skills and concepts become gradually complex. Useful information and directions to teachers as well as students should be provided for mathematics learning by adopting proper assessment procedure (National Council of Teachers of Mathematics, 2000). An important step in the assessment process is to determine students' understanding of and ability to use mathematical terms, both in written and oral form. (Bryant, et.al., 2000).

Generally, achievement tests are the assessment tools that are used for determination of the students' level of achievement relating to the cognitive domain. The construction of a good achievement test requires in-depth knowledge of a content area and design of test items that are fair and valid measures of important knowledge and skills in a given content area. Most of the achievement tests have the potential to be used as screening tools to identify individuals in need of remedial instruction. Goh, et.al., (1981) reported that the Wide Range Achievement Test and the Peabody Individual Achievement served as the general achievement batteries most commonly utilized by school psychologists. Mostly the Key Math Diagnostic Achievement Test, the Illinois Test of Psycholinguistic Abilities (ITPA), and the Woodcock Reading Mastery Tests are used for the assessment of specific academic content areas all over the world. There is scarcity of achievement tests for primary classes in India in the area of specific academic area such as mathematics and language. It becomes more important to develop an achievement test in mathematics in the context of NEP-2020 that focuses on strengthening fundamental literacy and numeracy skills.

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Method of Construction and Standardization of Achievement Test

The Achievement Test for Numeracy Skills (ATNS) was developed by researcher to assess the students' performance within the four areas of numeracy skills, i.e. number system, fractions, money concept and time concept. The process of test construction was carried out in three phases:

- Planning Phase
- Construction Phase
- Standardization Phase

1. Planning Phase

Planning is the first step in any type of test construction. Planning phase involved identification of the areas of Numeracy skills for primary class students. For developing the Achievement test for numeracy skills, four areas of arithmetic were taken into consideration -number concept, concept of fractions, time concept and money concept.

2. Construction Phase

This phase involved the following steps:

- Preparation of Item Pool
- Editing of the Items
- Small try out of Test
- Final try out of the Test
- Item Analysis
- Preparation of the Final Draft
- Scoring

2.1 Preparation of Item Pool

An important step in the construction of a test is the creation of an item pool (Jackson, 1970). Items for constructing the present test were collected through critical study of the available literature on mathematics achievement tests from books, available journals and in consultation with experts. The reference books of grade 3 were also explored for this purpose. This exercise helped the investigators in the preparation of preliminary draft of the achievement test for numeracy skills. 135 statements were tentatively framed in English language for preliminary draft of diagnostic test for numeracy skills. Collected items were thoroughly screened and edited and necessary additions and deletions were done and second preliminary draft was prepared. It contained 112 items in the form of Multiple-Choice Questions (MCQ) for the purpose of editing by experts.

2.2 Editing of the Items

Second Preliminary draft of 112 items was given to 12 experts with longstanding experience in the field of Education, Mathematics and Language for editing. These experts were personally requested to go in for reflection over every statement and respond to this task critically and objectively with their comments and observations. Every expert was asked to give opinion as to whether the items were valid enough to test the achievement of students. These items were examined by the school teachers, educationists and experts who commented about the content, structure and language of items. Keeping in view the judgment and comments of experts, certain items were discarded, some were reframed and reworded. In this way, a pool of 102 statements was finalized for the provisional draft of achievement test for numeracy skills.

2.3 Small group try-out

After selection and editing of items, the provisional draft was administered on 80 students of Grade III, to determine the level of understanding of the appropriateness of the areas and the items of the test. For the achievement test, no time limit was fixed for the students rather they were encouraged to complete the test. Complete freedom was given to them to ask about the difficulties they faced during the test. After the small try out slight changes were made in sentences and language of the questions.

2.4 Final Tryout of the test items

For the final try out, the Achievement Test for Numeracy Skills consisting of 102 items was then administered on 200 students studying in Grade III of various schools of Yamunanagar District.

2.5 Item Analysis

In order to make selection of items objective and scientific, item analysis was done by computing the Difficulty Index and Discriminative Power for every item included in the final draft of 102 items. The score sheets of students were arranged in descending order i.e. from highest to lowest scores for item analysis. Top 27% and bottom 27% scores were used for this purpose.

2.5.1 Difficulty Value of Achievement Test for Numeracy Skills

The difficulty value of each test item was calculated by the formula given below:

$$\text{Difficulty Value (D.V.)} = \frac{\text{Number of students who answered the items correctly in Upper group and in lower group}}{\text{Total number of students}}$$

The calculated difficulty value of the items that ranged from +0.20 to +0.80 were included in the test. The difficulty value of items below +20 were considered to be too easy and items above +80 were considered to be too difficult. On the basis of difficulty value, the items that were too easy and too difficult were rejected and the rest were accepted.

2.5.2 Discriminating Power of Achievement test for Numeracy Skills

Discriminating power value is used to discriminate between the above average learners and below average learners. The following formula was used to calculate the discriminating power of the item.

$$\text{Discriminating Power (D.P.)} = \frac{NU - NL}{N}$$

NU= Number of students who answered the item correctly in upper group

NL= Number of students who answered the item correctly in lower group

N = Total number of students in each group

The calculated values of the items which lie between +0.20 to +0.50 were taken for the test. The difficulty value and discriminative power of each item for ATNS is given in the table no.1:

Table - 1
Difficulty Value and Discriminating Power of Items for ATNS

Item no.	Difficulty Value	Result	Discriminating Power	Result
1	(47+26)/108=0.67	Accepted	(47-26)/54=0.39	Accepted
2	(50+28)/108=0.72	Accepted	(50-28)/54=0.41	Accepted
3	(50+27)/108=0.71	Accepted	(50-27)/54=0.42	Accepted
4	(46+23)/108=0.63	Accepted	(46-23)/54=0.42	Accepted
5	(16+00)/108=0.14	Rejected	(16-00)/54=0.29	Accepted
6	(42+24)/108=0.61	Accepted	(42-24)/54=0.33	Accepted
7	(00+00)/108=0.00	Rejected	(00-00)/54=0.00	Rejected
8	(46+25)/108=0.65	Accepted	(46-25)/54=0.39	Accepted
9	(48+24)/108=0.66	Accepted	(48-24)/54=0.44	Accepted
10	(26+08)/108=0.31	Accepted	(26-08)/54=0.33	Accepted
11	(33+15)/108=0.44	Accepted	(33-15)/54=0.33	Accepted
12	(43+18)/108=0.56	Accepted	(43-18)/54=0.46	Accepted
13	(10+08)/108=0.16	Rejected	(10-08)/54=0.03	Rejected
14	(43+20)/108=0.58	Accepted	(43-20)/54=0.42	Accepted
15	(44+18)/108=0.57	Accepted	(44-18)/54=0.48	Accepted
16	(37+12)/108=0.45	Accepted	(37-12)/54=0.46	Accepted
17	(41+23)/108=0.59	Accepted	(41-23)/54=0.33	Accepted
18	(00+00)/108=0.00	Rejected	(00-00)/54=0.00	Rejected
19	(63+38)/108=0.93	Rejected	(63-38)/54=0.46	Accepted
20	(09+08)/108=0.15	Rejected	(09-08)/54=0.02	Rejected
21	(21+06)/108=0.25	Accepted	(21-06)/54=0.28	Accepted
22	(32+15)/108=0.43	Accepted	(32-15)/54=0.31	Accepted
23	(00+00)/108=0.00	Rejected	(00-00)/54=0.00	Rejected
24	(41+28)/108=0.63	Accepted	(41-28)/54=0.24	Accepted
25	(27+14)/108=0.37	Accepted	(27-14)/54=0.24	Accepted
26	(32+10)/108=0.38	Accepted	(32-10)/54=0.40	Accepted
27	(60+34)/108=0.87	Rejected	(60-34)/54=0.48	Accepted
28	(20+09)/108=0.26	Accepted	(20-09)/54=0.20	Accepted
29	(13+10)/108=0.21	Accepted	(13-10)/54=0.05	Rejected
30	(32+26)/108=0.53	Accepted	(32-26)/54=0.11	Rejected
31	(34+36)/108=0.64	Accepted	(34-36)/54=0.03	Rejected
32	(13+8)/108=0.19	Rejected	(13-08)/54=0.09	Rejected
33	(47+35)/108=0.75	Accepted	(47-35)/54=0.22	Accepted
34	(40+16)/108=0.51	Accepted	(40-16)/54=0.44	Accepted
35	(27+11)/108=0.35	Accepted	(27-11)/54=0.29	Accepted
36	(38+20)/108=0.53	Accepted	(38-20)/54=0.33	Accepted
37	(40+19)/108=0.54	Accepted	(40-19)/54=0.38	Accepted

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38	(50+23)/108=0.67	Accepted	(50-23)/54=0.50	Accepted
39	(44+31)/108=0.69	Accepted	(44-31)/54=0.24	Accepted
40	(27+05)/108=0.29	Accepted	(27-05)/54=0.41	Accepted
41	(54+28)/108=0.75	Accepted	(54-28)/54=0.48	Accepted
42	(22+10)/108=0.29	Accepted	(22-10)/54=0.22	Accepted
43	(39+18)/108=0.52	Accepted	(39-18)/54=0.39	Accepted
44	(50+28)/108=0.72	Accepted	(50-28)/54=0.41	Accepted
45	(33+12)/108=0.41	Accepted	(33-12)/54=0.38	Accepted
46	(21+10)/108=0.28	Accepted	(21-10)/54=0.20	Accepted
47	(04+05)/108=0.08	Rejected	(04-05)/54=0.01	Rejected
48	(26+16)/108=0.39	Accepted	(26-16)/54=0.18	Rejected
49	(61+38)/108=0.91	Rejected	(61-38)/54=0.42	Accepted
50	(22+22)/108=0.40	Accepted	(22-22)/54=0.00	Rejected
51	(20+09)/108=0.26	Accepted	(20-09)/54=0.20	Accepted
52	(45+41)/108=0.79	Accepted	(45-41)/54=0.07	Rejected
53	(33+14)/108=0.43	Accepted	(33-14)/54=0.35	Accepted
54	(52+31)/108=0.76	Accepted	(52-31)/54=0.38	Accepted
55	(54+28)/108=0.75	Accepted	(54-28)/54=0.48	Accepted
56	(54+31)/108=0.78	Accepted	(54-31)/54=0.42	Accepted
57	(38+12)/108=0.46	Accepted	(38-12)/54=0.48	Accepted
58	(50+31)/108=0.75	Accepted	(50-31)/54=0.35	Accepted
59	(00+00)/108=0.00	Rejected	(00-00)/54=0.00	Rejected
60	(44+42)/108=0.79	Accepted	(44-42)/54=0.04	Rejected
61	(49+30)/108=0.73	Accepted	(49-30)/54=0.35	Accepted
62	(34+20)/108=0.50	Accepted	(34-20)/54=0.25	Accepted
63	(26+22)/108=0.44	Accepted	(26-22)/54=0.07	Rejected
64	(24+21)/108=0.41	Accepted	(24-21)/54=0.05	Rejected
65	(39+17)/108=0.51	Accepted	(39-17)/54=0.40	Accepted
66	(38+12)/108=0.46	Accepted	(38-12)/54=0.48	Accepted
67	(39+13)/108=0.48	Accepted	(39-13)/54=0.48	Accepted
68	(30+32)/108=0.57	Accepted	(30-32)/54=0.04	Rejected
69	(26+08)/108=0.31	Accepted	(26-08)/54=0.33	Accepted
70	(42+23)/108=0.60	Accepted	(42-23)/54=0.35	Accepted
71	(35+15)/108=0.46	Accepted	(35-15)/54=0.37	Accepted
72	(27+10)/108=0.34	Accepted	(27-10)/54=0.31	Accepted
73	(46+24)/108=0.64	Accepted	(46-24)/54=0.40	Accepted
74	(23+08)/108=0.28	Accepted	(23-08)/54=0.27	Accepted
75	(55+30)/108=0.78	Accepted	(55-30)/54=0.46	Accepted
76	(39+15)/108=0.50	Accepted	(39-15)/54=0.44	Accepted
77	(35+14)/108=0.46	Accepted	(35-14)/54=0.38	Accepted
78	(40+17)/108=0.52	Accepted	(40-17)/54=0.42	Accepted
79	(35+13)/108=0.44	Accepted	(35-13)/54=0.41	Accepted
80	(45+26)/108=0.65	Accepted	(45-26)/54=0.35	Accepted
81	(53+26)/108=0.73	Accepted	(53-26)/54=0.50	Accepted
82	(32+25)/108=0.52	Accepted	(32-25)/54=0.12	Rejected
83	(55+31)/108=0.79	Accepted	(55-31)/54=0.44	Accepted
84	(44+28)/108=0.66	Accepted	(44-28)/54=0.29	Accepted
85	(25+09)/108=0.31	Accepted	(25-09)/54=0.29	Accepted
86	(53+30)/108=0.76	Accepted	(53-30)/54=0.43	Accepted
87	(21+08)/108=0.26	Accepted	(21-08)/54=0.24	Accepted
88	(30+14)/108=0.40	Accepted	(30-14)/54=0.29	Accepted
89	(26+11)/108=0.34	Accepted	(26-11)/54=0.27	Accepted
90	(32+13)/108=0.41	Accepted	(32-13)/54=0.35	Accepted
91	(26+09)/108=0.32	Accepted	(26-09)/54=0.31	Accepted
92	(32+28)/108=0.55	Accepted	(32-28)/54=0.07	Rejected
93	(13+10)/108=0.21	Accepted	(13-10)/54=0.05	Rejected
94	(23+16)/108=0.36	Accepted	(23-16)/54=0.12	Rejected
95	(14+10)/108=0.22	Accepted	(14-10)/54=0.07	Rejected
96	(19+09)/108=0.25	Accepted	(19-09)/54=0.18	Rejected
97	(18+05)/108=0.21	Accepted	(18-05)/54=0.24	Accepted
98	(41+16)/108=0.52	Accepted	(41-16)/54=0.46	Accepted
99	(20+08)/108=0.25	Accepted	(20-08)/54=0.22	Accepted
100	(28+11)/108=0.36	Accepted	(28-11)/54=0.31	Accepted
101	(05+04)/108=0.08	Rejected	(05-04)/54=0.02	Rejected
102	(52+29)/108=0.75	Accepted	(52-29)/54=0.42	Accepted

2.6 Final form of the test

The final form of the test consisted of 73 items related to four areas of numeracy skills. These 73 items were arranged topic wise for the final administration. The maximum score on Achievement Test for Numeracy skills was 73 and the minimum score is 0. The weightage given to the Areas of Numeracy Skills after selection of items is shown in the following table:

Table - 2
Weightage to the Areas of Numeracy Skills

Sr. No.	Learning area	Q.No.	Marks Assigned
1.	Number Concept	1-33	33
2.	Fractions	34-42	09
3.	Time Concept	43-63	21
4.	Money Concept	64-73	10
	Total	73	73

2.6 Scoring of the Test

The Achievement Test for Numeracy Skills was a multiple-choice type test. Each statement has four responses and the student was assigned mark 1 for each correct response. The maximum score on Achievement Test for Numeracy skills was 73 and the minimum score is 0.

3. Standardization Phase

To standardize an achievement test, next step is to find its reliability and validity. Therefore, this phase was completed in two steps:

(i) Determination of Reliability of the test

(ii) Establishing the validity of the test

3.1 Determination of Reliability of the Test

The split half method was used to estimate the consistency of the test. In Split half method the test items were divided into two halves i.e. odd and even items and co-relation between two halves was calculated. The split half reliability of Achievement Test for Numeracy skills was 0.921.

3.2 Establishing the Validity of the Test

For validation of Achievement Test for Numeracy Skills, content and face validity was found out. The initial draft of the test was given to 12 experts including 4 subject experts, 2 language experts and 6 Educationists for their opinion, content analysis and its understanding. For this purpose, the "Form for Content Validity of Achievement Test for Numeracy Skills" was made by the researcher. The purpose of the validity form was to determine whether the test items fulfill the objectives of the test, whether the items were quite relevant to the specific learning units and whether the test items representing appropriate knowledge, behaviours and skills. On the basis of observations and suggestions given by experts, some items were modified. Only those items were retained in the final form of test which are approved by the experts.

II. Conclusion

The test was constructed for measuring the achievement of Grade III students in numeracy skills. Systematic efforts were made to validate the tool using appropriate statistical techniques. The tool will be helpful to measure the level of achievement in basic numeracy skills i.e. number concept, fractions, time and money concept. So that, appropriate measures may be adopted to improve their performance.

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