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Construction of Mathematics Achievement Test for Numeracy Skills

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Abstract: *The present study was undertaken to construct and standerdised the ' Achievement Test for Numeracy Skills' to measure the numeracy skills of primary school students. Initially, a pool of 102 items was framed by reviewing the related litratutre, which was then given to experts for analysing the content. The preliminary tryout and item analysis was done, 73 items were selected out of 102 items for the final form of the test. The reliability of the test was ascertained by test retest method and it was found to be relatively high. The content validity of the test was also asertained.*

Key words: *Numeracy skills, Primary school students, constrcution & standerdisation*

Humans are born with the ability to respond to the numerical properties of their visual world, without assistance of language and conceptual reasoning (Butterworth, 2005). Tasks that require such responses are described as tasks of numerosity and a child's numerosity is inherent. In fact, different researches give confirmation of how babies varying from a few weeks to 13 months old seem to be sensitive to numerosity (Starkey & Cooper, 1980; Starkey et al., 1990; Antell & Keating, 1983; Brannon, 2002). At the age of two, children have knowledge of basic number concepts and have the ability to identify the numbers and things formed from four or five items (Strauss & Curtis, 1981). Numerosity can therefore be defined as "an invariant property of a collection of objects specifying its numerical size" (Van Loosbroek & Smitsman, 1990)

Numerosity, Numeracy and Mathematics are interrelated with each other. Numerosity is the foundation of numeracy and mathematics. The numerosity, which is innate, leads to numeracy which in turn allows the development of mathematics. The term numerosity refers to the very

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basic ability to perceive quantity. The term numeracy denotes one or more of the 10 components of numeracy mentioned by Dowker (2004). The term mathematics is referred to a wider definition of numeracy which also includes data handling, geometry and the other topics mentioned by the NCTM (in Chinn, 2004). Sousa (2008) suggests that mathematics is the aptitude to determine the number of objects in a small collection, to count, and to perform simple addition and subtraction, without any direct instruction.

The Ministerial Council for Education, Employment, Training and Youth Affairs (MCEETYA) in its 1997 National Report on Schooling in Australia stated "Numeracy is the effective use of mathematics to meet the general demands of life at home, in paid work, and for participation in community and civic life." The term numeracy originated in the United Kingdom in the Crowther Report on the education of children ages 15-18. As "the mirror image of literacy," numeracy was a way of bridging scientific and literary cultures (MOE, 1959). The definition explained that numeracy is not only the ability to reason quantitatively but also some understanding of scientific method and some association with the achievement of science. Numeracy sometimes subsumed within literacy but numeracy is skill to do basic arithmetic and literacy is ability to apply numeracy in life.

Learning mathematics is becoming a necessity in a modern society; the societal expectancies as appears on school curriculums are higher and the learning difficulties are more obvious. Mathematics is a symbolic language that allows us to deal with the abstract ideas and concepts that is not possible in our alphabetic language. Lack of achievement in mathematics is growing global as well as national concern and it is likely that there will be an internal emphasis on mathematics instruction for the new future, for learning disabled students. In fact mathematics is a way to settle in mind a habit of reasoning so the question arises, "How do we do mathematics in our heads". This question is related to the issues such as children's acquisition of arithmetic knowledge and skills and nature of arithmetic problems among children.

Numeracy is closely related to mathematics. Without a solid foundation in mathematical concepts and procedures, there cannot be numeracy. On the other hand, knowledge of

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mathematical concepts and procedures alone is not enough to guarantee numeracy. The basic numeracy skills are required for understanding mathematics in early years of education. What mathematics is taught and how it is taught is important for the development of numeracy skills in young children. Numeracy skills are the key result of how mathematics is taught and learned. Thus there is a need to evaluate the numeracy skills of elementary school students. This will help teachers and educators to identify the weak numeracy skills of students at early years and they can take corrective measures for helping those students to become efficient in maths problem solving.

Objectives of the Study

1. To construct an achievement test for numeracy skills.
2. To establish the reliability of achievement test for numeracy skills.
3. To establish the validity of achievement test for numeracy skills.

Methodology of the Study

For construction and standardization of achievement test for numeracy skills to assess the numeracy skills of primary school students, following steps were followed:

- **Preparation of the Items Pool**

An important step in the construction of a test is the creation of an item pool (Jackson, 1970). Items were collected through critical study of the available literature on mathematics diagnostic tests from books, available journals and in consultation with experts. The reference books of Grade III and internet was also explored for this purpose. This exercise helped the investigator in the preparation of preliminary draft of the diagnostic test for numeracy skills. 135 statements were tentatively framed in English language for preliminary draft of diagnostic test for numeracy skills. After discussion with supervisor, 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.

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❖ **Editing of the Items**

Second Preliminary draft of 112 items was given to 12 experts with long standing 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 and also whether the statements were most relevant. These items were examined by the school teachers 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 diagnostic test for numeracy skills.

❖ **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.

❖ **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 of Grade III.

❖ **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

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items. The score sheets of students were arranged in descending order from highest to lowest scores for item analysis. Top 27% and bottom 27% scores were used for this purpose.

a) 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.

b) Discriminating Power of Diagnostic 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

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

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

N_L= 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.

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❖ **Final form of the test**

The final form of the test consisted of 73 items related to four areas of numeracy skills, 34 items of Number System, 9 items of Fractions, 21 items of Time Concept, and 9 items of Money Concept. Separate sub test was not prepared for word problems. The items related to word problems are incorporated within each sub test. 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 table 1.1

Table – 1.1
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**

The weightage given to the instructional objectives in behavioural terms i.e. Knowledge, Understanding, Application and Skill is shown in table 1.2

Table – 1.2
Weightage to Instructional Objectives in Behavioral Terms

	Number System	Fractions	Time Concept	Money Concept	Total
Knowledge	10	02	06	02	20
Understanding	07	03	04	03	17
Application	07	03	05	03	18
Skills	09	01	06	02	18
Total	**33**	**09**	**21**	**10**	**73**

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❖ **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.

❖ **Determination of Reliability of the Test**

For finding out the reliability, 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 established. The split half reliability of Achievement Test for Numeracy skills was 0.921.

❖ **Establishing the Validity**

For validation of each subtest of Achievement Test for Numeracy Skills again content and face validity was found out. The initial draft achievement test was given to 12 educated practitioners 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, behaviors and skills.

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