



## Construction and Standardization of Mathematical Aptitude test for Secondary Stage.

Dr. Supreet Kaur

Assistant Professor in Education, University School of Open Learning, Panjab University, Chandigarh

Meenu

Research Scholar (JRF), Department of Education, Panjab University, Chandigarh

### ABSTRACT

*This study focused on the necessity of construction and standardization of mathematical aptitude test. In referring to a person's aptitude for mathematics or the arts or carpentry or law, we are looking for his future in these specialized areas. Mathematical aptitude signifies some aspects of the present ability of the individual that predicts some future performance in mathematics. The study discussed the need, for constructing standardized mathematical aptitude test for secondary stage learners. The aptitude test was constructed in mathematics for class 10th. In final draft there were 29 items. The opinion of experts was taken to find content validity. The reliability coefficient was found with the help of test-retest method. The reliability coefficient was found to be 0.786 which is significant at 0.01 level.*

**KEYWORDS :** Aptitude test and mathematical aptitude test

### Introduction

Aptitude is variously defined as the innate learning ability, the specific ability needed to facilitate learning a job, aptness, suitability, readiness, tendency, natural or acquired disposition or capacity for a particular activity.

### Aptitude test

An aptitude test is one, designed to measure a person's potential ability in an activity of a specialized kind within a restricted range. According to Bingham (1937) aptitude tests do not directly measure future accomplishment. They make no such prediction, they measure present performance. Then, in so far as behavior, past and present, is known to be symptomatic of future potentialities. The test data supply a means of estimating those potentialities. The estimate is necessarily in terms of potentialities only.

### Mathematical aptitude

We use aptitude test in mathematics to predict the future performance of students in the subject i.e. it means that to achieve more in the subjects of mathematics; the student should have higher mathematical aptitude. Esteem needs of the student are met by using mathematical aptitude test and pupils are recognized for their talents and abilities.

### Importance of the research:

It becomes one of the most important functions of the counselor and teachers to find a particular aptitude in the child. By knowing the mathematical aptitude of a child, he can be guided to adopt a profession related to the fields of mathematics. It is said that mathematical aptitude is related to academic achievement. In other words, mathematical achievement of a child to a great extent depends upon his mathematical aptitude. So, the main focus of this study is on the construction and standardization of mathematical aptitude test so that teacher can properly guide the student to choose their profession.

### Objectives:

- To construct an aptitude test in the mathematics subject for the students of 10<sup>th</sup> class.
- To standardize the mathematical aptitude test prepared for the students of 10<sup>th</sup> class.

### Research method:

Survey method was used as it was most appropriate for the study.

### Identification of components of mathematical aptitude test

The component wherein variations in the student's mathematical aptitude were possible was firstly identified.

**Table-1:- components to be included in mathematical aptitude test and number of items**

Serial number	Name of component/dimension	Number of items
1	Numbers	9
2	Simplification	8
3	Fractions	9
4	L.C.M and H.C.F of numbers L.C.M and H.C.F of polynomials	6 2
5	Percentages	8
6	Square Root and Cube Root	6
7	Ratio and Proportion	9
8	Numbers and Letters	2
9	Averages	8
10	Probability	6
11	Counting	3
12	General Aptitude	7
13	Classification Type	2
14	Bar Graph	2
Total items		87

### Try out of mathematical aptitude test by a panel of experts.

A number of 87 items concerning mathematical aptitude were originally constructed. After that the investigator discussed these items with the subject experts in the field of mathematics. They were requested to give their opinions regarding the difficulty and relevance of the items in a particular component as well as language, vagueness and ambiguity of items. The panel of 21 subject experts in which there were 7 assistant professors, 7 mathematics teachers from different schools and 7 research scholars were consulted.

On the basis of judgment of panel of experts, 18 items were deleted from the components of mathematical aptitude test.

### Preliminary tryout of mathematical aptitude test on a group of students

The mathematical aptitude test was administered to 43 students selected from two schools of Hoshiarpur district. These students were contacted personally and after explaining the purpose for which the test was being constructed, they were given test booklets containing 69 items. The procedure of scoring for right response was '1' and for wrong response was '0'.

### Item analysis

After the items have been written, reviewed and carefully edited, they are subjected to a procedure called item analysis (Singh, 2013). The

main objectives of item analysis are enumerated below:

- Item analysis indicates which items are difficult, easy, moderately difficult or moderately easy. In other words, it provides an index of the difficulty value of each item.
- It also provides indices of the ability of the items to discriminate between high and low. In other words, item analysis indicates the discrimination value of each item. This is known as discrimination index (Singh, 2013).

Item analysis of 69 items was done by analyzing the items statistically by finding item difficulty value and discriminating power of the items.

**Difficulty value**

The number of students who gave right answers (R) were counted (presented in table 2) and divided by total number of students who were given test.

$$D.V = R/N$$

**Table- 2: Showing the total number of right responses of each item**

Item no.	No of students who gave right answers	Item No.	No of students who gave right answers	Item No.	No of students who gave right answers	Item No.	No of students who gave right answers
1	15	19	24	37	20	55	14
2	14	20	21	38	3	56	20
3	29	21	12	39	26	57	29
4	40	22	38	40	10	58	7
5	9	23	34	41	1	59	34
6	14	24	22	42	5	60	5
7	37	25	36	43	38	61	20
8	1	26	3	44	6	62	19
9	40	27	15	45	24	63	30
10	40	28	12	46	4	64	30
11	28	29	23	47	9	65	41
12	23	30	14	48	9	66	41
13	21	31	10	49	20	67	38
14	9	32	32	50	21	68	26
15	38	33	38	51	10	69	21
16	10	34	31	52	23		
17	38	35	13	53	16		
18	5	36	36	54	4		

Thus, D.V. of 69 items was calculated with the help of above mentioned formula, which have been presented in the table 4. The items which have D.V. within the range of 0.20 to 0.90 were retained. The items which have difficulty value lower than 0.20 and higher than 0.90 were rejected at this stage.

**Discriminative power**

The discriminative power for items were calculated, which have been presented in table 4. For this upper 27% and lower 27% cases were chosen. The total number of students who gave right responses in upper group (R<sub>u</sub>) and who gave right responses in the lower group (R<sub>l</sub>) were calculated. The discriminative power was calculated by subtracting (R<sub>l</sub>) from (R<sub>u</sub>) and dividing by the number of students in either group. The discriminative power ranges from -1 through 0 to +1. If the inferior answer correctly but the superior cannot answer correctly, then it shows negative discrimination. The items having D.P. less than 0.2 were rejected at this stage.

$$D.P. = \frac{R_u - R_l}{N}$$

**Table-3: Showing the Difficulty Value and Discriminating Power of each item of the Aptitude test**

Item no.	R <sub>u</sub>	R <sub>l</sub>	D.V	D.P.	Accepted (A)/ Rejected (R)	Item no	R <sub>u</sub>	R <sub>l</sub>	D.V	D.P.	Accepted (A)/ Rejected (R)
1	3	6	0.348	-0.25	R	36	12	9	0.837	0.25	A
2	8	1	0.325	0.58	A	37	10	0	0.465	0.83	A
3	7	9	0.67	-0.16	R	38	1	0	0.069	0.08	R
4	12	12	0.93	0	R	39	11	2	0.60	0.75	A
5	3	0	0.209	0.25	A	40	2	5	0.23	0.25	R
6	7	0	0.325	0.58	A	41	0	1	0.02	-0.08	R
7	11	8	0.860	0.25	A	42	2	0	0.116	0.166	R
8	0	0	0.02	0	R	43	12	8	0.88	0.33	A
9	12	12	0.93	0	R	44	2	2	0.139	0	R
10	12	10	0.93	0.166	R	45	10	1	0.558	0.75	A
11	12	0	0.65	1	A	46	1	2	0.09	-0.08	R
12	11	3	0.53	0.66	R	47	1	6	0.209	-0.42	R
13	3	12	0.488	-0.75	A	48	3	0	0.209	0.25	A
14	7	0	0.209	0.58	A	49	10	2	0.465	0.66	A
15	12	9	0.88	0.25	R	50	9	1	0.488	0.66	A
16	2	6	0.232	-0.33	A	51	3	2	0.232	0.08	R
17	12	9	0.88	0.25	R	52	10	3	0.534	0.58	A
18	2	0	0.116	0.166	A	53	5	2	0.372	0.25	A
19	11	0	0.558	0.91	A	54	0	2	0.09	-0.17	R
20	10	1	0.488	0.75	A	55	7	2	0.325	0.42	A
21	3	0	0.279	0.25	A	56	10	2	0.46	0.66	A
22	10	7	0.88	0.25	A	57	10	5	0.67	0.42	A
23	12	8	0.79	0.33	A	58	2	1	0.16	0.08	R
24	11	0	0.51	0.916	A	59	10	7	0.79	0.25	A
25	12	8	0.837	0.33	A	60	3	1	0.11	0.17	R
26	2	0	0.069	0.166	R	61	10	5	0.46	0.42	A
27	6	0	0.348	0.5	A	62	8	5	0.44	0.25	A
28	6	3	0.279	0.25	A	63	11	8	0.69	0.25	A
29	3	12	0.534	-0.75	R	64	12	7	0.69	0.42	A
30	4	1	0.325	0.25	A	65	12	10	0.95	0.17	R
31	5	2	0.232	0.25	A	66	12	10	0.95	0.17	R
32	12	8	0.744	0.33	A	67	11	8	0.88	0.25	A
33	12	9	0.880	0.25	A	68	12	1	0.60	0.92	A
34	11	6	0.72	0.416	A	69	6	2	0.488	0.33	A
35	3	6	0.32	-0.25	R						

After finding the difficulty value and discriminative power of each item the number of items which was deleted were 25 items at serial number 1, 3, 4, 8, 9, 10, 13, 16, 18, 26, 29, 35, 38, 40, 41, 42, 44, 46, 47, 51, 54, 58, 60, 65, 66.

**Final tryout of the mathematical aptitude test**

Now the booklet contains 44 items and was given to the 70 students. Again the difficulty value and discriminative power of 44 items were calculated.

**Table 4: Showing the total number of right responses of each item**

Item no.	No of students who gave right answers	Item No.	No of students who gave right answers	Item No.	No of students who gave right answers	Item No.	No of students who gave right answers
1	15	12	49	23	38	34	35
2	24	13	43	24	51	35	32
3	51	14	47	25	44	36	33
4	56	15	58	26	44	37	38
5	17	16	59	27	66	38	24
6	55	17	16	28	35	39	29
7	48	18	42	29	26	40	35
8	54	19	50	30	29	41	27
9	61	20	18	31	31	42	48
10	28	21	51	32	48	43	41
11	34	22	57	33	41	44	35

**Table 5: Showing the difficulty value and discriminative power of the 70 students and 44 items**

Item no.	R <sub>u</sub>	R <sub>L</sub>	D.V	D.P.	Accepted(A)/ Rejected (R)	Item no	R <sub>u</sub>	R <sub>L</sub>	D.V	D.P.	Accepted(A)/ Rejected (R)
1	4	1	0.21	0.07	R	23	19	3	0.54	0.42	A
2	3	10	0.34	-0.18	R	24	12	14	0.728	-0.05	R
3	19	11	0.72	0.21	A	25	19	5	0.62	0.368	A
4	19	11	0.80	0.21	A	26	19	5	0.62	0.368	A
5	9	1	0.24	0.21	A	27	19	19	0.94	0.289	R
6	17	17	0.78	0	R	28	19	8	0.5	0.289	A
7	9	17	0.68	-0.21	R	29	19	9	0.37	0.26	A
8	18	15	0.77	0.08	R	30	19	5	0.41	0.368	A
9	19	11	0.87	0.21	A	31	19	5	0.44	0.368	A
10	7	6	0.4	0.026	R	32	19	2	0.68	0.447	A
11	12	3	0.48	0.236	A	33	18	13	0.58	0.13	A
12	15	7	0.70	0.21	A	34	15	7	0.5	0.21	A
13	13	10	0.61	0.078	R	35	12	7	0.45	0.13	R
14	19	10	0.67	0.23	A	36	15	4	0.47	0.28	A
15	19	17	0.82	0.052	R	37	15	4	0.54	0.28	A
16	18	19	0.84	0.026	R	38	13	5	0.34	0.210	A
17	11	0	0.228	0.28	A	39	14	5	0.41	0.23	A
18	17	7	0.6	0.26	A	40	16	8	0.5	0.21	A
19	19	11	0.71	0.21	A	41	15	7	0.38	0.21	A
20	7	4	0.25	0.078	R	42	19	10	0.68	0.184	R
21	19	11	0.72	0.21	A	43	19	5	0.58	0.36	A
22	19	11	0.81	0.210	A	44	14	8	0.5	0.15	R

On the basis of criteria for D.V. and D.P. 15 items were dropped out of 44 items and only 29 items were retained which forms the final draft.

**Final draft of the aptitude test**

The final draft consisting of 29 items was given to a group of 20 students and the average time in which 90% of the cases were able to complete the test was taken as the time limit for the test. This comes out to be 25 minutes.

**Table -6: Blue print of final draft of aptitude test**

Serial number	Name of component/dimension	Number of items
1	Numbers	2
2	Fractions	1
3	L.C.M and H.C.F of numbers L.C.M and H.C.F of polynomials	3 1
4	Percentages	3
5	Square Root and Cube Root	3
6	Ratio and Proportion	2
7	Averages	3
8	Probability	3
9	Counting	2
10	General Aptitude	5
11	Pie Chart	1
Total items		29

**Reliability and validity**

A test score is called reliable when we have reasons for believing the score to be stable and trustworthy (Garrett, 2010). Reliability has been defined as “the degree to which test scores for a group of test takers are consistent over repeated application of measurements procedure and hence are inferred to be dependable and repeatable for an individual test taker” (Berkowitz, Wolkowitz, Fitch & Kopriva, 2000).

There are many procedures by which the reliability of the test measures can be established namely:

- 1 Alternative forms reliability
- 2 Split-half technique
- 3 Retest reliability or test-retest reliability.

All these forms have a common approach of obtaining the two sets of measures from the same scale and administer to the same sample for the purpose of finding coefficient of reliability.

The aptitude test was administered to a 70 students studying in class 10<sup>th</sup>. The second administration of the test was given after 15 days. Reliability coefficient was calculated by finding the coefficient of correlation between scores of the two administration of the test by product moment method. The reliability coefficient was found to be 0.786 which is significant at 0.01 level.

**Validity:-**

Validity refers to the degree to which the test actually measures what it claims to measure. The validity of a test refers to whether the test provides the type of information desired (Ebel and Frisbie, 1991; Popham, 1995).

The most important criterion for the usefulness of a test- especially an aptitude test is whether it assesses what the user wants it to assess. This criterion is called “content validity”. Content validity is a non- statistical type of validity of “The systematic examination of the test content to determine whether it covers a representative sample of the behavior domain to be measured” (Anastasi & Urbina, 1997).

For the present test content validity was determined with the help of 21 experts – 7 assistant professors of education, 7 mathematics teachers from different schools and 7- research scholars of mathematics background. As the judges agreed on their judgment, therefore this showed that the test having content validity.

**REFERENCES**

Anastasi, M., & Urbina, S. (1997). Psychological testing, 7th edition. New Delhi: Dorling Kindersley Publishing Inc (India). | Antonio, et. al. (2002). A structural equation model of parental involvement, motivational and aptitudinal characteristics and academic achievement. The Journal of Experimental Education, 70 (3), 257-287. | Berkowitz, D., Wolkowitz, B., Fitch, R., & Kopriva, R. (2000). The use of tests as point of high-stakes decision-making for students: A resource guide for educators and policy makers. Washington, DC: U.S. Department of Education. Retrieved November 24, 2012 from | http://www2.ed.gov/offices/OCR/archives/pdf/TestingResource.pdf. | Bingham, W.V.D. (1937). Aptitude and aptitude testing. New York: Harper and Brothers, p.21. | Carragher, T., & Schlieman, A. (1985). Computation routines prescribed by schools: help or hindrance? Journal for Research in Mathematics Education, 16, 37-44. | Carroll, J. (1973). Implications of aptitude test research and psycholinguistic theory for foreign language teaching. Linguistics, 112, 5-14. | Ebel, R. L., & Frisbie, D.A. (1991). Essentials of Educational Measurement. Englewood Cliffs, N.J.: Prentice Hall. | Fennema, E., & Carpenter, T. (1981). Sex related differences in mathematics: results from the national assessment. Mathematics Teacher, 74, 554-559. | Garrett, H. E. (2010). Statistics in Psychology and Education. Chandigarh: Vishal Publishers. | James, A., Kulik, C., & Bangert, L. (1984). Effects of practice on aptitude and achievement test scores. American Educational Research Journal, 21(2), 435-447. | Moore, G. J., & Smith, A. (Reviewed work) (1986). Sex and race differences in mathematics aptitude: Effects of schooling. Sociological Perspectives, 29 (1), 77-100. | Popham, W.J. (1995). Classroom Assessment: What Teachers Need to Know. Boston: Allyn and Bacon. | Singh, A. K. (2013). Tests, Measurements and Research Methods in Behavioural Sciences. New Delhi: Bharati Bhawan. | UNESCO Planning Mission. (1985). National council of educational research and training. | Chief Publication Officer, Sunder Nagar, New Delhi, 69-70.