

Development and Validation of an Achievement Test in Mathematics

J.Jayanthi, Ph.D Scholar,

Department of Mathematics, Presidency College, Chennai – 600 005. India.

ABSTRACT: *The main objective of the study was to develop and validate an achievement test in Mathematics for high school students of standard 10 in Chennai district. A multiple choice test of 150 items from 10th standard Mathematics syllabus was selected. The test was administrated to a sample of 327 students of 5 schools of Chennai district. The answer sheets were evaluated and marks were awarded. Several work sheets were prepared to perform item analysis. Through regular method of item analysis, facility index and discrimination index were calculated. The Cronbach's alpha was calculated as 0.888.*

I. INTRODUCTION

Mathematics is the gate and key of the Science. Mathematics is a Science by any criterion, an efficient and necessary tool used for all Sciences like Physics, Chemistry, Engineering and Medicine. It could be aptly remarked as “Mathematics is a Science of all Sciences and Art of all Arts”. Mathematics is a universal part of human culture. Mathematics provides us with a broad range of skills in problem solving, logical reasoning and flexible thinking. Academic achievement in Mathematics seems to be one of the predictors of peoples success in their career. Achievement in Mathematics is important in order to understand how society functions and for people able to exercise their rights to democratic participation. Mathematics is significant in our daily life. The need for high quality professional development programs in mathematics and science has become increasingly important in the current climate of educational reform (Blank, Alas, & Smith, 2007). Mathematics is an important school subject because it is associated with more academic and or career opportunities (Akinsola and Tella, 2003). Burton cited in Agwagah and Usman (2003) relates the importance of mathematics to the scientific, industrial, technology and social progress of a society.

II. OBJECTIVES OF THE STUDY

The objective of the study is to develop and validate an achievement test in Mathematics of standard 10 to find the academic achievement in Mathematics with respect to the achievement test prepared and given by the researcher.

III. METHOD OF THE STUDY

This test is intended to evaluate the achievement in mathematics of the students of standard X. The syllabus of Mathematics for standard X of Tamilnadu state for the academic year 2012-13 was analysed. Text books, reference materials, question banks, question papers and hand books of Mathematics were utilized as sources for framing items. The achievement test questionnaire was developed after the review of a large number of related literature. The Mathematics text book was studied thoroughly and concepts were understood. Every chapter was given importance and questions were selected with the help and advice of subject experts and also by choosing repeated questions by verifying many question banks. The multiple choice item technique was used to construct the items. There were 150 items totally.

IV. POPULATION

Students of standard 10 in Chennai district of different management type of schools like corporation, aided, unaided and government were selected as the population for the study.

V. SAMPLE

Sample for the present study was selected randomly from schools located in Chennai district. Different management schools like corporation, government, government-aided and matriculation and different types like boys, girls and co-education schools were selected as sample.

VI. TOOL USED

Mathematics achievement test of objective type for 10th standard.
(Developed and constructed by the researcher).

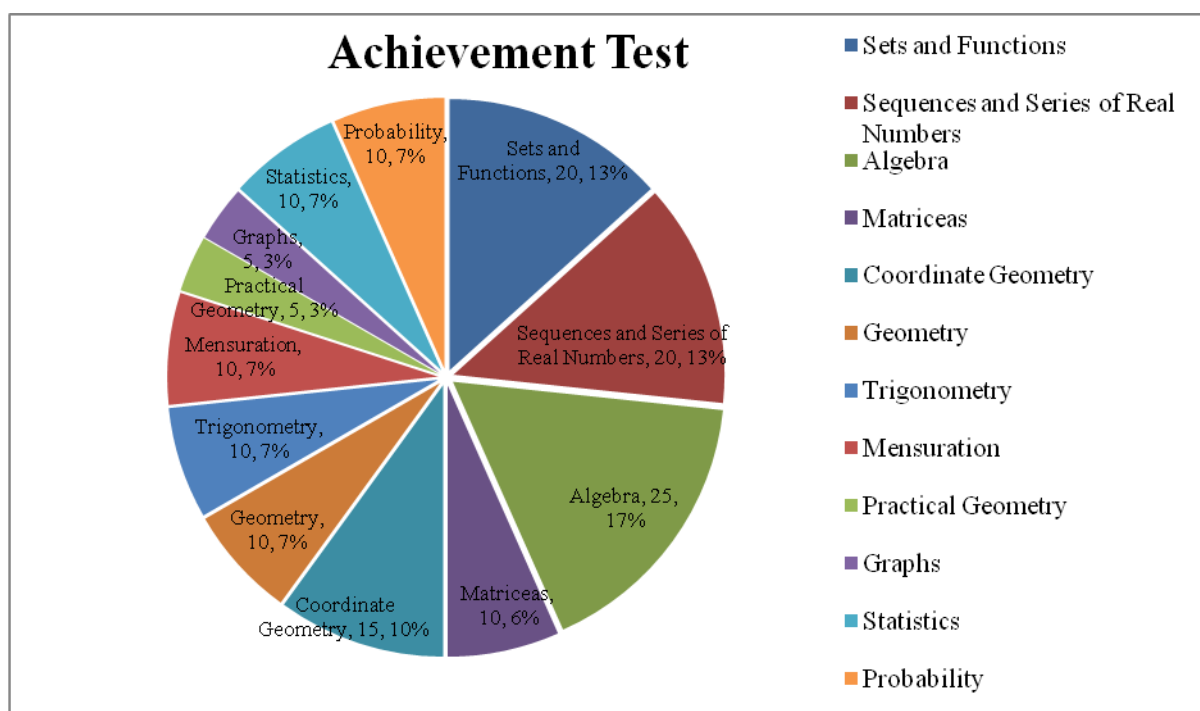
VII. STATISTICAL TECHNIQUES USED

- i). Simple random sampling technique was used to select the sample.
- ii). Statistical methods were used to measure mean, variance, standard deviation, correlation, Cronbach's alpha and validity.

VIII. DEVELOPMENT OF THE TEST

For collection of data, the tool named Mathematics Achievement Test was used. The researcher developed 150 items under each chapter, that is 20 items from Sets and Functions, 20 items from Sequences and Series of Real Numbers, 25 items from Algebra, 10 items from Matrices, 15 items from Coordinate Geometry, 10 items from Geometry, 10 items from Trigonometry, 10 items from Mensuration, 5 items from Practical Geometry, 5 items from Graphs, 10 items from Statistics and 10 items from Probability. There were four options in each item.

Graphical representation of Items Selected



IX. PILOT STUDY AND FINALISATION OF THE TOOL

The achievement test was administered to 327 students, among which 149 are male and the remaining 178 are female. The test was conducted in different management type of schools in Chennai like corporation, government, aided and unaided consists of coeducation, boys and girls schools. Totally the pilot study was conducted in five schools. A personal data sheet was also attached with the questionnaire to collect relevant information of the students. Each correct response of the question was given one mark and wrong answer was given zero. Total score was recorded by adding the correct responses. Using the score of the achievement test, facility index and discrimination index were calculated for item analysis. The facility index gives an indication of the easy or difficulty of an item and is most simply expressed as the proportion of the number of candidates who selected the correct response of the item to the number of candidates taken the test. Values of F ranged from 0% (extremely difficult) to 100% (extremely easy). The discrimination index D of an item indicates the effectiveness of the item in distinguishing between the high and low group students. With the help of statistical analysis, mean, variance, corrected item total correlation, cronbach's alpha and validity were calculated by the support of subject expert. Finally, 78 items were selected.

X. DATA COLLECTION AND DATA ANALYSIS

The researcher personally visited various schools in Chennai district and met the Heads of the schools and sought their permission and cooperation in administering the test, for their school students. Finally, the test was conducted for five school students on different dates. The information about the test was communicated to the students earlier itself so as to prepare themselves for the achievement test. A personal data sheet was attached with the questionnaire to get relevant personal datas of the students. Clear instructions were given to the students to respond to the questionnaire in time. The test procedure was strictly followed and answer sheets were collected on time. One mark for each correct answer and zero for each wrong answer was awarded. Answer key was prepared for scoring. The total scores were recorded for item analysis.

Total number of samples collected is 327. Total number of items in the achievement test is 150. The procedure for calculating facility index and discrimination index is as follows:

- i). Arrange 327 papers by score.
- ii). Multiply 327 by 0.27 and round off to the nearest whole number, say N, that is $N = 327 \times 0.27$, $N = 88$.
- iii). Count N best papers from the bottom of the stack. This is called the high group.
- iv). Count N poorest paper from the top of the stack. This is called the low group. The middle group (appxly. 46 percent of papers), is not used in the item analysis.
- v). Find R_H and R_L for each item. R_H stands for number of right responses in high group. R_L stands for number of right responses in low group.

$$N_H = N_L = 88$$

1. Facility Index $F = [(R_H + R_L) \times 100] / (N_H + N_L)$
2. Discrimination Index $D = (R_H - R_L) / N_H$
3. Cronbach Alpha = $[k/(k-1)][1 - (\sum S_i^2 - S_T^2)]$,
where S_i^2 stands for variance of i^{th} item and
 S_T^2 stands for variance of total.
4. Validity = $\sqrt{\text{Cronbach's alpha}}$

Facility index and discrimination index were calculated and used for item analysis. The reliability coefficient cronbach's alpha and validity were also calculated.

XI. RESULTS

The value of facility index lies between 0.20 and 0.78. Item number 19 has largest value 0.78 and item number 139 has smallest value 0.20. The value of discrimination index varies from 0.193 to 0.579. Item number 67 has the greatest discrimination power 0.579 and item number 81 has the least discrimination power 0.193. Corrected item correlation lies between 0.204 and 0.546. Item number 124 has least and item number 67 has greatest corrected item correlation. The reliability coefficient was calculated as 0.888 and validity coefficient is calculated as 0.942. Also the mean, variance, standard deviations are calculated as 49.84, 264.321 and 16.258 respectively.

XII. DISCUSSION AND CONCLUSION

Item total correlation less than 0.20 is dropped. The remaining items were selected for the final study. 78 items were selected based on the facility index and discrimination index and also based on the corrected item total correlation. For the standardisation of the test, the sample size should be increased. Many other schools from other districts also can included in the test. Schools belonging to rural areas are also can included in the study.

REFERENCES

- [1] Aiken, L.R. (1988). Psychological testing and assessment (6th ed.). Boston: Allyn and Bacon Inc.
- [2] Ann, P.S.(2004). Measurement, Assessment and Evaluation, Lagos: Concepts Publications Ltd.
- [3] Best, J.W. (2001), "Research in Education" (6th Ed.), New Delhi, Prentice Hall of India.
- [4] Gronlund, N.E. (1981). Measurement and Evaluation in teaching. NewYork: Macmillan Publishing Co.
- [5] National Policy on Education (1986). Ministry of Human Resource Development. Government of India. New Delhi.
- [6] Rao, S.N. (1990). "Educational Psychology", New Delhi: Wiley Eastern Ltd.
- [7] Saleem, M. (1994), "Development of an Aptitude Test of Mathematics at SSC level". Dept. of Education Bahauddin Zakariya University, Multan.
- [8] Wiersma, W. (1986), "Research Methods in Education: An Introduction", (4th edition). Boston: Allyn Bacon Inc.

Reliability Statistics

Cronbach's Alpha	N of Items
.888	150

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Selected/ Not Selected
Q1	49.55	259.072	.347	.887	Selected
Q2	49.53	264.273	-.011	.889	Not Selected
Q3	49.60	262.561	.115	.888	Not Selected
Q4	49.34	257.712	.395	.886	Selected
Q5	49.76	265.234	-.115	.889	Not Selected
Q6	49.40	258.813	.329	.887	Selected
Q7	49.51	258.663	.359	.887	Selected
Q8	49.64	262.564	.123	.888	Not Selected
Q9	49.46	258.741	.342	.887	Selected
Q10	49.15	256.801	.490	.886	Selected
Q11	49.17	257.114	.460	.886	Selected
Q12	49.23	258.062	.383	.886	Selected
Q13	49.09	258.261	.421	.886	Selected
Q14	49.37	260.200	.240	.887	Selected
Q15	49.76	265.649	-.158	.889	Not Selected
Q16	49.23	262.088	.125	.888	Not Selected
Q17	49.50	261.120	.195	.888	Not Selected
Q18	49.31	257.860	.386	.886	Selected
Q19	49.05	259.283	.366	.887	Selected
Q20	49.39	258.090	.373	.887	Selected
Q21	49.66	264.169	.001	.889	Not Selected
Q22	49.45	256.444	.490	.886	Selected
Q23	49.57	262.155	.137	.888	Not Selected
Q24	49.60	262.939	.087	.888	Not Selected
Q25	49.23	257.243	.434	.886	Selected
Q26	49.64	260.050	.318	.887	Selected
Q27	49.48	259.337	.307	.887	Selected
Q28	49.51	263.120	.064	.889	Not Selected
Q29	49.59	259.604	.324	.887	Selected
Q30	49.40	257.544	.409	.886	Selected
Q31	49.55	260.261	.263	.887	Selected
Q32	49.61	261.748	.176	.888	Not Selected
Q33	49.42	264.519	-.028	.889	Not Selected
Q34	49.51	261.497	.172	.888	Not Selected
Q35	49.69	263.082	.098	.888	Not Selected
Q36	49.49	260.709	.221	.888	Selected
Q37	49.37	259.526	.282	.887	Selected

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Selected/ Not Selected
Q38	49.60	263.636	.036	.889	Not Selected
Q39	49.53	262.411	.113	.888	Not Selected
Q40	49.58	263.879	.018	.889	Not Selected
Q41	49.55	265.266	-.078	.890	Not Selected
Q42	49.59	261.717	.173	.888	Not Selected
Q43	49.55	258.935	.356	.887	Selected
Q44	49.53	263.245	.057	.889	Not Selected
Q45	49.38	261.631	.151	.888	Not Selected
Q46	49.56	262.990	.078	.889	Not Selected
Q47	49.54	260.718	.230	.888	Selected
Q48	49.43	258.178	.373	.887	Selected
Q49	49.51	259.440	.308	.887	Selected
Q50	49.43	258.932	.324	.887	Selected
Q51	49.54	260.456	.248	.887	Selected
Q52	49.37	256.006	.504	.886	Selected
Q53	49.46	256.558	.484	.886	Selected
Q54	49.53	260.753	.226	.888	Selected
Q55	49.48	261.188	.188	.888	Not Selected
Q56	49.50	261.703	.156	.888	Not Selected
Q57	49.42	257.891	.390	.886	Selected
Q58	49.51	259.120	.328	.887	Selected
Q59	49.52	260.640	.230	.888	Selected
Q60	49.51	260.251	.254	.887	Selected
Q61	49.60	262.629	.110	.888	Not Selected
Q62	49.65	263.725	.036	.889	Not Selected
Q63	49.56	264.030	.006	.889	Not Selected
Q64	49.43	259.195	.308	.887	Selected
Q65	49.57	265.355	-.086	.890	Not Selected
Q66	49.24	258.206	.371	.887	Selected
Q67	49.23	255.537	.546	.885	Selected
Q68	49.26	257.577	.408	.886	Selected
Q69	49.31	257.027	.439	.886	Selected
Q70	49.45	261.323	.175	.888	Not Selected
Q71	49.62	263.026	.084	.888	Not Selected
Q72	49.48	258.868	.338	.887	Selected
Q73	49.56	259.287	.336	.887	Selected
Q74	49.53	260.936	.214	.888	Selected
Q75	49.35	256.081	.498	.886	Selected
Q76	49.26	256.763	.461	.886	Selected
Q77	49.44	258.362	.362	.887	Selected
Q78	49.51	258.971	.338	.887	Selected
Q79	49.48	256.457	.496	.886	Selected
Q80	49.41	257.923	.386	.886	Selected
Q81	49.41	259.638	.278	.887	Selected
Q82	49.56	260.590	.245	.887	Selected

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Selected/ Not Selected
Q83	49.54	262.273	.124	.888	Not Selected
Q84	49.41	260.015	.254	.887	Selected
Q85	49.54	260.536	.242	.887	Selected
Q86	49.62	264.603	-.034	.889	Not Selected
Q87	49.64	264.416	-.020	.889	Not Selected
Q88	49.53	262.845	.085	.889	Not Selected
Q89	49.61	260.318	.285	.887	Selected
Q90	49.40	259.544	.283	.887	Selected
Q91	49.45	259.232	.309	.887	Selected
Q92	49.57	265.857	-.120	.890	Not Selected
Q93	49.48	261.817	.146	.888	Not Selected
Q94	49.65	265.155	-.077	.889	Not Selected
Q95	49.69	266.225	-.177	.890	Not Selected
Q96	49.68	265.167	-.083	.889	Not Selected
Q97	49.61	263.051	.080	.888	Not Selected
Q98	49.50	259.474	.303	.887	Selected
Q99	49.46	258.901	.332	.887	Selected
Q100	49.47	259.667	.283	.887	Selected
Q101	49.59	262.255	.135	.888	Not Selected
Q102	49.60	260.928	.232	.888	Selected
Q103	49.59	263.123	.072	.889	Not Selected
Q104	49.43	258.452	.355	.887	Selected
Q105	49.60	265.052	-.066	.889	Not Selected
Q106	49.61	263.097	.077	.889	Not Selected
Q107	49.60	264.311	-.012	.889	Not Selected
Q108	49.53	262.982	.075	.889	Not Selected
Q109	49.60	264.516	-.027	.889	Not Selected
Q110	49.45	264.752	-.042	.889	Not Selected
Q111	49.69	264.696	-.043	.889	Not Selected
Q112	49.56	261.516	.180	.888	Not Selected
Q113	49.53	263.142	.065	.889	Not Selected
Q114	49.51	260.057	.267	.887	Selected
Q115	49.60	262.242	.137	.888	Not Selected
Q116	49.65	263.153	.081	.888	Not Selected
Q117	49.57	262.417	.120	.888	Not Selected
Q118	49.66	262.809	.110	.888	Not Selected
Q119	49.52	261.143	.196	.888	Not Selected
Q120	49.33	257.731	.394	.886	Selected
Q121	49.53	262.445	.111	.888	Not Selected
Q122	49.63	261.641	.190	.888	Not Selected
Q123	49.41	260.758	.208	.888	Selected
Q124	49.52	261.028	.204	.888	Selected
Q125	49.54	261.450	.180	.888	Not Selected
Q126	49.57	259.652	.313	.887	Selected
Q127	49.54	261.576	.171	.888	Not Selected

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Selected/ Not Selected
Q128	49.58	261.079	.216	.888	Selected
Q129	49.36	256.985	.441	.886	Selected
Q130	49.44	259.242	.307	.887	Selected
Q131	49.61	266.617	-.180	.890	Not Selected
Q132	49.67	265.079	-.074	.889	Not Selected
Q133	49.50	258.674	.356	.887	Selected
Q134	49.57	261.846	.160	.888	Not Selected
Q135	49.52	264.240	-.009	.889	Not Selected
Q136	49.63	263.183	.074	.889	Not Selected
Q137	49.60	261.464	.195	.888	Not Selected
Q138	49.63	260.407	.284	.887	Selected
Q139	49.62	262.614	.115	.888	Not Selected
Q140	49.46	260.227	.246	.887	Selected
Q141	49.59	263.490	.046	.889	Not Selected
Q142	49.49	258.011	.398	.886	Selected
Q143	49.37	258.771	.329	.887	Selected
Q144	49.62	263.129	.076	.889	Not Selected
Q145	49.55	263.895	.015	.889	Not Selected
Q146	49.48	258.983	.331	.887	Selected
Q147	49.56	261.105	.209	.888	Selected
Q148	49.38	257.367	.418	.886	Selected
Q149	49.62	264.306	-.012	.889	Not Selected
Q150	49.49	260.731	.219	.888	Selected