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CONSTRUCTION AND STANDARDIZATION OF COGNITIVE ABILITIES TEST FOR ELEMENTARY SCHOOL STUDENTS

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Abstract

The present task was undertaken to construct and standardize test for measuring cognitive abilities of elementary school students. For this, data were collected from elementary school students by adopting multistage sampling along with incidental sampling technique. An item pool was created initially by consulting various sources and theoretical and empirical literature availablein concerned area. This item pool was put to evaluation and criticism by technical as well as language experts. The preliminary draft of cognitive abilities test was further subjected to item analysis to select only those items which were having average difficulty and possessed adequate validity. The reliability of test was established with the help of test-retest and split-half methods which were found to be appreciably high. The validity of cognitive abilities test was ascertained and norms were established for interpretation of obtained scores on the test. In the last, conclusions have been presented and applicability of cognitive abilities test have been discussed.

Keywords: *Construction, Standardization, Cognitive Abilities.*

Introduction

Cognitive abilities are the determining factors of an individual's learning abilities. These are the mental skills that are used in the process of acquiring knowledge. These are the set of abilities that are learned to varying degrees as a person grows and develops mentally. Cognitive abilities are the abilities that are used to learn, understand and integrate information in a meaningful way. Other aspects of cognitive abilities include creativity, which is the talent for combining ideas or objects into a new and useful product and interpersonal competence which is the ability to solve problems between people. In students' life, cognitive abilities play an important role. The major cognitive development occurs in adolescent age. When children enter in adolescent stage which is characterized by the beginning of development of more complex thinking processes including abstract thinking (thinking about possibilities), the ability to reason from known principles (form own new ideas or questions),

the ability to consider many points of view according to varying criteria (complex or debate ideas or opinions) and the ability to think about the process of thinking. These all represent some sort of cognitive abilities.There are many cognitive abilities which can be broken down into very specific sets of skills. But four major cognitive abilities i.e. verbal ability, numerical ability, verbal reasoning ability and abstract reasoning ability are the basic cognitive abilities which are generally expected that these abilities are developed during elementary years of life of a child. Laing (1999) examined the relative contribution of the proportion of explanatory inferences, general language ability, non-verbal ability, non-verbal intelligence, and working memory on listening comprehension performance. The findings of the study revealed that factors that underlie spoken language problem in children also underlie reading comprehension problem. Regression analysis revealed that the general language measure was the best predictor of comprehension performance. The good reader had significantly better language abilities than the poor readers. The studies of Ricci & Ansari (2004) and Melhuish (2010) found that the parents' active involvement and creative strategies adopted by them were helpful to promote young children's cognitive development. The study of Woodbury (2011) revealed the relationship between parenting stress index factors and child's cognitive abilities. The results of the study indicated the negative effect of distractibility, demandingness, and mood on long term retrieval processing speed, and fluid intelligence. Conversely, distractibility, adaptability, and demandingness seemed to improve the cognitive processes of auditory processing, crystalized intelligence, and short-term memory.Sigfusdottiret.al. (2011) and Rudasill (2013) revealed in their studies that the family conflicts, less warmth and responsiveness and low expectations led adolescents towards frustration, depression and lower side in their cognitive development.Anjum and Rani (2012) found that cognitive abilities were measured on the basis of creativity and intelligence. The children of democratic rearing group were intellectually superior to those of authoritarian rearing group and urban subjects were found to be more creative in all dimensions of non-verbal creativity.Carlsson, Dalh&Rooth (2012) found that extra 10 days of school instruction raises cognitive scores on crystallized intelligence tests (synonym and technical comprehension test) by appropriately one percent of standard deviation, whereas extra non-school days have almost no effect. Further, they revealed that test scores on fluid intelligence test (spatial and logic tests) did not increase with additional days of schooling, but do increase modestly with age.Decker and Roberts (2015) reported that basic calculation skill was a significant predictor of Math problem solving across the entire sample of their study. Additionally, only selected cognitive variables contributed to the prediction of Math problem

solving, and these variables change in importance as children develop higher-level Math skills.

From the review of related literature, it was revealed that very few empirical investigations have been carried out to study cognitive abilities in Indian situations. Moreover, there is no particular test available to measure the cognitive abilities of elementary school students of our country. Hence, it was thought to construct and standardize a cognitive abilities test for Indian elementary school students with the following specific objectives:

Objectives:

1. To prepare the preliminary draft of cognitive abilities test for elementary school students.
2. To carry out item analysis of preliminary draft of cognitive abilities test.
3. To estimate reliability of cognitive abilities test through test-retest method and split-half method.
4. To ascertain the validity of cognitive abilities test for elementary school students.
5. To establish norms for interpretation of scores obtained on cognitive abilities test.

Methodology

For construction and standardization of cognitive abilities test, survey technique underdescriptive method of research was employed.

Purpose of the Test

The present test is intended to measure the cognitive abilities of students studying in 7^{th} and 8^{th} classes (age group 12 to 14 years).

Sampling

Multistage sampling along with incidental sampling technique was employed.Firstly, a sample of 150 elementary school students was selected from 7 schools of Mandi District of H.P. to carry out item analysis of preliminary draft of cognitive abilities test. At the second stage, a sample of 63 students was selected from 3 schools of Shimla district to compute test-retest reliability of cognitive abilities test. At the time of second administration, 8 students were not present. Therefore, test-retest reliability was computed on the basis of responses given by 55 students. At third stage, 45 students were selected from two schools of Mandi districtto estimate spilt-half reliability of cognitive abilities test. At last stage, a sample of 2595 students was chosen from four districts i.e. Hamirpur, Kullu, Chamba and Bilaspur for establishing norms for interpretation of scores obtained on cognitive abilities test. The selection of schools was made by employing incidental sampling technique. Further, all the

class 7th and 8th students studying in selected schools were taken intoconsideration for data collection.

Planning and Preparation of Initial Draft of Cognitive Abilities Test.

At the very beginning, it was considered worthwhile to plan for the content of cognitive abilities test for elementary schoolstudents. For this, the investigator thoroughly screened the related literature, existing tests on cognitive abilities and carried out discussions with the experts in the concerned area. On the basis of this, the investigator prepared a list of 139 test items in which 46 items were on verbal ability, 24 items for numerical ability, 24 items for abstract reasoning ability and44 items belonged to verbal reasoning ability. These test items of cognitive abilities test was oriented around five core subjects viz. English, Hindi, Mathematics, Social Science and Science along with content based on various life experiences gained by the children upto the age of 14 years in different formal and informal situations. All the test items had 4 alternatives out of which one alternative was correct. There was 1 mark for everycorrect response. The total cognitive abilities score of a student on this test was computed by adding the score on all individual items in the test.

Editing and Revision of initial Draft of Cognitive Abilities Test

After writing the test items of cognitive abilities test, they were edited and revised. For this, the initial draft of test containing 139 items was given to language teachers, experienced school teachers, research scholars and teacher educators to judge the content and linguistic accuracy of each item and its relevance. Each item was personally discussed with the experts and their suggestions were taken into consideration in order to remove any sort of logical, technical and linguistic ambiguity in the items. On the basis of expert opinion, it was decided to have 120 items in preliminary draft of cognitive abilities test. Out of these 120 items, 45 items belonged to verbal ability, 24 items belonged to each numerical and abstract reasoning ability and 27 items were based on verbal reasoning ability.

Data Analysis and Results:

Item Analysis of Preliminary Draft (Try-Out Form) of Cognitive Abilities Test

Data were analyzed by employing appropriate statistical techniques. The details are given as under:

The technique of item analysis was employed for selection/rejection of items for preparing final draft of cognitive abilities test. For carrying out item analysis, the preliminary draft of cognitive abilities test was tried out on a sample of 150 students studying in class 7th and 8th inMandidistrict of Himachal Pradesh. Afterwards, the scoring of 'cognitive abilities test' in respect of eachsampled student was done by following the procedure mentioned earlier. The

obtained scores on preliminary draft of cognitive abilities test ranged from 25 to 103. Afterwards, 27% of the students (40 students) with highest total scores and 27% of the students (40 students) with lowest total scores on cognitive abilities test were taken into consideration. Afterwards,the validity indices for each item were computed by using biserial 'r' and only those items were retained for final draft of test which was having r_{bis}value equal to greater than 0.21. Further, for finding out the difficulty indices, test items whose difficulty indices lied between0.21and 0.79 were selected for the final draft. Thus, on the basis of this, out of 120 questions, 44 questions were rejected and 76 questions were retained for final draft of cognitive abilities test.The values of difficulty and validityindices in respect of selected 120 questions of preliminary draft of cognitive abilities test are given in Table 1.

TABLE 1 Values of Difficulty and ValidityIndices in respect of 120 Questions of Preliminary Draft of Cognitive Abilities Test

Item no.	Difficulty index	Validity Index	Item no.	Difficulty index	Validity Index	Item no.	Difficulty index	Validity Index	Item no.	Difficulty index	Validity Index
1	0.34	0.23	31	0.15	0	61	0.43	0.43	91	0.32	0.27
2	0.28	0.14	32	0.60	0.40	62	0.17	0	92	0.23	0.23
3	0.12	0	33	0.54	0.42	63	0.50	0.40	93	0.48	0.11
4	0.60	0.70	34	0.54	0.40	64	0.38	0.16	94	0.90	0.33
5	0.54	0.40	35	0.38	0.24	65	0.37	0.40	95	0.90	0.45
6	0.81	0.43	36	0.27	0.30	66	0.87	0.32	96	0.78	0.45
7	0.80	0.44	37	0.27	0.09	67	0.35	0.11	97	0.68	0.30
8	0.58	0.42	38	0.28	0.31	68	0.40	0.21	98	0.22	0.21
9	0.38	0.51	39	0.56	0.54	69	0.67	0.28	99	0.85	0.37
10	0.78	0.21	40	0.10	0	70	0.63	0.53	100	0.92	0.51
11	0.25	0.12	41	0.38	0.24	71	0.56	0.36	101	0.84	0.37
12	0.73	0.36	42	0.43	0	72	0.43	0.26	102	0.77	0.31
13	0.64	0.28	43	0.58	0.72	73	0.83	0.41	103	0.54	0.24
14	0.51	0.46	44	0.67	0.47	74	0.72	0.77	104	0.80	0.44
15	0.49	0.38	45	0.59	0.64	75	0.83	0.60	105	0.76	0.49
16	0.34	0.11	46	0.51	0.26	76	0.75	0.74	106	0.69	0.58
17	0.78	0	47	0.72	0.04	77	0.48	0.51	107	0.81	0.62
18	0.62	0.35	48	0.68	0.60	78	0.57	0.47	108	0.85	0.13
19	0.66	0.67	49	0.12	0	79	0.42	0.02	109	0.54	0.12
20	0.70	0.48	50	0.57	0.54	80	0.29	0.08	110	0.83	0.27
21	0.66	0.63	51	0.34	0.34	81	0.51	0.26	111	0.67	0.17
22	0.54	0.33	52	0.48	0.11	82	0.26	0.05	112	0.88	0.56
23	0.63	0.65	53	0.27	0	83	0.33	0.07	113	0.75	0.47
24	0.83	0.68	54	0.52	0.08	84	0.49	0.32	114	0.88	0.56
25	0.53	0.36	55	0.59	0.29	85	0.31	0.05	115	0.87	0.59
26	0.61	0.39	56	0.44	0.13	86	0.65	0.33	116	0.88	0.35
27	0.43	0.20	57	0.59	0.59	87	0.52	0.43	117	0.88	0.25
28	0.47	0.64	58	0.59	0.62	88	0.29	0.08	118	0.81	0.41
29	0.63	0.33	59	0.28	0.25	89	0.56	0.64	119	0.72	0.69
30	0.54	0.51	60	0.37	0.32	90	0.23	0	120	0.83	0.14

Note: values written in bold letters indicate rejected items.

Reliability of Cognitive Abilities Test

The reliability of the 'Cognitive Abilities Test' was established with the help of test-retest method and spilt-half method.

Test-Retest Reliability

The test-retest reliability of cognitive abilities test was estimated by administering the final draft of the test on students of 7^{th} and 8^{th} classes of 3 senior secondary schools of Shimla district. At the time of first administration, 63 students were taken for data collection. However, at time of second administration after three weeks, 8 students were not present. Hence, test-retest reliability was estimated on 55 students.Then, the correlation coefficient was calculated between the two sets of scores by applying "Pearson Product Moment Correlation Method". On applying this method, the correlation coefficient 'r'i.e. reliability index came out to be 0.58 which was greater than the table value (r = 0.342) at 0.01 level of significance, for d_f 53 and hence, was highly significant. This indicated thatthere is high stability over time in cognitive abilities test scores of elementary school students.

1. Split-Half Reliability

For estimating the reliability of 'cognitive abilities test' by split-half method, the questions of final draft of the test were divided into two halves by following odd-even procedure. The two halves of the test were administered on 45 students selected from two schools of Mandi district. The reliability coefficient for half of the test was found to be 0.602 by employing product moment correlation. After applying Spearman-Brown Prophecy formulae, the reliability coefficient for whole cognitive abilities test was found to be 0.75 which was considered to be appreciably high.

Validity of Cognitive Abilities Test:

The validity of cognitive abilities test was ascertained in terms of item validity, content validity and cross validity**.** Cognitive abilities test was considered to be valid enough in terms of item validity because only those items were retained in the final draft of the test which were having validity index equal to greater than 0.21 and difficulty index values between 0.21and 0.79. The content validity of cognitive abilities test was established by carrying out critical discussions with the field experts at the time of development of preliminary draft of the test. The experts were of the opinion that the test items in cognitive abilities test were fully adequate and relevant to measure the cognitive abilities of elementary school students. In addition to this, only those items were retained in the preliminary draft to cognitive abilities test for which there had been at least 80% agreement amongst experts with regard to relevance of items. Thus, the cognitive abilities test was found to possess adequate content

validity. Furthermore, the cognitive abilities test can be considered to have adequate intrinsic validity because split-half reliability of the test was found to be 0.602 which is a high correlation index. The cross validity of the cognitive abilities test was ensured by taking entirely different samples of elementary school students in order to carry out item analysis, establishing reliability and developing norms.

Norms for Interpreting Scores on Cognitive Abilities Test:

The test was administered on a sample of 2595 elementary school students (class 7^{th} and 8^{th}) from four districts (Hamirpur, Bilaspur, Chamba and Kullu) of Himachal Pradesh. On the basis of collected data, the mean and standard deviation in respect of overall cognitive abilities test of all sampled students were calculated which came out to be 43.8556 and 10.4511 respectively. Then, the raw scores were converted into z-scores by taking into consideration the values of mean and standard deviation for the purpose of establishing norms for interpretation of obtained scores on cognitive abilities test. The following range of z-scores on a continuum can be used as suggestive norms for interpreting scores obtained on cognitive abilities test for elementary school students.

Table 2 Norms for Interpretation of Scores on Cognitive Abilities Test

Sr. No.	Range of Raw Scores	Range of Z-Scores	Interpretation of Cognitive Abilities Level
1.	65-76	+2.01and above	Extremely High
2.	58-64	+1.26 to +2.00	High
3.	50-57	+0.51 to +1.25	Above Average
4.	39-49	-0.50 to +0.50	Moderate Average
5.	31-38	-0.51 to -1.25	Below Average
6.	23-30	-1.26 to – 2.00	Low
7.	0-22	-2.01 and below	Extremely Low

Conclusions

Following conclusions were drawn with respect to construction and standardization of test for measuring cognitive abilities of elementary school students:

1. The present cognitive abilities test has been specifically constructed forelementary school students.
2. The initial draft of cognitive abilities test was comprised of 139 questions which was put to strict and rigorous examination in terms of expert opinions. After such critical examination and taking into consideration the suggestions of field experts, 19questions were rejected and certain questions were modified/revised. The preliminary draft of the test was thus comprised of 120 items. After carrying out item analysis, 44 questions were rejected on the basis of values of validity and difficulty indices. Only those items

were retained in the final draft of the test which were having validity index equal or to greater than 0.21 and difficulty index values between 0.21and 0.79. The final form of the test consisted of 76 items.

3. The reliability coefficients computed through test-retest and split-half method were found to be 0.58 and 0.75 which were significant and thus, cognitive abilities testpossessed satisfactory index of stability and high internal consistency respectively.
4. The validity of cognitive abilities testhas also been ascertained in terms of item validity, content validity,intrinsic validity and cross validity which have been found to be satisfactory.
5. The suggestive norms for interpretation of obtained scores on the cognitive abilities test have been developed on the basis of which, the cognitive abilities level of elementary school students can be ascertained.

Applicability and Implications:

The present research work was carried out to construct and standardize a test for measuringcognitive abilitiesof elementary school students. This test can be used for comparing the cognitive abilities of students on the basis of gender, residential background and other personal or psychological variables.The test is fairly reliable and valid to measure the cognitive abilities of elementary school students. This test can be easily administered in individual situations and can be scored andinterpreted conveniently. On the basis of scores obtained on this test, necessary steps can betaken to improve cognitive abilities of elementary school students by bringing changes in curriculum transaction procedures.

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