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Construction And Development Of A Scientific Knowledge And Aptitude Test

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ABSTRACT

The objective of the study is to develop or construct a Scientific Knowledge and Aptitude Test. 200 items were initially selected with 60 items from Life Science, 80 items from Physical Science and 60 items from Mathematics. A draft test was administered on 150 boys and girls of Class IX and 50 boys and girls of class X English Medium Secondary Schools of Kolkata. The major purpose of the study was to find out the difficulty value and discriminating power of the items by the method of item analysis, Where N = 150, boys and girls of Class Ix, difficulty value has ranged between .12666 to .79333 and discriminating power between .0118824 and .902439. The difficulty values were determined in terms of the samples passing an item and discriminating power was determined as per difference of such proportion between the top and bottom 27% of the sample groups. 100 items were selected for the final item pool and was administered on 99 boys and 127 grills (N=226 of the standardization sample. The range of Difficulty value and discriminating power of the final 100 item pool was 0.1681415 to 0.7654867 and 0.0044642 to 0.7951388 respectively. From the range of difficulty value and discriminating power of the final 100 items, it can be revealed that the items are spreaded equally on both the sides of .50 the items included was from the easiest to the most difficult the sampling was purposive.

Key words: Aptitude, Difficulty value, Discriminating power, Scientific knowledge,

INTRODUCTION

In the "New Encyclopaedia Britanica" (Vol 10) the word Science is defined as "Any of the various disciplines or intellectual activities concerning, the physical world and its phenomena and entailing unbiased observations and systematic experimentation. In General, a Science involves a pursuit of Knowledge covering general truths on the operations of fundamental laws obtained and tested with the highest precision." The knowledge of science means the knowledge of Physical science, Chemistry, Biology, Mathematics, Geology, Botany, Zoology, Geography etc.

"Science is a process of thought deals with the mysteries, it can benefit not only the minority involved with cosmic problems but in everyday concerns. Science demands the power of observation, criticism and careful planning but it also requires imaginative vision that people often tend to associate only with arts. It should therefore give people the pleasurable feeling which is often shifted in schools' science classes because the mystery does not seem important to people or because the solution in is disclosed before the search begins." (Aicken Frederich – The Nature of Science).

In the International Encyclopaedia of Education the two terms – ability and aptitude are used synonymously to mean an individual's potential of acquiring new knowledge and skill. The term intelligence refers to a general sort of aptitude, not limited to such skills as Mathematical, clerical or Mechanical performance, but it treats a widely encompassing ability that influences many sorts of performances.

Aptitudes are psychological constructs about individual differences in learning or performance in situations, where individuals are required to learn from instructions.

An Aptitude Test attempts to measure what an individual has acquired as a result of more general experience. It can serve to predict an individual's ability to acquire new knowledge or skill in a given area such as Mathematics, Mechanics and foreign language learning etc.

Review of Related Literature

The study of Dr.Sonali. N.Channar (2018) investigated the level of Scientific 'Aptitude among the boys and girls of Government High School. 100 students (50 girls and 50 boys) were selected as sample through random sampling method from Government High School, Raipur, Chhatisgarh. Researcher used Scientific Aptitude Test Battery (SATB) for collection of data, constructed by Dr. K.K. Aggarwal and Dr.Saroj Arora. Mean, S.D. and t-test were used for analysis. The result reveals that there was more scientific aptitude in Boys as compared to that of the Girls. The study also revealed that there was a significant difference in different area or part of scientific Aptitude like Reasoning Test, Numerical Ability. But, there was no significant difference between boys and girls in scientific Information and Scientific vocabulary test.

The study of Gopikanta Suna (Jan, 2025) was intended to measure the relationship between Scientific Aptitude and Academic Performance of Post Graduate students in Gangadhar Meher University with the objective to find out the relation between Scientific Aptitude and Academic Performance of 1) Boys 2) Girls students and 3) Post Graduate students. Correlation method was used to find out the relationship between the two variables. 30 students from science, 30 from arts and 30 from commerce stream (N=90) were comprised as samples of the present study, was collected through purposive sampling technique. Scientific Aptitude Test was developed and standardized by K.K. Aggarwal and Dr. Saroj Arora (1986). Data was collected from the scores of the previous semester examination of the selected sample of students. Pearson's Coefficient of Correlation was used to analyse

and interprete the obtained data. The findings revealed that there is a high positive correlation between postgraduate boys and girls between Scientific Aptitude and Academic Performance for Post Graduate students in Gangadhar Meher University, Sambalpur.

The study of Pradhan, Suna and Meher (Jun, 2023) intended to measure scientific temper among 108 undergraduate students, selected by stratified purposive sampling. Primary data was collected by "Scientific Temper Inventory". The result revealed that most of the undergraduate students from Urban Areas, and joint families had significantly higher scientific Temper No significant variation was found among the students as regards Gender, Stream, relation, or caste in case of Scientific Temper.

With the intention to build up a society with positive approach with the help of science and technology, the study was relevant in developing scientific approach of observing day-to-day activities of society, government, parents of school children and the incidents (thinking part) happening around them. The study provides a new direction to the problems of environment and it's solution, which takes place in the world today. Osho stated, "Science is needed from impregnation'. Hence science awareness is very important for new society".

Paramita Ghosh (2012) investigated the gender disparity of class12th standard students scores and physics among whom 248 boys and 159 girls (N=407) of Science Stream of Kendriya Vidyalayas (Central Schools) of Kolkata and suburbs. Two way samples was done. First, samples were randomly selected from seven Kendriya Vidyalayas of Kolkata from class XII science students. Second, a socio-economic – status – scale (SESS) was administered to these pupils to screen and include only those who belonged to middle SES families in the final sample. Then standardized tool was administered to the students of the final sample for assessing their final attributes. The exam scores of the students were noted from the school records. Multiple Regression Analysis and ANOVA revealed the significant gender disparity of Physics scores was predicted on the basis of students' attributes.

The preliminary research work of Pandia and Sridhar (July, 2016) intended to measures the Scientific Attitude, Scientific Aptitude and Scientific Knowledge of Secondary School students in two districts of Tamilnadu, India. Normative survey method was applied and a total of six null hypotheses (gender, studying class, medium of instruction, board of affiliation, locality and type of management were framed. The sample consisted of 76 secondary school students from seven different schools in Channai and Thiruvallur district. Data were collected by standardized tool, recorded and analyzed using SPS 19.0 version, IBM Corporation. The measuring scores (low, average and high) were prepared using Normal probability Curve method. The statistically significant results were obtained for all selected variable except board of affiliation (State and Central Board of Secondary Education) towards scientific attitude and scientific knowledge. The study concluded that the samples drawn from the selected schools were standardized for conducting further experimental study.

The study of Dr.Sonali N. Channar (2018) investigated the level of Scientific Aptitude among the boys and girls of Government High School, Raipur, Chhatishgarh. 100 students (50 girls and 50 boys) were selected as sample through random sampling method Scientific Aptitude Test Battery (SATB) was used for collection of data; constructed by Dr. K.K. Aggarwal and Dr.Saroj Arora. Mean, S.D. and t-test test were used for analysis. The result revealed that there is more scientific aptitude in Boys as compared to that of the girls. The study also reveals that there is a significant difference in different area or part of Scientific Aptitude like Reasoning Test, Numerical Ability. But, there is no significant difference between boys and girls in Scientific Information and Scientific vocabulary test.

The study of Gopikanta Suna (Jan, 2025) was intended to measure the relationship between Scientific Aptitude and Academic Performance of Post Graduate students in Gangadhar Meher University with the objective to find out the relation between Scientific Aptitude and Academic Performance of 1) Boys 2) Girls students and 3) Post Graduate students. Correlation method was used to find out the relationship between the two variables. 30 students from science, 30 from arts and 30 from commerce stream (N=90) was collected through purposive sampling technique. Scientific Aptitude Test was developed and standardized by K.K. Aggarwal and Dr. Saroj Arora (1986). Data was collected from the scores of the previous semester examination of the selected sample of students. Pearson's Coefficient of Correlation was used to analyse and interprete the obtained data. The findings revealed that there is a high positive correlation between postgraduate boys and girls between Scientific Aptitude and Academic Performance for Post Graduate students in Gangadhar Meher University, Sambalpur.

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With the intention to build up a society with positive approach with the help of science and technology, the present study is relevant in developing scientific approach of observing day-to-day activities of society, government, parents of school children and the incidents (thinking part) happening around them. The study provides a new direction to the problems of environment and it's solution, which takes place in the world today. Osho stated, "Science is needed from impregnation. Hence science awareness is very important for new society".

Objectives

The objectives of the study in to select and prepare a scientific knowledge and aptitude test.

Item Selection

1. Syllabi for Secondary level, i.e. for grades VIIIth, IXth & Xth of different boards (ICSE, CBSE, and WBBSE) were consulted.
2. Similar other tests were consulted.
3. A pool of 200 items were prepared initially with items of Life Science (60 items), Physical science (80 items) and Mathematics (60 items).
4. After thorough screening and consultation with the subject teachers a draft test was prepared for pilot testing.

Pilot Testing

The draft test with 200 items had been administered on 150 boys & girls of class IX and 50 boys and girls of class X of English Medium secondary schools level from Kolkata. The major purpose was to find out the difficulty values and discriminating, powers of the items by the method of Item Analysis. The difficulty values and discriminating powers have been stated in Table-1.

Table 1. The difficulty values and discriminating powers of the items where, N = 150 of class IX

Item No.	Difficulty Values	Discriminating Powers	Item No.	Difficulty Values	Discriminating Powers
1	0.42	-.0956848 x	51	0.39333	.5791119 *
2	0.453333	.3545966 *	52	0.68666	.2163853 x
3	0.37333	.6572858 *	53	0.61333	.902439
4	0.51333	.4008756 *	54	0.38	.2045028
5	0.38666	.4277844 *	55	0.20666	.2170106
6	0.666666	.406511 x	56	0.46666	.558474 *
7	0.426666	.804878 *	57	0.43333	.429018 *
8	.18666	.2426516 x	58	0.58666	.5753596 *
9	0.306666	.7292058 *	59	0.48	.8242651 x
10	0.306666	0.869293 x	60	0.43333	.799879 *
11	0.02666	0.487804 x	61	0.40666	.6522827 *
12	0.53333	0.755472 x	62	0.29333	.4853033 *
13	0.473333	.7485929 *	63	0.14	.188868 x
14	0.26666	-.0343965 x	64	0.36	.4534083 *
15	0.57333	.8999375 *	65	0.31333	.3595997 x
16	0.34666	.0838024 x	66	0.49333	.7485929 *
17	0.16666	.0669168 x	67	0.21333	-.0368981 x
18	0.41333	.0850532 x	68	0.42666	.2226391 x
19	0.79333	-.131332 x	69	.38	.6266417 *
20	0.4	.681676 *	70	0.33333	.4108818 *
21	0.34666	.2801751	71	0.47333	.7229519 *
22	0.18	.214509 x	72	0.54	.9011882 x
23	0.37333	.5539724 *	73	0.55333	.0187617 x
24	0.54	.7767355 *	74	0.27333	.3570982 x
25	0.40666	-.0969355 x	75	0.5	.8742965 x
26	0.36666	.681676 *	76	0.42666	.3252032 *
27	0.33333	.5547217 *	77	0.49333	.6485303 *
28	0.26	.0118824	78	0.42	.7292058 *
29	0.42666	.7060663 *	79	0.66666	.6228893 *
30	0.54	.9255785 x	80	0.21333	.2657911 x

31	0.50666	.9255785	81	0.35333	.5778612 *
32	0.38666	.6791745 *	82	0.6	.315197 x
33	0.38	.8524077	83	0.56	.3420888 *
34	0.44666	.228893 x	84	0.3	.6328955 *
35	0.14666	.1438399 x	85	0.32	.4046278 *
36	0.34	-.2839275 x	86	0.38666	.3277048 *
37	0.22	-.2858036 x	87	0.37333	.2545341 *
38	0.44	.2789244 x	88	0.14666	.3145716 x
39	0.32	.0594122 x	89	0.8666	.0218887 x
40	0.34	.0813011 x	90	0.17333	.2132583 x
41	0.08666	-.0293934 x	91	0.22	.3364602 x
42	0.46666	.7523452 *	92	0.40666	.7292058 *
43	0.51	.70222	93	0.38	.5278299 *
44	0.44	,3033146 *	94	0.32	.5572233 *
45	0.4	.2801751 x	95	0.66	.1944965 x
46	0.44	.5240778 *	96	0.50666	.3227017 *
47	0.30666	.2326454 x	97	0.48	.276423 x
48	0.57333	.3946216 *	98	0.27333	.4853033 *
49	0.29333	.4340212 *	99	0.39333	.6547843 *
50	0.12666	.2182614 x	100	0.2	.1657285 x

* means selected items | x means rejected items

Table 2. The difficulty values of the items where N = 50 of 8th standard

Item No.	Difficulty Value	Item No	Difficulty Values
1	0.42	51	0.39333
2	0.45333	52	0.68666 *
3	0.37333	53	0.51333
4	0.51333	54	0.38
5	0.38666	55	0.20666
6	0.66666 *	56	0.46666
7	0.42666	57	0.43333
8	0.18666	58	0.58666
9	0.30666	59	0.48
10	0.30666	60	0.43333
11	0.02666	61	0.40666
12	0.53333	62	0.29333
13	0.47333	63	0.14
14	0.26666	64	0.36
15	0.57333	65	0.31333
16	0.34666	66	0.49333
17	0.16666	67	0.21333
18	0.41333	68	0.42666
19	0.79333 *	69	0.38
20	0.4	70	0.33333
21	0.34666	71	0.47333
22	0.18	72	0.54
23	0.37333	73	0.55333
24	0.54	74	0.27333
25	0.40666	75	0.5
26	0.36666	76	0.42666
27	0.33333	77	0.49333
28	0.26	78	0.42
29	0.42666	79	0.66666
30	0.54	80	0.21333
31	0.50666	81	0.35333

32	0.38666	82	0.6
33	0.38	83	0.56
34	0.44666	84	0.3
35	0.14666	85	0.32
36	0.34	86	0.38666
37	0.22	87	0.37333
38	0.44	88	0.14666
39	0.32	89	0.08666
40	0.34	90	0.17333
41	0.08666	91	0.22
42	0.28	92	0.40666
43	0.46666	93	0.38
44	0.44	94	0.32
45	0.4	95	0.66
46	0.44	96	0.50666
47	0.30666	97	0.48
48	0.57333	98	0.27333
49	0.29333	99	0.39333
50	0.12666	100	0.2

Difficulty values were determined in terms of the sample passing an item. Discriminating powers were determined as per difference of such proportion between the top and bottom 27% of the sample groups. [Lindquist, 1957]

Item Analysis

The process of item analysis done in the present study is as follows :

Firstly, the right and wrong responses of the total no.of respondents have been identified.

Secondly, how many items have correctly or wrongly responded by an individual had been determined.

Thirdly, how many individuals have responded a single item rightly or wrongly have been determined.

Fourthly, the difficulty value of each item was being detected.

$$\textbf{Difficulty Value} = 1 - \frac{\textit{The no. of right responses}}{\textit{The total no. of respondents}}$$

Fifthly, the upper 27% among the total respondents and the lower 27% of the total respondents have been identified i.e., the number of respondents in the upper group and the number of respondents in the lower group have been identified serially.

Sixthly, among the total number of respondents how many individuals have responded an item correctly in the upper group have been determined.

Seventhly, among the total number of respondents, how many individuals have responded an item correctly in the lower group, have been determined.

Eighthly, discriminating powers were determined by the difference of the proportion between the difficulty values of top 27% and the bottom 27% of the sample groups.

Discriminating Powers = $\frac{U_R - L_R}{n}$ (U=upper group and L = lower group)

Discriminating Power

1. 27% of N = n
2. Upper 27% group (27% of the upper group)
3. Lower 27% group (27% of the upper group)
4. N. of R (respondent) in upper group
5. No. of R (respondent) in the lower group

The final pool of items is given in Table below :

Table-3. No. of items in Scientific Knowledge and Aptitude Test.

Subjects	Initial Pool	Final Pool
Life Science	60	30
Physical Science	80	40
Mathematics	60	30
Total	200	100

Sample :

Total 200 samples (N=200) – 150 boys and girls from girls from class IX and 50 boys and girls from class X were classification from Kolkata for Pilot Testing which is presented in Table-4 below.

Table-4. The Total area & class wise selection of sampling for pilot testing.

Area	Class	Total
Urban	IX Boys & Girls	150
Urban	X Boys & Girls	50
Total		200

The final form of the test was administered on the standardisation sample which is shown in Table 4 below :-

Area	Class	Boys	Girls	Total
Urban	X	24	-	24
Urban	XI	75	-	75
Urban	XII	-	42	42
Urban	XII	-	30	30
Urban	XII	-	55	55
	Total	99	127	226

The difficulty values and discriminating powers of the final 100 items are given below :- where n = 226.

Item No.	Difficulty Values	Discriminating Powers	Item No.	Difficulty Values	Discriminating Powers
1	0.4336283	0.6207837	51	0.4955752	0.5280257
2	0.6106194	0.1200396	52	0.4778761	0.3844246
3	0.5884955	0.5917658	53	0.4159292	0.6046626
4	0.3628318	0.3355654	54	0.5929203	0.3244047
5	0.0707964	0.079613	55	0.2610619	0.3191964
6	0.738938	0.6086309	56	0.1681415	0.2388392
7	0.3274336	0.5255456	57	0.4911504	0.5109126
8	0.6902654	0.6396329	58	0.5619469	0.5131448
9	0.7300884	0.7028769	59	0.3805309	0.6205357
10	0.1769911	0.1599702	60	0.5619469	0.7951388
11	0.7168141	0.0424107	61	0.40265	0.3675595

12	0.7654867	0.5932539	62	0.278761	0.3824404
13	0.3716814	0.3675595	63	0.4247781	0.0230654
14	0.5221238	0.6684027	64	0.5486725	0.3556547
15	0.6283185	0.4499007	65	0.5884955	0.0257936
16	0.5929203	0.4489087	66	0.3053097	0.674603
17	0.2477876	0.4605654	67	0.2522123	0.0044642
18	0.4557522	0.1595535	68	0.4557522	0.2604166
19	0.3761061	0.2738095	69	0.4203539	0.2594246
20	0.3805309	0.4151785	70	0.6504124	0.1832837
21	0.3318584	0.2415674	71	0.5301734	0.4655257
22	0.3893805	0.1460813	72	0.738938	0.5771329
23	0.39823	0.5895337	73	0.5221238	0.4335317
24	0.539823	0.5121527	74	0.2920353	0.4293154
25	0.3539823	0.3048115	75	0.5884955	0.5438988
26	0.1681415	0.0962301	76	0.5442477	0.5517718
27	0.3672566	0.3531746	77	0.6238938	0.6703869
28	0.2566371	0.2251984	78	0.6238938	0.7016369
29	0.2345132	0.1140873	79	0.6238938	0.7805059
30	0.3362831	0.3511904	80	0.6858407	0.7180059
31	0.6548672	0.3566468	81	0.3938053	0.5582837
32	0.5132743	0.5902777	82	0.3893805	0.5424107
33	0.3008849	0.4293154	83	0.3893805	0.4005456
34	0.5132743	0.6540178	84	0.3451327	0.2891865
35	0.4292035	0.2430555	85	0.7433628	0.2485119
36	0.5619469	0.4799107	86	0.3849557	0.4950396
37	0.4955752	0.7165178	87	0.2920353	0.5565476
38	0.2522123	0.3348214	88	0.3938053	0.4474206
39	0.4026548	0.4950396	89	0.3849557	0.6369047
40	0.6681415	0.6703869	90	0.3805309	0.5890375
41	0.5176991	0.4804067	91	0.5	0.5902777
42	0.438053	0.6366567	92	0.3849557	0.4317956
43	0.6460176	0.3891369	93	0.5752212	0.6862599
44	0.5929203	0.5595238	94	0.3362831	0.4002976
45	0.699115	0.3422619	95	0.2566371	0.1788194
46	0.3761061	0.6517857	96	0.4026548	0.2901785
47	0.4734513	0.5272817	97	0.2079646	0.0879662
48	0.5	0.6054067	98	0.2123893	0.1150793
49	0.5486725	0.6527777	99	0.2831858	0.3831845
50	0.5044247	0.495357	100	0.238938	0.1929563

Interpretation

From the above difficulty values and discriminating powers it can be interpreted that the items are spreaded equally on both the sides of .50 and the items included are from easy, to difficult to more difficult and the most difficult.

Limitations

Sampling was done purposefully and more randomisation is required in case of sampling.

This final form of the test was administered on 99 boys and 127 girls of urban English Medium secondary schools and higher secondary schools, considered as standardisation sample and is shown in Table-2 below :

Conclusion

The standardisation procedure is reported in another paper.

In this way A Scientific Knowledge and Aptitude Test is constructed and

The paper is based on a project undertaken by the Researcher under the supervision of Prof. Dr. Pranab Kumar Chakraborty. (Ex. Professor, Dept. of Education, Calcutta University).

Author's Declaration

The corresponding author hereby declare that this work is solely original and out of the extension of Doctoral research and this is considered as first phase of Research on standardization of scientific knowledge and aptitude test. Dr. Chandra Mukherjee, Department of Education, Assistant Professor, S.A. Jaipuria College.

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