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Development and Standardization of Rationality Test

GIRISH KUMAR TIWARI
Research Scholar, Faculty of Education
Kamachha, Banaras Hindu University, Varanasi
India
Dr. S. B. BHATTACHARYA
Ex. Head and Dean, Faculty of Education
Kamachha, Banaras Hindu University, Varanasi
India

Abstract:

*The present paper describes the development and validation of a multiple choice questionnaire entitled "Rationality Test (**सचेतनता परीक्षण**)" for secondary level students. The purpose of the development of test is to measure the rational thinking (the exercise of reasoning in thinking out a problem and taking sound judgment without being biased or being free from emotions). Procedure of the tool development was followed completely during its development.*

Key words: Rationality Test, secondary level students, rational thinking

INTRODUCTION

Rationality test has been constructed to measure the rational thinking of students. In order to measure the rationality, basically the researcher assessed the ability to think clearly

and the ability to make decisions based on reason rather than emotion in subject's day to day life.

The present rationality test is a multiple choice type questionnaire. The term 'rationality' is very vague in its nature. Generally, it is being used as the synonym of logic and reasoning. But in reality, it is not the synonym of logic and reasoning. It is more than that. Rationality is a wider concept including logic and reasoning. Its wider scope demands an in-depth study to conceptualize it for developing a rationality test in order to measure the rational thinking. Etymologically, the term 'rationality' is derived from Latin word 'rationalitas' or French word 'rationalite' which means "fact of being agreeable to reason" or "quality of having reason"**(Online Etymological Dictionary)** . So, etymologically 'rationality' means "quality of having reason".

Oxford Advanced English Dictionary provides following meanings of rationality:

- Endowed with the capacity to reason; capable of logical thought
- Based on reason rather than emotions; and
- Able to think clearly and make decisions based on reason rather than emotions

According to the **Psychology Glossary** rationality refers to being of sound mind and having (or exercising) the ability to reason. In addition, in psychology being rational means using conscious thought process to solve problems.

Thus, rationality can be defined as "the ability to think clearly and deeply by using the conscious thought process to solve problems. It is a general way of thinking based on probability and expectation and makes someone able to infer or extrapolate in an ordered matter". This statement is in other words, is the operational definition of rationality. In other words, it can be said that it is the exercise of reasoning in

thinking out a problem and taking sound judgement without being biased or being free from emotions.

STATEMENT OF THE PROBLEM:

The problem is stated as following: "Development and standardization of rationality test"

OBJECTIVES:

The main objectives of the study are as following:

1. To construct the rationality test for secondary level students; and
2. To standardize rationality test with reference to its reliability, validity and norms

STEPS TAKEN IN CONSTRUCTION AND STANDARDIZATION OF RATIONALITY TEST

Researcher has taken following steps in order to construct and standardize the above test:

1. Preparation of the Blue Print

Preparation of Blue Print is a vital step. An extensive review of the related literature was carried out to have the concept of dysrationalia and rational thinking very clear. Then Blue print of items was prepared.

2. Collection of Items

Items of the tool must represent the construct to be measured. So, the researcher defined the rationality operationally and then wrote 32 multiple choice questions representative to that definition. The researchers took the help from the studies of Stanovich (1994), Wason's selection task (1968), puzzles of Shakuntala Devi (2012), various journals and books in order to

write item for the test. Further, items were arranged randomly and were edited. A questionnaire was prepared on the basis of that definition. Items of the questionnaire have four possible answers among which one is correct and three others are wrong but they have the quality of distractor. Since, cognitive misery, anchoring effect and mind-ware gap are the causes of dysrationalia means causes for not to think rationally, so, the researcher considered these three causes of dysrationalia as dimensions of rational thinking.

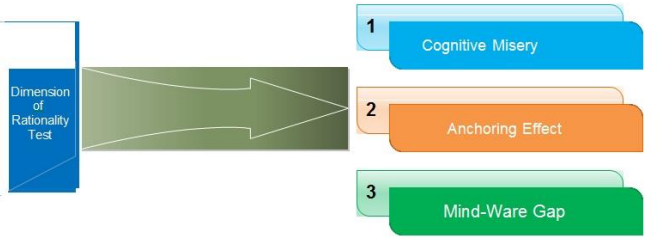

Fig. 1: Dimension of Rationality Test

The next step taken by the researcher was to name the set of those 32 multiple choice questions.

3. Providing a Suitable Name

Providing a suitable name to the tool which is going to be developed is also as important as the development of the tool because name of the tool is the first indicator of the purpose of the tool and it ensures the face validity of the tool. The aim of the present test is to measure the rational thinking skill of the students, hence, it was named as 'Rationality Test'. The tool is a bilingual (English & Hindi) and its bilingual nature seeks a Hindi name also. The researcher searched for Hindi synonyms of 'rationality' and found most the word '**सचेतनता**' as most suitable Hindi Synonyms for 'rationality'. Thus, the test was finally named as 'Rationality Test (**सचेतनता परीक्षण**)'.

4. Preparing the First Draft

The set of 32 multiple choice questions under the heading 'Rationality Test (**सचेतनता परीक्षण**)' preceded by essential instructions for respondents was the first draft of the tool. Criteria for a good questionnaire were kept in the mind during the preparation of the first draft of the tool. The researchers also provided some blank space for collecting general information about the respondents.

5. Editing of the First Draft

The test was given to 15 experts of the field of Psychology, Education, Hindi and English with a request for their kind opinions and suggestions regarding the appropriateness and relevance of the items and language of the items in questionnaire. Their kind opinion and suggestions were kept into consideration while editing the items of the questionnaire.

6. Pre Try Out

The edited form of the first draft of the test was administered on 58 students of class 9^{th} and 10^{th}. Proper instruction was given to them. Difficulties, raised by the students, at the time of responding the test, were recorded.

7. Preparation of Second Draft

Problems aroused by the respondents during pre-try out was removed at the time of the revision of the test. Three items were removed due to its vague nature reported by respondents and experts, both. So, there were 29 items in the second draft of the test. Only editing the items of the test is not enough for preparing a good test. Alternatives for answering items should also be analyzed because they play a great role in the development of a good test. It can be analyzed through distracter analysis. So, distracter analysis was carried out by the researcher.

8. Distracter Analysis

Distracters are all other responses except correct response for items of the test. Distractor has a significant role. It must distract students to reach the right answer. Distracter analysis is used to answer following two questions:

- How many people choose each option?
- Whether the number of wrong responses is equally distributed across the wrong answers means distracters?

The answer of above two questions, which is achieved by watching the response pattern of the respondents, provided the base for distracter analysis. The Responses pattern on the rationality test of 58 students was given in the table no. 1.

Table 1: Response Pattern of 58 students on Rationality test

Item No.	Option A	Option B	Option C	Option D	Missing	Total
1	*42	2 (5.33)	2 (5.33)	12 (5.33)	0	58
2	10 (14.33)	*14	15 (14.33)	18 (14.33)	1	58
3	3 (4)	9 (4)	*46	0 (4)	0	58
4	4 (7)	6(7)	11 (7)	*36	1	58
5	25 (12)	4 (12)	*22	7 (12)	0	58
6	18 (8.33)	4 (8.33)	3 (8.33)	*33	0	58
7	15 (15.66)	29 (15.66)	*11	3 (15.66)	0	58
8	17 (7.33)	*36	2 (7.33)	3 (7.33)	0	58
9	9 (7.66)	6 (7.66)	*33	8 (7.66)	2	58
10	*16	12 (13.33)	9 (13.33)	19 (13.33)	2	58
11	37 (17.66)	6 (17.66)	*3	10 (17.66)	2	58
12	16 (14.33)	*15	13 (14.33)	14 (14.33)	0	58
13	9 (5.66)	6 (5.66)	2 (5.66)	*40	1	58
14	18 (14)	14 (14)	10 (14)	*15	1	58
15	*6	18 (17.33)	28 (17.33)	6 (17.33)	0	58
16	9 (14.66)	14 (14.66)	21 (14.66)	*11	3	58
17	17 (13)	*18	11 (13)	11 (13)	1	58
18	21 (15.33)	11 (15.33)	*9	15 (15.33)	2	58
19	39 (15)	6 (15)	*13	0 (15)	0	58
20	6 (14)	34 (14)	*16	2 (14)	0	58
21	8 (10)	21 (10)	1 (10)	*27	1	58
22	*28	3 (10)	20 (10)	7 (10)	0	58
23	*15	16 (14.33)	13 (14.33)	14 (14.33)	0	58
24	12 (9)	*31	8 (9)	7 (9)	0	58
25	*20	9 (12.66)	27 (12.66)	2 (12.66)	0	58
26	31 (18.33)	12 (18.33)	*3	12 (18.33)	0	58

27	**19 (11)**	***24**	**11 (11)**	**3 (11)**	**1**	**58**
28	**12 (15.33)**	**30(15.33)**	**4 (15.33)**	***12**	**0**	**58**
29	**8 (13.66)**	***16**	**16 (13.66)**	**17 (13.66)**	**1**	**58**

*** = Numbers marked by stars show that how many persons have chosen the right answer.**

The number given in the bracket in cells (containing number of people who answered incorrectly) of the table refers the number of persons expected to choose each distracter for each item. It was calculated by using following formula:

No. of Persons Expected to Choose Distractor = $\frac{Number\ of\ people\ who\ answered\ incorrectly}{Number\ of\ distractor}$

On the basis of above table the researcher concluded that item no. 2, 5, 7, 10, 11, 14, 15, 16, 18, 19, 20, 25, 26, 28 have distractors chosen more than the right answer. Scenario of having distractor chosen more than the right answer indicates that distractor might be too similar to the correct answer and/or there might be something missing in the item or the alternatives. As suggested by Oosterhof (1990) both conditions are the indicator of the potentially problematic questionnaire. So, distractors of above mentioned items need to be changed.

The researchers also found that in some of the cases the number of person who chose a specific distractor is larger than the number of expected person for that specific distractor. For example – option 'D' for item no. 1. Such condition is an indicator of poorly worded trick question (Oosterhof,1990). So, the language of those items must be rectified.

The researcher changed distractors of items, wherever it was applicable and rectified the language of items and alternatives. Table 2 shows some examples of such changes and rectification.

Table 2: Example of change and rectification in some of the items of test

Change in Distractor		
Item No.	**Before Change**	**After Change**
7.	आप संख्या '25' में से संख्या '1' को कितनी बार घटा सकते हैं ? (1) 25 बार (2) 24 बार (3) 1 बार (4) इनमें से कोई नहीं **How many times can you decrease number '1' from number '25'?** **(1) 25 times (2) 24 times (3) 1 time (4) none of these**	आप संख्या '25' में से संख्या '1' को कितनी बार घटा सकते हैं ? (1) 25 बार (2) 24 बार (3) 1 बार (4) 23 बार **How many times can you decrease number '1' from number '25'?** **(1) 25 times (2) 24 times (3) 1 time (4) 23 times**
10.	हमारे पास $5\frac{1}{4}$ डिग्री का एक कोण है । जब हम इसे उत्तल लेंस में देखेंगे तो ये कोण कितना बड़ा दिखेगा ? (1) $5\frac{1}{4}$ डिग्री (2) $10\frac{1}{2}$ डिग्री (3) **2 x 5** $\frac{1}{4}$ डिग्री (4) इनमें से कोई नहीं **I have an angle of** $5\frac{1}{4}$ **degree. If I see it from a convex lens how much big it will be?** 1) $5\frac{1}{4}$ **degree** (2) $10\frac{1}{2}$ **degree** (3) **2 x 5** $\frac{1}{4}$ **degree** (4) **None of these**	मेरे पास $5\frac{1}{4}$ डिग्री का एक कोण है । जब मैं इसे उत्तल लेंस में देखूँगा तो ये कोण कितना बड़ा दिखेगा ? (1) $5\frac{1}{4}$ डिग्री (2) $10\frac{1}{2}$ डिग्री (3) **2 x 5** $\frac{1}{4}$ डिग्री (4) उत्तल लेंस की क्षमता पर निर्भर करेगा **I have an angle of** $5\frac{1}{4}$ **degree. If I see it from a convex lens how much big it will be?** 1) $5\frac{1}{4}$ **degree** (2) $10\frac{1}{2}$ **degree** (3) **2 x 5** $\frac{1}{4}$ **degree** (4) **It will depend on the capacity of convex lens**
Rectification in Language		
Item No.	**Before Rectification**	**After Rectification**
1.	एक हाथी को तौला जा रहा था लेकिन वो इतना बड़ा था कि उसके तीन पैर हीं तराजू पर आ रहे थे और एक पैर बाहर था। हाथी को तराजू पर जब रखा गया तो तराजू 1000 किलो वजन बता रहा था । यदि हाथी के चारों पैर तराजू पर आ जाते तो उसका वजन कितना होता ? (1) 1000 किलो (2)1050 किलो (3)1200 किलो (4) 1333 किलो **An elephant was being weighed but he was too big to fit on the scale and only three of his legs out of 4 legs were on the scale. In this situation weight of the elephant was 1000 Kg. If 4 legs fit on the scale what would**	एक हाथी को तौला जा रहा था लेकिन वो इतना बड़ा था कि उसके तीन पैर हीं तराजू पर आ रहे थे और एक पैर बाहर हवा में लटक रहा था। हाथी को तराजू पर जब रखा गया तो तराजू 1000 किलो वजन बता रहा था । यदि हाथी के चारों पैर तराजू पर आ जाते तो उसका वजन कितना होता ? (1) 1000 किलो (2)1050 किलो (3)1200 किलो (4) 1333 किलो **An elephant was being weighed but he was too big to fit on the scale and only three of his legs out of 4 legs were on the scale and one was hanging in the air out side of the scale. In this situation weight of the elephant was 1000 Kg. If 4 legs fit on the scale what would be the weight of**

	be the weight of the elephant? (1) 1000 Kg. (2) 1050 Kg. (3) 1200 Kg. (4) 1333 Kg.	**the elephant? (1) 1000 Kg. (2) 1050 Kg. (3) 1200 Kg. (4) 1333 Kg.**

Thus, the second draft of the 'rationality test' was prepared with 29 items and place for personal information and clear instruction. A separate answer sheet and answer key were also prepared.

9. Try Out

Second draft of the test was administered on a randomly selected sample of 300 students of class 9th and 10th and data were collected for try-out of the test. The test was administered in conducive condition of testing. Instructions were read carefully. After the completion of the test question booklets and answer sheets were collected. Scoring was done with the help of scoring key. A score of '1' was given to each correct answer and a score of '0' was given to each incorrect answer. The total score of a respondent on the test is the sum of the total correct answers. So, Scores of total correct answer were added and a master chart was prepared.

10. Item Analysis

To determine the suitability of the items of the second draft of the test, difficulty value and discrimination power for each item were calculated for 300 students on rationality test. The total score of each student on rationality test was computed which further became the base for sorting the data in ascending order. Out of 300 respondent 27% of respondent, i.e., 81(27% of 300 = 81) high scorer and 81 low scorer respondents were cut and taken in consideration for item analysis. Thus, the researchers got two groups of respondents, i.e., high scorer group and low scorer group. Later on, number of right responses for each items in both the groups were calculated. Further, the researcher used the following formula and computed difficulty value and discriminating power:

$$D.V. = 100 - \frac{RH+RL}{2n} \times 100$$

$$\text{D. P.} = \frac{\text{RH} - \text{RL}}{\text{n}}$$

Here, D. V. = Difficulty Value;
D.P. = Discriminating Power;
RH = Number of Right Responses in High Scorer Group;
RL = Number of Right Responses in Low Scorer Group; and
n = Number of respondent in high or low group

RH, RL, Difficulty value and Discriminating power for each item are given in table no. 3.

Table 3: The gist of item analysis

Item No.	RL	RH	D.V.	D.P.	Decision
1	32	71	36.41975	0.481481	*S
2	17	44	62.34568	0.333333	*S
3	14	60	54.32099	0.567901	*S
4	12	62	54.32099	0.617284	*S
5	10	35	72.22222	0.308642	*S
6	17	47	60.49383	0.37037	*S
7	5	30	78.39506	0.308642	*S
8	10	59	57.40741	0.604938	*S
9	14	58	55.55556	0.54321	*S
10	13	38	68.51852	0.308642	*S
11	8	33	74.69136	0.308642	*S
12	8	33	74.69136	0.308642	*S
13	12	46	64.19753	0.419753	*S
14	5	30	78.39506	0.308642	*S
15	6	12	88.88889	0.074074	**R
16	5	31	77.77778	0.320988	*S
17	17	40	64.81481	0.283951	**R
18	12	25	77.16049	0.160494	**R
19	4	29	79.62963	0.308642	*S
20	17	45	61.7284	0.345679	*S
21	9	34	73.45679	0.308642	*S
22	24	30	66.66667	0.074074	**R
23	15	28	73.45679	0.160494	**R
24	9	35	72.83951	0.320988	*S
25	11	36	70.98765	0.308642	*S
26	12	19	80.8642	0.08642	**R
27	7	32	75.92593	0.308642	*S
28	14	36	69.1358	0.271605	**R
29	11	36	70.98765	0.308642	*S

*S – Selected **R - Rejected

The difficulty value of the items for retaining in the test should lie between 30% to 80% and discriminating power for same should range between 0.30 to 0.80 (Oosterhof.,1990). So, 7 items were rejected out of 29 items. Thus, only 22 items were retained in the final draft of the rationality test as evident from table 3.

11. Final Draft

The final draft of the tool comprising of 22 items was reprinted with the same instruction as the second draft of the tool. Place for personal information like name, age, class, sex, etc., was also provided. A separate answer sheet was prepared. The dimension wise distribution of the items are given in table 4.

Table 4: Dimension wise distribution of items of rationality test

Sl. No.	Dimension of rationality test	Item wise total components	Total no. of items
1.	Cognitive misery	1, 4, 5, 13, 19, 21, 25, 29	8
2.	Anchoring effect	2, 3, 6, 7, 10, 16, 20, 24	8
3.	Mind-ware gap	8, 9, 11, 12, 14, 27	6
Total			22

Some of the items of the test are given below for example:

11. Weight of an iron cube is 4 kg. What would be the weight of 4 times smaller cube than first cube made by same iron?

(1) 1 Kg. (2) 500 gm. (3) 62.5 gm. (4) None of these

लोहे के एक अघनाकार टुकड़े का वज़न 4 कोलोग्राम है। इससे चार गुना छोटे लेकिन उसी लोहे से बने एक घनाकार टुकड़े का वज़न क्या होगा ?

(1) 1 किलोग्राम (2) 500 ग्राम (3) 62.5 ग्राम (4) इनमें से कोई नहीं

18. Lotus flowers are bloomed in a pond. The numbers of flowers became twice each day. If pond becomes filled with flower in 48 days then how many days the pond will be half filled by flowers?

(1) 48 days (2) 24 days (3) 46 days (4) none of these

एक तालाब में कमल खिले हुए हैं। प्रत्येक दिन तालाब में कमल की संख्या दोगुनी हो जाती है। यदि तालाब 48 दिनों में कमल से भर जाता है तो तालाब को आधा भरने में कितने दिन का समय लगेगा। ?

(1) 48 दिन (2) 24 दिन (3) 46 दिन (4) इनमें से कोई नहीं

12. Reliability

In the present context, Reliability of 'rationality test' was calculated by split half method and test-retest method. For split half method test was split using odd-even method of splitting and was found to be 0.81 and when test was split using first half- second half method of splitting it was found to be 0.82. For test-retest method it was found to be 0.94. So, the test seems to be reliable.

13 Validity

For the present test, face and content validity was estimated. The test has been given to seven experts from the field of Education, Psychology, English and Hindi languages. The percentage of agreement between researchers and experts and among experts was calculated. It ranges from 50% to 100% which is satisfactory. So, it seems to be a valid test. The internal consistency of a test also refers the content validity of the test. Here, the internal consistency of the test was computed by split half method and was found to be 0.81 by odd-even method and 0.82 by first half-second half method. It also indicates that the present test is valid.

14. Interpretation

The researcher cut 27% high score respondents and 27% low scorer respondents and determine three category of the respondents on rationality test. The cut-off point is based on the

score of 27% of 500 (135) high scorer and the score of 27% of 500(135) low scorer secondary students on rationality test.

Table 5: Category of rational students and their score

Category	Lower Limit	Upper Limit
High rational	9	Above 9
Average rational	5	8
Low rational	1	4

CONCLUSION:

Researchers constructed 'Rationality Test' to measure the rational thinking of secondary level students. It is a multiple choice type questionnaire and comprises of 22 items. The scale has 3 dimensions of rationality.

The reliability of the scale is 0.81 and 0.82 by split half method (Odd-even method and first half – second half method both were used to split the data in two parts) and 0.94 by test-retest method. The test is quite valid on the criterion of face validity and content validity by means of judgment.

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