

Development and Standardization of Creativity Scale in Mathematics

Ruchi Manchanda

Assistant Professor, Sohan Lal D.A.V College of Education, Ambala

Abstract

This paper explains the procedure of developing and standardizing a creativity scale in mathematics to measure the creativity in mathematics among school students falling in the age-group of 10-12 years. After critical study of the related literature of creativity, three dimensions viz. fluency, flexibility and originality were selected for construction of the scale. The final draft of scale consisted of 16 items. The reliability of the scale was calculated by split-half method and test-retest method. The scale had face validity, content validity, criterion validity as well as higher intrinsic validity.

Introduction

Creativity is a cognitive activity that results in a new or novel way of viewing or solving a problem. It is a multifaceted construct (Tan & Zhang, 2005). Creativity is desirable; it is from creativity that major inventions, scientific discoveries and great work of music, literature and art derive. Modern art and literature, philosophy and religion, science and technology, industry and commerce, transportation and communication, agriculture and social institutions owe their origin due to creativity (Sharma, 2000).

Although many researchers have attempted to define the concept of creativity, there is no universally accepted definition of creativity. Kronfeldner (2009) defined creativity as a process that includes psychological novelty, originality, spontaneity, usefulness and adaptive value. However, Plucker and Beghetto (2004), in their literature review on creativity argued that there are two key elements of creativity, specifically novelty (i.e. original, unique, new, fresh, different creations) and usefulness (i.e. specified, valuable, meaningful, relevant, appropriate, worthwhile creations). They also pointed out that the combination of these two elements serves as the keystone of many scholarly discussions and definitions of creativity.

Mathematicians as well as mathematics educators agree that creativity plays an essential role in doing Mathematics. Sriraman (2008) claimed that mathematical creativity ensures the growth of the field of Mathematics as a whole. Promoting mathematical creativity is one of the aims of mathematics education and thus of mathematics teachers. Creativity in Mathematics means divergent thinking ability in solving mathematical problems. The purpose of the scale is to measure the creativity in Mathematics among school students falling in the age group 10-12 years. The scale covers the following three dimensions:

Fluency

Fluency means number of relevant and unrepeated responses given by the examinee.

Flexibility

Flexibility is represented by a person's ability to produce ideas which differ in approach or thought trend.

Originality

Originality means novelty or uniqueness of a given response.

Construction and Standardization of the Scale

The procedure for the construction of the scale was carried through the following steps:

- Item Formulation
- Item Selection
- Administration of the Scale
- Scoring
- Item Analysis
- Reliability
- Validity

a) Item Formulation

Before formulating the statements the investigator thoroughly studied the related literature. The statements were formulated from different sources viz. relevant literature, discussions with the research scholars working in the related fields, opinion of school teachers and deliberations held with the experts in the field of psychology, education and mathematics. In this way, 50 questions were framed to assess the creativity in Mathematics among the school students. The questions were so framed that each question measures all the three dimensions of creativity viz. fluency, flexibility and originality.

b) Item Selection

The list of the statements so prepared, was reviewed. Firstly, the statements were judged from language point of view by a language expert. The statements which were having ambiguity were either modified or dropped out. After this, the list of statements was given to the experts in the field of psychology, education and mathematics. The statements were modified in the light of their suggestions. After this, the scale was administered to a small group of school students (15 students) falling in the age group of 10-12 years to know whether they properly followed these statements or not. The statements which were not properly interpreted or followed were dropped out.

In this way, 24 statements were retained in the first draft of the scale.

c) Administration of the Scale

After obtaining due permission from the concerned authorities of the school, the scale was administered on 50 students falling in the age group of 10-12 years. The instructions were explained to the respondents by the investigator. The respondents were asked to solve each question in number of ways in the separate sheets provided to them by the investigator. The maximum time limit for completing the scale was one and a half hour.

d) Scoring

Each question in the creativity scale was scored for fluency, flexibility and originality. Every correct response or every relevant and novel idea was awarded with 1 score. Thus, if five correct responses were given by the examinee then the fluency score was five. If all the ideas or responses fall under one category of approach then they were treated as one for the purpose of flexibility scoring. Thus, if five ideas/responses were produced by the examinee and all belong to one category of approach, then the score for flexibility was one, but if all the five ideas/responses were based on five different approaches, then the flexibility score was five. Originality scoring for creativity scale was done on the basis of uncommonness of the responses. If a response was given by 2% of the examinees, then the response was given an originality weight of 4, if a response was given by 4% of the examinees, then the response was given an originality weight of 3, if a response was given by 6% of the examinees, then the response was given an originality weight of 2, if a response was given by 8% of the examinees, then the response was given an originality weight of 1 and if a response was given by more than 8% of the examinees, then the response was given the originality weight of zero.

e) Item Analysis

After scoring, item analysis was done. Item analysis is primarily concerned with item difficulty and item discrimination. Item difficulty is taken in terms of proportion of individuals completing the item successfully but as here, there was no pass or fail on any item so indices of item difficulty was not determined.

Item discrimination index refers to the degree to which it differentiates between those obtaining high and low scores. All the scores of each item were arranged in ascending order of total scores. The top 27 percent and the bottom 27 percent scores were taken out. The significance of difference between the mean scores in each item of the top and bottom piles were tested. The items which showed the significant difference were considered to be worth retaining

Table 1
Difference between Top and Bottom Mean Scores on Creativity Scale in Mathematics

Sr.No.	Mean (M1) for higher group	Mean (M2) for lower group	SD (σ_1) for higher group	SD (σ_2) for lower group	SE _D	't'
1	6.83	3.33	1.69	2.14	0.72	4.86**
2	0.91	2.75	1.56	2.37	0.75	2.45*
3	1.33	2.83	0.98	1.02	0.36	4.16**
4	8.08	2.58	8.07	1.31	2.18	2.52*
5	1.50	2.75	2.49	2.49	0.93	1.34

6	7.75	4.25	3.59	1.71	1.05	3.33**
7	3.50	1.83	3.45	1.02	1.01	1.65
8	11.5	6.00	4.54	3.07	1.46	3.76**
9	2.16	5.33	1.93	2.67	0.87	3.64**
10	6.83	3.33	1.69	2.14	0.72	4.86**
11	3.50	1.64	0.84	1.16	0.37	5.02**
12	2.50	3.33	1.69	2.96	0.90	0.92
13	8.25	3.91	4.33	2.87	1.38	3.14**
14	5.58	1.16	4.10	1.22	1.14	3.87**
15	3.70	3.30	0.43	0.93	0.26	1.53
16	7.66	5.91	2.77	3.62	1.21	1.44
17	6.50	3.40	3.38	2.64	1.14	2.71*
18	8.33	3.16	3.90	2.16	1.18	4.38**
19	5.75	1.50	3.15	1.73	0.95	4.47**
20	6.33	2.08	2.90	2.77	1.06	4.00**
21	3.40	3.00	1.15	1.32	0.45	0.88
22	2.83	0.66	3.98	1.55	0.90	2.41*
23	0.50	1.25	1.15	2.73	0.78	0.96
24	2.85	2.07	1.61	1.81	0.64	1.21

*indicates significant at .05 level of significance

**indicates significant at .01 level of significance

The items which were not significant at .05 level of significance were rejected on the ground that they had not discriminatory power. In this way item number 5, 7, 12, 15, 16, 21, 23 and 24 were rejected from the preliminary draft.

Thus, in the light of the item analysis of the first draft the final form of the scale was prepared. Out of 24 items, 8 items were dropped out and 16 items in all were retained for the final draft.

f) Reliability

To test the reliability of the scale both Split-Half method and Test-Retest method were used.

- **Split-Half Reliability Coefficient**

In this method, odd and even items were split and their correlation was computed by applying product-moment coefficient of correlation. The reliability coefficient of the whole test was computed with the help of Spearman-Brown Propensity formula:

$$r_{tt} = 2r_{hh} / 1 + r_{hh}$$

where, r_{tt} = reliability of the whole scale

r_{hh} = coefficient of correlation between the two halves of the scale. The reliability of the whole (test) scale came out 0.83 which indicated that the test was highly reliable.

- **Test-Retest Reliability Co-efficient**

After four weeks of time interval the scale was administered to same 50 students. The test-retest reliability co-efficient indicating the stability of measurement over a period of time came out 0.89 which was quite high.

g) Validity

A technique or test is valid if it measures what it claims to measure. The validity of the scale was calculated through face validity, content validity, criterion validity and intrinsic validity.

- **Face Validity**

The face validity of the scale was fairly high. There was a close agreement among the judges and experts to ensure its face validity.

- **Content validity**

Content validity was examined to determine whether the scale covered all the items adequately from which all the aspects of creativity was to be assessed. The judges were in consonance with the view that the contents were covered in the test in all the items.

- **Criterion Validity**

Correlation of a test with a criterion as an external measure is referred to criterion validity. It was computed by using Baqer Mehndi's Verbal Creativity Test. The obtained validity coefficient was 0.89, which indicated that the test was highly valid.

- **Intrinsic Validity**

Intrinsic Validity was calculated by using the following formula:

$$\text{Intrinsic Validity} = \sqrt{\text{Reliability}}$$

$$V_{tt} = \sqrt{r_{tt}}$$

$$= 0.91$$

Coefficient of V_{tt} was quite high. Thus, the test was highly valid.

Conclusion

The creativity scale developed and standardized by the researcher can be used to measure the creativity in mathematics among the school students falling in the age-group of 10-12 years. This can also be used to find out and analyse various factors associated with creativity in mathematics so that necessary steps can be taken to create an environment to develop creativity among students in mathematics.

References

- Aggarwal, Y.P. (1998). *Statistical methods: Concepts, Applications and Computations*. New Delhi: Sterling Publishers Pvt. Ltd.
- Deshmukh, M.N. (1984). *Creativity in Classroom*. Ramnagar, New Delhi: S.Chand and Company Ltd.
- Eevynck, G. (1991). Mathematical Creativity. In D.Tall (Ed.). *Advanced Mathematical thinking* (pp. 42-53). New York: Kluwer Academic Publishers.
- Sriraman, B. (2008). Are Mathematical Giftedness and Mathematical Creativity Synonyms? A Theoretical Analysis of Constructs. In B. Sriraman (Ed.), *Creativity, Giftedness, and Talent Development in Mathematics* (pp. 85-112). USA: Information Age Publishing, INC.
- Tan, A., & Zhang, A.D. (2005). What is creativity. In A. Tan, A.D. Zhang, & Fang (Eds), *Lighting the fire of imaginative thinking*. Singapore and Hong Kong: SPN.