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An Approach to Study on Mathematical Creativity and Some of its Correlates[1]

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Mathematical creativity is the most important factor for the advancement of mathematics. Only creative mind can produce creative results. But not much research work has been done in this direction. The present author has taken a scheme of developing a mathematical creativity test to identify creative children in mathematics and to find the relationships of psychoticism, neuroticism, intelligence, ability to achieve in mathematics and general creativity with mathematical creativity and their composite effect on it over a population of Bengali medium school students. In this approach, Bengali adaptation of English version of the "Verbal Test of Creative Thinking" by Mehdi [Mehdi, B. (1985). *Manual of verbal test of creative thinking* (revised edition). Agra, India: National Psychological Corporation.] has been completed. Works of adapting intelligence test, developing mathematical creativity test, adapting personality test in Bengali are in process. Relationships are to be found later.

Keywords: mathematical creativity, psychoticism, neuroticism, intelligence, relationship
ZDM Classification: C40, D50
MSC2000 Classification: 97C30, 97D50

1. INTRODUCTION

Mathematics is a fast growing subject. New concept-space, new relationships among different concepts in mathematics are emerging to solve the challenging problems of mathematics. This has been possible only through the work of creative mathematicians. When a person encounters a mathematical problem, he/she fails to overcome it, because,

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one fixes his/her thinking in wrong direction and/or fails to think divergently for remote options and/or fails to canalize one's thinking in a way to rich the goal. Persons creative in mathematics become more successful in a mathematical encounter and sometimes produce something which is unique and original. For the development of mathematical creativity, persons should be identified and fostered from his early childhood.

In class room, mathematics learning should not be restricted only to gather existing facts and principles and to know well established rules and methods for solution, because it could develop fixation in children's mind and which has an adverse effect to the imaginative power and creative faculty of children. Children in mathematics classroom are to be allowed to play with a mathematical situation in their own way. School mathematics curriculum should be designed in such a way that children get much open space to promote their creativity. Sriraman (2004) says, "It is in the best interest of the field of mathematics education that we identify and nurture creative talent in mathematics classroom."

2. DESCRIPTION OF CREATIVITY AND MATHEMATICAL CREATIVITY

2.1 Creativity

Creativity is a very complex trait to define and there is no universally accepted definition of it. Great psychologist Eysenck (1995, p. 83) describes, creativity is a dispositional trait or ability which enables a person to put forward ideas, or execute and produce works of imagination, having an appearance of novelty, which are immediately or in due course accepted by experts and peers as genuine contribution having social value. According to Cropley (1992), "creativity is the capacity to get ideas, especially original, inventive and novel ideas." A creative person should have flexibility of thinking which enables him to produce original divergent responses in a practical situation.

2.2 Mathematical Creativity

It is very difficult to define creativity within a subject area like mathematics. Mathematical creativity is the ability to produce new concepts in mathematics, to recognize new relationships among apparently not related areas of mathematics, to find original ideas for a solution. In other word, it is the ability to generate something novel in the field of mathematics that has not existed before. Singh (1990) describes it as the ability to produce original and unusual applicable methods and solutions to problems. Sriraman (2004) describes it as the process that results in unusual and insightful solutions to a given problem, irrespective of the level of complexity. Ability to emerge creative

product in mathematics depends upon the ability to produce original divergent responses to a problem and one should have flexibility in thinking to produce such responses. Several criteria mentioned by Balka (1974) for measuring creative ability in mathematics are of divergent category. Besides divergent thinking, Haylock (1987) analyzed that mathematical creativity of a person depends upon the ability of overcoming fixation.

3. SOME TRAITS IN RELATION TO MATHEMATICAL CREATIVITY

According to Singh (2003), "personal characteristics such as personality, intelligence, attitude, self concept, etc. of mathematically creative children are of monumental importance." There are many creative persons who are successful in their own field but large numbers of them are not creative in mathematics. Mathematics is an important school subject and students are to learn it successfully. In these contexts one may quest for the relationships of mathematical creativity with the following traits.

3.1 Psychoticism

Psychoticism is one of the three traits used by Eysenck in his P-E-N (Psychoticism-Extraversion-Neuroticism) model of personality. Persons with high score in psychoticism tend to be aggressive, hostile, inhuman, cruel, intolerant, and reckless. They are inclined to show psychotic attitude under certain circumstances. Eysenck (1993) argued that more creative persons generally have higher psychoticism score than persons with a lower creativity.

3.2 Neuroticism

Neuroticism is another personality trait used by Eysenck in his P-E-N model of personality. Neuroticism is associated with sensitivity to fear, worries, anxieties, and psychological distress. Persons with high score in neuroticism tend to be emotionally overresponsive. They experience higher negative effect and under stress they may develop neurotic disorder. Dagaur (1981) found in his Ph. D. thesis that high and low scores on composite creative thinking differ significantly on neuroticism. Strong, Nowakowska, Santosa, Wang, Kraemer & Ketter (2007) say in a research study "... Neuroticism/Cyclothymia/Dysthymia may contribute to creativity."

3.3 Intelligence

The term intelligence is used to describe the ability to think rationally, capacities to reason, to plan, to search and to learn quickly. It is the ability to learn from experience,

solve problems, and use our knowledge to adapt new situations. Researchers found that a base level of intelligence is essential for creative productivity, but above a threshold value (about IQ 120), there is virtually no relationship between intelligence and creativity. In a research study Olatoye & Oyundoyin (2007) find "IQ significantly predicts each of the four components of creativity."

3.4 Ability to Achieve in Mathematics

Mathematics is one of the most essential areas of learning. Pupils need to develop their mathematical concept, understanding, skill and problem solving ability. It is to be found that how ability to achieve in mathematics and mathematical creativity are interdependent with each other.

3.5 General Creativity

The relationship of mathematical creativity with general creativity is to be found.

The relationships of *psychoticism, neuroticism, intelligence, ability to achieve in mathematics and general creativity* with mathematical creativity and their composite effect on it are to be explored as those may help to find better strategies to foster and develop children's creative mind in the field of mathematics. Also it will advance research study in mathematical creativity.

4. RESEARCH WORK REPORT

In this paper, validity and reliability test of the Bengali adaptation of English version of the "Verbal Test of Creative Thinking" (*cf.* Mehdi, 1985) has been presented. It has been shown that the adaptation is valid and reliable.

4.1 Theoretical Framework

As provided in the mother test, creative potential of a person is defined to be closely related to the divergent thinking ability, which produces variety of responses and creativity is measured by measuring the divergent thinking ability. The primary traits of divergent thinking as mentioned by Guilford are sensitivity to problems, fluency, flexibility, originality, redefinition and elaboration. Three out of these six traits viz., fluency, flexibility and originality have been considered to give fairly valid information to measure divergent thinking ability and hence to measure creative potential of a person. Descriptions of the three considered traits are as follows.

i) **Fluency**: Fluency of thinking is the ability to produce many unrepeated responses.
ii) **Flexibility**: Flexibility of thinking is the ability of shifting of thinking from one category to another category.
iii) **Originality**: Originality of a response depends upon its statistical infrequency. One must think apart from a conventional one to produce original response.

4.2 Activities Included in the Test

The verbal test of creativity includes four activities namely, consequence test, unusual use test, new relationship test consisting of three items each and product improvement test with one item.

4.3 Rational for the Activities Included in the Test

The rationality for the selection of the *activities* included in the test is given bellow.

I **Consequences**: In this activity the students are given hypothetical situations, which may seem to be impossible but they have to imagine what could happen if that situation occurs in practical. The happenings may be usual or unusual, logical or illogical. This activity examines the power of imagination in different ways.
II **Unusual Uses**: In this activity the subjects are given some common things of everyday use and they have to think unusual uses of those. This activity forces the students to break fixation of mind about uses of those things. Pupils should think divergently to produce many different and novel responses.
III **New Relationship**: In this activity the subjects are given pairs of things about which they are familiar. Apparently it may be seemed that there is no relationship between the things of a pair, but the students are to find relationships. This activity gives the students a scope of widening the range of their thought process and to produce remote responses.
IV **Product Improvement**: In this activity the subjects are to roam in their field of imagination to improve a simple model of horse to make it interesting to the child. This activity allows the students to think in different way.

4.4 Technical Information

The test was administered to a sample of 110 students studying in classes of Grades 7 and 8. Each item was scored for fluency, flexibility and originality. The raw scores of fluency, flexibility, and originality of each item were converted into T score with mean 50 and SD 10. Score of each item, activity and grand total were calculated. Total fluency, flexibility, and originality score of the test were also calculated.

4.5 Results

Results of analysis of the data are given in the tables below.

Table 1. Pearson Correlation Sig. (2-tailed) of Test Items with the Activity Score and Grant Total ($N = 110$).

Activities (See Section 4.3)	Items	Correlation with activity total	Correlation with total creativity score
I	1	0.882	0.789
	2	0.836	0.751
	3	0.878	0.793
II	1	0.843	0.676
	2	0.761	0.628
	3	0.785	0.685
III	1	0.879	0.754
	2	0.880	0.764
	3	0.866	0.851
IV	1	1.00	0.719

Note: Correlations are significant at the 0.01 level (2-tailed).

Table 1 show that all the items are highly correlated with the activity total indicating that items in a activity measuring the same thing and high correlations of items with total creativity score indicates that the items are internally consistent.

Table 2. Pearson Correlation Sig. (2-tailed) of Activity Score and Total Creativity Score ($N = 110$).

Activity (See Section 4.3)	Correlation
I	0.899
II	0.832
III	0.902
IV	0.719

Note: Correlations are significant at the 0.01 level (2-tailed).

Correlations in Table 2 show that all the activities are highly correlated with the total creativity score indicating that all the activities together measuring the same thing, which is creativity.

The correlation coefficients between various factors and total creativity score are given in Table 3.

Table 3. Correlation Coefficients between Various Factors of Creativity and Total Creativity Score ($N = 110$).

Factor	Fluency	Flexibility	Originality	Creativity Total
Fluency	-			
Flexibility	0.960	-		
Originality	0.874	0.835	-	
Creativity Total	0.984	0.972	0.931	-

Note: Correlations are significant at the 0.01 level (2-tailed).

The above table shows that the factors and the total creativity score are highly correlated, which indicates that the factors are measuring the same thing creativity.

Reliability of the Test

The test and retest reliabilities of the factors and total creativity score obtained on a sample of 82 are given in Table 4.

Table 4. Test and retest Reliabilities of Factor Scores and the Total Creativity Score ($N = 82$).

Fluency	Flexibility	Originality	Total Creativity Score
0.905	0.883	0.859	0.910

Note: Correlations are significant at the 0.01 level (2-tailed).

It has been seen from the above table that test-retest reliabilities of the factors and that of the total creativity score is considerably high.

4.6 External Validity of the Test

The external validity of the adapted test against teacher's rating for total creativity score is 0.736, which is considerably high.

4.7 Conclusion

Examined validity and reliability of the adapted test indicate that it can safely be used in research studies.

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