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Scientific Creativity: A Review of Researches

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Abstract:

Scientific creativity is an ability of conducting creative science experiments and finding out and solving creative science problems and science activities. The aim of the review of previous researches is to present a thematic analysis of the related research evidences and provide guidelines to further researchers, teachers and administrators.

This review paper points out the importance of scientific creativity and differences in scientific creativity on the basis of gender, school types etc. some of the studies revealed that scientific creativity can be fostered by using different types of teaching techniques, methods and some specialized programs. Some studies reported no significant difference on the basis of gender while significant difference is also been underlined. Thus, the review of studies highlights the research gaps in the relevant knowledge and provides guidelines for further researches in the field of scientific creativity.

Key words: Creativity, Scientific Creativity and Teaching Methods

STUDIES RELATED TO SCIENTIFIC CREATIVITY:

The paper is based on an analysis of Ph.D. theses, research papers and articles published in the various types of national and international journals and books.

Girija (2013) analyzed the Scholastic Backwardness and the Science Process Skills with respect to the level of Scientific Creativity. The sample consisted of 1243 students of upper primary classes who were backward in science from four southern districts of Kerala. Self-developed Scientific Creativity Test was used in this study. She concluded that Level of Scientific Creativity was not a significant predictor of Scholastic Backwardness and Science Process Skill scores of upper primary students. She also reported that the Scientific Creativity did not differ significantly with respect to their gender and the type of school.

Gangadharrao (2012) studied "Scientific Creativity of secondary level students". The main objective of the study was to explore scientific creativity of students in secondary school and to analyze fluency, flexibility and originality factors of scientific creativity of secondary school students. The study was conducted on 100 students selected by lottery method. The Verbal Test of Scientific Creativity (VTSC) developed by V.P. Sharma and J.P. Shukla was used for measuring scientific creativity. The result indicated that the originality factor was dominant and factor of flexibility is the least.

Philip (2008) conducted a Study on the Relationship among Intelligence, Scientific Creativity, Achievement Motivation, Home Environment and Achievement in Science of Higher Secondary School Pupils of Kerala. The study was conducted on a sample of 1120 Standard XI1 students from four districts of Kerala. The Tools used were self-developed Test of Scientific Creativity for Higher Secondary school students, Home Environment Inventory, Verbal Group Test of Intelligence, Raven's progressive Matrices Test and Achievement Motivation Scale. The results showed positive and significant relationship between Achievement in Science and Scientific Creativity, Intelligence and Scientific Creativity, Achievement Motivation and Scientific Creativity, and Home Environment and Scientific Creativity.

Charyton and Snelbecker (2007) studied "general, artistic and scientific creativity attributes of engineering and music students." Main objective of the study was to investigate similarities and differences in general, artistic and scientific creativity between engineering versus music students. The sample was consisted of 100 music students and 105 engineering students from North Eastern University. The Creativity Personality Scale (CPS) and Purdue creativity test were used. The results were found as follows: (i) Music students had statistically higher levels in all three attributes of general creativity i.e. creative attributes, creative temperament and cognitive risk tolerance, (ii) The music students had higher levels of music creativity than engineering students and (iii) The engineering students have higher levels of scientific creativity than music students but there was no significant difference between groups on this variable.

Mohamed (2006) studied "investigating the scientific creativity of fifth grade students." The purpose of this study was to develop and validate a test of scientific creativity to identify fifth grade students who were creative in the domain of science. A related purpose was to explore gender differences in scientific creativity. The scientific creativity test consisted of three subtests: problems and solutions, grouping of flowers and design as experiment. The researcher administered the test to 138 fifth grade students from six different elementary schools. The analysis of the scores showed that the scientific creativity test had a 0.89 coefficient as a consistency of scores. The researcher also found that there was no significant difference between boys and girls in the scientific creativity.

Wanjari (2005) conducted an experimental study 'effectiveness of concept attainment model and inductive thinking model of teaching on students' achievement in science, scientific creativity and attitude towards science'. The main objectives of the study were as follows: (i) to study the effectiveness of teaching through concept attainment model, inductive thinking model and traditional method of teaching on

development of students' scientific creativity, and (ii) to compare the effectiveness of teaching through concept attainment model, inductive thinking model and traditional model of teaching in fostering scientific creativity. Quasi experimental method was employed for the study with parallel group design and 377 students of class IX of Marathi medium schools of Nagpur selected by using purposive sampling method. Verbal Test of Scientific Creativity (VTSC) in Hindi by V.P. Sharma and J.P. Shukla (1985) was used for measuring scientific creativity of the students. The result was found that concept attainment model as well as inductive thinking model of teaching was more effective than convention teaching method in the development of scientific creativity and favorable attitude towards science among the students of IX standard.

Lin, Hu, Adey and Shen (2003) conducted a study on the influence of the cognitive acceleration through science education (CASE) programme on the scientific creativity of secondary school students. He reported that the CASE programme did promote the overall development of scientific creativity of secondary school students.

Liang (2002) explored the scientific creativity of eleventh grade students in Taiwan. The main objectives of the study were as follows: (i) To explore the correlation between students' scientific creativity and selected variables including creativity, problem finding, formulating hypothesis, science achievement, nature of science and attitudes towards science and (ii) To determine significant predictors of eleventh grade students' scientific creativity in the process of learning science. The sample consisted of 130 male eleventh grade students of biology classes from Taiwan. The test of divergent thinking (TDT), the creative rating scale (CRS) and the creative activities and accomplishments check lists (CAACL) were used. The results were found as follow: (i) students' scientific creativity significantly correlated with some of selected variables such as attitudes towards science, problem finding, formulating hypotheses, the nature of science, resistance to closure,

originality and elaboration and (ii) four significant predictors including attitudes towards science, problem finding, resistance to closure and originality accounted for the variance of students' scientific creativity.

Imran (2002) conducted a comparative study of scientific creativity in the pupils of VIIIth standard of different media schools of Aurangabad. Objectives of the study were as follows: (i) To study the scientific creativity factor of the students studying in VIII standard in different media school, (ii) To study the difference in the creativity of different medium school students and (iii) To investigate the level of students' scientific creativity of different area schools. The sample included 600 students of class VIIIth from English, Urdu and Marathi medium schools. The verbal test of scientific creativity developed by V.P. Sharma and J.P. Shukla was used. Results were found as follows: (i) The students learning in English medium schools situated in posh locality were found superior on scientific creativity than the students learning in Marathi and Urdu medium schools situated in posh as well as slum areas and (ii) The students of Marathi medium schools situated in posh locality were found superior in scientific creativity than the students of Urdu medium schools situated in posh locality as well as slum areas.

Hu and Adey (2002) developed a scientific creativity test for secondary school students. They constructed a scientific creativity structure model (SCSM) on the basis of an analysis of various meanings and aspects of scientific creativity. In this study 50 science teachers of China took part in as initial evaluation of this model. On the basis of their analyses and comments, and using the experience of the Torrance tests of creative thinking, a seven item scale for measuring scientific creativity of secondary school students was developed and validated through analyses of item response data of 160 secondary school students in English. They concluded that the scientific creativity of secondary school students increases with

increase in age, and science ability is a necessary but not sufficient condition for scientific creativity.

Hota (1998) conducted a study on the topic 'a study of the impact of home environment and institutional climate on scientific creativity of high school students. The objectives of the study were as follows: (i) To study the impact of home environment and institutional climate on scientific creativity of the high school students, and (ii) To find out the difference in creative ability between high school boys and girls. The sample consisted of 190 students of Xth grade of secondary schools of Sundargarh district of Orissa selected by using cluster random sampling. The tool for measuring scientific creativity was 'Gupta's Test of Scientific Creativity (1979) (adopted Oriya version by Dungdang)'. The results were obtained that: (i) Home environment and institutional climate showed significant impact on the creative thinking of the high school students, and (ii) There was significant sex difference in creative ability of students. It means boys and girls differed significantly on scientific creativity scores.

Stumpf (1995) has reported fourfold classification of scientific creativity in his academic paper on 'scientific creativity: a short overview' i.e. the creative product, the creative person, the creative process and the creative situation.

Sansanwal and Sharma (1993) conducted a study to know the gender difference in scientific creativity. They selected 228 secondary school students (131 males and 97 females) of grades from 9 and 10. The Majumdar Scientific Creativity Test was used for measuring scientific creativity. The result was found that gender did not have any significant influence on scientific creativity.

Gujarathi (1992) prepared an integrated programme for training in scientific creativity and conducted an experimental study to know its effect on students of grade IX'. The sample was consisted of 60 students of grade IX. The tools were Majumdar scientific creativity test (part I and Part II), scientific creativity test developed by the researcher and

progressive matrices test developed by Raven. The result was that the experimental group obtained significantly higher scores on scientific creativity tests on all the four dimensions of scientific creativity.

Singh (1992) carried out 'A comparative study of scientific creativity, problem solving and risk taking in tribal and urban students.' The main objective of the study was to investigate the differences between tribal and urban students with respect to scientific creativity, problem solving ability and risk taking tendency. The study was conducted on 650 students. The tools were scientific creativity, problem solving ability and risk taking tendency developed by the investigator. The results were found as follows: (i) Urban students were significantly better than the tribal in fluency, flexibility and originality and (ii) Urban students were superior to tribal at all levels of Green's classification of problem solving ability and risk taking tendency.

Srinivasan (1991) studied on 'psycho-social and educational profiles of adolescents in relation to scientific and mathematical creativity at +2 stage'. The main objective of the study was to identify and ascertain the incidence of scientific, mathematical and overall creativity among pupils at the +2 level of education of Jammu city. The study was conducted on 1200 students of mathematics and science stream of 10+2 level of education of Jammu city and normative survey method was used in the study. The result showed that scientific and mathematical creativity were normally distributed in the population of adolescents and existed significance difference between the adolescents with high and low scientific creativity on the selected psychological, social and educational variables.

Roy (1990) investigated 'personality differentials of adolescents with scientific creativity in relation to environment.' The main objectives of the study were as follows: (i) To study the difference between the low and high scientifically creative adolescents on various dimensions of creativity based on the S.I. model of Guilford, and (ii) To

examine the perception of the school environment by low and high scientifically creative adolescents. The study was conducted on 200 students of 12th level from private and government schools. Tools used were scientific creativity test (MSCT) developed by Majumdar and personality questionnaire. The results were found as follows: (i) Higher scientific creative adolescents differed from the lower scientific creative adolescents in terms of most of the personality traits and (ii) Both the groups differed significantly so far as perceived impacts of home and school environment were concerned.

Datta (1989) studied the differences in scientific creativity among high school students. Main objectives of the present study were as follows: (i) To study the main effects of sex and school on the differences in the scientific creativity of high school students, and (ii) To study the dominant factors in scientific creativity. The study was conducted on 500 high school students from four districts of Jammu province. The tools were scientific creativity test developed by the investigator, Group verbal test of intelligence by Joshi and socio-economic status scale developed by S. Jalota et.al. The results were found as follows: (i) Sex and school differences did exist in scientific creativity, (ii) Scientific creativity depends on intelligence, academic achievement and socio-economic status and (iii) Dominant factors of scientific creativity were fluency, flexibility and originality in the case of Boys and girls.

Sharma (1979, 1988) studied on 'Artistic Creativity versus Scientific Creativity'. He distinguished between artistic creativity and scientific creativity which is as follows: (i) artistic creativity has a root in the needs, motives, perceptions, emotions of the creator, whereas scientific creativity has its roots in the external world, (ii) the scientific creativity takes a longer route of time than the artistic creativity in creating the final output, and (iii) artistic creativity is subjective creativity whereas scientific creativity is objective creativity.

Husain (1988 a) studied the factors affecting scientific creativity and reported that scientific creativity is an ability

which influenced with the factors of personality, intelligence, birth order, social psychological factors and achievement.

Raina (1986) studied on 'psycho-social correlates of scientific creativity among high-school students.' Primary objectives of the study were (i) To find out the relationship between scientific creativity and achievement in science for boys and girls, and (ii) To study the effect of sex and type of school on scientific creativity among high school students. The study was conducted on 1000 students (459 boys and 541 girls) from two missionary, eight government and 14 private schools. The tools used were Gupta scientific creativity test, Joshi group test of intelligence and an achievement in science. The results were as follows: (i) Achievement in science was significantly related with scientific creativity, (ii) The girls scored high on the intelligence and fluency components of scientific creativity, and (iii) Missionary school students were more creative than those of private and government schools.

Yawalkar (1985) studied on 'Development of some personality correlates of scientific creativity.' The key objective of the study was to investigate the efficacy of two creative teaching technique, viz. bionics and morphological analysis conducive to develop some personality correlates of scientific creativity. The study was conducted on 250 students of class IX of Nagpur city. The results were found as follows: (i) The bionics group had shown positive gains on four variables i.e. emotional, dominance, super-ego-strength and self-reliance and negative gains on one variable venture some, and (ii) The morphological analysis group had shown positive gains on three variables i.e. dominance, super-ego-strength and venturesome and negative gains on two variables, emotional and self-reliance.

Adinarayana (1979) conducted a study on a teaching strategy for developing appropriate skills required in students for conducting scientific investigations. The general objectives of the study were as follows: (i) To develop strategies for improving science teaching in schools at class VII stage and (ii)

To develop competence in skills in children for undertaking scientific investigations. The study was conducted in various phases with different sample sizes. The samples were selected from district Madurai, Tamil Nadu, and C.T. on skills & fluids, reaction scale, attitude scale and performance test were employed in the study. The results were obtained as follows: (i) The learning package was effective in bringing about a significant change improvement in observational and induct skills, (ii) Children of VIIth standard have been become abled to formulate hypotheses, revise the hypotheses and draw generalizations and (iii) No special classroom organizations were necessary to accommodate this programme.

Bhatnagar (n. d.) investigated the Scientific Temper in Relation to Scientific Creativity of Senior Secondary Science Students. Purposive and strata random sampling method was used to select sample of 300 senior secondary school students from the three divisions of Rajasthan- Ajmer, Jaipur and Bikaner. The tools used were the Verbal Scientific Creativity Test (VSCT) constructed by V.P. Sharma and J.P. Shukla (2006) to measure scientific creativity and Self-made scientific temper test. He reported that (i). Boy and girl science students were found equal on reasoning and logical ability, problem solving ability, and scientific temper and free from superstitions. Girl science students had significantly higher scientific information and cause finding ability as compare to boys but boys had higher curiosity than girls. (ii). Urban and rural science students were equal on scientific information but free from superstitions, reasoning and logical ability, problem solving ability, cause finding ability, curiosity and scientific temper of urban students were found significantly higher than the rural students. (iii). High and low scientific creative students of PCM & PCB group had same scientific temper, and (iv). There was a very low but significant positive correlation between scientific information and scientific creativity of senior secondary science students. Values of dimensions of scientific

temper could be predicted on the basis of scientific creativity as a predictor.

CRITICAL OVERVIEW OF REVIEW OF RESEARCHES IN THE FIELD OF SCIENTIFIC CREATIVITY:

Review of the related literature reflects that scientific creativity is a multifaceted phenomenon. It can be explained with the help of fourfold classification i.e. the creative product, the creative person, the creative process and the creative situation (Stumpf, 1995). Scientific creativity is differed from general or artistic creativity (Sharma, 1979, 1988 and Charyton and Snelbecker, 2007) and assumed as a specific domain of personality.

Scientific creativity was explored in relation to academic achievement, intelligence, achievement motivation, SES, birth order and other psychological factors. The studies reported significant relationship of scientific creativity with academic achievement (Philip, 2008; Datta, 1989; Husain, 1988 and Raina, 1986), intelligence (Philip, 2008; Datta, 1989 and Husain, 1988), psycho-social and educational profiles of adolescents (Srinivasan, 1991) and attitudes towards science and problem findings (Wanjari, 2005 and Liang, 2002). School and home environment have significant effect on scientific creativity of the students (Hota, 1998; Roy, 1990; Datta, 1989 and Raina, 1986).

Some researchers (Girija, 2013; Mohamed, 2006 and Hota 1998) reported that there was no significant difference on the basis of gender while significant difference is conveyed by Sansanwal and Sharma (1993) and Datta (1989).

It is also revealed that scientific creativity can be fostered by using different type of teaching techniques, methods and specialized programmes (Lin, Hu, Adey and Shen, 2003; Gujarathi, 1992 and Yawalkar, 1985) while these methods and programmes were applied for developing creativity by Ahmadi, Abdolmaleki and Khoshbakht (2011), Tajari and Tajari (2011),

Rezwans (2007), Wanjari (2005), Laius (2003), Pathak (2002), Venkataraman (1996), Passi and Martis (1993), Srivastava and Srilatha (1992) and others.

The review of the previous studies provides valuable suggestions and implications. In the light of above critical overview of previous researches, it may be worthwhile to take an account that some innovative teaching methods are necessary for the development of scientific creativity of students. These innovative teaching methods are very beneficial to students in developing reasoning power, understanding about various concepts of science and tendency to participate in discussion on scientific topics and compelling students to explore noble ideas.

The review of previous researches is also important for school teachers to make their learning outcome more effective by adopting various types of teaching methods and techniques. It provides a direction to teachers for systematic preparation of classroom interaction patterns. The review also gives suggestions to school managers and administrators for providing an abundant supply of teaching materials and resources for better implementation of innovative teaching methods and techniques. The experiences gained during this review of previous researches have enabled the investigators to make suggestions for further researches. The researchers realized that most of the studies were conducted on school level. So, further study may be conducted on degree college and university students. It is also recommended that the studies may be undertaken to find out the effectiveness of various innovative teaching methods in the development of artistic creativity, scientific creativity and mathematical creativity.

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