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Scientific Creativity in relation to Cognitive Style and Achievement in Science of Secondary School Students

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Abstract

The aim of present paper was to study the influence of Cognitive Style, Achievement in Science and their Interaction on Scientific Creativity of secondary school students. Total 205 students of classes IX and X (mean age 14.8 Years) studying in schools affiliated to Central Board of Secondary Education were taken as sample. Standardized tools, namely, Group Embedded Figures Test by Witkin, Oltman, Raskin and Karp (1971), Scientific Creativity Test by Majumdar (1982) were used to collect data. Marks of students from school records were taken as a measure of their achievement in science. The data were analysed using 2 × 3 Analysis of Variance. Field Independent Students had significantly higher Scientific Creativity than Field Dependent Students. Also, Students with High Achievement in Science had significantly higher scientific creativity than students with Low Achievement in Science.

Key Words: *Scientific Creativity, Cognitive Style, Field independent, Field dependent and Achievement in Science*

Introduction

Due to progress of civilization, modern world has become highly complex and needs a large no of creative persons to meet multidimensional challenges emerging in the society. Not only the survival, but also future prosperity of the society depends upon creative vision and its implementation. Creativity has the immense scope to be investigated in the context of learning (Mukhopadhyay, 2011). Guilford, one of the pioneers in the field of research on creativity, also emphasized cultivation of creativity among school children (Baghetto & Kaufman, 2007) and therefore supported the view.

Feldhusen (1994) and Diakidoy & Constantinou (2001) argued that creativity is considered in relation to a specific domain in the context of learning. They further emphasized that though most of the earlier researches on creativity recognized it as domain independent, but learning related creativity is domain specific by nature; its functioning in one domain is unique and psychologically differs from that of in other. This is why domain specific creativity is gradually receiving more and more attention of researchers, working in the field of creativity in the context of school education.

The complex society, being technical and scientific, needs a good number of scientifically tempered and skilled persons who may effectively contribute to its development. These two prime requirements of the society obviously suggest the importance of fostering creative thinking in the field of science. Scientific discovery and creativity has recently become one of the special concerns in education. In evaluations of the reasons for accomplishment and failure, creativity appears to have replaced intelligence as the focus of interest (Smith and Carlson, 1990).

Scientific creativity may be viewed as the attainment of new and novel steps in realizing the objectives of science. Moravesik (1981) has explained scientific creativity as comprehending the new ideas and concepts added to scientific knowledge, in formulating new theories in science, finding new experiments, preventing the natural laws, in recognizing new regulatory properties of scientific research and scientific group, in giving the scientific activity plans and projects originality and many other ideas. Hu and Adey (2002) defined scientific creativity as a kind of intellectual trait or ability producing or potentially producing a certain product that is original and has social or personal value, designed with a certain purpose in mind, using given information. . Heller (2007) conceptualized scientific creativity as an individual and social capacity for solving complex scientific and technical problems in an innovative and productive way.

Getzels & Csikszentimihalyi (1967) and Mackworth (1965) contented that scientific creativity is the ability to formulate fresh questions rather than only to solve given problems. Therefore, ability of problem finding seems to be close to the heart of originality in creative thinking in science. The discovered problem situation seems like the problem itself remains to be discovered. Liang (2002) suggested that scientific creativity is the ability to find and solve new problems and the ability to formulate hypotheses; it usually involves some addition to our prior knowledge, whereas artistic creativity may give some new representation of life or feelings.

Cognitive style or "thinking style" is a term used in cognitive psychology to describe the way individuals think, perceive and remember information. It describes how the individual acquires knowledge and processes information. Witkin (1967) defined cognitive styles as the characteristic self-consistent mode of functioning which individuals show in their perceptual and intellectual activities. Cognitive style measures do not indicate the content of the information but simply how the brain perceives and processes the information. Kirton (1994) suggested that creativity is related to individual's cognitive style preferences. He conceptualized cognitive preferential style as bipolar continuum with adaptors at one end of continuum and innovators at the other. Puccio (1987), using Kirton's Adaption-Innovation Inventory found that students with more innovative cognitive styles were more fluent and original when asked to generate problem statements based on a real business problem. Again using Kirton's measure, Hurley (1993) found a relationship between students' cognitive style preferences and use of creative problem solving (In Puccio, Wheeler & Cassandro, 2004). Sternberg and Lubart (1995) believe that cognitive style is a component of creativity. Field independent individuals were considered to be more creative than field dependent individuals. Fleenor and Taylor (1994) reported a significant relationship between cognitive style and creativity.

Creativity has been subjected to many different definitions. Academic achievement or academic ability, on the other hand, is relatively more easily defined, measured and interpreted (Palaniappan, 2005). Singh (2006) in his study concluded that academic achievement of students was significantly related to creativity. He found that high creative students' achievement was higher as compared to low creative students. One of the most important factors contributing to the achievement is the knowledge of the subject matter. To get good achievement in science subjects, one has to use knowledge effectively and reason abstractly. Thus, knowledge in science is an indicator of achievement and creativity. Metz (2000) hypothesized that students' cognitive performance is multidimensional because scientific skills, attitudes and specific knowledge are intimately related.

Unlike general creativity across domains, creativity in science is highly connected with scientific knowledge, skills, and attitudes. In addition, Tang (1986) suggested that broad knowledge may enhance scientific creativity. Tang emphasized that a broad background in several scientific fields may increase the creative powers of scientists because it will allow them to make novel connections (quoted by Liang, 2002). In scientific creative activity, it is very considerable to understand the role of knowledge in students' scientific creativity. Creativity researchers, such as Simonton (2004) said that creative new ideas start from domain-relevant knowledge and skills. Mohamed (2006) found that students' scientific creativity was related to science content knowledge measured by teachers' ratings. This empirical finding is evidence that scientific content knowledge and skills also influence children's scientific creativity. In other words, students' creativity is related to scientific knowledge, skills and achievement in science that are developed by teachers in the school setting. Because science has been viewed as the process of observation and theory building using logic, empiricism, and analytical thinking, intelligence and academic performance were deemed as powerful predictors of creative performance in science (Higgins, Peterson, Robert, & Lee, 2007).

After reviewing the above painted literature the investigator design a study to examine scientific creativity in relation to cognitive style and achievement in science of Class IX students

Method

Data was collected from 205 students of Class IX students studying in schools affiliated to Punjab School Education Board. The sample was selected by cluster-random sampling procedure from Kapurthala and Jalandhar Districts.

Measures

Scientific Creativity Test designed by Majumdar (1982) was used to assess scientific creativity of students. Cognitive style was assessed in terms of field dependent/field independent with the help of Group Embedded Figures Test (1971) developed by Herman A. Witkin, Philip K. Oltman, Evelyn Raskin and Stephen A. Karp while for achievement in science , marks of students from school records were taken. The data were described and analyzed in the light of formulated objectives and hypotheses.

Design

The objective was to study the influence of cognitive style, achievement in science and their interaction on scientific creativity of secondary school students. There were two levels of cognitive style, namely, field independent and field dependent. The students were also categorized into three levels of achievement in science, namely, high, average and low. Thus, there were two levels of Cognitive Style and three levels of Achievement in science. Therefore, 2 × 3 Analysis of Variance was performed on the students' scientific creativity.

Results and Discussion

The 2 × 3 ANOVA on the Scientific Creativity indicated significant main effects for Cognitive Style, $F(1, 199) = 31.21$, $p < 0.01$; and Achievement in Science, $F(1, 199) = 10.62$, $p < 0.01$. No significant interaction was found. The mean scores for factors are presented in Table 1.

Table 1Mean scores of Scientific Creativity

Cognitive Style	Achievement in Science	N	M
Field Independent	High	20	112.21
	Average	41	101.32
	low	6	74.00
	Total	67	104.40
Field Dependent	High	10	79.40
	Average	93	74.87
	low	35	54.11

	Total	138	69.93
Total	High	34	102.55
	Average	134	82.96
	low	37	55.19
	Total	205	81.20

An examination of the mean scores (vide Table 1) indicated that field independent students (Mean = 104.40) had significantly ($p < 0.01$) greater mean scores than field dependent students (69.93). Moreover, an examination of the mean scores (vide Table 1) also indicated that students with high achievement in science (Mean = 102.55) had significantly ($p < 0.01$) greater mean scores than students with low achievement in science (Mean = 55.19).

It can be said that both Cognitive Style and achievement in science had significant influence on the scientific creativity of secondary school students. These findings confirm and extend the results of the preceding investigations of the influence of such factors on the scientific creativity of school students. Many researchers have suggested that scientific creativity is related to individual's cognitive style preferences (Puccio, 1987; Katra, 1993; Kirton, 1994; Sternberg & Lubart, 1995; Katz, 2001 and Banerjee, 2011). Naderi et al. (2010), Alam (2009), Son Mi (2009), Okere and Ndeke (2008), Philip (2008), Mohamed (2006), Diakidoy and Constantinou's (2001), Rajnish (1998), Asmali ('l994) and Dubey (1994) found that science achievement and content knowledge is a considerable factor when describing scientific creativity. Although the researches in this area lack the final conclusion and specific conceptual knowledge was found to be a prerequisite, but not an adequate condition for scientific creativity.

The findings of the study have important implications, like, for enhancing scientific creativity of students schools should adopt teaching strategies in accordance with the cognitive styles of the students. The factors responsible for the lower scientific creativity of field dependent students must be studied and the longitudinal studies have to be conducted in order to ascertain the causes of varying cognitive styles of the students. Most importantly, further attention should be given to the development of instructional designs that are relevant to the needs of students with field dependent cognitive style and/or low achievement in science. Since measuring scientific creativity in students involve complicated tools and procedures, influence and relationship studies can have an indirect bearing on the development of scientific creativity.

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