Pakistan Journal of Psychological Research Vol. 4, Nos. 3-4, Winter 1989, 81-92

CREATIVITY AND PSYCHOLOGICAL DIFFERENTIATION IN HIGH AND LOW ACHIEVING SCIENCE STUDENTS

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The study aimed at exploring the relationship between academic excellence, creativity, achievement in science and psychological differentiation. 68 students of Class XI who had passed Secondary School Certificate Examination (SSCE) with Science subjects, consisting of academically superior (N= 39, Grade A+) and below average (N = 29, Grade D/E) were given three psychological tests: Wallach-Kogan Creativity Test (abbreviated form), Urdu version of Dallas Times–Herald Science Achievement Test and Group Embedded Figures Test (GEFT). The results showed that academically superior group earned significantly higher scores on all these tests as compared to below average group. Analysis of data further revealed that the correlations between scores on creativity and science achievement test are significant in case of academically superior group but not in case of below average group. Correlations between creativity, psychological differentiation and science achievement are insignificant in both the groups.

Psychological investigations on the nature and development of creativity have followed two fundamental approaches, namely, the study of adults who have achieved eminence (Cattell & Drevdahl, 1955; Galton, 1983; Mackinnon, 1962; Roe, 1952), and the studies of gifted children (Getzels & Jackson, 1962; Terman & Oden, 1959; Wallach & Kogan, 1965). The former approach makes direct observation of creative persons possible but it involves many practical difficulties. Moreover, there is always a possibility that the eminence of some individuals may be shortlived and there are many who may be recognized as creative after their deaths. On the other hand, the exploration of creative children to discover the characteristics of creative adults seems somewhat an indirect approach, but it makes it possible to have a developmental view of the problem enabling the psychologists to identify significant environmental influences that foster/stifle the creative ability (Haddon & Lytton, 1968; Hurlock, 1978;

Taylor, 1964). Consequently, interest today is centered on ways of discovering potential creativity so that it could be properly nurtured by providing optimum environmental conditions. Researches by Getzels and Jackson (1962), Wallach and Kogan (1965), Torrance (1962), Kagan and Kogan (1970), etc., show that excessive success-orientation, pressure for conformity, work-play dichotomy, fear of risk-taking, which, wittingly or unwittingly, are part of school situation, have important consequences for the development of creative potential. Such evidence emphasizes an urgent need to focus attention on identification and evaluation of creative potential at an early stage so as to formulate educational and cognitive strategies and procedures suitable for nurturance of this talent.

In general, studies have shown that there is a particular pattern of psychological traits that consistently characterizes creative individuals, regardless of their age, cultural background, or area of work. The most important variables which seem to distinguish creative individuals are interests, attitudes, and other personality dimensions (Dellas & Gaier, 1970). While intelligence, as measured by conventional tests of intelligence, seems to be related niether to creativity test scores (Ansari, 1976; Riaz, 1979; Wallach & Kogan, 1965), nor to creative performance in life (Gibson & Light, 1967; Terman & Oden, 1959); other cognitive measures appear to be important in preference for science, as well as performance as scientists (Barron, 1965; Cropley, 1967; Cropley & Field, 1969; Hudson, 1963a, 1963b). These cognitive measures are generally stylistic in nature. The 'cognitive styles', as Guilford (1980) calls them, are the characteristic self-consistent modes of functioning found pervasively throughout an individual's cognitive activities (Witkin, 1967). They are now known to be the manifestations, in the cognitive sphere, of still broader dimensions of personal functioning, evident in similar form in many areas of the individual's psychological activity.

Creativity is one of the cognitive styles that has been extensively investigated. Another cognitive style that has been frequently studied is Field-Dependence (FD) and Field-Independence (FI). The FD–FI cognitive style, and the broader dimension of psychological differentiation of which it is a component, have been explored in a number of cross cultural studies. Witkin, Dyk, Faterson, Goodenough, and Karp (1962)

have shown that the way in which the individual perceives his environment is an expression of a more general aspect of his cognitive style. Initially, Witkin and his associates referred to the style differences as 'field dependence vs. independence', later they used the term 'psychological differentiation'. The field-independent or differentiated person excels at problems that require the isolation of essential components from a context and the recombination of these components in new relationships. Various studies have shown that FI people are in general less dependent on others and have greater ability to separate themselves from pressures of social environment, sometimes even to the point of isolation from other people. A FD or undifferentiated person reacts to the complex situation without analyzing it. His perception is strongly dominated by the overall organization of the surrounding field. The FD person is relatively handicapped in disembedding parts from their context and performs poorly on restructuring tasks. FD and FI cognitive styles have important educational implications especially in the areas of teaching, learning, vocational and career planning. The independent person is more active, resourceful, self-directing, less affected by social norms, more realistic in self-appraisal, and displays greater clarity in his concepts. Individuals having more extreme positions on the FD–FI continuum show certain general consequences in behaviour, as in vocational and educational choices (Witkin, 1967). Those low on FI are likely to prefer the social sciences and social vocations, such as clinical psychology or nursing, while those high on FI would show a preference for natural sciences, engineering, and mathematics. Ahmad's (1985) findings, that high achieving Pakistani science students are high on FI, lends support to this hypothesis.

While several studies have demonstrated positive correlation between creativity and academic achievement (Cline, Richards, & Needham, 1963; Getzels & Jackson, 1962; Riaz, 1979), but the relationship has not been so thoroughly studied among FD–FI and academic achievement. The present study attempts to fill in this void. The present study also aims to investigate whether the relationship between creativity and academic achievement found at lower grade levels (grades 6–8) in Pakistan (Riaz, 1979) can be replicated at Higher Secondary School (HSS) level. Further, the study aims at exploring the relationship between creativity and FD–FI. The study was

conducted on students of two extreme levels of academic achievement to bring out the differences between these two groups more sharply.

Hypotheses

The following two hypotheses were formulated:

1. Academically superior group will score significantly higher than below average group on measures of creativity.

2. The academically superior group will score significantly higher on Embeded Figures Test as compared to below average group.

METHOD

Sample

One hundred students (science group) of class XI (78 boys and 22 girls) were initially selected from 4 men's and 4 women's colleges of Peshawar. Half of them were "superior" students, obtaining grade A+ in Secondary School Certificate (SSC) examinations, and the rest were "below average", with D or E grade in SSC examinations. Of these, only 68 could complete the tests due to unscheduled closure of the colleges. The distribution of Ss in these groups and their marks in SSC Examinations are shown in table – 1.

Table 1

Marks in SSCE of 'superior' and 'below average' groups (N =68)

	N	*M*	*SD*
Academically superior group	39	698.54	16.8
Below average group	29	378.24	14.9

Instruments

A) Tests of Creativity

An abridged form of Wallach-Kogan Creativity Test (1965) consisting of 12 items was used. The items were grouped into the following three subtests: i) Instances (e.g., "name all the things you can think of that are round"); ii) Alternate Uses (e.g., "list all the uses you can think of for a knife"); iii) Line and Pattern Meanings (e.g., "name all the things a given pattern makes you think of").

There is evidence that this abbreviated version can be used without any serious loss of reliability (Ansari, 1976; Riaz, 1979).

B) Measure of Psychological Differentiation

Group Embedded Figures Test (GEFT) was used as a measure of psychological differentiation. This test consists of a set of perceptual tasks. It measures an individual's ability to delineate a hidden simple geometric figure from a complex pattern. This test measures the level of field dependence-independence or psychological differentiation (Witkin et al., 1962).

C) Measure of Academic Achievement in Science

The following two measures of academic achievement in science were used:

1) Total marks in SSCE

2) Scores on Science Achievement Test which is the Urdu version of Dallas Times Herald Science Achievement Test (Ahmad & Ansari, 1983). It consists of 20 multiple–choice items which are not based on any specific country's curriculum. The authors claim that the test requires understanding of science concepts rather than simple recall of facts.

Procedure

The tests were administered to the subjects in small groups. As only a few students had to participate in the testing session, the college authorities were not willing to disturb their schedule of classes. It took about 2 to 3 days to administer the tests to each group. The tests were administered in accordance with their standard instructions.

Scoring

Science Achievement Test and GEFT were scored by hand scoring keys. Total number of correct responses given by a subject constituted his/her total score on these tests. Creativity tests were scored to obtain the following two measures:

(a) Ideational Fluency Score: It is a sum total of all the appropriate responses given to all the 12 items

(b) Originality Score: Any appropriate response that occurred just once in the whole sample was scored as an original response. Total number of all such responses constituted the originality score of that subject.

RESULTS

The main results of this study are presented in table– 2, which compares the performance of academically superior group with below average group on a number of measures.

The results show that there are significant differences between the academically superior and below average groups on all the tests. The most significant differences between the two groups are in GEFT and Science Achievement Test, although other differences are also significant.

In order to find out the nature of relationship between various variables, correlations between these variables were computed for the two groups separately. The results are shown in tables 3 and 4.

Table 2

Comparison of Academically Superior and Below Average groups on various tests

Tests	Academically Superior *N= 39*		Below Average *N= 29*		*t*	*p*
	M	*SD*	*M*	*SD*		
Fluency	61.23	22.59	46.07	19.82	2.839	.01
Originality	6.77	5.3	4.0	4.7	2.42	.02
GEFT	10.36	4.38	5.69	3.11	6.348	.00
Sc. Ach. Test	11.10	3.49	6.79	2.87	9.254	.00

Table 3

Correlation between Scores on Creativity, GEFT and Science Achievement Test for the Academically Superior Group (N= 39)

	1	2	3	4
1. Fluency	1.000	0.669**	0.059	0.473**
2. Originality		1.000	0.038	0.315*
3. GEFT			1.000	0.240
4. Sc. Ach. Test				1.000

**$p<.01$
*$p<.05$

Table 4

Correlation between Scores on Creativity, GEFT and Science Achievement Test for the Below Average Group (N= 29)

	1	2	3	4
1. Fluency	1.000	0.548*	0.170	0.096
2. Originality		1.000	0.048	0.064
3. GEFT			1.000	0.109
4. Sc. Ach. Test				1.000

*$p<.05$

The results in table–3 indicate highly significant correlation (r=0.473, $p<$ .01) between ideational fluency and science achievement for academically superior group and a significant correlation between originality and science achievement test (r=0.315, $p<$ .05) for academically superior group. In case of below average group these correlation are insignificant. Moreover, the correlations between measures of creativity and GEFT are insignificant in case of academically superior as well as below average group.

DISCUSSION

Table–2 presents a comparison between the academically superior and below average group on all the measures used. Our analysis reveals that academically superior group is significantly better than below average group on measures of Ideational Fluency, Originality and Science Achievement. The results show that the mean scores of the academically superior group on GEFT are statistically higher than that of below average group, indicating that the academically superior group is relatively more field independent and is superior in cognitive differentiation as compared to below average group.

An abbreviated form of Wallach-Kogan Creativity Test was used to explore if scores on this test can differentiate between

the academically superior and below average groups. The ideation of academically superior individuals is believed to be quantitatively and qualitatively different from that of below average individuals. Fluency in generation of novel ideas and flexibility of thinking usually facilitates high scores on divergent thinking tests. So, the test was scored in terms of ideational fluency and originality. The product-moment coefficient of correlation between these two measures of creativity is .6645 ($p<.001$) for the whole sample ($N = 68$); .669 ($p<.001$) for academically superior group; and .5481 ($p<.001$) for below average group. These findings are consistent with earlier findings of positive and statistically significant correlations between ideational fluency and originality scores on Wallach and Kogan Creativity Test (see for instance Ansari, 1976; Riaz, 1979).

Table–3 shows that in case of academically superior Ss, Fluency and Originality are positively related with scores on Science Achievement. On the other hand, a zero correlation is found between creativity measures and Science Achievement in case of below average group. This means that some threshold effect is operating. While for the whole range of academic abilities creativity is significantly related with science achievement as shown in table–2, the relationship of creativity with achievement contribution at lower level is insignificant, while it is quite significant at higher levels.

An earlier investigation in Pakistan (Riaz, 1979) had shown significant relationship between academic achievement and creativity for students of middle school. The results of the present investigation indicate that this relationship is true for high school students also.

A major finding of this study is the relationship between field dependence and academic achievement level of science students. The difference between the academically superior group and the below average group is highly significant.

Further analysis of data revealed that the correlation between measures of creativity and psychological differentiation is not significant. This means that creativity and psychological differentiation, while independent of each other, are contributing to general academic achievement of science students, although in case of psychological

differentiation the correlation with Science Achievement Test fails to reach significance level.

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