IMPACT OF COGNITIVE STYLE ON PROBLEM SOLVING ABILITY IN PHYSICS

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ABSTRACT

The present study was conducted on a sample of 500 students studying physics in class XII from 30 schools of Rohilkhand region. To find out the impact of cognitive style on problem solving ability in physics survey method was used. The data were analyzed by employing 't' test, ANOVA and Scheffe test. Researchers found that cognitive style has a marked impact on problem solving ability in physics. Interaction with sex/locality/type of school does not alter this main effect of cognitive style.

Introduction

Progress and welfare of a society is inseparably linked with the progress and welfare of its individual members which basically depends upon the fact that how best a person can adjust with his environment; how best he can solve his problems. Problem solving ability is therefore one of the most important ability which schools are supposed to develop in their students.

Our whole education system is result oriented i.e. marks obtained by the student in final exams. But the development of various mental abilities such as problem solving ability, creativity, appropriate cognitive style, planning ability, forecasting ability, communicating ability, decision making ability and the ability of interacting socially in our society are of paramount importance in dealing with the present day world .

At the intermediate level of school education, it is very important to assess the problem solving ability in physics among the students. Development of problem solving ability in the students automatically ensures the learning, at the levels of knowledge, understanding and application which would lead them towards a successful career. Self awareness regarding their problem solving ability in physics may benefit students in many ways viz. they can gain confidence in their strengths and develop diverse strategies for coping with challenging situations, they may analyze that how they solve physics problems most effectively and efficiently and therefore they may be able to take responsibility for their own learning.

There are certain personal difficulties which play significant role in problem solving. These difficulties have been considered as barriers by McCaw. These barriers are lack of motivation, attitudes which interfere with clear thinking such as prejudice, lack of independence from authority such as too much reliance on a text book, lack of adequate technique or system such as in the use of trial and error, lack of flexibility in thinking and lack of confidence on the part of the learner. These variables are mainly linked with aptitude, creativity, cognitive style etc. Thus, with this backdrop in mind, researchers became curious to take in hand the present problem i.e. to explore the role of an important psychological variable- cognitive style in displaying problem solving ability in physics by the students.

Some of the researchers have shown their interest in this area. Artley (1980) have observed that problem solving and cognitive style were uncorrelated. Dugger (1985) found in his study that the field dependence-independence cognitive dimension applied to teaching improved the student's performance in maths problem solving. Roessler & Jacoby (1985) found that field independent subjects scored significantly higher on the problem solving task than the field dependent. Nasser (1993) inferred the importance of cognitive style opposed to cognitive development alone in ability to solve algebra word problems. Dutt (1989) reported that the field independent students generally scored higher than the field dependent ones on the problem solving ability test. Gill (1990) revealed that the group having the field-independent cognitive style scored higher than the field-dependent group on creative problem solving skill test. Thus, in a nut shell it can be inferred that findings regarding the relationship between cognitive style and problem solving ability in physics are neither sufficient nor conclusive which necessitates more studies in this field.

Objective

The main aim of the study is to find out the influence of cognitive style on problem solving ability in physics. Further, to investigate the interplay of sex, locality and type of school in the above mentioned relationship is also the objective of the study.

Hypotheses

Following hypotheses have been framed to fulfill the objectives of the study –

(1) There is insignificant main effect of cognitive style on problem solving ability in physics.

(2) There is insignificant interaction effect of sex and cognitive style on problem solving ability in physics.

(3) There is insignificant interaction effect of locality and cognitive style on problem solving ability in physics.

(4) There is insignificant interaction effect of type of school and cognitive style on problem solving ability in physics.

Methodology

Study has been carried out through survey method.

Sample

A sample of 500 students studying physics in class XII of 30 schools located in Rohilkhand region was selected on the basis of multi stage random sampling technique taking into consideration proper representation to both the sexes (Boys and Girls), locality (Urban & Rural) and type of schools (Privately managed and Government managed).

Tools

The following tools were used by the investigators for collection of data:

(1) Physics Problem Solving Ability Test

A test for measuring problem solving ability in physics was developed by the investigators. The test was validated and revised at three stages; individual testing, small group testing and field testing. The initial draft of the test consisted of 150 items based on problems under major units of class XII physics. After revisions and item analysis, the final form of

physics problem solving ability test consisted of 74 multiple choice type items. The reliability of the test was calculated by test –retest method and was found to be 0.73. It was validated for its content only.

(2) The Group Embedded Figures Test (GEFT)

Out of the various tests of cognitive styles, The Group Embedded Figures Test (GEFT) was used to assess broad dimensions of personal functioning that comes from cognitive style which included the characteristics, self consistent mode of functioning which individuals show in their perceptual and intellectual activities. This test has been developed by Philip K. Oltman, Evelyn Raskin & Herman A. Witken.

Statistical Techniques: - Quartile deviation was used to categorize the students in three groups of preferred cognitive style – field dependent style, integrated style, and field independent style. 't' test, ANOVA and Scheffe test have been used for analyzing the data of variations in problem solving ability in physics.

Results and Discussions

Table-1 : One way ANOVA of physics problem solving ability scores of students belonging to three groups based on type of cognitive style

Sources of Variation	df	Sum of Squares	Mean Squares	'F'-ratio
Between the groups	2	16903.20	8451.60	61.21**
Within the groups	497	68629.05	138.09	

**Significant at 0.01 level

A perusal of data presented in table-1 makes it evident that the value of 'F' (61.21) for variance in the physics problem solving ability scores of the students belonging to three groups based on their type of cognitive style, is significant at 0.01 level of confidence. So, it can be said that field dependent, integrated and field independent students differ significantly in their physics problem solving ability.

To know where the actual differences lie, the pair-wise comparisons of mean physics problem solving ability scores at different types of cognitive style were made by applying protected‘t’ test.

Table-2: Differences in the mean physics problem solving ability scores of students belonging to three groups based on type of cognitive style

Groups	N	M	S.D.	Groups Compared	‘t’
Field Dependent (FD)	88	34.44	10.15	FD Vs I	4.34**
Integrated (I)	289	40.64	12.16	FD Vs FI	11.02**
Field Independent (FI)	123	51.62	11.83	I Vs FI	8.45**

Table-2 shows that in all the three comparisons, i.e. field dependent and integrated; field dependent and field independent; integrated and field independent, groups of students significantly differ from each other (t =4.34, 11.02 and 8.45 respectively) on physics problem solving ability at 0.01 level of significance. When the mean values of these three groups were compared it was found that the mean value of field independent students group (M =51.62) is higher than the mean value of field dependent and integrated students group (M =34.44 and 40.64 respectively). It implies that the field independent students are superior in physics problem solving ability than the field dependent and integrated cognitive style students. It means that as there is an increase in the field independence in the cognitive style among the students, their problem solving ability in physics also increases. Hence, it can be said that cognitive style has a marked influence on problem solving ability in physics.

Similar finding was obtained by Roessler & Jacoby (1985), Dutt (1989) and Gill (1990) that field independent cognitive style facilitates problem solving ability among the subjects. However, Artely (1980) inferred that no significant correlation exists among the variables of problem solving and cognitive style.

The finding is easy to interpret. As the independent cognitive style is characterised by the abilities of analyzing and restructuring the experiences in new ways making the use of reflective thinking, it is quite obvious that the individuals preferring independent cognitive style will score high on problem solving ability tests particularly in the science subjects.

Table 3 : Two way ANOVA of physics problem solving ability scores of students belonging to 2x3 groups based on sex (boys, girls), locality (urban, rural), type of school (privately managed, government managed) and types of cognitive style (field dependent, integrated and field independent)

Variables	Sources of Variables	df	Sum of Squares	Mean Squares	'F'- ratio
Sex	Between the groups	5	17419.37	3483.87	25.27**
	Within the groups	494	68112.88	137.88	
Locality	Between the groups	5	17376.70	3475.34	25.19**
	Within the groups	494	68155.55	137.97	
Type of school	Between the groups	5	18362.18	3672.44	27.01**
	Within the groups	494	67170.07	135.97	

It is evident from the table- 3 that the F- values for the interaction effect of sex and cognitive style, locality and cognitive style, type of school and cognitive style on physics problem solving ability is significant at 0.01 level of confidence with df 5/494. It means that the interaction between sex and cognitive style, locality and cognitive style, type of school and cognitive style affects significantly to physics problem solving ability . In order to know specifically the groups which differ significantly with each other, Scheffe test was applied.

Table-4: 't' values regarding significance of mean differences between physics problem solving ability scores of 2x3 groups of students (sex x cognitive style)

	FDB	FDG	IB	IG	FIB	FIG
FDB	-	0.13	2.78**	3.98**	7.76**	7.80**
FDG	-	-	2.46*	3.52**	6.89**	6.96**
IB	-	-	-	1.92	6.91**	6.94**
IG	-	-	-	-	4.88**	4.97**
FIB	-	-	-	-	-	0.19

* Significant at 0.05 level

FDB : Boys of Field Dependent Cognitive Style
FDG : Girls of Field Dependent Cognitive Style
IB : Boys of Integrated Cognitive Style
IG : Girls of Integrated Cognitive Style
FIB : Boys of Field Independent Cognitive Style
FIG : Girls of Field Independent Cognitive Style

Table-4 illustrates that t-values between boy and girl students who have either field dependent or integrated or field independent cognitive style are found to be insignificant. In rest of the possible comparisons t-values are found significant at 0.01 level of confidence except the

one (girls of field dependent cognitive style and boys of integrated cognitive style) which is significant at 0.05 level of significance.

Boys and girls of same cognitive style group either field dependent or integrated or field independent cognitive style do not differ in their physics problem solving ability. Thus, gender does not effect the physics problem solving ability when their type of cognitive style is controlled. It is also evident from the data mentioned in table-4 that when the sex was controlled (boys or girls), field dependent students are inferior in physics problem solving ability than integrated and field independent students. Again it is clear that integrated boy and girl students are inferior in physics problem solving ability than field independent boy and girl students. So, it can be said that cognitive style have significant role in developing problem solving ability in physics among the students. The finding is similar to the previously reported one in table-2 for the main effect of cognitive style on physics problem solving ability. Hence, interaction with sex does not influence the main effect of cognitive style.

Table-5 : 't' values regarding significance of mean differences between physics problem solving ability scores of 2x3 groups of students (locality x cognitive style)

	FDU	**FDR**	**IU**	**IR**	**FIU**	**FIR**
FDU	-	1.26	3.68**	2.00*	9.12**	5.28**
FDR	-	-	3.41**	2.54*	6.81**	5.16**
IU	-	-	-	1.10	7.61**	3.61**
IR	-	-	-	-	6.67**	3.90**
FIU	-	-	-	-	-	0.16

FDU : Urban Students of Field Dependent Cognitive Style
FDR : Rural Students of Field Dependent Cognitive Style
IU : Urban Students of Integrated Cognitive Style
IR : Rural Students of Integrated Cognitive Style
FIU : Urban Students of Field Independent Cognitive Style
FIR : Rural Students of Field Independent Cognitive Style

Table-5 clearly states that the t-values between the rural and urban students who have either field dependent or integrated or field independent cognitive style, are not significant at any level of confidence. In rest of the possible comparisons t-values are found significant at 0.01 level of confidence except the one (field dependent and integrated cognitive style rural students) which is significant at 0.05 level of confidence.

On controlling the type of cognitive style, rural and urban students of field dependent, integrated or field independent cognitive style do not differ significantly to each other in physics

problem solving ability. Thus, locality has no effect on physics problem solving ability when their type of cognitive style is controlled.

The results also revealed that when the locality was held constant, the field independent students are superior in physics problem solving ability than the field dependent and integrated students. It is also clear that integrated style students are superior in physics problem solving ability than the field dependent students. Thus, the trend is same that problem solving ability in physics rises with the rising in the level of field independence in cognition of the students (similar to finding previously reported in table-2). Further, interaction with locality (alike sex, table-4) does not show the significant effect on impact of cognitive style upon problem solving ability in physics of students.

Table-6: 't' values regarding significance of mean differences between physics problem solving ability scores of 2x3 groups of students(type of school x cognitive style)

	FDP	FDG	IP	IG	FIP	FIG
FDP	-	0.77	4.05**	0.59	9.10**	5.03**
FDG	-	-	3.53**	1.20	7.21**	4.87**
IP	-	-	-	3.12**	7.41**	3.08**
IG	-	-	-	-	8.08**	4.53**
FIP	-	-	-	-	-	0.66

FDP : Private School Students of Field Dependent Cognitive Style
FDG : Government School Students of Field Dependent Cognitive Style
IP : Private School Students of Integrated Cognitive Style
IG : Government School Students of Integrated Cognitive Style
FIP : Private School Student of Field Independent Cognitive Style
FIG : Government School Students of Field Independent Cognitive Style

Table-6 indicates that only four t-values i.e. between the groups of field dependent students studying in private and government schools, field dependent students studying in private schools and integrated students studying in government schools, field dependent and integrated students studying in government schools, field independent students studying in private and government schools are found to be insignificant. In rest of the comparisons t-values are found significant at 0.01 level of significance.

Findings reveal that on controlling the type of cognitive style (either at field dependence or at field independence cognitive styles) students of private and government schools do not differ significantly in their physics problem solving ability but integrated cognitive style students studying in private and government schools differ significantly in their physics problem solving

ability. The mean values infer that private school students are superior in physics problem solving ability than the government school students. Thus, when the type of cognitive style is kept constant, type of school has no impact on physics problem solving ability at field dependent and field independent cognitive style but it produces the impact on physics problem solving ability in group of integrated cognitive style. The reason behind this finding may be that field dependent and field independent styles have impact on physics problem solving ability unaltered environmental factors which are related with school. But, physics problem solving ability of the students who prefer integrated cognitive style can be increased by providing an appropriate learning environment because such type of students are characterised by the ability of changing style quickly and easily as well as a proactive approach to problem solving. Better school environment like opportunities to participate in various co-curricular activities, facilities of developed laboratories, rich library and modern technology, sincere and devoted teachers, better discipline, regular evaluation etc. as seen in private schools (in contrast to government schools) are probably helpful in developing better problem solving ability in them.

Again table-6 illustrates that when type of school was controlled with few exceptions the students have shown improvement in physics problem solving ability with increase in field independence in cognition. The finding is similar to the previously reported ones in table-2 for the main effect of cognitive style on problem solving ability in physics.

Conclusions and Suggestions

The conclusions and respective suggestions based on finding are as follows :

1. Cognitive style has a significant influence on problem solving ability in physics. As the field independence enhances in the style of cognition, problem solving ability in physics of intermediate level students also increases. Interaction with sex/locality/type of school does not alter this main effect of cognitive style.
2. Sex and type of cognitive style together do seem to show significant interaction effect on problem solving ability in physics. Gender does not affect the physics problem solving ability when their type of cognitive style is controlled.

3. The interaction of locality and type of cognitive style affects significantly the problem solving ability in physics. Locality does not play any role in physics problem solving ability when their type of cognitive style is controlled.
4. Cognitive style interacts with type of school to produce significant effect on physics problem solving ability. Private school students with integrated cognitive style are better problem solvers than those studying in government schools.

Findings reveal that the students of field independent cognitive style show the highest performance and the students of field dependent cognitive style show the lowest performance in problem solving ability. On one hand, this finding sets the limit for inculcation of problem solving ability among the students whereas on the other side this suggests about characteristic features of learning and thinking process such as analyzing and reconstructing experiences in a systematic way giving attention to reflective thinking and creative mode of facts and data collection and presentation which facilitate problem solving ability among the students. For that the teachers and parents may encourage and guide the students focusing on the above mentioned characteristics.

Finding of the study also reveals that the private school students of integrated cognitive style are better than their counterparts of government schools in problem solving ability, therefore the provision of appropriate learning environment, regular encouragement for their pro-activeness, provisions for co-curricular activities, arrangement of developed labs, rich library, modern educational materials and the co-operation and motivation on the parts of school management, teachers and parents can help in increasing problem solving ability of the students of government schools.

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