Effect of Inductive Thinking Model on Achievement in Scientific Creativity of Class IX Students

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Abstract:

In the present study the effect of Inductive Thinking Model on achievement in Scientific Creativity of class IX students was investigated. Non-randomised pre-test-post-test control group experimental design was followed. Sample of 201 students was picked up for the study comprising of two groups viz. Control and experimental group. Tools used were: Scientific creativity test developed by S.K. Majumdar to assess Scientific Creativity, Raven's Standard Progressive Matrices to assess Intelligence. Mean, SD, t-test, ANCOVA were used as statistical techniques. Results of the study revealed that Inductive Thinking Model was found to be effective in terms of achievement in scientific Creativity of class IX students. Further, Achievement in Scientific Creativity was found to be independent of the interaction between treatment and gender; treatment and intelligence when pre achievement in Scientific Creativity was taken as covariate.

Key Words: *Inductive Thinking Model, Achievement, Scientific Creativity*

I. INTRODUCTION

It is generally seen that our school programmes are not giving due place to the educational experiences and proper environment which are conducive to the development of creative potential. This may be due to our unawareness of creative talent in relation to national development. Also may be due to inadequate understanding of the creative process on the part of teachers or difficulties in identifying the creative children or due to lack of proper method of teaching or lack of knowledge of factors which inhibit and accelerate the development of creativity.

Getzels (1975) stated that no universal consensus for the definition of creativity was found, but he defined creativity as the subjective experiences that are derived by process and product. On the other hand, Vernon (1989) believed an agreement exists about the definition of creativity. He believed that creativity is the person's ability to generate ideas, inventions, artistic objects, insights, and products that are judged by experts as being of high scientific, social, aesthetic, or technological value. There is strong evidence which indicates that creativity does not just happen. The conditions for creative productions will have to be carefully planned, if we want more creative act to be demonstrated (Torrance, 1962; Murphy, 1966; Goyal, 1973). Creativity needs appropriate seeds as well as soil and climate for its development and fruition. There are indications that our whole educational structure is unable to assess creativity but actually is biased against.

According to Simonton (2003), scientific creativity entails what is called a stochastic process. Dunbar (1999) also concluded that the most prevalent way of exploring scientific creativity has been scrutinizing either the life of a creator in science or the way a scientist made a difference by coming up with a scientific discovery. Science creates a sense of wonder and deepens man's consciousness of the world around. Art creates a sense of order of harmony and of beauty and enriches man's emotional life. A scientist seeks to uncover the secrets of nature, to understand the causes of things and phenomenon so that he may learn how to control nature for the enrichment of human life. For this, science has to probe deep into nature to search for truth and this is not possible without creative imagination. To enhance creative imagination teachers need to understand the importance of various new methods of teachings. Among these methods model approach of teaching is one. There are various models of teachings, investigators has selected inductive thinking model of teaching.

II. INDUCTIVE THINKING MODEL

The Inductive Thinking Model is an adaptation from the work of Hilda Taba (1966). This Model was developed by Hilda Taba, a curriculum theorist. Taba identifies three inductive thinking skills and three teaching strategies; each is built around a mental operation. First is Concept Formation: Enumeration or listening, grouping, labelling or categorization. Second is Interpretation of Data: Identifying critical relationships, exploring relationships, making references. Third is Application of Principles: Predicating consequences or explain unfamiliar, Explaining and/ or supporting the predictions and hypotheses, verifying the prediction. Billing (2013) explored that Inductive Thinking Model of Teaching is better than that of Traditional Method of teaching on learner's achievement in History, Civics, and Geography. Prusty (2006) found Inductive Thinking Model of Teaching to be better than that of traditional method of teaching on learner's inductive reasoning ability and for enhancing learner's concept attainment ability. Wanjari (2005) explored that concept attainment model and inductive thinking model were more effective than the traditional method of teaching. Kumar (2002) found that retention through the inductive thinking model has been found greater than through the traditional method.

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III. CREATIVITY AND SCIENTIFIC CREATIVITY

Hu, Shen, Lin and Adey (2014) studied English adolescents' other scientific creativity and whole scientific creativity are evidently superior to that of Chinese adolescents, also concluded that school environment is more important on the development of scientific creativity than school type. Mukhopadhyay and Sen (2011) found that creativity in physics can be predicted significantly by all the predictor variables. Results of step-wise regression analysis indicated that aptitude in physics, deep approach, and scientific attitude played the dominant roles in prediction. Mohanmed (2006) no significant differences were found between females and males in the scientific creativity test except fluency, originality and complexity measures on grouping of flowers activity. Sharma (2003) results revealed that there exists a significant positive correlation between scientific creativity and academic achievement and no significant relationship between scientific creativity and socio economic status. Hu and Adey (2002) stated that the reason why scientific creativity is worth attention is because scientific research requires creativity and going beyond what is already known. Hu and Adey (2002) also concluded that sensitivity to problems is an essential component of scientific creativity. Haneeshia (2001) conducted a comparative study of scientific creativity of pupils in DPEP and non-DPEP schools in the State of Kerala. The study found that the two groups differ significantly with respect to fluency (CR = 4.27), flexibility (CR = 2.02), originality (CR = 2.07) and total creativity (CR = 4.56). Sansanwal and Sharma (1 997) found that male and female students did not differ significantly in scientific creativity. Baby (1989) found no significant difference based on sex in the relation between science learning environment and divergent thinking in science. Sinha and Singh (1987) developed an English-Hindi instrument for assessing scientific creativity in secondary school students. Comparing females to males on the teacher ratings of scientific creativity, scientific ability, and science content knowledge did not yield any significant differences. Another interesting implication of the Scientific Creativity Test for science teaching is the integration of teaching models in the education of both regular education and gifted education students, examples of these models are Discover (Maker, 1996), Problem-Based Learning (PBL) (Maker and Schiever, 2005), Teaching Actively in a Social Context (TASC) (Maker and Schiever, 2005), and Hilda Taba Questioning Techniques (Maker and Schiever, 2005). These teaching models can be used in promoting scientific creativity.

The review of above-mentioned studies does not enable to draw a generalised conclusion regarding the effect of achievement in science and creativity related variables. Some of the studies show a significant relationship between the selected variables whereas some studies clearly indicate that the relationship is not significant. Literature review also make it clear that models of teaching are gaining popularity throughout the world of education and are being applied for teaching various subjects at elementary, secondary and college level. Models of teaching are very helpful in developing language, in concept retention, for better achievement in history, civics, geography, science etc. Many studies are conducted on scientific creativity in relation to student's achievement. But investigator did not found any study on the effect of inductive thinking model on the achievement in science creativity of class IX students. From the review it is clear that inductive thinking model is good method of teaching. Identifying scientific creativity in early grades can help children make the best use of their potential. Moreover, educators can better serve the children's needs through providing appropriate teaching methods and learning opportunities that promote scientific creativity, so the present work is an attempt to study the effect of inductive thinking model on the achievement in scientific creativity of class IX students. The drawbacks observed stimulate the investigator for a more systematic and adequate study in the above field.

IV. OBJECTIVES

1. To compare Pre-Test and Post-Test mean scores of achievement in Scientific Creativity of students taught through Inductive Thinking Model.
2. To compare the adjusted mean scores of achievement in Scientific Creativity of students taught through Inductive Thinking Model and Traditional Method Groups by considering Pre-achievement in Scientific Creativity and Intelligence as covariates.
3. To study the effect of Treatment, Gender and their interaction on achievement in Scientific Creativity by considering Pre-achievement in Scientific Creativity as covariate.
4. To study the effect of Treatment, Intelligence and their interaction on achievement in Scientific Creativity by considering Pre-achievement in Scientific Creativity as covariate.
5. To compare mean scores of students liking of Inductive Thinking Model and Traditional Method Groups.

V. HYPOTHESES

1. There is no significant difference in Pre-Test and Post-Test Mean scores of achievement in Scientific Creativity of students taught through Inductive Thinking Model.
2. There is no significant difference in adjusted mean scores of achievement in Scientific Creativity of students taught through Inductive Thinking Model and Traditional Method Groups by considering Pre-achievement in Scientific Creativity and Intelligence as covariates.
3. There is no significant effect of Treatment, Gender and their interaction on achievement in Scientific Creativity of students when pre-achievement in Scientific Creativity is taken as a covariate.
4. There is no significant effect of Treatment, Intelligence and their interaction on achievement in Scientific Creativity of students when Pre-achievement in Scientific Creativity is taken as a covariate.
5. There is no significant difference in mean scores of Students Liking of Inductive Thinking Model and Traditional Method Groups.

VI. DESIGN OF THE STUDY

In the proposed study, non-randomised pre-test-post-test group design was employed. The factorial design was used as it permits to evaluate the combined effect of two or more than two independent variables. There were two groups: experimental group and control group. Experimental group was exposed to Inductive Thinking Model and Control group was exposed to Traditional Method. Duration of the experiment was one month.

Sample

In the proposed study IX class students from four schools (two Government and two Private) of Phagwara, were selected for the study. For the selection of the sample, the purposive sampling technique was used. In all 201 students (100 boys and 101 girls) of class IX were selected from the schools. Then the students were randomly assigned into the groups: viz; experimental group and control group. The experimental group in the schools were given treatment according to Inductive Thinking Model and the control group in the school were taught according to Traditional Technique or Method of Teaching.

Tools to be used:

1. Scientific Creativity was assessed with the help of test by S.K Majumdar (1982).
2. Lesson plans were prepared by the investigator based on Inductive Thinking Model.
3. Intelligence was assessed with the help of Raven's Standard Progressive Matrices (SPM), (1938).
4. Students Liking for the teaching method was assessed with the help of Student Liking Scale by Malhotra and Passi (1976).

Experimental Procedure

S. No.	Duration	Stage	Experimental group	Control group
1.	2days	Pre-Test	1. Scientific Creativity Test 2. Raven'sStandard Progressive Matrices	1. Scientific Creativity Test 2. Raven'sStandard Progressive Matrices
2.	27 days	Treatment	Teaching Science through Inductive Thinking Model	Teaching Science through Traditional Method.
3.	1 Day	Post-Test	Scientific Creativity Test	Scientific Creativity Test

Situational variables were kept constant and uniform. Before starting the session, it was ensured that the IX class students were seated comfortably in the room where there was no disturbance.

VII. STATISTICAL ANALYSIS

The data collected was analyzed by employing statistical computations namely mean, standard deviation, r, t-test, ANCOVA, t-value, F-value.

VIII. RESULTS AND DISCUSSION

H_1: There is no significant difference in Pre-Test and Post-Test mean Scores of achievement in Scientific Creativity of students taught through Inductive Thinking Model.

The first objective was to compare Pre-Test and Post-Test Mean Scores of achievement in Scientific Creativity of students taught through Inductive Thinking Model. The data in this respect were analyzed with the help of correlated t- test and results are given below in table 1:

Table 1: Testing wise N, M, SD, r, and correlated t-value of achievement in scientific creativity of students of ITM group

Testing	M	N	SD	R	t- value
Pre- Test	64.39	101	34.404	.945	28.584**
Post- Test	103.52	100	40.255		

** Significant at 0 .01 level

From table 1, it is evident that the correlated t-value is 28.584, which is significant at 0.01 levels with df 99. It indicated that Pre-Test and Post-Test Mean Scores of achievement in scientific creativity differ significantly. In this content null hypothesis namely, "There is no significant difference in Pre-Test and Post-Test Mean scores of achievement in Scientific Creativity of students taught through Inductive Thinking Model," is rejected. Further the Post-Test Mean scores of achievement in Scientific Creativity are significantly higher than the Pre-Test Mean scores of achievement in Scientific Creativity. It may, therefore, be said that Inductive Thinking Model (ITM) was found to be significantly effective in terms of achievement in scientific creativity of students.

H_2: There is no significant difference in adjusted mean scores of achievement in Scientific Creativity of students taught through Inductive Thinking Model and Traditional Method Groups by considering Pre-achievement in Scientific Creativity and Intelligence as covariates.

The second objective was to compare the adjusted mean scores of achievement in Scientific Creativity of students taught through Inductive Thinking Model and Traditional Method by considering Pre- achievement in Scientific Creativity and Intelligence as covariates. The data related to this objective were analyzed with the help of analysis of covariance. The results are given below in table 2:

Table 2: Summary of ANCOVA for achievement in Scientific Creativity of students by considering pre-achievement in Scientific Creativity and Intelligence as Covariates

Source of variance	df	Sum of square	Mean square	F-value
Treatment	1	34237.37	34237.37	291.71**
Error	197	23121.38	117.37	
Total	201	2241227.00		

** Significant at 0.01 level.

From table 2, it can be seen that the adjusted F- value is 291.171, which is significant at 0.01 level with df 1/197. It indicates that the adjusted mean scores of Inductive Thinking Model group and Traditional Method group differ significantly when Pre- achievement in Scientific Creativity and Intelligence were considered as covariates. In this context, the null hypothesis that, "There is no significant difference in adjusted mean scores of achievement in Scientific Creativity of Inductive Thinking Model and

Traditional Method group by considering Pre- achievement in Scientific Creativity and Intelligence as covariates," is rejected.

Further, from the data the adjusted mean score of achievement in Scientific Creativity of Inductive Thinking Model group was 103.119, which is significantly higher than that of Traditional Method group whose adjusted mean score was 92.960. It reflects that the treatment given to Inductive Thinking Model group in relation to Lecture Method was found to be significantly superior when Pre-achievement in Scientific Creativity and Intelligence were taken as covariates. It may, therefore, be said that Inductive Thinking Model group was found to be superior to Traditional Method group in enhancing Scientific Creativity.

H_3: There is no significant effect of Treatment, Gender and their Interaction on Achievement in Scientific Creativity of students when Pre-Achievement in Scientific Creativity is taken as a Covariate.

The third objective was to study the effect of Treatment, Gender and their interaction on achievement in Scientific Creativity by considering Pre- achievement in Scientific Creativity as covariate. There were two levels of Treatment, namely, teaching with Inductive Thinking Model and Traditional Method. The students were categorized into two levels of Gender i.e. male and female groups. Thus, there were two levels of Treatment and two levels of Gender. Therefore, the data were analyzed with the help of 2×2 factorial design analysis of covariance. The results are given in table 3:

Table 3: Summary of 2×2 Factorial Design ANCOVA for achievement in Scientific Creativity by Considering Pre-achievement in Scientific Creativity as a Covariate

Source of variance	df	Sum of square	Mean square	F- value
Treatment	1	4833.42	4833.42	3.192**
Gender	1	4576.05	4576.05	3.022
Treatment*Gender	1	224.53	224.531	0.148
Error	197`	298289.83	1514.162	
Total	201	2441227.00		

**Significant at 0.01 level

From table 3, it can be seen that the adjusted F- value of Treatment is 3.192, which is not significant at 0.01 level. It indicates that mean score of Pre-Scientific Creativity of students taught through Inductive Thinking Model and Traditional Method do not differ significantly, when Pre–achievement in Scientific Creativity was taken as a covariate. In this context, the null hypothesis, "There is no significant effect of Treatment, Gender and their interaction on achievement in Scientific Creativity by considering Pre-Scientific Creativity as covariate," is not rejected.

The adjusted F- value for gender is 3.022 which is not significant at 0.01 level. It indicates that adjusted mean score of achievement in Scientific Creativity of students belonging to male and female groups do not differ significantly when Pre-achievement in Scientific Creativity was taken as covariate. Thus, the null hypothesis, namely, "There is no significant effect of treatment, Gender and their interaction on achievement in Scientific creativity of students when Pre-achievement in Scientific Creativity is taken as a covariate," can-not be rejected. It may, therefore, be concluded that achievement in Scientific Creativity was found to be independent of the interaction between treatment and Gender when Pre-achievement in Scientific Creativity was taken as covariate.

H_4: There is no significant effect of Treatment, Intelligence and their Interaction on achievement in Scientific Creativity of students when Pre-achievement in Scientific Creativity is taken as Covariate.

The fourth objective was to study the effect of Treatment, Intelligence and their interaction on achievement in Scientific Creativity by considering Pre-achievement in Scientific Creativity as covariate. There were two levels of treatment, namely, teaching with Inductive Thinking Model and Traditional Method. The students were categorized into three levels of intelligence namely, high, average and below. Thus, there were two levels of Treatment and three Levels of Intelligence. Therefore the data were analyzed with the help of 2×3 factorial design analysis of covariance. The results are given below in table 4:

Table 4: Summary of 2×3 factorial design ANCOVA for Scientific Creativity by considering Pre-achievement in Scientific Creativity as a Covariate

Source of variance	Df	Sum of square	Mean square	F- value
Treatment	1	30382.56	30382.56	258.54**
Intelligence	2	206.68	103.34	0,879
Treatment intelligence	1	18.08	18.08	0.695
Error	195	22915.68	117.52	
Total	201	22415.68		

**Significant at 0.01

From the table 4, it can be seen that the adjusted F-value of Treatment is 258.539, which is significant at 0.01 level. It indicates that the mean score of achievement in Scientific Creativity of students taught through Inductive Thinking Model and Traditional Method differ significantly, when Pre-achievement in Scientific Creativity was taken as covariate. In this context, the null hypothesis, "There is no significant interaction effect of Treatment, intelligence on achievement in Scientific Creativity of students when Pre-achievement in Scientific Creativity is considered as a covariate", is rejected.

The adjusted F-value for Intelligence is 0.879, which is not significant at 0.01 level. It indicates that adjusted mean score of achievement in Scientific Creativity of student belonging to high, average and above intelligence groups do not differ significantly when Pre-achievement in Scientific Creativity was taken as Covariate. Thus, the null hypothesis, "There is no significant effect of Intelligence on achievement in Science of class IX students when Pre-achievement in

Scientific Creativity was taken as covariate", can-not be rejected. It may, therefore, be concluded that achievement in Scientific Creativity was found to be independent on Intelligence when Pre-achievement in Scientific Creativity was taken as covariate.

The adjusted F-value for interaction between Treatment and Intelligence is 0.69, which is not significant at 0.01 level. It indicates that there was no significant influence of the result of interaction between the Treatment and Intelligence on achievement in Scientific Creativity when Pre-achievement in Scientific Creativity was taken as covariate. In this context, the null hypothesis, "There is no significant effect of the interaction between Treatment and Intelligence on achievement in Scientific Creativity of IX class students when Pre-achievement in Scientific Creativity was taken as covariate," can-not be rejected. It may, therefore, be said that achievement in Scientific Creativity was found to be Independent of the interaction between Treatment and Intelligence when Pre-achievement in Scientific Creativity was taken as covariate.

H_5: There is no significant difference in mean scores of Student Liking of Inductive Thinking Model and Traditional Method groups.

The fifth objective of the study was to compare mean scores of students Liking of Inductive Thinking Model and Traditional Method. The data related to this objective were analyzed with the help of t-test. The results are given in the table 5.

Table 5: Group-wise M, N, SD and t-value of students Liking

Group	M	N	SD	t- value
ITM	128.36	101	12.70	1.288**
TM	126.02	100	13.00	

**Not Significant at 0.01 level

From table 5, it can be seen that t-value is 1.288, which is not significant at 0.01 level. It indicates that mean scores of student liking of ITM and TM groups do not differ significantly. In this context, the null hypothesis, namely, "There is no significant difference in mean scores of student liking of Inductive Thinking Model and Traditional groups" cannot be rejected. Further, the mean scores of students liking of ITM group is 128.36 which does not differ significantly from mean scores of student liking of TM group which is 126.02. It may, therefore, be concluded that students taught through Inductive Thinking Model were found to have approximately same students liking as for those who were taught through Traditional method.

IX. CONCLUSIONS

1. Inductive Thinking Model was found to be effective in enhancing Scientific Creativity of class IX students.
2. Inductive Thinking Model group was found to be superior to Traditional Method group in enhancing Scientific Creativity.
3. Inductive Thinking Model group was found to be significantly superior in comparison to Traditional Method group when Pre-achievement in Scientific Creativity and intelligence were taken as covariates.
4. Achievement in Scientific Creativity was found to be independent on Gender when Pre- achievement in Scientific Creativity was taken as covariate.
5. Achievement in Scientific Creativity was found to be independent of the interaction between Treatment and Gender when Pre–achievement in Scientific Creativity was taken as covariate.
6. Achievement in Scientific Creativity was found to be independent on Intelligence when Pre-achievement in Scientific Creativity was taken as covariate.
7. Achievement in Scientific Creativity was found to be Independent of the interaction between Treatment and Intelligence when Pre-achievement in Scientific creativity was taken as covariate.

X. EDUCATIONAL IMPLICATIONS

1. The innovations in educational technology, especially in the field of models of teaching, are worth implementing and they must be employed after careful try out procedure.
2. In this age of heightened competition in an increasingly closed world it is essential that our school subjects introduce all such skills which are needed for the social survival of an intellectually developed individual.
3. Inductive Thinking Model in this direction can be eminent as they are not only compatible for enhancement of thinking traits but walk hand in hand with enhancement in academic achievement too.
4. Teaching and learning can be once be transformed into a fun filled meaningful activity by following these engrossing models of teaching.
5. These models can prove instrumental in attaining our micro as well as macro teaching objectives.
6. All subjects and all levels of students can be involved for further strengthening the research evidences generated by this study.
7. Standardized teaching modules, based on Inductive Thinking Model, in various subjects for different student population can also be constructed for getting results in the domain of education.
8. The research can also be extended in the field of other existing models of teaching.
9. Fresh models of teaching can be conceived, tried and tested for furthering enhancement in the educational outputs.

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