

EFFECT OF TABA'S INDUCTIVE THINKING MODEL ON ACHIEVEMENT IN SCIENCE AND CREATIVE THINKING IN RELATION TO INTELLIGENCE OF STUDENTS AT SECONDARY SCHOOL STAGE

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The present study intends to assess the effect of inductive thinking model of teaching on academic achievement in science and creative thinking in relation to intelligence of students at secondary school stage. For conducting the study, four public schools of Jalandhar City in Punjab (India) were selected randomly. Two sections of approximately 35 students were taken from each school. The experimental group was taught following the principles of the inductive thinking model of teaching while the control group was taught through the conventional method (lecture) of teaching. The findings of the study revealed that inductive thinking model was found to be effective in terms of achievement of students in Science. There was also a significant increase in originality, fluency, and flexibility of students when taught by Taba's Inductive Thinking Model.

KEYWORDS: Inductive Thinking Model, Academic Achievement, Creative Thinking, Intelligence.

INTRODUCTION

Innovations are directly or indirectly related to human inventiveness and creative abilities. As such, creative abilities need to be enhanced among all the individuals through appropriate means for the maximum benefit to the society. Education is the most effective means for the development of the

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innate abilities of the individuals, and thus appropriate educational programmes need to be evolved in the form of teaching methods, strategies and techniques for the development of creative potential among the learners. Even the best curriculum and the most perfect syllabus remain dead unless quickened to life by the right methods of teaching and the right kind of teacher. It seems that the teaching learning process has become more mechanical than meaningful. Suitable instructional strategies or techniques are required for achieving the educational objectives. This led researchers to explore various methods and techniques for the development of cognitive, affective and psychomotor domains. Today's classroom transaction systems provide little opportunity for creative pursuit. Keeping this view in mind, many models of teaching have been developed to enhance creativity and academic achievement among the learners.

Inductive thinking model of teaching is one such approach specifically meant for enhancing creativity and academic achievement among learners. Making our classrooms more interactive, interesting, and teaching through a creative programme will enable the students to feel that science is very practical, easy to learn and close to real life. To satisfy the needs of students of the 21st century new experiments, creative innovations, and appropriate strategies are being developed and tried out to improve education at all levels.

EFFECTIVENESS OF INDUCTIVE THINKING MODEL

According to Wittrock (1986), models of teaching are designed to shape and implement the strategies to help learners to develop their capacity to think clearly and wisely and build social skills and commitment. Inductive thinking model of teaching (ITMT), developed by Taba (1966) is a model under information processing family of teaching models designed to enhance the process of using information and environmental stimuli through training of mental operations. Hilda Taba's inductive thinking model envisages teaching through certain cognitive tasks. Its tasks induce the students to find and organize information, to create names for concepts and to explore ways of becoming more skilful at discovering or organizing information and at creating and confirming hypotheses describing relationship among sets of data.

Singh (1994) found that inductive thinking model was more effective than the traditional method in terms of achievement in Economics. Gupta (1995) concluded that concept attainment model and inductive thinking model were found to be superior to advanced organizer model of teaching for teaching the concepts of science to class-IX students. Naik (1996) found that inductive thinking model was effective in increasing reasoning ability as compared to the

conventional method and this model was more interesting for the pupils to learn through it. Alam (1997) looked into the effectiveness of inductive thinking and inquiry training models for teaching biology to secondary school students and found the effects positive. Kumar (2002) found that retention through the inductive thinking model has been found to be greater than through the traditional method. Bhardwaj (2009) conducted a study on the effectiveness of inductive thinking model and the study revealed that mean gain scores of students in economics taught through inductive thinking model was better than conventional method. Mondal (2013) indicated that both inductive thinking model (ITM) and advance organizer model (AOM) are equally effective on the criteria of immediate learning but AOM group establishes superiority than the ITM group on retention. Walia and Walia (2014) concluded that integrated syntax (AOM and ITM) enhanced student's attitude towards mathematics. Patel (2015) developed a teaching package in General Science for class X using inductive thinking model and it was found to be effective in terms of achievement of students in General Science. There are some other studies that have been conducted on the inductive thinking model of teaching and its impact on academic achievement and other cognitive variables by Bhattacharya (1984), Singh (1988), Baveja (1989), Gupta (1991), Singh (1994) and Hota (2000), whose results were found inconsistent. Many researches have been done in various subjects till date to find the effectiveness of concept attainment model and inductive thinking model of teaching and found that both strategies were equally good and effective (Aziz, 1990; Kochhar, 1993; Sanjiwani, 2005; & Wanjari, 2005).

ACADEMIC ACHIEVEMENT

Achievement signifies accomplishment or gain, or a performance carried out successfully by an individual on the completion of task. It means all those behavioural changes that take place in an individual as a result of learning experiences of various kinds. According to Dictionary of Education (2008), academic achievement is a measure of knowledge gained through formal education usually indicated by test scores, grade point average and degree. Achievement is concerned to a great extent with the development of knowledge, understanding and acquisition of skills (Rao, 1980). Achievement is the attainment or accomplishment of an individual in some or particular branch of knowledge after a certain period of training (Verma & Upadhyay, 1981). Howe (1997) found a positive relationship between academic achievement and intelligence of students. Kumari (1985) found that strategies of instruction, creativity and sex factors did not have any interaction effect on achievement of students.

Rengarajan (1999) found inquiry training model more effective than conventional method of teaching in terms of academic achievement and tolerance of ambiguity. Imtisingba (2003) found that intelligence and achievement motives of high school students revealed that the number of under achievers were highly intelligent which was four fold of normal achievers and two fold of over achievers. Mukherjee (2009) concluded that concept attainment model of instruction was more effective than traditional method of teaching in terms of achievement in Science. Kaur (2011) conducted a study on the effectiveness of concept attainment model of teaching on achievement in chemistry and found positive results. Basapura (2012) found that concept attainment model of instruction was more effective in terms of achievement as compared to the traditional method. Kumar (2012) studied effectiveness of concept attainment model of instruction on achievement of concepts in Physics and found positive outcomes. Billing (2013) explored that inductive thinking model of Teaching was better than that of traditional method of teaching on learner's achievement in History, Civics, and Geography. Prusty (2015) explored that inductive thinking model has better impact on student's achievement in History than the traditional method of teaching.

CREATIVE THINKING

Craft (2006) has suggested that fostering creativity with wisdom could help to nurture the learner's moral development. On such occasions, a teacher needs to clear the notion of creativity in general and problem solving in particular subject. Creative Thinking is defined in the dictionary of the American Psychological Association (Vanderbos, 2006) as mental processes leading to a new invention, solution, or synthesis in any area. Creative thinking is a thinking style that enables the individuals to produce new and authentic products, find new solutions, and reach a synthesis. A creative person is the one who searches for the new fields, makes new observations, makes new guesses, and propose new implications. Creative people need to have the ability to think fluently, authentically, and flexibly (Torrance, 1965).

There are critical ideas about framework of creativity in general concept, such as Torrance (1965) who has described that the components of creativity involved a number of abilities and were not a unitary factor, and Guilford (1963) agreed that there are a number of components of creativity, that are different for a scientist or a musician than a mathematician. Some of the most commonly listed creative traits are fluency, flexibility, originality, elaboration, and redefinition, as noted by Torrance (1965). Burt (1970) has listed the traits of creativity composed of fluency, divergent association, receptivity, and insight

into a problem's solution. Whereas, Guilford (1970) defined the abilities of creativity as fluency, flexibility and originality that come under general heading of divergent thinking. Gill (1990) found that irrespective of training, introverts and students with high I.Q. scored higher on originality in solving mathematical problems. He also found that right brain training emerged as superior strategy so far as creative problem solving in mathematics was concerned.

There have been numerous interesting studies conducted on creativity (Chan & Chan, 2007) including the impact that individual artistic techniques have on the development of creativity. Different studies (Getzels, & Jackson, 1962; Yamamoto, 1964; & Barron, 1988) that searched for a correlation between intelligence and creativity indicated that all combinations were possible between intelligence and creativity. Some researchers (Getzels, 1962; Marjoribanks, 1976; Asha, 1980; Mahmodi, 1998; Ai, 1999; & Karimi, 2000) found that there is a relationship between creativity and academic achievement. Other researchers (Edwards, 1965; Mayhon, 1966; Tanpraphat, 1976; Behroozi, 1997; & Nori, 2002) showed that creativity was not related to academic achievement in any significant way. However, Ai (1999) referred to others who investigated this matter (Bentley, 1966; Smith, 1971; Shin, & Jacobs, 1973) and deduced that creativity was actually correlated with advanced levels of academic achievement. Al-Mehasen (2000) examined the effect of a suggested method that was derived from Creative Thinking researches on Creative Thinking of higher primary school students in science. The results indicated that there was a significant difference between the Experimental and Control Groups in the fluency, flexibility and originality skills in favour of the Experimental Group. Ismail (2000), Khatab (2007), & Al Zaidy (2009) found positive correlation between academic achievement and creative thinking. The study indicated that every aspect of creative thinking is predicting a relationship with academic achievement (Anwar, Anees, Khizar, Naseer, & Muhammad, 2012). Meenakshi (2015) revealed that inductive thinking model was found to be effective in terms of achievement in scientific creativity of class IX students.

INTELLIGENCE

Intelligence is the ability and capacity to learn and carry out abstract thinking to respond appropriately to a new situation. Intelligence has been of great interest to educators because of its relationship to classroom learning and school achievement (Sternberg & Kaye, 1982). The most important factor affecting achievement is intelligence. The magnitude of relationship between

intelligence and achievement is found to differ from study to study, perhaps due to different intelligence tests used.

Patak (1961) reports a positive relation between intelligence and creativity. Yamamoto (1964) found positive correlation between intelligence and creativity ranging from 0.33 to 0.39. Naidu and Aron (1969) reported significant correlation at 0.01 level between IQ and academic achievement of high school students. Passi (1971) was of the opinion that creativity and intelligence were significantly related. Sharma (1974) reported that there was no relationship between creativity, and intelligence. Richard (1979) administered a test of intelligence and creativity on school children and found that intelligence and school achievement was positively related. Siotter (1981) studied a sample of 202 male and female students studying in class 10th and reported significant relationship between intelligence and academic achievement.

Levine (1983) tested a sample of 50 students on creativity and intelligence and the findings revealed that the two factors are significantly related at 0.01 level. Singh (1990) studied the relationship of intelligence and attitude on science achievement and the findings indicated that there was effective relationship between intelligence, attitude and achievement. Kaur (1991) found that for teaching of concepts in economics AOM is more effective than CAM, and the interaction between teaching strategies, intelligence and creativity were not found to be significant. Most of the studies indicate a significant positive relationship between intelligence and achievement (Sween, 1984; Trama, 2002). Yadav (2015) indicated that the intelligence and self-concept of the students affect in a positive way the creative thinking of the students. George and Rajaguru (2016) indicated the strong positive relationship between intelligence and academic achievement of tribal and non-tribal children.

NEED OF THE STUDY

In the present scenario, students no longer want to be passive recipients in getting the information rather they want to be active participants in the learning process. For this reason, there is a need to adopt innovative instructional strategies and methods especially for teaching a subject like science. There is no single or best method of teaching but alternative approaches to teaching based on instructional goals, type of content and learner characteristics are now available. As teachers, we have to always keep in mind that students are an important part of the teaching - learning process and that method of teaching employed makes a lot of difference to what is

learned and how it is learned. From the appraisal of above given research studies it has been found that models of teaching are effective in the teaching-learning process. But very few studies have been conducted for inductive thinking model by taking into account creative thinking, achievement in science and intelligence of students. So the investigator felt the need to study the effectiveness of inductive thinking model on achievement in science and creative thinking in relation to intelligence of students at secondary school stage.

OBJECTIVES OF THE STUDY

Following are the objectives of the study:

1. To identify students with high intelligence and low intelligence.
2. To study the effect of Taba's inductive thinking model on creative thinking and academic achievement of students in science.

HYPOTHESES OF THE STUDY

Following are the hypotheses of the study:

1. H1: There is no significant difference in the creative thinking and academic achievement gain scores of students in science taught through Taba's inductive thinking model and conventional method.
2. H2: There is no significant difference in the creative thinking and academic achievement gain scores of students in science with high intelligence and low intelligence.
3. H3: There is no interaction between method of instruction and intelligence on the creative thinking and academic achievement gain scores of students in science.

SAMPLE OF THE STUDY

In order to conduct the present study, two intact sections of approximately 35 students were taken as sample from each of the four randomly selected public schools of Jalandhar City. The experimental group was taught following the principles of the inductive thinking model of teaching and the control group was taught through the conventional method (lecture method) of teaching. On the basis of intelligence, in each section, 30% top students were taken as high intelligence students and 30% bottom students were taken as low intelligence students on which further investigation was carried out. In the final stage of data collection the sample was restricted to 168 students.

TOOLS USED

The following tools have been used in the study:

1. Lesson plans based on Taba's Inductive Thinking Model prepared by the investigator.
2. Achievement test prepared by the investigator.
3. Intelligence test – Measuring intelligence with culture fair tests by Cattell and Cattell.
4. Creative Thinking test by Dr. Baquer Mehdi.

METHOD AND PROCEDURE OF THE STUDY

Intelligence test was administered to identify students with high intelligence (H.I.) and low intelligence (L.I.). The achievement test and creative thinking tests were administered to both the groups i.e. experimental group and control group prior to teaching. After the completion of teaching, post-tests were administered to students of both the groups. The present study employed an experimental method with 2x2 factorial designs on the creative thinking and academic achievement gain scores of students in science.

ANALYSIS AND INTERPRETATION OF THE DATA

The means and SDs of sub-groups for 2x2 design of ANOVA on the academic achievement gain scores in science have been calculated and are presented in Table 1.

Table 1

Means of Sub-Groups of ANOVA for 2×2 Design in Respect of Academic Achievement Gain Scores in Science.

	Experimental Group	Control Group	
H.I.	$M_1 = 1.62$ $\sigma_1 = 0.74$	$M_2 = 0.52$ $\sigma_2 = 0.65$	$M_1M_2 = 1.07$
L.I.	$M_3 = 1.57$ $\sigma_3 = 0.66$	$M_4 = 0.48$ $\sigma_4 = 0.58$	$M_3M_4 = 1.02$
	$M_1M_3 = 3.19$	$M_2M_4 = 1.00$	

The means and SDs of sub-groups for 2x2 design of ANOVA in respect of three different traits of creative thinking i.e. Originality (O), Fluency (FN) and Flexibility (FL) have been calculated and are presented in Table 2.

Table 2
Means of Sub-Groups of ANOVA for 2×2 Design in Respect of Three Different Traits of Creative Thinking.

Traits		Experimental Group		Control Group		
		Mean	σ	Mean	σ	
O	H.I	M ₁ = 5.10	σ ₁ = 1.68	M ₂ = 3.10	σ ₂ = 2.95	M ₁ M ₂ = 4.1
	L.I	M ₃ = 5.12	σ ₃ = 1.68	M ₄ = 3.16	σ ₄ = 1.32	M ₃ M ₄ = 4.14
		M ₁ M ₃ = 5.11		M ₂ M ₄ = 6.26		
FN	H.I	M ₁ = 4.12	σ ₁ = 1.57	M ₂ = 2.90	σ ₂ = 1.51	M ₁ M ₂ = 3.51
	L.I	M ₃ = 4.17	σ ₃ = 1.56	M ₄ = 2.95	σ ₄ = 1.46	M ₃ M ₄ = 3.56
		M ₁ M ₃ = 4.145		M ₂ M ₄ = 2.925		
FL	H.I.	M ₁ = 3.40	σ ₁ = 1.41	M ₂ = 2.90	σ ₂ = 1.36	M ₁ M ₂ = 3.15
	L.I.	M ₃ = 3.41	σ ₃ = 1.414	M ₄ = 2.93	σ ₄ = 1.37	M ₃ M ₄ = 3.17
		M ₁ M ₃ = 3.405		M ₂ M ₄ = 2.915		

In order to analyse the variance in academic achievement gain scores in science and in traits of creative thinking, the gain scores obtained were subjected to ANOVA and the results have been presented in Table 3.

Table 3
Summary of ANOVA For 2×2 Design in Respect of Academic Achievement Gain Scores in Science and Three Different Traits of Creative Thinking.

Source of Variance	Academic Achievement Gain Scores in Science		Three Different Traits of Creative Thinking					
			Originality (O)		Fluency (FN)		Flexibility (FL)	
	MSS	F-Ratio	MSS	F- Ratio	MSS	F-Ratio	MSS	F-RATIO
Method Of Instruction (A)	50.38	121.39**	162.05	70.76**	61.93	26.35**	10.00	5.05*
Intelligence (B)	0.10	0.24	0.15	0.06	0.1	0.04	0.053	0.03
Interaction (AxB)	0.6	1.44	17.51	7.65**	4.52	1.92	0.01	0.05
Within	68.15	1	2.29	1	2.35	1	1.98	1

*df*for variables =1, *df*for within =164, *Significant at 0.05 level, **Significant at 0.01 level of confidence

Method of Instruction (A)

It may be observed from Table 3 that F-ratio for the difference between means of two groups viz., experimental and control group on the academic achievement gain scores in science was found to be significant at the 0.01 level of confidence. This indicates that two groups differ significantly on the mean academic achievement gain scores in science. It may also be observed from Table 3 that F-ratio for the difference between means of two groups on Trait I

i.e. 'Originality', Trait II i.e. 'Fluency' and Trait III i.e. 'Flexibility' of creative thinking was found to be significant either at the 0.05 or 0.01 level of significance. Hence H1 i.e. There is no significant difference in the creative thinking and academic achievement gain scores of students in science taught through Taba's inductive thinking model and conventional method stands rejected. Thus, the rejection of the hypothesis H1 implies that the inductive thinking model performed better than the conventional method of teaching on students' achievement in science and in creative thinking.

Further analysis of means suggests that experimental group i.e. students taught by inductive thinking model have yielded higher academic achievement gain in science than the control group i.e. students taught by conventional method of teaching. The examination of respective group means for all the three traits of creative thinking from Table 2 suggests that the experimental group was found to score more in all the three traits than the control group. Thus, the present investigation reveals that students taught through Taba's inductive thinking models developed different dimensions of creative thinking viz. originality, fluency and flexibility than the students taught by conventional method of teaching.

The present finding is in tune with the study of Sween (1984) who stated that academic achievement in relation to instructional design and intelligence is having a positive relationship. There are some studies, which have been conducted on inductive thinking model of teaching and its impact on academic achievement in various subjects and found positive results (Sanjiwani, 2005; Bhardwaj, 2009; Billing, 2013; Patel, 2015; & Prusty, 2015). Gill (1990) found that irrespective of training, introverts and students with high I.Q. scored higher on originality in solving mathematical problems.

Intelligence (B)

It may be observed from Table 3 that F-ratio for the difference between means of students with high intelligence and low intelligence on the academic achievement gain scores in science was not found to be significant even at the 0.05 level of significance. It may also be observed from Table 3 that F-ratio for the difference between means of students with high intelligence and low intelligence on the gain scores of three different traits of creative thinking were not found to be significant even at the 0.05 level of significance.

Hence H2 i.e. There is no significant difference in the creative thinking and academic achievement gain scores of students in science with high intelligence and low intelligence" is accepted. Thus, the present investigation reveals that high intelligence and low intelligence is not related to academic achievement

gain scores of students. The results were in tune with the findings of Kaur (1991) who concluded that there exists no significant difference in creative thinking gain scores of high intelligence students and low intelligence students.

Method x Intelligence (A x B)

It may be observed from Table 3 that F-ratio for the interaction between method of instruction and intelligence on the academic achievement gain scores in science was not found to be significant even at the 0.05 level of significance. It may also be observed from the table that F-ratio for the interaction between method of instruction and intelligence on traits II and III, i.e. 'Fluency' and 'Flexibility' respectively were not found to be significant even at the 0.05 level of significance. Hence H3 i.e. There is no interaction between method of instruction and intelligence on the creative thinking and academic achievement gain scores of students in science” is accepted. It may be, therefore, concluded that there was no difference in the academic achievement gain scores and creative thinking gain scores due to interaction of method of instruction and intelligence.

The present findings are in tune with the study of Kumari (1985). She found that strategies of instruction, creativity and sex factors did not have any interaction effect on academic achievement of students. Since the interaction between method of instruction and intelligence on the gain scores of 'Originality' i.e. Trait I of creative thinking was found to be significant. To find out the inter-difference between various sub-groups, due to which interaction was found to be significant, t-ratios were compared and are presented in Table 4.

Table 4
Table Showing t-Ratios of Means of Sub-Groups of Originality.

Sub-Groups	M _D	SE _D	t-ratio
M ₁ -M ₂	2.00	0.35	5.70**
M ₁ -M ₃	0.02	0.37	0.054
M ₁ -M ₄	1.94	0.33	5.88**
M ₂ -M ₃	2.02	0.35	5.77**
M ₂ -M ₄	0.06	0.30	0.20
M ₃ -M ₄	1.96	0.30	5.94**

df= 164 *Significant at the 0.05 level **Significant at the 0.01 level

It may be observed from Table 4 that t-ratios for the inter-difference between various sub-groups of originality i.e. M1-M2, M1-M4, M2-M3 and M3-M4 are significant at the 0.01 level of significance. The present study is in tune with the findings of Malhotra (1990). He found that synectics model showed more improvement on the factors of fluency, flexibility, originality and elaboration. This improvement had a high positive correlation with the intelligence levels of the students.

This suggests that,

- a) Students who were taught through inductive thinking model with high intelligence have yielded higher gain in originality than students who were taught in a conventional manner.
- b) Students who were taught through inductive thinking model with high intelligence have yielded higher gain in originality than students who were taught in a conventional manner with low intelligence.
- c) Students who were taught through inductive thinking model with low intelligence have yielded higher gain in originality than students who were taught in a conventional manner with high intelligence.
- d) Students who were taught through inductive thinking model with low intelligence have yielded higher gain in originality than students who were taught in a conventional manner with low intelligence.

EDUCATIONAL IMPLICATIONS

The present study has the following significant educational implications in the field of education:

1. It is highly desirable to teach science through inductive thinking model while developing creative thinking and academic achievement.
2. Teacher education programmes in India should incorporate training for a variety of models of teaching so that tomorrow's teachers are more rational and flexible in selection and use of teaching strategies suitable to pupil's characteristics and their needs.
3. These models can prove instrumental in attaining our micro as well as macro teaching objectives.
4. All subjects and all levels of students can be involved for further strengthening the research evidences generated by this study.
5. Inductive thinking model should be considered as an integral part of the methodology used for teaching concepts in science to secondary class students.

6. More so, it has got implication for textbook writers who could use the principle of Taba's inductive thinking model while writing the textbooks for science.

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