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A Comparative Study of The Effectiveness of Science Inquiry Model And Advance Organiser Model in Achievement In Biology

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Abstract
Science Inquiry Model lays stress on understanding the content and process of science and scientific investigations. Even today, lecture method is commonly used method of teaching in the classroom. Most teachers give lectures without understanding the cognitive structure of students which results in poor learning. To solve this problem of teachers, Advance Organiser Model is a novel teaching strategy through which organized bodies of content can be taught in a meaningful way keeping in mind the cognitive map of learner. Simple ideas are presented first to the students followed by complex ideas so that learning can take place in sequential and integrated manner. In this habit of precise thinking and interest in Inquiry can be developed among the learners.
This experimental study determined the Effectiveness of Science Enquiry Model , Advance Organiser Model and Conventional Method of teaching in achievement in Biology . In the research paper, pre-test, experimental treatment and post-test design was employed. It involved three groups of students, two experimental groups and one control group. The Experimental Group-I was taught Biology through Science Enquiry Model. Experimental Group-II was taught Biology through Advance Organiser Model and the Control Group was taught Biology through Conventional Method. The design comprised three stages. The first stage involved pre-testing of all the students of three groups on achievement in Biology, Intelligence and Socio-Economic Status . The second stage involved treatment of twenty weeks. The experimental treatment consisted of teaching of four units of Biology through Science Inquiry Model to Experimental Group-I, through Advance Organiser Model to Experimental Group-II and through Conventional Method to Control Group. In the third stage, the students were post tested on Achievement in Biology and Self-Concept. Purposive sampling was used for the research paper. D.A.V. Centenary Public School, Sirsa was selected. Four sections of IXth class were taken. These were divided in to Experimental Group - I and Experimental Group - II and Control Group having 60 students in each group. The Experimental Group - I, Experimental Group - II and Control Group were equated on Mental Ability or Intelligence and Socio-Economic Status. After equating the groups there were 40 students in Each Experimental Group - I, Experimental Group - II and Control Group. Results indicated that the students who were taught Biology through Science Enquiry Model and Advance Organiser Model have shown significant improvement in the Achievement in Biology than the students who were taught through Conventional Method. The group of students taught Biology through Advance Organiser Model have shown significantly higher gain in achievement than the group of students taught Biology through Science Inquiry Model.

Key Words
Science Inquiry Model, Advance Organizer Model , Effectiveness , Achievement, Biology

Introduction

'Education' is generally conceived as a process or method of learning and training that moulds the whole of human personality in different dimension. It modifies man's experience, transforms his instinctive urges and impulses and determines his attitudes and beliefs. Education enables man to draw out his hidden talents. It trains him to increase his productivity and thus it helps him to render more effective service to society. The basic purpose lying at the very root of every plan and programme of education is evidently growth of the student into full-fledged responsible citizens. Education is evidently a process through which desirable changes in the behavior of a child in terms of knowledge, value, skills, attitudes etc. are expected to be brought about. In school desirable attitude, knowledge and beliefs are inculcated in him through the teaching of different subjects and a regular course of training.

Teaching is often thought of as something that comes rather naturally to people who know their subject. In general, it is thought that it is a simple process that produces simple outcomes. But teaching is an intriguing, important and complex process. It is true that teaching is a process by which teacher and students create a shared environment including sets of values and beliefs which in tern color their view of reality.

Model is a pattern of something to be made or reproduced and means of transferring a relationship or process from its actual setting to one in which it can be more conveniently studied. In the point of view of teaching, a model of teaching is to improve the instructional effectiveness in an interactive atmosphere and to improve or shape of curriculum. Model of teaching are the innovative practices which have drawn the attention of educational researchers and teachers since last few years.

Joyce and Weil (1980) have identified 23 models of teaching which are classified into four families – Information processing models, personal models, social Interaction models and behavioral modification models. Information processing may be defined as the ways people handle stimuli from the environment, organize data, sense problems etc. The goals of information processing models are to help individuals to acquire knowledge through an analysis of data from the world around us. They aim at intellectual growth of the individual. These models of teaching are inductive thinking model, inquiry training model, concept attainment model, cognitive growth model, biological Science Inquiry Model, Advance Organiser Model, memory and group investigation.

Science Inquiry Model: Science Inquiry is one of the learner centered approach propounded by J. Schwab (1965) to teach scientific knowledge and to develop interest in scientific inquiry.

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Not only can the nature of science but process of research in Biology also be introduced to students. They can also learn planning and execution of projects and self learning involving acquisition of knowledge through observation of phenomena, creative thinking and activities.

Science Inquiry Model is based on Science Curriculum Study. This approach emphasizes the need to teach students to process information using technique similar to those of research biologists (Joyce & Weil 1980). In this way, students are able to identify the problems and use a particular method to solve them. Science Curriculum Study stresses the need to understand content and processes. Generally people understand only products of science and not the process of science. It is however clear that understanding of products can't be attained adequately unless the process of science is understood.

Advance Organiser Model: Advance Organiser Model is a deductive, expository, sequential and interactive teaching strategy propounded by David P. Ausubel (1968). It is designed to teach hierarchically organized content by strengthening cognitive structure of learners. Broad concepts or more inclusive ideas are placed at the top and narrow or less inclusive ideas are arranged at lower levels of the hierarchy.

Advance Organiser Model is the derivative of theory of meaningful verbal learning. According to Ausubel, mind is an information processing and information storing system where ideas and concepts are stored that constitutes the cognitive structure of an individual. Learning and retention take place only if new ideas are subsumed in already available concept. If an individual does not possess ideational anchors, new ideas or concepts can't be related and meaningful learning does not occur. A person's cognitive structure is the fore most determinant whether the new knowledge being transmitted to him would be meaningful and how it is acquired and retained. Cognitive structure of a child, therefore, needs to be strengthened before new learning material is communicated to him.

Rationale of The Study

Change is a very important phenomenon of the present age and it affects the life of each and every individual. The world of today is changing rapidly because of the fast changes in the field of science and technology. Thus science is a compulsory subject in the schools has become the needs of the hour as also envisaged by different education commissions and committees right from Secondary Education Commission (1955) to National Education Policy (1986). This scientific revolution going at an ever accelerating pace for the past few decades that science teaching became inevitable. Thus for progress of the country, it is required that its citizens successfully understand and practice the concepts and principles of science. Thus emphasis should be laid on basic principles, concepts and generalizations rather than on information and facts.

Looking into the practical situation, the researcher felt that there is need to use such as teaching strategy which can motivate students to learn. Science Inquiry Model lays stress on understanding the content and process of science and scientific investigations. Through this model, open mindedness, independent thinking, cooperative skill, problem solving skill and interest in inquiry can be developed among students which are the dire needs of the present. Traditional method of teaching is just the transmission of knowledge but Science Inquiry Model of teaching provides scientific knowledge as well as inculcated habit of searching more knowledge through inquiry approach. Therefore researcher has planned to study the Effectiveness of Science Inquiry Model in attaining Mastery in Biology.

Even today, lecture method is commonly used method of teaching in the classroom. Most teachers give lectures without understanding the cognitive structure of students which results in poor learning. To solve this problem of teachers, Advance Organiser Model is a novel teaching strategy through which organized bodies of content can be taught in a meaningful way keeping in mind the cognitive map of learner. Simple ideas are presented first to the students followed by complex ideas so that learning can take place in sequential and integrated manner. In this habit of precise thinking and interest in Inquiry can be developed among the learners. The researcher has, therefore, selected Advance Organiser Model to test its effectiveness in attaining Mastery in Biology.

Since some long term effects of both the models e.g. interest in Inquiry are common, researcher has planned to study the relative Effectiveness of Advance Organiser Model and Science Inquiry Model in the classroom situation.

In India, research in the area of models of teaching has been gaining momentum since last decade. Researchers have compared Advance Organiser Model with other teaching strategies. An experimental study using Ausubel's and Burners strategy to ascertain their Comparative Effectiveness with Traditional Method for teaching of Mathematics was conducted by Chitrive (1983). The relative Effectiveness of two different types of Advance Organiser on learning was studied by Ghosh (1985). The effectiveness of Advance Organiser Model and Inquiry Training Model for teaching social studies was compared by Pandey (1986). The instructional material using Advance Organiser Model and Operant Conditioning Model for teaching Educational psychology was developed and compared by Buddhisagar (1987). The effect of Advance Organiser Model, Concept Attainment Model and traditional Method on conceptual learning efficiency and retention in relation to divergent thinking was investigated by Jaimini (1990). The effect of Advance Organiser Model and Concept Attainment Model on achievement of pupils was studied by Mujeeb (1991).

Ranjana (1992) conducted a study on the Effectiveness of Mastery Learning Strategy on VI graders in the subject of science and reported that students taught through Mastery Learning Strategy showed significant improvement in the achievement, Self-Concept and classroom trust behavior.

Studies were conducted to compare the Effectiveness of Concept Attainment Model and Biological Science Inquiry Model (Sushma Kumari, 1988), Concept Attainment Model, Inductive Thinking Model and Advance Organiser (Gupta, 1995) and Halda Taba's Inductive Thinking Model and Advance Organiser Model (Khare, 2000). It is evident from this brief survey of researches conducted in India on the use of Advance Organize Model and Science Inquiry Model that very little work has been done to test their effectiveness in Indian situations and to adapt them to our peculiar need Effectiveness of Science Inquiry and Advance Organiser Models in attaining Mastery in Biology particularly has not been attended to adequately. Since the subject is gaining importance in school curriculum and has been made compulsory up to secondary level, research to use Advance Organiser Model and Science Inquiry Model to improve pupil's achievement in science needs to be conducted.

Statement of The Problem

"A COMPARATIVE STUDY OF THE EFFECTIVENESS OF SCIENCE INQUIRY MODEL AND ADVANCE ORGANISER MODEL IN ACHIEVEMENT IN BIOLOGY"

Objectives

1. To compare the mean achievement scores, on the criterion achievement test in Biology, of the three groups of students, to be taught Biology with the use of Science Inquiry Model , Advance Organiser Model and Conventional Method of teaching before the experimental treatment.
2. To compare the mean achievement scores, on the criterion Achievement Test in Biology, of the three groups of students, to be taught Biology with the use of Science Inquiry ModeI , Advance Organiser Model and Conventional Method of teaching after the experimental treatment.
3. To compare the mean gain scores , on the criterion Achievement Test in Biology, of the three groups of students, to be taught Biology with the use of Science Inquiry Model, Advance Organiser Model and Conventional Method of teaching after the experimental treatment.

Hypotheses

In order to realize the objectives of the research following hypotheses were tested.

H1 There is no significant difference in the mean score, on the criterion Achievement Test in Biology, of the three groups of students, to be taught Biology with the use of Science Inquiry Model , Advance Organiser Model and Conventional Method of teaching before the experimental treatment.

H2 There is a significant difference in the mean scores, on the criterion Achievement Test in Biology, of the three groups of students, to be taught Biology with the use of Science Inquiry Model, Advance Organiser Model and Conventional Method of teaching after the experimental treatment.

H3 There is a significant difference in the mean gain scores, on the criterion Achievement Test in Biology, of the three groups of students, to be taught Biology with the use of Science Inquiry Model, Advance Organiser Model and Conventional Method of teaching after the experimental treatment.

Delimitations

Keeping in view the constraints of time and resources, certain delimitations need to be imposed for conducting the study. Following were the delimitations of the present paper.

1 The study was confined to a single Centenary Public School at Sirsa in Haryana only.
2 The sample was chosen from IXth class only.
3 Only four units from Biology syllabus of IXth class have been selected for collecting the data.
4 The study was conducted in the subject of Biology only.
5 The experiment was limited to twenty weeks of the academic session.
6 Although there are various teaching models . the research paper was confined to Science Inquiry Model and Advance Organiser Model only.

The study can be conducted on a variety of other educational outcomes but it was conducted only on achievement

Design

In the research paper, pre-test, experimental treatment and post-test design was employed. It involved three groups of students, two experimental groups and one control group. The Experimental Group-I was taught Biology through Science Inquiry Model. Experimental Group-II was taught Biology through Advance Organiser Model and the Control Group was taught through Conventional Method. The design comprised three stages. The first stage involved pre-testing of all the students of three groups on achievement in Biology, Intelligence, Socio-Economic Status and Self-Concept.

The second stage involved treatment of twenty weeks. The experimental treatment consisted of teaching of four units of Biology through Science Inquiry Model to Experimental Group-I, through Advance Organiser Model to Experimental Group-II and through Conventional Method to Control Group. In the third stage, the students were post tested on Achievement in Biology.

The Sample

Purposive sampling was used for the research paper. D.A.V. Centenary Public School, Sirsa was selected. Four sections of IXth class were taken. These were divided in to three Groups i.e. Experimental Group - I and Experimental Group - II and Control Group having 60 students in each group.

The Experimental Group - I, Experimental Group - II and Control Group were equated on Mental Ability or Intelligence and Socio-Economic Status. After equating the groups, there were 40 students in Each Experimental Group - I, Experimental Group - II and Control Group.

Variables

In the experimental researches the relationship between three types of variables namely independent ,dependent and intervening variables are studied. All these three kinds of variables which were identified for the study are discussed below.

Independent Variables

Different methods of teaching which were used in the research paper to see their effect on achievement of pupils in Biology and Self-Concept constitute the independent variables. The experimental Group-I was taught Biology through Science Inquiry Science Inquiry Model, Advance Organiser Model and Conventional Method were the three independent variables for the research paper.

Dependent Variables

Achievement in Biology and Self-Concept were the dependent variables. These variables were measure twice during the course of the study first before the experimental treatment which is pre-test stage and then after providing experimental treatment i.e. post-test stage.

Intervening variables

There are certain variables which have their effect on the learning outcome. These variables, known as intervening variables, can influence both.

It is necessary to control all those variables that may effect the dependent variables. Hence suitable: the independent and dependent variables. Different intervening variables in a research study can be nature of school, grade level, subject to be taught, intelligence of pupils, Socio-Economic Status of pupils, previous knowledge of pupils etc. These intervening variables were controlled either experimentally or statistically.

Control Employed : Control were employed for each such variables.

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Nature of school : The sample was selected from a single school in Sirsa (Haryana) . It was a D.A.V. Centenary Public School situated in Barnala Road, Sirsa.
Grade level : IXth class selected for the research paper and grade level was thus kept constant during the study.
Subject: All the three groups were taught same units of Biology.
Socio-Economic status: This variable was controlled experimentally .
Intelligence of pupils: This variable can greatly affect the achievement of pupils. It was also controlled by experimentally.

Tools Used

For the purpose of collecting data related to different variables covered in this study, following tools were used.
Biology Achievement Test (Developed by the investigator himself) to measure the achievement of pupils in Biology.
Raven's Progressive Matrices developed by J.C. Raven to measure the intelligence of students.
Socio-Economic Status Scale by Dr. Gyanendra P. Srivastva measure the Socio-Economic Status of the Student.

Experimental Procedure

It consisted of three stages: (i) Pre-testing (ii) Experimental treatment (iii) Post-testing.
Pre-testing
Before the commencement of experiment, pre-tests were conducted. They were administered in all the three groups by the investigator himself. Cooperation of the class teacher was sought for conducting the tests properly. All the instructions were explained clearly to the students before administering the test.
Experimental Treatment:
After pre-testing the experimental treatment of teaching Biology to Class IX students was started. All the three groups Control Group, Experimental Group-I and Experimental Group - II were taught by the investigator himself. The Control Group was taught through Conventional Method of teaching. Experimental Group-I and Experimental Group-II were taught through Science Inquiry Model and Advance Organiser Model respectively. Content of the Biology was identified for the experiment. Four Chapters/ Major concepts and twenty nine sub concepts were analyzed and arranged in proper sequence.
The treatment was of 20 weeks duration for both the groups. The researcher taught Control Group through Conventional Method of teaching Experimental Group-I through Science Inquiry Model and Experimental Group-II through Advance Organiser Model on the same day the same content. This was done to avoid carry over effects of one teaching strategy into other. The time was of one period (40 minutes) duration only so that schedule of schools was not disturbed.
Post- Testing
After teaching the contents to all the three groups, the students were given post – tests.

Statistical Analysis

Statistics has become an indispensable tool for research. It is fundamental to the proper analysis of data. In order to achieve the objectives of the study, the data collected was statistically analyzed using the following techniques.
1. Analysis of variance (ANOVA) was used on pre-test, post-test and gain scores of Achievement Test in Biology . Analysis of variance was also used on pre-test Intelligence test scores and Socio-Economic Status score of control variables'
2. Mean and Standard Deviations were used on pre-test, post-test and gain scores of Achievement Test in Biology.
3. "t" test was applied for testing the significance of difference between the Experimental Group - I, Experimental Group - II and Control Group on means achievement scores and means gain scores of post testing stage.

Interpretation of The Results

In the scheme of this study, students Achievement in Biology is the first outcome variable. This has been studied here focusing on the following objectives:
1. To compare the mean achievement scores, on the criterion Achievement Test in Biology, of the three groups of student, to be taught Biology with the use of Science Inquiry Model , Advance Organiser Model and Conventional Method of teaching, before the experimental treatment.
2. To compare the mean achievement scores , on the criterion Achievement Test in Biology, of the three groups of students, to be taught Biology with the use of Science Inquiry Model, Advance Organiser Model and Conventional Method of teaching, after the experimental treatment.
3. To compare the gain scores, on the criterion Achievement Test in Biology, of the three groups of students, to be taught Biology with the use of Science Inquiry Model, Advance Organiser Model and Conventional Method of teaching, after the experimental treatment.

Student's Achievement in Biology of the three groups have been compared by employing analysis of variance (ANOVA). The ANOVA results are given in Table: 1.1 to 1.4 and 1.8 and 1.9.
The three groups have been further compared using 't' test. For this purpose, the Table: 1.5 to 1.7 and 1.10 to 1.12 provide the mean, standard deviation and 't' values in respect of post-test and gain scores of experimental and control groups of students.

i) Comparison of mean achievement scores of Experimental Group - I, Experimental Group - II and Control Group, before the experimental treatment.

Table: 1.1 and 1.2 provide ANOVA results of student's Achievement in Biology before the experimental treatment i.e. at pre test.

Table: 1.1 :ANOVA for the Pre-Test Achievement Scores Sums, Squares Sums and Means of Experimental Group - I, Experimental Group - II & Control Group

Group	N	Pre- Test Achievement Scores			
		$\sum X$	$\sum X^2$	Mean	S.D.
Experimental Group – I	40	675.00	11813.00	16.87	±4.26
Experimental Group – II	40	700.00	13090.00	17.50	±5.68
Control Group	40	645.00	10705.00	16.12	±3.45
Total	120	2020.00	35608.00	50.49	

Table: 1.2 : Summary of ANOVA for the Pre-Test Achievement Scores in Biology Between Experimental Group - I, Experimental Group - II &Control Group

Sources of Variance	Degree of freedom (df)	Sum of Squares (S.S.)	Mean Squares (M.S.)	F Value	Level of Signifi-cance
Between	(3 -1) = 2 (a-1)	37.92	18.96	18.96 / 13.39 = **1.41**	Not significant at 0.01 level of signifi-cance
Within	(120-3) = 117 (N-a)	1566.75	13.39		

It is clear from the above Table: 1.2 that the F value of 1.41 for df (2,117) for the Experimental Group - I, Experimental Group - II and Control Group is not significant at 0.01 level. This reveals that there is no significant difference in the pre-test mean achievement scores of two Experimental Groups and Control Group.

ii) Comparison of mean achievement scores of the Experimental Group - I, Experimental Group - II and Control Group after the experimental treatment.

ANOVA results of students Achievement in Biology after the experimental treatment i.e. Post –test stage are provided in Table: 1.3 and Table: 1.4.

Table: 1.3 : ANOVA for Post-Test Achievement Scores Sums, Square Sums and Means of Experimental Group - I, Experimental Group - II & Control Group

Group	N	Post- Test Achievement Scores			
		$\sum X$	$\sum X^2$	Mean	S.D.
Experimental Group – I	40	1198.00	36444.00	29.95	±5.14
Experimental Group – II	40	1309.00	43825.00	32.72	±5.42
Control Group	40	0997.00	25325.00	24.92	±4.77
Total	120	3504.00	105594.00	87.59	

Table: 1.4 : Summary of ANOVA for Post- Test Achievement Scores in Biology Between Experimental Group - I, Experimental Group - II & Control Group

Sources of Variance	Degree of freedom (df)	Sum of Squares (S.S.)	Mean Squares (M.S.)	F Value	Level of Signifi-cance
Between	(3 -1) = 2 (a-1)	1250.55	625.27	6125.27 / 17.32 = **36.11**	Signifi-cant at 0.01 level of signifi-cance
Within	(120-3) = 117 (N-a)	2026.65	17.32		

Table: 1.4 indicate that the F- value of 36.11 for df (2,117) for the Experimental Group – I, Experimental Group - II and Control Group is significant at 0.01 level. It shows that there is a significant difference between the post-test mean achievement scores of Experimental Group - I, Experimental Group - II and Control Group. This can, further be tested by applying the 't' test. "t" test has been applied to test the significance of difference between the means of (i) Experimental Group - I and Control Group (ii) Experimental Group – II and Control Group(iii) Experimental Group - I and Experimental Group - II . These have been discussed below.

Table: 1.5 : Difference in Post-Test Mean Scores of the Students of Experimental Group - I and Control Group on Achievement in Biology

Treatment	N	Mean	S.D.	't' value	Level of Significance
Experimental Group – I	40	29.95	±3.14	**5.56**	Significant at 0.01 level of significance
Control Group	40	24.92	±4.77		

From Table: 1.5, it may be observed that the 't' value of 5.56 for the difference in the mean achievement scores, at the post test stage, of the students of Experimental Group - I and Control Group is significant at 0.01 level. This table also reveals that at the post-test stage, the mean score of 29.95 of the students of Experimental Group - I is higher than the mean score of the Control Group which is 24.92. This indicates that Achievement in Biology of the students of Experimental Group-I is higher than that of the Control Group after the treatment.

Table: 1.6 :Difference in Post – Test Mean Scores of the Students of Experimental Group-II and Control Group on Achievement in Biology

Treatment	N	Mean	S.D.	't' value	Level of Significance
Experimental Group – II	40	32.72	5.42	**6.84**	Significant at 0.01 level of significance
Control Group	40	24.92	4.77		

From Table: 1.6, it is clear that at post-test stage, the 't' value of 6.84 for the difference in mean scores of the students of Experimental Group - II and Control Group, on Achievement in Biology is significant at 0.01 level of significance . It may also be observed from the table that the mean score of the students of Experimental Group - II is higher than the mean score of 24.92 of the students of Control Group. This indicates that Achievement in Biology of the students of Experimental Group - II is higher than that of the Control Group after the treatment.

Table: 1.7 : Difference in Post-Test Mean Scores of the Students of Experimental Group - I and Experimental Group - II on Achievement in Biology

Treatment	N	Mean	S.D.	't' value	Level of Significance
Experimental Group – I	40	29.95	±3.14	**2.81**	Significant at 0.01 level of significance
Experimental Group – II	40	32.72	±5.42		

Table: 1.7 indicates that at the post-test stage, the 't' value of 2.81 for the difference in mean scores of the students of Experimental Group - I and Experimental Group - II on Achievement in Biology

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is significant at 0.01 level of significance . The mean score of 32.72 of the students of Experimental Group -I
is higher than the mean score of the students of Experimental Group - II which is 29.95. This indicates that the Achievement in Biology of the students of Experimental Group - I is higher than that of the Experimental Group - II.
Comparison of mean gain scores of Experimental Group - I, Experimental Group - II and Control Group, after the experimental treatment.
ANOVA results of student's gain scores in Biology after the experimental treatment are provided in the Tables 1.8 and 1.9.

Table: 1.8 : ANOVA for the Gain Scores Sums, Square Sums and Means of Experimental Group - I, Experimental Group - II & Control Group

Group	N	∑X	∑X ²	Mean	S.D.
Experimental Group - I	40	523.00	7899.00	13.07	±4.02
Experimental Group - II	40	609.00	10697.00	15.22	±3.20
Control Group	40	352.00	3866.00	08.80	±8.80
Total	**120**	**1484**	**22462.00**	**37.07**	

Table: 1.9 : Summary of ANOVA for the Mean Gain Scores in Biology Between Experimental Group - I, Experimental Group-II and Control Group

Sources of Variance	Degree of freedom (df)	Sum of Squares (S.S.)	Mean Squares (M.S.)	F Value	Level of Signifi-cance
Between	(3 -1) = 2 (a-1)	855.72	427.86	427.86 / 27.81 = **15.38**	Significant at 0.01 level of signifi-cance
Within	(120-3) = 117 (N-a)	3254.15	27.81		

Table: 1.9 exhibit that the F –value 15.38 for df (2,117) for the Experimental Group - I, Experimental Group - II and Control Group is significant at 0.01 level. Thus the application of "t" test becomes necessary to compare the two groups at a time done at post-test stage.

Table: 1.10 : Difference in the Mean Gain Scores of the Students of Experimental Group - I and Control Group on Achievement in Biology

Treatment	N	Mean	S.D.	t-value	Level of Significance
Experimental Group-I	40	13.07	±4.02	**4.49**	Significant at 0.01 level of significance
Control Group	40	08.80	±4.52		

Table: 1.10 indicates that the 't' value of 4.49 for df 78 for the difference in mean gain achievement scores in Biology of the students of Experimental Group-I and Control Groups is significant at 0.01 level. The mean, score of 13.07 of the student of Experimental Group-I have gained significantly higher than the students of Control Group on achievement in Biology

Table: 1.11 : Difference in the Mean Gain Scores of the students of Experimental Group - II and Control Group on Achievement in Biology

Treatment	N	M	S.D.	't' value	Level of significance
Experimental Group - II	40	15.22	±3.2	**7.35**	Significant at 0.01 level of significance
Control Group	40	8.80	±4.52		

Table: 1.11 indicates that the 't' value of 7.35 , for the difference in mean gain scores of the students of Experimental Group - II and Control Group on achievement in Biology, is significant at 0.01 level, for df 78. Also, the mean gain score of 15.22 of the students of Experimental Group - II is higher than that of Control Group which is 8.80. This indicates that the students of Experimental Group - II have gained significantly higher than the students of Control Group.

Table: 1.12 : Difference in the Mean Gain Scores of the Students of Experimental Group - I and Experimental Group - II on Achievement in Biology

Treatment	N	Mean	S.D.	't' value	Level of Significance
Experimental Group - I	40	13.07	±4.02	**2.65**	Significant at 0.01 level of significance
Experimental Group - II	40	15.22	±3.2		

Table: 1.12 indicates that the 't' value of 2.65 for d.f. 78, for the difference in mean gain scores of the students of Experimental Group - I and Experimental Group-II on achievement in Biology, is significant at 0.01 level. The mean gain score of 15.22 of the students of Experimental Group - II is higher than that of Experimental Group - I which is 13.07. This indicates that the students of Experimental Group - II have been gained higher than the students of Experimental Group - I.

Discussion of The Results

The results obtained from Table: 1.5 to 1.7 and from Table: 1.10 to 1.12 indicate that the mean score and mean gain score on Achievement in Biology of the students of:

1. Experimental Group - Is significantly higher than that of Control Group.

This finding is supported by following studies.
Aabassum Ahmed (1996) found that there was a significant gain in pupil's scholastic achievement when taught through Biological Science Inquiry Model.
The study done by Sushma (1987) provides support to the findings of the present investigation. She found that Biological Science Inquiry Model was more effective than Traditional Method of teaching in terms of achievement of students in Biology. Self-experimentation always creates interest among the students and supports the principle "learning by doing". Students solve the problem themselves and acquire the knowledge how do scientist work. These experiences may facilitate learning and enhance scholastic achievement.
Students are exercised and skilled in the process of inquiry. Formulation of hypothesis, collection of data and drawing conclusions are the essential tasks done by students when Biological Science Inquiry Model is used in the class room. While doing so, pupils acquire more knowledge about scientific processes which

may result in better understanding.
Biological Science Inquiry Model helps in generating co-operative climate in the classroom. The results compare their observations and inferences with each other. In this way, they realize their own errors and select means to correct them. Owing to its inductive approach, Biological Science Inquiry Model is an effective way of teaching Biology.

2. Experimental Group - II is significantly higher than that of Control Group.

This finding is corroborated by a number of studies; Dennis (1984) found significant gain in achievement when Advance Organiser was used in a high school Biology class. Healy (1985) compared the effects of Advance Organiser and Pre- Requisite Knowledge passages on the learning of science concepts and found that Advance Organiser group performed significantly better than the Pre Requisite Knowledge Group. Results of the study conducted by Morgon (1985) showed that pre-laboratory exercises when used as Advance Organiser facilitate the achievement of students. Lewis (1986) also proved that Advance Organiser enhanced achievement of pupils in science.
Budhisagar (1987) compared Advance Organiser Model and Operant Conditioning Model. Results of her study revealed that Advance Organiser Model was significantly effective in terms of achievement of students. Rajoria (1987) found that the Advance Organiser Model was significantly superior to Traditional Method in terms of achievement in science of class VIIIth students when the groups were matched separately in respect of intelligence and previous year achievement in science. Besides this, Jaimini (1990) found that Advance Organiser Model was significantly more effective than the Conventional Method in fostering conceptual learning. Tabussum Ahmed (1996) reported that there is significant difference between the gain achievement scores of the student teacher taught through Advance Organiser Model and Traditional Method.
As for as the effectiveness of Advance Organized Model concerned it is derived from the theory of meaningful verbal learning to facilitate the learning written materials . The written material should be organized in such a way so that it could maximize learning. David P. Ausubel emphasized the meaningful verbal learning. If a particular learner possesses ideas in his cognitive structure to which the new learning material can be related in a substantive and non-arbitrary fashion, then we say that the material is potentially meaningful to him, or that it possesses potentially meaningfulness. On the basis of this few theoretical aspect of Advance Organiser Model propounded by David P.Ausubel, the researcher developed his lesson plans so that the students could understand the learning materials which were presented in systematic, meaningful and logical way. This fact shows that the Advance Organized Model is also superior to Conventional Method in classroom teaching learning process.
The significant achievement after being taught through Advance Organiser Model may be because of the specific instructional effects of this model and the effects nurtured by the teaching learning environment created through Advance Organiser Model. Pupils understand easily if learning material is presented to them in the increasing order of difficulty which is the one of the characteristics of Advance Organiser Model. Broad, abstracts concepts are arranged at the top and more concrete concepts are included at lower stages of organization. The progressive differentiation of ideas during the lesson proceeds by repeatedly relating of the new ideas by the teacher to the Advance Organiser presented at a higher level of abstraction and inclusiveness. This facilitates learning and may be the reason of higher achievement.
According to the Ausubel, cognitive structure is a person's knowledge of a particular subject matter at any given time. It is the most important variable affecting the meaningful learning. The achievement through Advance Organiser Model can be enhanced if new learning material is encored in the students existing cognitive structure. Besides this, Ausubel believes that the structural concepts of each discipline can be identified and taught to the students which then become an information processing system for them. Students can analyze particular domain and solve problems within those domains. All these may have facilitated learning of the Experimental Group.
Teaching based on Advance Organiser Model includes several ways to promote active reception e.g. asking students for additional examples of the concepts, asking students to verbalize the essence of the material using their own terminology, asking students to examine the material from alternative point of view etc.
These activities motivate the pupils to learn and develop habit of precise thinking. As a result, students have shown better result in terms of scholastic achievement.

3. Experimental Group - II is significantly higher than that of Experimental Group - I.

This finding show that Advance Organiser Model is more effective than Science Inquiry Model in terms of mean scores and mean gain score on Achievement in Biology and supported by finding of Aabassum Ahmed (1996). He found that Advance Organiser Model is significantly more effective as compared to Biological Science Inquiry Model in terms of pupil's scholastic achievement.
Advance Organiser Model is an expository and deductive approach. Ausubel is of the view that systematically presented instructional material can bring effective learning. Further, new ideas are subsumed with the previously existing ideas in the cognitive structure of learners for better achievement. In contrast to this, Science Inquiry Model is based on inductive approach where only the problem is presented to students. The task of relating the problem under study with previously solved problem and find out the solution of the problem themselves. This may be the reason of such results obtained in present experiment.
In our schools, teaching is text book based and there is less scope of various activities. Self learning is not emphasized; students constituting the sample may not be undergoing practice properly for stating and analyzing the problem. Besides this, more information can be presented by a teacher who is using Advance Organiser Model. Comparatively limited quantum of knowledge is provided when Science Inquiry Model is used in the classroom. Therefore, after being taught through Advance Organiser Model pupils may get better scores on an Achievement Test which assesses knowledge, understanding and application.
Teaching through Advance Organiser Model proceeds by presenting. Advance Organiser at the beginning of lesson, followed by progressively differentiated and integrative reconciled content and recapitulating the lesson to strengthen cognitive structure of students at the end. Therefore, deductive reasoning ability developed by Advance Organiser Model might have served as a tool for learners to analyze their own thinking and increase their ability to process information accurately. This may be one of the reasons of better learning in the Experimental Group-II which was taught through Advance Organiser Model. Joseph

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schwab developed the Biological Science Inquiry Model from the recommendations of Biological Science Curriculum Study (B.S.C.S.). It was proposed for conditions where schools and science laboratories are well equipped. In India all facilities are not available for experimentation which is a prerequisite of Biological Science Inquiry Model. This may be one of the causes for the results obtained in this study using Science Inquiry Model based teaching.

On the basis of the results obtained from analysis of the data and the interpretation of the results done numerically, related to a students achievement in Biology the following hypotheses of the research paper are retained .

H1 There was no significant difference in the mean scores on the criterion Achievement Test in Biology, of the three groups of students taught Biology with the use of Science Inquiry Model, Advance Organiser Model and Conventional Method of teaching, before the experimental treatment.

H2 There was significant difference in the mean scores on the criterion Achievement Test in Biology of the three groups of students taught Biology with the use of Science Inquiry Model, Advance Organiser Model and Conventional Method of teaching, after experimental treatment.

H3 There was a significant difference in the mean gain scores on the criterion Achievement Test in Biology of the three groups of students taught Biology with the use of Science Inquiry Model, Advance Organiser Model and Convention Method of teaching after experimental treatment.

Findings

The statistical data of the research paper reveal the following findings.

1. The group of students taught Biology through Science Inquiry Model have scored significantly higher on the criterion Achievement Test than the group of students taught Biology through Conventional Method.
2. The group of students taught Biology through Advance Organiser Model have scored significantly higher on the criterion Achievement Test than the group of students taught Biology through Conventional Method.
3. The group of students taught Biology through Advance Organiser Model have scored significantly higher on the criterion Achievement Test than the group of students taught Biology through Science Inquiry Model.
4. The group of student taught Biology through Science Inquiry Model have scored significantly higher gain on the criterion Achievement Test than the group of students taught Biology through Conventional Method.
5. The group of student taught Biology through Advance Organiser Model have scored significantly higher gain on the criterion achievement test than the group of students taught Biology through Conventional Method.
6. The group of students taught Biology through Advance Organiser Model have scored significantly higher gain, on the criterion Achievement Test than the group of students taught Biology through Science Inquiry Model.

Conclusions

On the basis of findings, the following conclusions have been drawn

1. This study shows that the post-test achievement mean scores of the experimental and control groups, controlling for intelligence and Socio-Economic status, differ significantly in favor of the experimental groups. This implies that the students who were taught Biology through Science Inquiry Model and Advance Organiser Model have shown significant improvement in the Achievement in Biology than the students who were taught through Conventional Method. This suggests that Science Inquiry Model and Advance Organiser Model contributes in raising the achievement of students.
2. The group of students taught Biology through Advance Organiser Model have shown significantly higher achievement than the group of students taught Biology through Science Inquiry Model.
3. The group of students taught Biology through Science Inquiry Model have shown significantly higher gain in achievement than the group of students taught Biology through Conventional Method.
4. The group of the students taught Biology through Advance Organiser Model have shown significantly higher gain in achievement than the group of students taught Biology through Conventional Method.
5. The group of students taught Biology through Advance Organiser Model have been shown significantly higher gain in achievement than the group of students taught Biology through Science Inquiry Model.

Educational Implications

Analysis, interpretation and conclusion of the research paper indicate that the modern teaching strategies in the form of models of teaching should be applied in Indian classroom teaching. The aim of teaching should be not only to acquaint the learners with the knowledge of their subjects but also surrounding awareness has equal importance for the learners in the present day of scientific world.

The teacher seems to be more active than the learner in the present day teaching learning process. This may be due to over work load of teachers so they may not be able to implement new techniques of teaching, or may be due to overloaded curriculum of the school, they are not in a position to introduce new techniques in teaching. New techniques in teaching-learning process always helps in developing the interest of the learners to understand instructional material well. This may be due to over work load of teachers so they may not be able to implement new techniques of teaching, or may be due to overloaded curriculum of the school, they are not in a position to introduce new techniques in teaching. New techniques in teaching-learning process always helps in developing the interest of the learners to understand instructional material well. To achieve the most important educational objectives with reference to 'Blooms Taxonomy of Educational Objective', Traditional Method or Teacher Dominated Method will not help. New teaching strategies should be given due importance.

From the present experimental study, it has found that Advance Organiser Model is most effective when the achievement is taken into consideration. However Science Inquiry Model is also found effective over Traditional Method of teaching in terms of achievement. From the results of the study, Model based teaching can be introduced in the Indian situation.

The research paper has implications for teachers, teacher educators and curriculum and instructional material developers.

Implications for Teachers

The models of teaching serve as a repertoire of instructional approaches for teachers to tailor the teaching-learning environment

to the pre-disposition of the learners to achieve a variety of educational objectives. With the Advance Organiser Model, a teacher organizes the content of a discipline in a hierarchical order and subsume the content with already known content to pupils through progressive differentiation and integrative reconciliation. In such teaching – learning environment efficient learning takes place. By using Science Inquiry Model in classroom, teacher develops interest in the process of inquiry among students and motivate them to learn the process themselves. The teacher should help them at every stage of learning. Today, when there is an exponential increase in knowledge, it is impossible for teachers to teach everything in the classroom. However, if the students are trained in the skill of self learning, they would be able to acquire efficiently more knowledge with lesser dependence on their teacher. Advance Organiser Model and Science Inquiry Model help teachers to overcome this problem.

Implications for Teacher Educators

Science Inquiry Model and Advance Organiser Model are effective teaching strategies in enhancing scholastic achievement of learners as shown by results of the present study. Therefore teacher educators should analyze every activity of the models and attain competency in them. They should plan and implement training strategies based on these models of teaching to train teachers.

Teacher educators should provide theory of Science Inquiry Model and Advance Organiser Model to pre-service teachers, demonstrate lessons through these models and help student teachers to undergo practice in the use of these models. In this way, student-teachers should be trained in the application of Science Inquiry Model and Advancer Organiser Model so that they may use these strategies in their classrooms for better teaching.

Not only this, Science Inquiry Model and Advance Organiser Model are better transactional approaches for in-service teachers. These teachers need to be oriented time to time through these strategies for improvement of teaching skills.

Implications for curriculum and Instructional Material Developers

Ausubel's ideas about subject matter and cognitive structure have direct implications for the organization of curriculum and development of instructional material. Keeping in mind the Advance Organiser Model, curriculum and instructional material designer should organize the school text-books in such a manner that familiar and most inclusive topics are put at the beginning followed by topics of higher levels of complex. Not only this, the sequence of the curriculum should be so arranged that each successive learning is carefully related to what has been presented before. Thus in most instances the students are required to learn the details of new and unfamiliar disciplines after they have acquired an adequate body of relevant subsumers at an appropriate level of inclusiveness (Ausubel, 1968).

The use of Science Inquiry Model in teaching learning process helps in promoting self-learning and interest in inquiry skills on the part of learners which in turn enhances achievement . Designers of instructional material should develop the material in such a way that understanding of different concepts and principles takes place at a faster rate in students.

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