Horizons of Holistic Education **p ISSN : 2349-8811**
Vol-2, July - September 2015, pp. 222-232 **e ISSN : 2349-9133**

A STUDY OF EFFECTIVENESS OF INQUIRY TRAINING MODEL FOR TEACHING SCIENCE TO STANDARD VIII STUDENTS OF VADODARA CITY

Priti Chaudhari*

Assistant professor, Department of Education [CASE], Faculty of Education and Psychology, The Maharaja Sayajirao University of Baroda, Vadodara
Email: zinki_1980@yahoo.co.in

Received : 12-09-2015 Accepted : 18-09-2015

ABSTRACT
Science forms an integral part of learning. Essentially it has to be learnt mainly through concrete situations related to immediate environment. The main focus of imparting science education is on sharpening the senses of the learners and encouraging them to discover and explore their environment and surroundings. Instead of loading the students with scientific information, efforts should be made to help them learn key concepts which cut across all the disciplines of science. This would generate curiosity and would enhance awareness and understanding. Whenever we come across anything which is unfamiliar, may it be an object, event or situation, our mind is stirred by questions which may help us in knowing more about the object of our curiosity. Nature has gifted us with the tool of curiosity for learning more and more about environment. It is common to observe children asking lot of questions about anything which arouses curiosity. According to Singh (1995), "Whenever we are in a process of finding out or investigating through questions, we are in the process of inquiry. From a simple array of questions, if the inquiry takes the form of disciplined and systematic approach, it becomes the spirit of scientific method". The present study was an attempt to implement the Inquiry Training Model on standard VIII students of Vadodara city to teach science. The programme was found to be effective in terms of the achievement of the students. Also the opinion of the students proved the programme to be effective. It was also a good learning experience for the students. Inquiry Training Model is effective in terms of arising curiosity in students, better retention of the concepts, generating interest in students and provoking them to ask questions and interact in class. The results of the study shows that if regular classroom science teaching is made activity based and interactive then it will definitely positively affect the learning and achievement of the students.
Keywords:
** Author for correspondence*

INTRODUCTION

Science forms an integral part of learning. Essentially it has to be learnt mainly through concrete situations related to immediate environment. The main focus of imparting science education is on sharpening the senses of the learners and encouraging them to discover, observe and explore their environment and surroundings. Instead of loading the students with scientific information, efforts should be made to help them learn key concepts which cut across all the disciplines of science. This would generate curiosity and would enhance awareness and understanding.

Whenever we come across anything which is unfamiliar, may it be an object, event or situation, our mind is stirred by questions which may help us in knowing more about the object of our curiosity. Nature has gifted us with the tool of curiosity for

learning more and more about environment. It is common to observe children asking lot of questions about anything which arouses curiosity. According to Singh (1995), "Whenever we are in a process of finding out or investigating through questions, we are in the process of inquiry. From a simple array of questions, if the inquiry takes the form of disciplined and systematic approach, it becomes the spirit of scientific method". Therefore training the learners for investigating and explaining ant type of puzzling problem, phenomena or event can be a way of orienting their minds towards scientific inquiry. The nature of science is such that it demands the spirit of inquiry and science as a school subject has a wide scope of scientific inquiry. There are various methods and models of teaching through which learners can be taught science through the process of inquiry.

Nature of Science

From these definitions three basic principles of nature of science can be defined.

1) An accumulated and systematized body of knowledge.
2) The scientific method of inquiry and
3) The scientific attitudes.

The first point indicates the product of science, while second and third points indicate the process of science. Science is not just a static body of already established knowledge, but a living tradition of never finished exploration into the integrated and unexpected vistas of nature. Science as a body of knowledge characterized by a highly dynamic structure of knowledge, which is founded on numerous bits of information linked with one another into many generalization forming the substantive corpus of science constituting its product dimension. This structure of knowledge interacts actively with the reality. The mode of this active interaction is governed by the logic of the processes of scientific inquiry or the scientific method. This constitutes the process dimension of science. The method of construction of knowledge follows certain systematic logical steps for collecting and processing information, tracing out general trends and constructing theoretical models. This chain of activities mediates between the reality and the structure of knowledge, and constitutes the processes of scientific inquiry or scientific method which as stated earlier forms the process dimension of science. the process of scientific inquiry represents the spirit of science as an activity and is its essence that distinguishes science from other disciplines.

Need Of Teaching Science Through Inquiry

In order to achieve the objectives of teaching science, it is imperative that teaching methods should be modified. According to NCERT (2006), "for any qualitative change from the present situation, science education in India must undergo a paradigm shift. Rote learning should be discouraged and inquiry skills should be strengthened and supported". According to Menon (1986), science teaching should depend on following premises:

The essence of science is its process of inquiry and not the diverse information that form part of its substantive of product dimension.

Teaching of science should not be taken to constitute merely of presenting the bits of

information, which have already been established as integral part of knowledge structure.

Learning of a concept from learner's point of view and not memorizing the verbal statements of the concept. Hence science is best learnt and taught through an inquiry approach.

Learning is acting upon the environment and solving his or her problems and making his or her own discoveries.

Superficial view of present teaching of science consists of a body of facts, principles and descriptions of our surroundings, demonstrations and laboratory operations. According to Mohapatra and Mahapatra (1999), "In present education system science is taught only as a product. The process part of science is being neglected. As a result pupils may not be able to apply science as a process operating in daily life situations". This view may incorporate limited understandings of the relationships among various aspects of our surroundings of the relationships among various aspects of our surroundings including man's dependence upon and use of his surroundings. The content of science is primarily a record of man's accomplishment. It is a kind of history of what man has achieved. It's major value lies in the use that we can make out of it to improve man's thought and action in future.

Richardson et.al. (1968) " Science as a school subject should be far more than a description and history. Science will not produce its full impact on human life until it permeates thought and action. To produce this impact, science should provide experience far beyond the recapitulation of facts and principles". As the researcher discussed earlier the scientific method and scientific attitude are also the components of nature of science, it is necessary to develop this scientific behavior in students. This behavior is characterized by exploration resulting from lively curiosity and by the careful and critical investigation of problems.

Importance Of Questioning

Questions are the primary tools and basic fundamental necessity of scientific inquiry. Whenever an individual is puzzled about phenomena, the curiosity propels him to ask questions and thus leads to inquiry. According to Menon (1986), "questions recognize the wide possibility of thought and are built around varying forms of thinking". Since each question is directed towards learning and evaluative thinking but unfortunately questions of children are often neglected or marginalized by teachers. According to Anderson (1970), "the activities the students engage in when controlled with instructional tasks are of crucial importance in determining what he will learn". Thus what is learnt largely depends on the activities and questions of the students. The questions are perhaps the primary tools by which the individual processes information regardless of the diversity of his procedure. Questions serve to focus students functioning and to provide a means for determining relevant from irrelevant information and for pointing major relationships among variables, as well as creating new insights and assessing the results of inquiry.

Concept Of Inqiry Training Model (I.T.M.)

The emphasis of I.T.M. is upon making the learners aware of the inquiry process through structuring and re-structuring of questions and sequencing them appropriately. The learners are actively involved in data gathering and hypotheses verification but all this happens through questioning related to the problem presented by the teacher in the beginning. The teacher guide the students to frame such questions which can be answered in 'Yes' or 'No'.

Objectives of I.T.M.

Singh (1995) and Joycee et.al. (2008) gave objectives of I.T.M. in their respective books. Author has presented relevant objectives from both the books. These objectives are as follows.

a) To develop scientific process skills: observing, collecting and organizing data, identifying and controlling variables, formulating and testing hypothesis, explanations and inference.
b) To develop autonomous learning.
c) To develop ability to tolerate ambiguity.
d) To develop logical thinking.
e) To make students understand that all knowledge is tentative.

I.T.M. Chart

Joycee et.al. (2008) summarizes I.T.M. in the following way:

A) Syntax

Phase 1: Presentation of Puzzling event and explanation of inquiry procedure. In this phase the teacher demonstrates through an experiment or narrates a phenomena which seems puzzling for students and triggers their thinking process.

Phase 2: Data gathering and verification In this phase the students try to find out the variables associated with the given phenomenon and their interrelationship.

Phase 3: Hypotheses and testing In this phase the students try to find out the probable causes of the phenomenon. They formulate various hypotheses which are subjected to testing in the form of questions. If the answer of the particular question is 'no', then that particular hypotheses is rejected. Thus out of many hypotheses only few are not rejected which stand as the causes of phenomenon.

Phase 4: Formulating an explanation After testing all hypotheses, students try to form an explanation considering the hypotheses which are not rejected. Thus they try to reason out the occurrence of that particular phenomenon.

Phase 5: Analysis of inquiry process Finally the teacher concludes by summarizing the concept to be taught. Also teacher analyze the entire process and point out the mistakes made by the students and also discuss the ways to rectify the mistakes.

B) Social System

Co-operation, intellectual freedom and equality is must among students- students and teacher – students. Interaction among students should be encouraged.

C) Principles of Reaction

a) Ensure that questions are phrased so they can be answered in 'yes' or 'no' and that substance does not require the teacher to do the inquiry.

b) Ask the students to rephrase invalid questions.

c) Point out unvalidated points.

d) If necessary, new information can be provided to keep the inquiry moving.

e) Try to provide a free intellectual environment by not evaluating student theories.

f) Encourage interaction among students.

D) Support System

The optimum support is a set of confronting materials, a teacher who has content mastery and understands the strategy of inquiry and resource materials bearing on the problem.

Limitation of I.T.M.

Singh (1995) gave some limitations of I.T.M. which are as follows:

Helps in developing explanations on the basic previous knowledge. So it is very necessary that students have some basic information which will guide them in the inquiry process.

New concepts and formulae cannot be taught.

As students need some knowledge to start the inquiry process so if the concept is entirely alien to the students then it cannot be taught through I.T.M.

If the puzzling situation is not presented in the form of a problem requiring explanation, the students cannot effectively arrive at generalization through inquiry.

Role of Teacher

Should guide the students during the inquiry process, prevent them from going on wrong track and creating chaos in the class and have content mastery.

Be flexible and provide free environment to the students and manage the time.

Continuously motivate the students so they are inquisitive to know more.

Help in inquiry but should not do inquiry for students.

Before planning and implementation of I.T.M., the teacher should check the previous related knowledge of the students.

After students arrive at generalization, teacher should summarize in such a way that concept clarity is attained by students.

Teacher should have clear knowledge of all the related content matter.

The hypotheses/questions having 'yes' answers should be written on board so that it becomes easy for students to generalize.

If questions are not framed properly, teacher should not ignore that question but ask the students to reframe them properly.

Rationale Of The Study

The present world is a world of science and technology. Everything or every event happening around us demands some knowledge of simple scientific facts and principles. Looking into the nature of science, it is both process and product and also the objectives of teaching science emphasize on development of scientific attitude. Moreover almost all commissions and committees appointed by govt. of India recommended the development of scientific attitude. According to NCF (2000), "Science education should be such that it helps to generate and promote among the learners scientific temper

characterized by the spirit of inquiry, problem solving, courage to question and objectivity leading to elimination of superstition and fatalism". Thus science education if properly conceived should primarily be concerned with the education of mind rather than the acquisition of violated pieces of scientific knowledge.

An important purpose of science teaching in general education up to secondary stage is to familiarize the learners with various dimensions of scientific literacy. Scientific attitude, a very important attitude should be developed in the children who are the future citizens, if the objectives of teaching science are to be achieved. Science teaching through the use of models of information processing family is to help the students become more powerful learners.

Amin (2011) implemented I.T.M. as one of the activity of science teaching on pre-service student teachers. The findings reflects its effectiveness in terms of understanding, content clarity, attitude development, decision making, achievement and science process skills. Also the main focus of the present study is to make students pass through an inquiry process, which probably will help in development of scientific attitude and better learning. Thus, according to the researcher I.T.M. was apt for the present study. The effectiveness of this model was founded in terms of the achievement of the students as well as the opinion of students regarding the developed programme on I.T.M. One of the reasons to select school students for the present study was that the researcher could not find any study related to implementation of I.T.M. on school students. Also the study of Menon (1986) shows that there is increase in the process skills of students from std. VIII till std. XII. So std. VIII can be considered as a base for development of process skills. Thus those students must be taught using various methods and models which can initiate the development of scientific attitude and science process skills. Thus the researcher selected std. VIII students for the present study. Science concepts such as combustion, transfer of heat, properties of air, depletion of ozone and static electricity were selected as they are very general concepts and they form a part of science curriculum of std. VIII and the students do have a prior basic knowledge about these concepts which is a very important precondition for implementation of I.T.M.

Statement Of The Study

"A study of Effectiveness of Inquiry Training Model for teaching Science to standard VIII students of Vadodara city"

Objectives Of The Study

1) To develop a programme on inquiry training model to teach concepts of science.
2) To implement the developed programme on std. VIII students.
3) To study the effectiveness of the programme in terms of
   a) achievement of students
   b) opinion of the students regarding the programme

Hypothesis

There will be no significant difference between the mean achievement scores of the experimental group and that of controlled group.

Operationalisation Of The Term

Effectiveness: The difference between the mean achievement scores of the experimental group and that of controlled group as well as opinion of students represented effectiveness of the programme.

Opinion: For the present study the views of the students regarding the programme constituted their opinion. A five point scale opinionnaire was used.

Delimitation Of The Study

The present study is delimited to the students of English medium Schools following Gujarat Secondary and Higher Secondary Education Board (GSHSEB) of Vadodara city during the academic year 2011-12.

Science concepts were delimited to concepts of combustion, properties of air, transfer of heat, depletion of ozone layer and static electricity.

Method Of The Study

The present study was quantitative in nature.

Design Of The Study

Design of the present study was quasi-experimental. Pre-test and post-test was implemented on experimental and controlled groups. Implementation of I.T.M. was independent variable and achievement of the students was dependent variable. Age was the controlled variable. Environmental factors like their motivational level, exposure to other agencies of knowledge gaining etc. were intervening variables which were thought to be equally affecting both groups.

Population

Approximately 3500 students of VIII Std. of 62 English medium schools of Vadodara city following GSHSEB syllabus was the population of the present study.

Sample

Purposive sampling technique was used. Bright Day school (Vasna) was selected as experimental group and Sabari Vidyalaya was selected as controlled group. All std. VIII students of Bright Day school (55) and Sabari Vidyalaya (65) constituted the sample for the present study. Thus the sample size was 120 students.

Phases Of The Programme

Phase 1 – Development Of The Programme: Content analysis was done of science textbook of standard VIII and six concepts were identified which could be taught through Inquiry Training Model. These six concepts were: (i) oxygen is necessary for combustion (ii) ignition temperature is necessary for combustion (iii) transfer of heat (iv) properties of air (v) depletion of ozone layer and (vi) static electricity. The students do have a basic knowledge about these concepts and there is a scope of inquiry for teaching these concepts. Separate experiments were designed for each concept except in depletion of ozone layer were a puzzling phenomena was presented before the students. The programme was validated by the experts of science field. The following table shows the designed experiments.

Table:1 Development of the Programme

Sr. No.	Concept	Experiment
1	Oxygen is necessary for combustion	Light a candle and invert a glass on it. Observe.
2	Ignition temperature is necessary for combustion	Take two balloons. Blow one balloon with air and another balloon with water. Bring both the balloons near a candle flame. Observe.
3	Transfer of heat	Fill one bottle with hot water and put some ink drops in it. Fill another bottle with ice cold water and invert it upon hot water bottle. Observe.
4	Properties of air	Place a funnel on a bottle. Cover the neck of the bottle along with the funnel with clay. Pour some water in the funnel. Observe. Now remove the clay and again pour some water in the funnel. Observe again.
5	Static electricity	Rub a plastic or comb against dry hair and bring it near the copper coil of an electroscope. Observe what happens to the two silver foils inside air tight bottle.
6	Ozone depletion	Puzzling event: Example of Australia recorded highest number of cases suffering from skin cancer was presented to the students in puzzle form.

Phase–2 Administration Of Pre-Test : An achievement test was administered on both experimental group and control group before implementation of developed programme. Proper sitting arrangement of the students was ensured before administering the test. Two children on one bench were allowed to sit. Stu dents were given 30 minutes for the completion of the test. They had to write the answer in question paper itself.

Phase–3 Implementation Of The Programme :

The developed programme was implemented only on experimental group. The students were asked to observe experiment and then were given time for inquiry and think of the probable causes of the phenomena. Then they had to present the probable causes in the question form which can be answered only in 'yes' and 'No'. Then at the end, suitable explanation was given by the students based on the positive hunches. Finally the researcher summarized the whole process and concept. The same method was used to teach all the concepts.

Phase–4 Administration Of Post – Test : After intervention program on experimental group, again the same achievement test was administered on both experimental group and controlled group. An opinionnaire was implemented only on experimental group for knowing the reactions of the students regarding the programme.

Tools

Achievement Test: An achievement test was constructed by the researcher. This test contained objective type of questions, covering the concepts of combustion, properties of air, transfer of heat, global warming and static electricity. Each question

was of one mark. The test contained total 30 questions. It was validated by the experts of science education.

Opinionnaire: The opinionnaire was prepared by the researcher and validated by the experts. Only close ended statements and 5 point rating scale was prepared on the effectiveness of the programme after intervention of experiment.

Data Collection

For the purpose of data collection, researcher personally visited both the schools and took permission from the respective principals and explained them the purpose of the research. First pre-test was administered on both the groups. Then I.T.M. was implemented on only experimental group by the researcher. Controlled group followed their regular teaching by lecture method. Investigator ensured that their regular teacher taught them all these concepts through lecture method. Lastly post-test was administered on both the groups. Thus the achievement scores in pre and post tests of the sample is the data for the present study.

Data Analysis

The data obtained was analyzed by using following statistical techniques such as frequency, percentage and t – test.

Major Findings

The major findings of the study were as follow:

t – value calculated > t – value in table at 0.01 level of confidence was 7.50. So the null hypothesis – "there will be no significant difference in the mean achievement scores of experimental group and that of controlled group" is rejected at both the levels of confidence. Thus there is significant difference in the mean achievement scores of the experimental group and controlled group.

Table : t value calculated from the gained scores.

N	MEAN	SD	SEM	t
Experimental group - 43	10.22	2.65	0.41	7.50
Controlled group - 56	4.54	2.50	0.33	

The mean achievement score of experimental group which is 10.22 is significantly high than the mean achievement score of the controlled group which is 4.54. Thus the implementation of Inquiry Training Model (I.T.M.) to teach science to standard VIII students is effective in terms of the achievement of the students.

Out of the total 45 students, 88.89 % students liked the new method of teaching and out of that 55.56 % of students were strongly agree to this statement.

91.11 % students had reported that the experiments performed were interesting and 95.55 % students had told that the method used for teaching was the new method having learning with fun.

77.77 % of students had revealed that they had openly asked the questions in the class and also enjoyed asking questions. They also felt that the questions asked by other students were interesting.

93.33 % of students were agreed that this method aroused curiosity in them to know more and they also easily understood the concepts. 86.66 % of the students had agreed that this new method provoked them to think more.

91.11 % students had reported that they are satisfied with this new method and think that they remember more when taught through this new method.

88. 89 % students had told that this new method of teaching is better than the regular lecture method.

Thus as per the analyzed data and the results obtained through opinionnaire, it can be concluded that implementation of Inquiry Training Model is effective in terms of arising curiosity in students, better retention of the concepts, generating interest in students and provoking them to ask questions and interact in class. The principal of the experimental group had observed many class and based on that reported that she was very pleased with the way the whole programme was implemented. Also she was surprised to see that the most notorious class was so much involved in the programme and the most introvert students asked questions and participated in the interaction. Also during the whole span of the programme, researcher observed that almost 85 % of the class participated in questioning.

Conclusion

The present study was an attempt to implement the Inquiry Training Model on standard VIII students of Vadodara city to teach science. The programme was found to be effective in terms of the achievement of the students. Also the opinion of the students proved the programme to be effective. It was also a good learning experience for the students. Inquiry Training Model is effective in terms of arising curiosity in students, better retention of the concepts, generating interest in students and provoking them to ask questions and interact in class. The results of the study shows that if regular classroom science teaching is made activity based and interactive then it will definitely positively affect the learning and achievement of the students.

References

Allport., G. W. (1973). *Educational Psychology*. New Delhi: Nilkamal Publication Pvt. Ltd.

Amin, J. A. (2011). *Development and implementation of and activity based science teaching programme for pre-service students and teachers*. Unpublished Ph.D. thesis, CASE, Vadodara.

Anderson, F. M. (1970). *The act of questioning in the classroom*. London: University of London Press ltd.

Education and National Development. (1964-66). Report of Education Commission. New Delhi. NCERT.

Gautam., (2002). *A study of scientific attitude in relation to interest in science of IX class students of Allahabad city.* Meeruet University, In Indian Education Abstracts. Vol (4), January-June.

Joshi., M. M. (2006). *Modern methods of teaching science*. New Delhi: Cyber tech Publications.

Joycee, B., Weil, M. & Calhoun, E. (2008). *Models of teaching*, New Delhi: Prentice hall of India pvt.ltd.

Kozlow., J. M. 7 Nay, M. A. (1976). *An approach to measure scientific attitudes*. Science

education, April-June.

Menon., S. B. (1986). *The study of a system of science education in the perspective of the processes of scientific inquiry.* An unpublished Ph. D. thesis. The M. S. University of Baroda, Vadodara: CASE.

Mohapatra, J. K. & Mahapatra, M. (1999). *New dimensions in science curriculum : An operational approach.* New Delhi. Common wealth publisher.

Ministry of Human Resource Development., (1986). *National Policy on Education*. New Delhi: Government of India.

Patel., R. C. (1997). *A study of scientific attitude and its correlates among secondary school students of Vadodara city*. An unpublished Ph.D. thesis. The M. S. University of Baroda, Vadodara: CASE.

Richardson, J.S., Williamson, S. E. & Stotler, D. W. (1968). *The education of science teachers*. Ohio, Columbus: Charles E. Merril Company.

Sanadhya., R. P. (1996). *Personality characteristics and scientific attitude*. Udaipur:
Shiva Publishers Distributors. In Patel., R. C. (1997). *A study of scientific attitude and its correlates among secondary school students of Vadodara city*. An unpublished Ph. D. thesis. The M. S. University of Baroda, Vadodara: CASE.

Singh, L. C. (1995). *Inquiry training model: Teaching problem solving through discovery and questioning*. In L.C. Singh (Ed). *Multiple models of teaching for educators*. New Delhi: Vikas publishing house pvt.ltd.

Taradevi Report., (1956). In Sharma., R. C. (2003). *Morden Science Teching*, New Delhi: Dhanpat Rai Publishing Company Pvt. Ltd.