Effectiveness of Inquiry Training Model in Teaching Science at the Secondary School Level

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Abstract

This study attempts to investigate the effectiveness of Inquiry Training Model (ITM) in teaching Science at secondary school level. Four chapters of physics of class IX were taught to 50 students through ITM method and 50 students through conventional method. The two groups of students were equivalent in terms of age, sex and their previous knowledge of concepts taught (pre-test). Students were assessed using the same test after instruction (Post–test I) and retention of learned concepts was assessed after 15 days of instruction (Post-test II). Gain in achievement and retention of both the groups of students was compared using t-test and it was found that gain and retention of students receiving instruction through ITM method was more than that of the students receiving instruction through conventional method.

Introduction

"Science is a great human enterprise, not only endless and faceless but also stable and fluid. It is a self-accumulation, self-growing, self-pervading, self-accelerating and self-correcting enterprise which originated in the collective curiosity of man since time immemorial." [Vaidya, 1997]. It has seen continuous advancement through researches leading to development of technology for greater application by the society, thus, becoming a priority field of education at all levels. It is a major subject area which equips the learner with the development of proper understanding of the subject matter and also helps in dealing with

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various phenomena around him in a more scientific way. The main aim of science education should, therefore, be development of abilities like questioning, inquiring, creativity etc. in the learners. These aims can never be achieved if science teaching is restricted only to the transmission of facts and concepts. Therefore, it is important that teaching of science should emphasise on the development of abilities and not only on the transfer of subject contents. In other words, we may say that science education should primarily be concerned with the education of mind rather than acquisition of knowledge.

The National Curriculum Framework (NCF 2005) also recommends that "curriculum should help learners to become constructor of knowledge" and emphasises "the active role of teachers in relation to the process of knowledge construction". However, the reality is not exactly so. The primary objective of science teaching has been transfer of subject matter. Science is a most challenging subject and it requires an inquiring mind on the part of the student but the teachers do not bother to accept their responsibility of inculcating such habits among students. This is evident from the low enrolment in higher science courses. This problem of low enrolment has bothered many researchers (Bridgham, 1973; Dietrich, 1973) and they infer that teaching style could be related with low achievement and low enrolment. It was found in above studies that most of the teachers had direct mode of teaching. Though the place of teaching science is at the top of hierarchy of different subjects, the researches in this area have been relatively scanty. The teaching of science in schools generally conforms to the traditional methods and continues to be dominated by teacher by making it dull and uninspiring. An observation of a traditional classroom gives a general impression that the teacher is either lecturing or dictating notes. Apparently, there is no active participation of learners in the teaching-learning process Instruction is not well-organised and much emphasis is laid on memorisation of facts and concepts.

In secondary schools, physical science is regarded as one requiring intellectual skills to collect and analyse data to solve problems. In fact, science process skills such as observing, classifying and collecting data act as prerequisites for integrated processes usually taught in secondary schools like hypothesising, controlling variables and defining operationally (Tobin and Capie, 1982). “Whether our focus is on classical education, the new math, or basics, the ultimate goal of education has been to teach children to think critically and

independently" (Sternberg and Baron, 1985). Various educationists and researchers have developed a number of models of teaching for various general/specific purposes. Joyce et. al. (1992) has suggested that the Inquiry Training Model is a prominent model for development of inquiring mind as well as for teaching of concepts in science at secondary school level.

Inquiry in teaching of science refers to the process of questioning, seeking knowledge, information or facts about phenomena. It involves investigation, searching, defining a problem, formulating hypothesis, gathering and interpreting data and arriving at a conclusion. Inquiry model was propounded by Suchman. The basic philosophies behind this model are–

1. Pupils inquire naturally when puzzled.
2. They can be conscious of and learn to analyse their thinking strategies.
3. New strategies can be taught directly.
4. "Co-operative inquiry helps pupils to learn about the tentative, emergent nature of knowledge and to appreciate alternative explanation". (Joyce and Weil,1992, pp.199-200).

Suchman provided a systematic structure within which the students are required to ask questions to understand the possible cause of occurence of the event in that way, to collect data and process it scientifically to develop a hypothesis capable of explaining the event. The inquiry training starts with presenting a discrepant event or a problem situation. The students are motivated to solve the puzzle by collection and verification of data through various experimentations.

Hofstein and Walberg (1995) suggested that inquiry-type laboratories are central to learning science since students are involved in the process of conceiving problems and scientific questions, formulating hypotheses, designing experiments, gathering and analysing data, and drawing conclusions about scientific problems or phenomena. Kuhn et al. (2000) argued that students who undergo inquiry process "come to understand that they are able to acquire knowledge they desire, in virtually any content domain, in ways that they can initiate, manage, and execute on their own, and that such knowledge is empowering" (p. 496). Malacinski (2003) worked on "student-oriented learning: an inquiry based developmental biology lecture course". He concluded that the use of the Socratic Method increases as the course progresses and represents the most successful aspect of the course.

Seeing the importance of science at school level and suitability of

inquiry training model in the development of an inquiring mind among learners, an experimental study was undertaken to investigate the effectiveness of Inquiry Training Model in teaching Science (Physics) at secondary school level.

Objectives

The main objectives of the study were as under–

1. To find out the effect of treatment on learning of students belonging to Inquiry Training Model, and Conventional Method groups.
2. To compare the mean learning scores of the students belonging to Inquiry Training Model and Conventional Method.
3. To find out the effect of treatment on retention of students belonging to Inquiry Training Model, and Conventional Method groups.
4. To compare the mean retention scores of the students belonging to Inquiry Training Model, and Conventional Method groups.

Hypotheses

The following null hypotheses were formulated and tested during the study–

H_1: There is no significant effect of treatments on learning of students belonging to Inquiry Training Model, and Conventional Method.

H_2: There is no significant difference between the mean learning scores of students taught through Inquiry Training Model when compared with Conventional Method.

H_3: There is no significant difference between the mean retention scores of students exposed to Inquiry Training Model when compared with the students exposed to Conventional Method.

Population and Sample

The population for this study was a group of students of secondary schools and the the sample consisted of two intact sections of class IX taken from an intermediate college of Varanasi district of Uttar Pradesh, India. These sections were highly comparable with respect to sex, age, intelligence and past achievement in science. The final sample consisted of 100 students having 50 students in each of the two groups who took part in the entire process of experimentation. The students who were absent during the process of teaching or testing were dropped from the final analysis.

Tools

Two types of tools were used–

- Treatment Tools – The lesson plans based on Inquiry Training Model and Conventional Method on selected topics of physics developed by the researcher.

- Observation Tools–
  a) Intelligence Test
  b) Achievement Test on selected topics of physics prepared by the researchers.

taught by the investigator himself. They were taught the same concepts of physics for same time duration. The detailed procedure of the experiment is given in Table 1.

Table 1
The Schematic Presentation of the Experiment

S.No.	*Phase*	*Activity*
1.	Pre-Treatment	The following tests were administered to both the groups: • Test of Intelligence • Pre-Test i.e. achievement test on the selected topics
2.	Treatment	The selected topics were taught to the groups as follows: **Experimental Group** Through Inquiry Training Model (ITM) N = 50 **Control Group** Through Conventional Method (CM) N = 50
3.	Post-Treatment	Both the groups were administered the post test-I immediately after the treatment
4.	Delayed Post-Treatment	Both groups were administered post test-II after a gap of 15 days from the treatment to measure retention.

These tests were to measure pre-test as well as post-test I and II.

Experimental Design

The present study is an experimental study for which pretest-post test equivalent group design suggested by Best (1983) was adopted. The design consisted of one experimental group and one control group. The experimental group was taught through Inquiry Training Model and the control group was taught through Conventional Method. The experimental as well as control treatments were assigned randomly to the groups. Both the groups were

Data Analysis

The data collected was analysed using various statistical techniques. The nature of data was studied by computing mean, standard deviation, skewness, kurtosis etc. Data analysis was done by applying t-test. The significance of difference between teaching methods were found out by using t-test on mean learning and retention scores and the results were tested at 0.05 and .01 level of confidence.

Results

A summary of means and standard deviations of the scores obtained

from both the groups on different stages of experiment have been presented in Table 2.

On the basis of above results the first hypothesis of no difference between the experimental and

Table 2
Means and Standard Deviations of both the Groups at Various Stages

Stage	*Experimental Group (N=50)*		*Control Group (N=50)*	
	Mean	*S.D.*	*Mean*	*S.D.*
Pre-test	7.52	3.12	7.44	3.26
Post-test I	39.16	5.92	32.18	5.56
Post –test II	32.27	5.12	26.77	5.45
Gain (Post test I-Pre test)	31.64	5.01	24.74	5.17
Retention (Post test II– Pre test)	24.75	4.95	19.33	5.04

The achievement scores of both the groups have been compared to find the effectiveness of the treatments on the basis of t-score calculated for various groups of comparison at various stages. A summary of t-values of the groups at various stages of comparison have been presented in Table 3.

control group could not be rejected i.e. the groups were alike with respect to their achievement in science at pre-treatment stage. The t-value for all the other comparisons was sufficient enough to reject the null hypothesis of no difference between groups at 0.01 level of significance i.e. the treatment has a positive

Table 3
Summary of t-values at Various Stages

Comparison Groups	*Stage*	*t-value*	*Significance*
ITM-CM	Pre-test	0.125	NS
ITM-CM	Post-test I	6.077	0.01
ITM	Pre test _ Post test I	33.433	0.01
CM	Pre test _ Post test I	22.39	0.01
ITM-CM	Gain	4.277	0.01
ITM-CM	Retention	2.84	0.01

effect on the groups in terms of achievement in science. The gain and retention scores were also compared and it was observed that the gain and retention of students receiving treatment through ITM method was more than the gain and retention of students receiving treatment through Conventional Method.

Major Findings

- Both the models were found effective in teaching of science at secondary school level when measured in terms of pupil learning immediately after the instruction.
- The Inquiry Training Model was found more effective than the Conventional Method in teaching of science at secondary school level when tested immediately after completion of the treatment.
- The Inquiry Training Model was found to be more effective than the Conventional Method in the measure of retention of the learned concepts.

The Inquiry Training Model has been found to be more effective than the Conventional Method in terms of pupil learning and retention. The results of the study are supported by other researchers (Adams, Bevevino & Dengel, 1999; Sungur, Tekkaya & Geban, 2001; Lord, 1999; Marek, Eubanks & Gallaher, 1990; Seyhan & Morgil, 2007; Anderson, 2002; Carak, Dikmenli and Saritas, 2008).

The possible cause for this effectiveness may be the use of method of questioning by the students in the Inquiry Training Model. They were actively involved in the learning process and have carefully observed the event in question and drawn inferences rather than memorising contents. All these steps together helped the student in better understanding of the subject leading to higher achievement and retention for the students of this group.

The results of this study have implications for the students, student teachers, teacher-educators and in-service education of teachers.

REFERENCES

Anderson, R. 1997. The Research on Teaching as Inquiry. Paper presented for the Center for Science, Mathematics and Engineering Education. National Research Council, Washington D.C.

Bevevino, M., J. Dengel. and K. Adams. 1999. *Constructivist Theory in the Classroom*. Interanalizing Concepts through Inquiry Learning. Clearing House, v. 72(5), pp. 275-278

Best John W. 1983. *Research in Education*. Prentice Hall of India Pvt. Ltd., New Delhi.

Bridgham, Robert G. 1973. Grading and Enrolment in Science. *The Science Teacher*, 40(6), pp. 41-42.

Carak, O, M. Dikmenli and O. Saritas. 2008. Effect of 5E Instructional Model in Student Success in Primary School sixth Year Circulatory System Topic. *Asia-Pacific Forum on Science Learning and Teaching*, 9(2), 2.

Dececco, John P. and W. Crawford. 1977. The Psychology of Learning and Instruction: Educational Psychology. Prentice Hall of India Pvt. Ltd., New Delhi.

Dietrich, Don. 1973. Grading Practices of High School Physics Teachers: A Contributing Factor to Declining Enrolment in Physics. *Science Education*, 57 (1), pp. 25-29.

Gagne, Robert M. 1983. *The Conditions of Learning* (4th ed.) Rinehart and Winston, Inc., Holt, New York.

George M. Malacinski. 2003. *Student-Oriented Learning: an Inquiry-Based Developmental Biology Lecture Course*, International Journal of Dev Biology. 47, pp. 135-140.

Hofstein, A. and H. J. Walberg. 1995. Instructional strategies. In B.J. Fraser and H.J. Walberg (eds.). *Improving Science Education* (pp. 70-89). National Society for the Study of Education, Chicago.

Joyce, B., M. Weil with B. Showers. 1992. *Models of Teaching* (4th ed.) Prentice Hall of India Pvt. Ltd., New Delhi.

Kuhn, D., J. Black, A. Keselman and D. Kaplan. 2000. The Development of Cognitive Skills to Support Inquiry Learning. *Cognition and Instruction*. 18, pp. 495-523.

Marek, E.A., C. Eubanks and T. Gallaher. 1990. Teachers' Understanding and the Use of the Learning Cycle. *Journal of Research in Science Teaching*. 27(9), pp. 821-834.

Seyhan, H. and I. Morgil. 2007. The Effect of 5E Learning Model on Teaching of Acid-Base Topic in Chemistry Education. *Journal of Science Education*. 8(2), pp. 120-123.

Sternberg, R.J. and J.B. Baron. (1985, October). A Statewide Approach to Measuring Critical Thinking Skill. *Educational Leadership*. pp. 40-41.

Suchman, J. Richard. 1962. The Elementary School Training Program in Scientific Inquiry. Report to the U.S. Office of Education. Project title VII. University of Illinois, Urbana.

Sungur, S., C. Tekkaya and Ö. Geban. 2001. The Contribution of Conceptual Change Texts Accompanied by Concept Mapping to Students' Understanding of Human Circulatory System. *School Science and Mathematics*. 101, pp. 91-101.

Tobin, K. G. and W. Capie. 1982. Relationships Between Formal Reasoning Ability, Locus of Control, Academic Engagement and Integrated Process Skill Achievement. *Journal of Research in Science Teaching*. 19, pp. 113-121.

Vaidya, N. 1977. *Science Education. Fifth Survey of Research in Education*. vol. I (Trend Reports). pp. 354-363. NCERT, New Delhi.