Science Achievement of Higher Secondary School Students -Using Inquiry Based Instruction Method

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Abstract

In modern society, knowledge increases at a terrific pace, and social changes are very rapid, requiring a radical transformation in the educational system. Education without an aim is relatively meaningless. Today students are quite advanced in their mental age in their intellect, ideas, and outlook. They are curious to know and have many doubts, and teachers have to meet the queries and satisfy this hunger with confidence. Therefore, they have to democratize their approach, methods, and class organization. There must be adequate freedom and flexibility in the classroom. Inquiry-based instruction helps involve students to do activities, have opportunities to explore possible solutions, develop cause and effect relations, explanations for the phenomena under investigation, elaborate on concepts and processes, and evaluate their understanding in light of obtainable evidence. Achievement in Science refers to the extent to which a learner is profiting from instructions in science. It indicates the knowledge attained and skill developed in the science subject, generally designated by test scores. The investigator used pre-assembled groups, as intact classes, for framing experimental and control groups. The pre-assembled groups were selected and were administered Pre-test. The pre-test scores were analyzed to show that the two groups' means and standard deviations do not differsignificantly.

KEYWORDS: Inquiry, Achievement in Science, Higher secondary school students.

INTRODUCTION:

In modern society, knowledge increases at a terrific pace, and social changes are very rapid, requiring a radical transformation in the educational system. Education without an aim is relatively meaningless. In response to traditional education, in the 1960s, a research-based teaching method was developed, now known as Inquiry-Based Education (IBE). Inquiry-Based education is a process whereby children and young people answer their questions and satisfy their curiosity about the world around them through activities and experiments. Inquiry-based instruction offers students opportunities to seek out answers. Science teachers are encouraged to begin their classes in the laboratory rather than start with a theoretical explanation, which means that science education should be based on looking for the answers to the secrets of nature to enable students to discover basic science concepts on their own rather than through memorization.Today students are quite advanced in their mental age in their intellect, ideas, and outlook. They are curious to know and have many doubts, and teachers have to meet the queries and satisfy this hunger with confidence. Therefore, they have to democratize their approach, methods, and class organization. There must be adequate freedom and flexibility in the

classroom.

INQUIRY BASED INSTRUCTION:

Inquiry Based Instruction is an approach that enhances students' academic excellence by engaging them within the learning process through various activities in the classroom that strengthen their confidence and understanding of the subject. It appreciates the sense of inquiry

and investigation in which questions are answered, and students are facilitated to memorize the information through the instructional materials.

ACHIEVEMENT IN SCIENCE:

Achievement in Science refers to the extent to which a learner is profiting from instructions in science. It indicates the knowledge attained and skill developed in the science subject, generally designated by test scores.

STUDIES RELATED TO INQUIRY- BASED INSTRUCTION:

Marilinda., et al., (2020) studied the effect of 7E learning cycle model toward students' learning outcome of basic science concept. This research is a quasi-experimental study with a randomized pretest-posttest control group design. The sample consisted of 24 control class students and 28 experimental class students. The experimental class uses the 7E Learning Cycle model while the control class uses the conventional model. The data collection technique is in the form of a learning outcome test (cognitive). The study reported that, there were differences in student learning outcomes taught using learning model Cycle 7E and conventional learning. Learning with 7E Learning Cycle model gives an effect of 72% (moderate) to the improvement of student learning outcomes in the Basic Science ConceptCourses.

Maskur., et al., (2019) studied the 7E Learning Cycle Approach to understand Thermal Phenomena. This research intended to reveal the effectivity of physics learning using the 7E Learning Cycle in improving students' understanding of temperature and heat concepts. The research design was quasi-experimental with a non-equivalent control group design. The sample consisted of 240 senior high school students. Cluster random sampling technique was used in the study. Objective test in the form of multiple choices equipped with reason was employed as the data collection instrument. The use of the 7E Learning Cycle model is sufficient to improve the learners' understanding of temperature and heat concepts. This could be seen from the success of the learning process that integrates the whole seven stages with the seven indicators of conceptual understanding indetail.

STUDIES RELATED TO ACHIEVEMENT IN SCIENCE:

Ma., et al., (2018) studied consistency of science achievement across science subjects among Chinese students and schools. A multivariate multilevel model was developed for secondary data analysis of 110,520 eighth grade students from 592 middle schools in China to examine the educational issue of consistency in science achievement across different science subjects among Chinese students and schools. Results indicated that Chinese students were highly consistent in science achievement across science subjects and this consistency did not depend on student and school characteristics. Meanwhile, Chinese schools were extremely consistent in science achievement across science subjects and this consistency did not depend on student and schoolcharacteristics.

Sheerasagar., and Kavyakishore., (2013) attempted to know the relationship of achievement in science and scientific attitude among students and found that there was no significant relationship in achievement in science and scientific attitude. The sample for the present study consisted of 600 IX standard secondary school students of Bangalore city. The sample was drawn using stratified random sampling technique from government and private secondary schools in Bangalore city.The interpretation of the results prompted the researcher to

draw the following important conclusions. The girls of IX standards have better Achievement in science than boys of IX Standard. The students of IX standard studying in private schools have better achievement in science than the students studying in Government Schools.

OBJECTIVES:

- To compare the mean Pre-test scores in Achievement in Science of Boys of Inquiry Based Instruction group and Conventional method group.
- To compare the mean Pre-test scores in Achievement in Science of Girls of Inquiry Based Instruction group and Conventional methodgroup.
- To compare the mean Post-test scores in Achievement in Science of Boys of Inquiry Based Instruction group and Conventional methodgroup.
- To compare the mean Post-test scores in Achievement in Science of Girls of Inquiry Based Instruction group and Conventional methodgroup.

HYPOTHESES:

- There is no significant difference in the mean Pre-test scores Achievement in Science, of Boys of Inquiry Based Instruction group and Conventional method group.
- here is no significant difference in the mean Pre-test scores in Achievement in Scienceof Girls of Inquiry Based Instruction group and Conventional methodgroup.
- There is no significant difference in the mean Post-test scores in Achievement in Scienceof Boys of Inquiry Based Instruction group and Conventional methodgroup.
- There is no significant difference in the mean Post-test scores in Achievement in Science, of Girls of Inquiry Based Instruction group and Conventional methodgroup.

DESIGN OF THE STUDY:

The investigator used pre-assembled groups, as intact classes, for framing experimental and control groups. The pre-assembled groups were selected and were administered Pre-test. The pre-test scores were analyzed to show that the two groups' means and standard deviations do not differ significantly. As there was no significant difference in the pre-test scores of the two groups, the investigator proceeded with the two groups available with science specialization in the school for the conduct of the experiment. Once the two groups were obtained, randomly, one group was assigned to the experimental treatment and the other as a control group. After determining the groups, the experimental treatment, namely Inquiry-based Instruction, was administered to the experimental group. The control group was taught with the conventional method based on the Herbartian approach. After the intervention for two months, the post-test was given to both groups. The difference between the pre-test and post-test scores is compared with the help of an appropriate statistical test to ascertain the effect of independent variable on dependentvariables.

VARIABLES OF THE STUDY:

As the study is designed in the form of an experiment, there should be independent and dependent variables, and the variables selected for this research are described as follows.

Independent Variables:

Independent variables selected for the study constitute the selected instructional strategies, namely, Inquiry-based instruction and Conventional method of instruction based on the Herbartianapproach.

Dependent Variables:

The dependent variables of the study include Achievement in Science,

LOCALE OF THE STUDY:

The present study was undertaken in the Chennai city in Tamil Nadu. The school selected for study, namely Chennai Metropolitan Development Authority (CMDA) Government Higher Secondary School, belongs to the category of the Governmentschool.

SAMPLE:

The sample selected for the present study consisted of 90 Higher Secondary School students studying in XI class who have opted for science group (Physics, Chemistry, Botany and Zoology) for their research. They are selected from CMDA Government Higher Secondary School Arumbakkam, Chennai. Purposive sampling technique was used to select participants because more cooperation and support were needed from the school for the conduct of the study, and the school selected was ready to take new initiatives and hence provided all facilities needed for the research.

7E – INQUIRY MODEL:

This model was proposed by Eisenkraft (2003), the project director of Active physics and Active chemistry, University of Massachusetts. It is an integrated instructional model that connects laboratory and hands-on activities with reading, discussion, and lectures. It is an elaborated form of the 5E learning model developed by Bybee (1987) with the five phases: Engage, Explore, Explain, Elaborate, and Evaluate.This model differs from the 5-E learning cycle in two ways- the step Engage in the 5E cycle is expanded into two different steps, Elicit and Engage, placing a greater emphasis on prior experience and eliciting knowledge that can be used as a foundation for the learning.The goal of the 7E learning model is to emphasize the increasing importance of eliciting prior understandings and extending or transfer of concepts. With this new model, the teacher should no longer overlook these essential requirements for student learning (Eisenkraft2003).

Elicit

Make the students interested and ready to learn, excite the students, ask questions to students, elicit responses from the students, and pose problems to students.

Engage

It gives importance to activating prior knowledge, making connections to previous lessons, asking questions, grabbing students' attention, generating curiosity, and motivating students. The different ways to activate prior knowledge and engage students include presenting a challenge to be solved, conducting a demonstration, using video clips related to the content, sharing experiences by both teacher andstudents.

Explore

Activate hands-on activities, where students observe and gain experience with the phenomena being studied. Students collaborate during this step. The teacher is a facilitator and may provide feedback. The different ways to make students explore include, activities where students plan and perform experiments, make graphs, develop hypotheses, provide opportunities for making observations and collecting data, provide opportunities to interpret results, and organize findings.

Explain

In this stage, the students analyze their data, observations and begin to form ideas. This is where the teacher may facilitate discussions; provide definitions and explanations of concepts. The teacher can explain the terminology and definitions, laws, theories and provide students with questions to guide them and help them by facilitating the connection between the exploration of

concepts and matching vocabulary to explain their results. The teacher can provide an opportunity for students to go back and attempt the activity again after it has been explained.

Elaborate

The elaborate phase of the 7E learning cycle gives an opportunity for students to apply their knowledge to new domains, which may include raising new questions and hypotheses to explore. The elaboration can be said to have a connection with the psychological construct called transfer of learning.

Evaluate

A continuous and comprehensive evaluation, including both formative and summative assessment, needs to be carried out throughout all stages of the cycle. It could be done by using different methods and techniques like observation, graphic organizers, and activities likeadiscussion. Ask questions relating to in-class investigations. Ask students to design experiments, draw conclusions from results, and interpret similar data.

Extend

In this step, the teacher helps the students to analyze the results and generate new questions and develop new hypotheses, apply knowledge to alternative concepts, new situations, and provide students with a new practice. These steps may cycle back through explain and explore several items.

ANALYSIS OF SCORES OBTAINED FOR ACHIEVEMENT IN SCIENCE:

Differential analysis is done for the Achievement in Science scores.

Analysis of Pre-test scores of Achievements in Science of Control group and Experimental group

t-test was conducted to compare the Pre-test scores on Achievement in Science of Control group and Experimental group, and the results are reported inTable.1.

Table 1.*Comparison of Pre-test scores on Achievement in Science of Control group and Experimental group*

Variable	Pre-test Scores					
	Control Group (N=45)		Experimental Group (N=45)			
	Mean	Standard Deviation	Mean	Standard Deviation	t-value	df
Achievement in Science	33.66	3.55	34.06	3.76	0.50	44

Note. N= Number of students,df=degrees of freedom

Table.1 shows no significant difference in the Pre-test scores on Achievement in Science of Control group and Experimental group. It is found that the calculated t-value (0.50) is less than the table value (2.66). The null hypothesis stated **as "there is no significant difference in the Pre-test scores on Achievement in Science of Control group and Experimental group" isaccepted.**

Analysis of Pre-test and Post-test scores of Achievements in Science of Control group.

An effort was made to compare the Pre-test and Post-test scores on Achievement in Science of Control group, and the results obtained are presented in Table 2.

Table 2.*Comparison of Pre-test and Post-test scores of Achievement in Science of Control group*

Variable	Control Group					
	Pre-test Scores (N=45)		Post-test Scores (N=45)			
	Mean	Standard Deviation	Mean	Standard Deviation	t-value	df
Achievement in Science	33.66	3.55	38.04	4.62	8.15**	44

*Note.***p*<0.01. N= Number of students,df=degrees of freedom

From Table 2, it is seen that 'there is a highly significant difference in the Pre-test and Post-test scores of the Control group on Achievement in Science as the calculated t-value (8.15) obtained for Post-test scores of the Control group is higher than the table value (2.66) and is significant at 0.01 level'. The value obtained for mean suggests that Post-test score of the Control group (38.04) is higher than the Pre-test scores (33.66) on Achievement in Science. Therefore, the null hypothesis stated as "th**ere is no significant difference in the Pre-test scores and Post-test scores on Achievement in Science of Control group" isrejected.**

Analysis of Pre-test and Post-test scores of Achievements in Science of Experimental group.

An endeavor was made to compare the Pre-test and Post-test scoresonAchievement in Science of Experimentalgroup using t-testand the results obtained are given in Table 3

Table 3. *Comparison of Pre-test and Post-test scores of Achievements in Science of Experimental group*

Variable	Experimental Group					
	Pre-test scores (N=45)		Post-test scores (N=45)			
	Mean	Standard Deviation	Mean	Standard Deviation	t-value	df
Achievement inScience	34.06	3.76	60.57	6.57	25.60**	44

*Note.****p*<0.01. N= Number of students,df=degrees of freedom

Table 3 shows that the t-value is 25.60which is greater than the table value 2.66 and is significant at 0.01 level with df =44. It shows that the mean Pre-test and Post-test scores of Achievements in Science of Experimental group differ significantly and hence the null hypothesis stated as "there is no significant difference in the Pre-test and Post-test scores on Achievement in Science of Experimentalgroup" is rejected. Further, the mean Post-test Achievement score of the Experimental group is 60.57, which is greater than the mean Pre-test score of 34.06. Therefore, it may be said that group taught by Inquiry- Based Instruction were found to have scored better in the Achievement test, implying that Inquiry- Based Instruction improved the students' Achievement in Science.

Analysis of Post-test scores on Achievement in Scienceof Control group and Experimental group

t- test was conducted to compare the mean Post-test scores on Achievement in Science ofControl group and Experimental group and the results are given in Table 4.

Table 4.*Comparison of Post-test Achievement scores of Control group and Experimental group*

Variable	Post-test Scores					
	Control Group (N=45)		Experimental Group (N=45)			
	Mean	Standard Deviation	Mean	Standard Deviation	t-value	df
Achievement in Science	38.04	4.62	60.57	6.57	19.54**	44

*Note.***p*<0.01. N= Number of students,df=degrees of freedom

Table 4shows that the t-value is 19.54which is greater than the table value 2.66 and is significant at 0.01 level with df =44. It shows that the mean Post-test scores of Achievements in ScienceofControl group and Experimental group differ significantly and so the null hypothesis that "t**here is no significant difference in the Post-test scores on Achievement in Science of the Control group and Experimental group" is rejected**. Further, the mean Post-test score on Achievement in Science of Experimental group is 60.57, which is greater than that of the Control group, whose mean Post-test score is 38.04. Therefore, it may be said that the group taught by Inquiry-Based Instruction were found to have performed better in the Achievement Test than the Control group students who were taught by the Conventional method.

CONCLUSION:

Differential analysis using t-test revealed that there is no significant difference in the Pre- test scores of Experimental and Control group students on Achievement in Science, also there is a highly significant difference in the Pre-test and Post-test scores of the Experimental group on Achievement in Science. Also, there is a highly significant difference in the Pre-test and Post- test scores of the Control group on Achievement in Science. Moreover, Achievement in Science, of Experimental group and Control group revealed that there is a significant difference in the Post-test and Adjusted Post-test mean scores of students of Inquiry-Based Instruction and Conventional method groups when their Pre-test scores on Achievement in Science, score were taken as a Covariate.

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