



Effects of Inquiry- Based Learning Approach on Learning Achievement and Learning Satisfaction among Grade Four Students towards Science

Sonam Tshering^{1*} and Pema Yangden²

¹*Gongzim Ugyen Dorji Central School, Haa, Bhutan.*

²*Katsho Lower Secondary School, Haa, Bhutan.*

Authors' contributions

This work was carried out in collaboration between both authors. Author ST designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors PY managed the analyses of the study, literature searches and wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

The purpose of this study was to examine the effects of Inquiry based learning approach on learning achievement and learning satisfaction among grade 4 students in science. The study used a quasi-experimental design. A clustered random sampling was used to select 2 sections out of 3 sections of grade four students. The research instruments implemented were achievement test, questionnaire and observation form were used to collect the data. The experiment was carried out for 5 consecutive weeks. The statistics used for data analysis were mean, standard deviation, paired and independent t-test. The analysis of the result on learning achievement showed that there was a significant difference between the means of pretest and posttest and paired t-test also gave the significant value of $p=0.00$ (<0.05). Similarly, the overall mean of the student learning satisfaction was 4.61 which indicated that students were extremely satisfied with inquiry based learning approach. The results of the data showed that the Inquiry-based learning approach was effective in achieving high scores and as well the learning satisfaction of the students in science.

*Corresponding author: Email: tshering.sonam@education.gov.bt;

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1. INTRODUCTION

Science was introduced in Bhutan with a borrowed curriculum from its neighbor, India. Later in 1986 the, 'New Approach to Primary Education (NAPE) was introduced, effectively seeking to orientate more firmly the primary science curriculum for classes IV to VI. The NAPE science curriculum was developed, to promote the teaching of science based on Bhutanese natural and social environment. [1]. Bhutan, like any other developing countries, places great importance in institutionalizing a relevant and challenging science curriculum for all of its school aged children. However, science is considered as one of the difficult subjects in the Bhutanese context.

Over the years, however, there was a growing concern that primary science textbooks and manuals were lacking in content and the teaching guides were similarly criticized. In 2001, textbooks were revised mainly to add content and update the learning activities. There was also a general public perception that standards are falling and that the science curriculum does not prepare students for the world of work and for national citizenship [2]. Despite the emphasis and importance given to science, the students are found performing poorly in science as revealed by the analysis of class X and XII results of [3].

Not only in Bhutan, there are well documented studies of declining interest in science and science careers in both primary and secondary schools [4]. The reason may be because the teaching and learning of science lacked inquiry, hands on activities, investigations and constructivism [5]. Science is taught in the traditional method and this lecture method is still very popular in among the teachers. Johnson et al. [1] found out that science subjects in Bhutan were taught using traditional methods which lacked activities.

Bozie [6] points out that the traditional way of teaching imparts knowledge of the content and students feel that learning science is just about recalling disconnected facts and definition.. Indeed the exercises based subject, in spite of the fact that exercises are exhausted a gather but don't empower dialog or investigation of the concepts included. This tends to overlook the critical thinking and unifying concepts essential to

true science literacy and appreciation [7]. Students are not able to apply the learned scientific knowledge to everyday problems. Many students also fail to understand the importance of learning science. To make children learn science it is important for the students to learn how to do scientific inquiry and use scientific information to make decisions that will affect their personal lives, careers, and societies. The science teachers must make room for scientific inquiry by decreasing their emphasis on teaching science as a sequence of lectures and reading assignments on the body of scientific knowledge [8].

Inquiry-Based Learning (IBL) is one approach that has been undertaken to improve the teaching of science by involving learners in authentic and practical investigations, as well as offering a more motivating and learner-centered environment [9]. IBL helps to develop curiosity in the students' minds about the world around them. In inquiry-based science education, children become engaged in many of the activities and thinking processes that scientists use to produce new knowledge. Science educators encourage teachers to replace traditional teacher-centered instructional practices like textbooks, lectures, and scientific facts with inquiry-oriented approaches that (a) pique students' interest in science, (b) allow students to collect evidence using appropriate laboratory techniques, and (c) require students to solve problems using logic. [10].

Inquiry is central to science learning. Students build explanations, test those explanations against existing scientific knowledge, and communicate their findings to others when they engage in inquiry. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. In this way, students actively develop their understanding of science by combining scientific knowledge with reasoning and thinking skills [11]. This inquiry based learning allows students to be more involved in the teaching of the course and encourages them to take more responsibility for learning. More importantly, it fosters greater interest, and when the students become interested in a subject, learning occurs without much assistance from the instructor [12].

A growing body of researcher found out that the IBL is effective teaching and learning approaches

if implemented properly with regards to context and the linking of teaching content, learning and assessment, [13-16]. In order to uplift the sanctity of true science, it is necessary for all teachers to teach the science concepts scientifically. Finally, this study seeks to replace the traditional method with recent but meaningful instructional strategy to teach science and that is inquiry based learning approach.

2. RESEARCH OBJECTIVES

The objectives of the study were as follows;

2.1 To examine the effectiveness of IBL approach on learning achievement of grade four students in science.

2.2 To find out students' learning satisfaction in using IBL approach in teaching and learning science.

3. RESEARCH METHODOLOGY

3.1 Research Design

This research was a quasi-experimental study with two groups, pretest and posttest design. The experiment design pattern is shown in Chart 1. In the pattern below, O1 is the pretest and O2 is the posttest. 'X' represents treatment i.e. Inquiry-Based learning approach.

3.2 Sampling

The selection of the sample was done through clustered random sampling method. The researcher selected two sections of 4th grade students. Classes were randomly assigned as experimental and control groups. Each group consisted of 34 research participants. In order to ensure the equivalence at 'experimental' and 'control' groups, pretest result was taken into account. It was found that the experimental group was statistically equal to the control group.

3.3 Research Instruments

The research instruments that were used to collect data included achievement test, learning satisfaction questionnaires and lesson observation form as follows:

3.4 Achievement Test

To find out the effect of IBL on the students' academic achievement, an achievement test was

used. The achievement test consisted of 24 multiple-choice questions. The validity of the item was done using Item Objective Congruency Index (IOC) to analyze the content and purpose of test objective. Content experts rated the items regarding how well they do or do not match with the established objectives. The result index ranges from -1 to +1, if the rating is

- 1) +1 Certain that the test is congruent with objectives or content.
- 2) 0 Uncertain that the test is congruent with objectives or content.
- 3) -1 Certain that the test is NOT congruent with the objectives or content.

$$\text{The formula for calculating IOC} = \frac{\sum R}{N}$$

Where R = sum of the scores of individual experts, N = number of experts.

(Source : Rovenelli & Hambleton, 1977)

The test was administered once before the experiment and once after the experiment in both the groups. The Kuder-Richardson reliability of the test was 0.72, which indicated the test items were reliable.

3.5 Questionnaires for Learning Satisfaction and Class Observation

A set of questionnaires was developed to determine the students' learning satisfaction as a result of using inquiry based learning in learning science. The questionnaire was used to assess in the area of their participation and satisfaction after the intervention. The learning satisfaction questionnaires were administered to the experimental group only. Likert scale was used to measure the degree of learning satisfaction. The content validity of the study was examined by three experts, a professor from Samtse College of education, and two senior teachers from the school where the research study was conducted. The internal consistency of reliability (Cronbach's alpha) of this questionnaire was found to be 0.89.

A class observation form was utilized to observe the learning behavior of the students. The learning behavior of the students was observed in both experimental and control groups. There were 12 indicators, and for each indicator the following rating scale was applied: (4) outstanding, (3) good, (2) fair, (1) not

Group	Pretest	Experiment treatment	Posttest
Experimental Group	O1	X	O2
Control Group	O1		O2

Chart 1. The experiment design pattern

demonstrated. During the study a total of 10 observations of experimental and control groups were done. Classes were observed from beginning till end. There were two-teacher observers to observe the class.

3.6 Research Procedure

The research participants were selected using clustered random sampling. One group was used as the experimental group and another as the control group. The pretest was conducted for both the groups. The questionnaire was administered only to the experimental group to study the learning satisfaction of the students in learning science when IBL approach is used. Classroom observation was carried out by two teacher observers using the observation form to check the learning behavior of the students in both the groups. Then the experimental group was taught using an IBL approach while the control group was taught using traditional method. Both the groups were taught the same topic: "Light and Sound". At the end of the treatment, posttest was conducted for both the groups. The data were analyzed using mean, standard deviation and significance value.

4. RESULTS AND DISCUSSION

Results of the data analysis

4.1 Pretest – Posttest Comparison (within the groups)

Firstly, the pretest and posttest scores of each group were compared. Table 1 shows the result of paired sample t-test of the pretest- posttest comparison of both groups in terms of mean and standard deviation.

Table 1 show that the mean in the pretest of the experimental group was 8.38 and the standard deviation was 2.80. On the posttest, the mean was 17.47 and the standard deviation was 3.97. In the control group, the mean of pretest was 8.00 and the standard deviation was 3.53. The

mean of the posttest was 11.71 and the standard deviation was 1.96.

Paired sample t-test indicated that both the groups mean score increased from pretest to posttest. It was also noted that the mean difference in the experimental group was significantly higher than that of the control group.

4.2 Pretest-Pretest and Posttest-Posttest Comparison

Table 2 shows the pretest means of the experimental group was 8.38 and the mean of the control group was 8.00. It was noted that they were almost equal and the 2-tailed significance value was 0.623, which indicated that there was no significant difference between the pretest means of the two groups. Thus, it indicated that the two groups had equal learning abilities in the beginning of the experiment.

The posttest mean of the experimental group was 17.47 and the control group was 11.71. The 2-tailed significance was 0.00, which indicates that the mean of the posttest of the experimental group was significantly higher than the mean of the posttest of the control group.

4.3 Analysis of Questionnaire on Learning Satisfaction and Students Learning Behavior

The second objective of the study was to determine the learning satisfaction of the students as a result of using inquiry approach in teaching science lessons. It was administered only to the experimental group after the treatment. The mean and standard deviation were computed. An overall analysis from the questionnaires revealed a positive gain in learning satisfaction that the students had about learning science using an inquiry approach. Table 3 shows the overall mean and the standard deviation of the learning satisfaction questionnaire after the treatment.

Table 1. Pretest and posttest comparison

Groups	Experimental Group		Control Group	
	Pretest	Posttest	Pretest	Posttest
Mean	8.38	17.47	8.00	11.71
Standard Deviation	2.80	3.97	3.53	1.96
Sig (2-tailed)	0.000		0.000	
Mean Difference	17.47 – 8.38 = 9.09		11.71- 8.00 = 3.71	

Table 2. shows the comparisons of the pretests and posttests of the experimental and control group

Group	Test	Mean	Mean difference	S.D	Sig. (2-tailed)
Experimental	Pretest	8.38		2.80	
Control	Pretest	8.00	=0.38	3.53	0.623
Experimental	Posttest	17.47		3.97	
Control	Posttest	11.71	= 5.76	1.96	0.000

*P<.05***Table 3. Overall mean and standard deviation of the student's learning satisfaction**

SI.No.	Overall	Mean	S.D.	Level of Satisfaction
1.	Learning satisfaction	4.61	0.52	Extremely satisfied

*Level of satisfaction: 0.00 – 1.50 (not at all satisfied)**1.51 – 2.50 (slightly satisfied)**2.51 – 3.50 (moderately satisfied)**3.51- 4.50 (very satisfied)**4.51 – 5.00 (extremely satisfied)*

The findings showed that the students exhibited a high level of satisfaction with the overall mean score of 4.61 and the standard deviation of 0.52. Therefore, the researcher concluded that when the inquiry method was integrated as a supplementary strategy to teach science, students displayed the high level of learning satisfaction.

4.4 Student's Learning Behavior Form

Class observation was done on the student's learning behavior during the treatment. The observation was made to both the control and experimental group. The mean and the standard deviation were computed. Table 4 shows the subtotal mean and the standard deviation of the students' learning behavior.

Table 4 shows that for the experimental group, the subtotal mean was 3.75 and the standard deviation was 0.35. The level of opinion was 'outstanding' result. In the control group, the subtotal mean was 1.5 and the standard deviation was 0.55. The level of opinion indicated 'not demonstrated' result. Therefore, the results

indicated that the students in the experimental group enjoyed and participated in activities when the science lesson was taught using inquiry based approach.

5. DISCUSSIONS AND CONCLUSION

This study revealed that the IBL approach increased the learning achievement and learning satisfaction of grade four students in science. Many other studies supported this finding. Abdi [13], Lord and Orwiszewski [17], Opara [18], Akpulluku and Gunay [16], they all found out that the academic achievement of the students increased significantly with the use of IBL as compared to students taught in a traditional manner.

The first finding of the study was that the use of IBL approach increased the academic achievement of the students. The evident from the achievement test result (Table 1) which showed the mean difference of pretest and posttest of both the groups. The scores of the pretest showed that the students in both the groups have the same ability (Table 1). Table 2

presented the posttest of both the groups and it was found that the achievement of the experimental group was significantly higher than that of the control group.

The second findings from the study revealed that the students were extremely satisfied when the science lesson was taught using Inquiry-Based Learning approach. The learning satisfaction questionnaires were used only with the experimental group since the control group was taught using the traditional method. Table 3 presented the mean and standard deviation on learning satisfaction. The overall mean was 4.61 and the standard deviation was 0.52, which indicates that the students were extremely satisfied with learning science using IBL approach.

The result of the learning satisfaction of students towards science was found extremely satisfying and this might be because of the process of inquiry engages the students' insatiable curiosity. The hands-on experiments the questions posed by young students can also be integrated into the active imagination. The traditional teaching formats simply give scientific facts, the students are less engaged, and they lose the interest very rapidly. Inquiry, however, puts the students in the middle of the experiment and gives the students a sense of responsibility for the results. The classroom setting changed throughout the study, from apprehensive and lacking classroom to active discussion and participation. Another reason that the inquiry approach created improvements within the class was that the student could apply the scientific inquiry as a social setting as well.

Constructivist Theory supports inquiry –based learning because students are encouraged to be actively involved in their learning by connecting prior experience with new information [19]. There are several studies that have investigated students' interest and students' achievement. Bayram and others [20] examined the effects of inquiry- based learning approach to promote students' motivation and to build positive attitude

towards science learning. They found that learners taught by inquiry- based approach scored considerably higher on achievement tests than those taught using the traditional lecture method when they had more positive attitudes towards learning science.

The result of the students' learning behavior towards science was found positive. The data were computed using the mean and standard deviation. The result showed that the students in the experimental group showed positive result compared to control group. The teacher observer agreed with most of the indicators. Data from the observation revealed that students in the IBL group were engaged on the task more often than students in the traditional group. Similar study done by Drake and Long [21] found an increase of on task behavior in students in IBL classes. As suggested by Aydeniz et al. [22] that to ensure that all students achieve in science, inquiry skill should be emphasized over rote memorizing facts. IBL has a positive impact on students' attitude toward learning in science. Another reason for positive change in opinion might be due to the pleasure and satisfaction that the student derives from the understanding of the concept. The students are actively involved and motivated to take active participation in the activities. The students were attentive and attended the lesson with interest.

The overall result concluded that the students in the experimental group were satisfied learning science using inquiry based learning approach. The findings of this study supported research regarding positive gains of students participating in the IBL. As students participated in IBL, they gradually learned to investigate, reason, and organize knowledge and then incorporate that knowledge into their understanding without intervention from the teacher participant. It is therefore concluded that inquiry based learning approach enhances effective understanding and comprehension of Science concepts and skill acquisition; therefore it should be used in teaching primary science.

Table 4. Subtotal mean and standard deviation of students' learning behavior

Students' learning behavior	Control Group			Experimental Group		
	Mean	S.D	Opinion	Mean	S.D	Opinion
Subtotal	1.50	0.55	'ND'	3.75	0.35	'O'

Students' learning behavior

Level of opinion: 0.00 – 1.50: Not demonstrated 'ND' 1.51 – 2.50 Fair 'F', 2.51- 3.50: Good 'G' 3.51 – 4.00 Outstanding 'O'

Based on the findings of the study, some recommendations have been made. First, since IBL approach was found to enhance or improve the student's performance in science, teachers should be encouraged to teach science using Inquiry Based approach and to improve the academic achievement and learning satisfaction of the students towards science, the nation's science curriculum should be made in view to accommodate an inquiry based science program for the students.

Second, it is recommended that further study be carried out to investigate whether the intervention may significantly increase the achievement, and satisfaction over a longer period of time with a larger group of students.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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