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

ผลกระทบของการจัดการเรียนรู้แบบสืบเสาะหาความรู้ (Inquiry-based learning) ที่มีผลต่อผลสัมฤทธิ์ทางการเรียนและความพึงพอใจ ในการเรียนรู้ของนักเรียนเกรด 4 ที่มีต่อวิชาวิทยาศาสตร์

Pema Yangden

Masters in Curriculum and Instruction Rangsit University, Pathumthani, Thailand

Corresponding author, E-mail: pemaytshering@gmail.com

บทคัดย่อ

การศึกษาครั้งนี้มีวัตถุประสงค์เพื่อวิเคราะห์ผลกระทบของการจัดการเรียนรู้แบบสืบเสาะหาความรู้ (Inquiry-based learning) ที่มีผลต่อผลสัมฤทธิ์ทางการเรียนและความพึงพอใจในการเรียนรู้ของนักเรียนเกรด 4 ที่มีต่อวิชาวิทยาศาสตร์ การศึกษานี้ได้ใช้การวิจัยเชิงกึ่งทดลอง (Quasi-experimental) โดยใช้วิธีการสุ่มตัวอย่างแบบกลุ่ม (Clustered random sampling) เพื่อคัดเลือกนักเรียนเกรด 4 จำนวน 2 กลุ่มจากนักเรียน 3 กลุ่ม เครื่องมือที่ใช้ในการวิจัยและเก็บข้อมูลประกอบด้วย แบบทดสอบวัดผลสัมฤทธิ์ (Achievement Test), แบบสอบถามและแบบสังเกต การทดลองใช้เวลาทั้งสิ้น 5 สัปดาห์ติดต่อกัน สถิติที่ใช้ในการวิเคราะห์ข้อมูลได้แก่ ค่าเฉลี่ย, ค่าเบี่ยงเบนมาตรฐาน (Standard deviation), การทดสอบความแตกต่างแบบจับคู่และการทดสอบแบบค่าเฉลี่ยสองกลุ่มเป็นอิสระต่อกัน (Paired and independent t-test) การวิเคราะห์ผลสัมฤทธิ์ทางการเรียนพบว่ามีความแตกต่างอย่างมีนัยสำคัญระหว่างวิธีการวัดผลก่อนและหลัง (ตารางที่ 1) นอกจากนั้น การทดสอบความแตกต่างแบบจับคู่จะให้ค่าที่มีนัยสำคัญทางสถิติ p=0.00 (<0.05) ในทำนองเดียวกัน ค่าเฉลี่ยในภาพรวมของความพึงพอใจในการเรียนรู้ของนักเรียนมีค่าเท่ากับ 4.61 ซึ่งแสดงว่านักเรียนมีความพึงพอใจกับการจัดการเรียนรู้แบบสืบเสาะหาความรู้อย่างมาก ผลการวิเคราะห์ข้อมูลแสดงว่าการจัดการเรียนรู้แบบนี้ทำให้นักเรียนได้คะแนนสูงและทำให้นักเรียนมีความพึงพอใจในการเรียนรู้อีกด้วย

***คำสำคัญ**: การจัดการเรียนรู้แบบสืบเสาะหาความรู้ ผลสัมฤทธิ์ทางการเรียน ความพึงพอใจในการเรียนรู้ วิชาวิทยาศาสตร์*

Abstract

The purpose of this study was to examine the effects of Inquiry-based learning approach on learning achievement and learning satisfaction of grade 4 students in science. The study used 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 in this study were achievement test, questionnaire and observation form. The experiment was carried out for 5 consecutive weeks. The statistics used for data analysis weremean,

standard deviation, paired and independent t-test.The analysis of the result on learning achievement showed that there was significant difference between means of pretest and posttest (Table 1) and paired t-test, if 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 score and as well the learning satisfaction of the students in science.

Keywords: *Inquiry-based learning approach, Learning achievement, Learning Satisfaction, Science*

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 (Johnson and others 2008). 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 subject 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 were falling and that the science curriculum did not prepare students for the world of work and for national citizenship (Department of Curriculum Research and Development, 2012). Despite the emphasis and importance given to science, the students were found performing poorly in science as revealed by the analysis of class X and XII results of 2014 (Palden, 2015).

Not only in Bhutan, there were well –documented studies of declining interest in science and science careers in both primary and secondary schools (Jarvis & Pell 2002). The reason may be because the teaching and learning of science lacked inquiry, hands on activities, investigations and constructivism (Yangzom, 2013). Science is taught in traditional method and this lecture method is still very popular in among the teachers. Johnson, Childs, Ramachandran, and Tenzin (2008: P.16) found out that science subjects in Bhutan were taught using traditional method which lacked activities.

Bozie (2014) 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. Even the activities based subjects, although activities are done in a group but do not encourage discussion or exploration of the concepts involved. This tends to overlook the critical thinking and unifying concepts essential to true science literacy and appreciation (Yore, 2001). 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 help

children learn science it is important for the students to learn how to do scientific inquiry and also use scientific information to make decisions that will affect their personal lives, careers, and societies. The science teachers must apply scientific inquiry in their classrooms by decreasing their emphasis on teaching science as a sequence of lectures and reading assignments on the body of scientific knowledge (Straver, 2007).

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 (Lane, 2015). IBL helps to develop curiosity in the student's 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, such as emphasis on textbooks, lectures, and scientific facts, with inquiry-oriented approaches that (a) engage student's interest in science, (b) provide opportunities for students to use appropriate laboratory techniques to collect evidence, (c) require students to solve problems using logic and evidence, (d) encourage students to conduct further study to develop more elaborate explanations, and (e) emphasize the importance of writing scientific explanations on the basis of evidence (Secker,2002).

Inquiry is central to science learning. When engaging in inquiry, students construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. 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 (National Research Council, 1996). 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 (Wurdinger,2005).

A growing body of researcher found out that IBL is an effective instruction approach if implemented properly with regards to context and the linking of teaching content, learning and assessment, (Abdi, 2014; Akpullukcu and Gunay, 2011; Hardin, 2009; Panday, Nanda & Ranjan, 2011). 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 Figure 1. In the pattern below, O1 is the pretest and O2 is the posttest. 'X' represents treatment i.e. Inquiry-Based learning approach.

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

Figure 1 The experiment design pattern

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 experimental group was statistically equal to 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:

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

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. 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 group. There were 12 indicators,

and for each indicator the following rating scale was applied (4) outstanding, (3) good, (2) fair, (1) not 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.

3.4 Research Procedure

The research participants were selected using clustered random sampling. One group was used as experimental group and another as the control group. The pretest was conducted to 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 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 to both the groups. The data were analyzed using mean, standard deviation and significance value.

4. Data Analysis 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 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 1 show that the mean in the pretest of the experiment group was 8.38 and the standard deviation was 2.80. In 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 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	= 0.38	2.80	0.623
Control	Pretest	8.00		3.53	
Experimental	Posttest	17.47	= 5.76	3.97	0.000
Control	Posttest	11.71		1.96	

Significance level: > 0.05 – not significant, < 0.05 – significant

Table 2 shows the pretest means of 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. Overall analysis from the questionnaires revealed a positive gain in learning satisfaction that the students had about learning science using inquiry approach. Table 3 shows the overall mean and the standard deviation of the learning satisfaction questionnaire after the treatment

Table 3 Overall mean and standard deviation of the student's learning satisfaction

Sl.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 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 inquiry method was integrated as a supplementary strategy to teach science, students displayed the high level of learning satisfaction.

Student's learning behavior form

Class observation was done on student's learning behavior during the treatment. The observation was done 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 Subtotal mean and standard deviation of 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'

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

Table 4 shows that for 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 thestudents in the experimental group enjoyedand 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 (2014), Akpulluku and Gunay (2011); Lord and Orwiszewski (2006), Opara (2011), 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 difference mean of pretest and posttest of both groups. The scores of the pretest showed that the students in both groups have the same ability (Table 1). Table 2 presented the posttest of both groups and it was found that 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 in 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 (Ozmon and Craver, 2008). There are several studies that have investigated students' interest and students' achievement. Bayram and others (2013) 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 attitude towards learning science.

The result of the students' learning behavior towards science was found positive. The data was computed using mean and standard deviation. The result showed that the students in the experimental group showed positive result comparing to control group. The teacher observer agreed to 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 (2009) found an increase of on task behavior in students in IBL classes. As suggested by Aydeniz, Cihale, Graham and Retinger (2012) that to ensure that all students achieve in science, inquiry skill should be emphasized over rote memory facts. IBL has a positive impact on students' attitude towards learning in science. Another reason for positive change in opinion might be due to the pleasure and satisfaction that the student derive from the understand-

ing 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 IBL. As students participated in IBL, they gradually learned to investigate, give reasons, 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.

Based on the findings of the study, some recommendations have been made. First, since IBL approach was found to enhance or improve 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 can be carried out to investigate whether the intervention may significantly increase the achievement, and satisfaction over a longer period of time with larger group of students.

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