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Effects of Using Inquiry Based Learning Pedagogy in Teaching Science

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Abstract

The research was purely done to examine the effects of Inquiry-Based Learning (IBL) on teaching and learning, interest and understanding of the lesson by the seventh-grade science students. Participants were from one class of grade seven science and their class teacher from Samtse Lower Secondary School, Bhutan. The students received Inquiry-Based learning instruction. A lesson was taught on the topic 'Chemical change' for fifty minutes to a group of Grade Seven students followed by a distribution of survey questionnaires to students and their class adviser to find out how effective the inquiry based teaching was for their learning. In this research, we came across greater improvements in students' science literacy. We also found that through inquiry-based teaching students gained self-confidence in scientific abilities and are more interested to learn.

INTRODUCTION

Education will always be the potential reason for the changes that occurs in a society. Development of man power to achieve different levels of the economy, relies on education. It is also the foundation to carry out many research and development. The country must put more efforts to extract the benefits from the assets which already exist. These assets were created in order to sustain the economy, ensuring that the benefits of change reach to all section in the nation. Education is the express way to achieve that goal. The education system is like a mirror through which one can see the shapes of the nation in terms of its economy and growth (Schwab, 1960). The progress of the nation can be predicted in the due course of time. Therefore, to acquire education, one must upgrade the teaching system and initiate better strategies through which teaching learning will be more effective.

A good teacher always tries to improve their teaching methods. The productivity of students can be improved if newer teaching techniques and strategies are applied. This will help students to learn more and acquire new knowledge. Thus, inquiry-based teaching is one constructive method for learning and obtaining education.

Inquiry based learning is a method where questions will be asked and thereby students will be encouraged to ask questions. These will help the students to conceptualize the subject and solve problems. Inquiry through good questions will generate significant answers. These requires lots of practice. A conflict would be raised with students' ideas and requires inquiry to solve the issue. Most often, there won't be correct answers for the problem, rather students will learn by trying to solve that particular problem and in this way, the students will be educated. They interpret the case, become practical by putting themselves into the question, and accumulate additional resources to collect the data. They predict feasible solutions, assess different options to get the best solution and the conclusion will be presented. So, in a way it is also a process-oriented learning (Miller, McNeal, & Herbert, 2010).

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For example; “All young children ask parents what could be called “Why” questions. Why is the sky blue? Why do things fall down? And many times, children ask the same questions again a few days later. Even though children may not understand the answers, the questions themselves show that children are thinking about the world and developing habits of thought. Similarly, in our adult lives, we build understanding largely through what we experience. We create meaning as much from efforts to answer our own questions as from what we read or hear. In that sense, it is often said that our greatest challenges become our greatest learning experiences”.

From mathematical analysis (“What does this equal?”) to literary survey (“What does this mean?”) to scientific experiments (“Why and how does this happen?”) to historical examination (“What took place, and why did it occur that way?”), Inquiry based learning helps students to discover the structure of a situation and leads to meaningful conception (Brew, 2003).

Therefore, the ability to ask the right questions lies at the core of the democratic process. The classroom has been described as the cradle of democracy and the teacher as one of the most influential nurturers of the democratic process. People who are interested in education, recognizes the significance of questioning as the means by which teachers help students to construct meaning on any kind of lesson in the classroom. The collective construction of action depends upon skills of students to ask productive questions. Inquiry based learning is offered in the hope that, by examining how we question, we will arrive at some answers which will generate richer classroom interaction. This will in turn provide students with scope to enhance and practice that essential democratic skill (Harlen, 2013).

Literature Review

Inquiry based learning is a method where a student is actively engaged in learning and exploring. They focus on questioning, critical thinking and problem-solving. It’s associated with the idea involve me and I understand (Johnson, 2014: 91). According to Suchman (2013: 91), “Inquiry is the way people learn when they are left alone.” To him, Inquiry based learning is an intrinsic way through which people learn about their environment and the nature. If a young kid is given with objects to explore and left in a courtyard, he will explore the objects by playing, throwing, touching and pulling. The child learns about the objects and how they interact by exploring them, by developing his ideas about the object. We can say that the child is learning about the particular object by inquiry. That is how learner learn when they are left alone with the help of inquiry.

Inquiry is the active pursuit of meaning involving thought processes that change experience to bits of knowledge. When we see a strange object, for example, we may be puzzled about what it is, what it is made of, what it is use for, how it came into being, and so forth. To find answers to questions (emphasis mine) such as these we might examine the object closely, subject it to certain tests , compare it with other , more familiar objects, or ask people about it ,and for a time our searching would be aimed at finding out whether any of these theories made sense. We might simply cast about for information that would suggest new theories for us to test. All these activities –observing, theorizing, experimenting, theory testing –are part of inquiry. The purpose of the activity is to gather enough information to put together theories that will make new experiences less strange and more meaningful (Suchman, 2013).

Scientific Point of View on Inquiry based learning.

- For scientific related teaching-learning, there are activities which need to followed like observing, measuring, predicting outcome, experimenting though hands-on exercises, inferring, calculating with numbers, formulating hypothesis, interpretation of data and controlling parameters. (Dewey, 1983: 91)

- In an Inquiry based learning environment an instructor's duty is not just to provide knowledge or information, but also to help and guide their students in the process of discovering knowledge and provide ideas or ways on how to achieve their goals.

According to Johnson (2014),

The ways to carryout inquiry-based learning:

Learners ask questions.



Questions helps in exploration for answers or solutions to a problem. This will result in the beginning of exploration and hypothesis creation.



Hypothesis leads to an experimentation and investigation. Data will be collected to test the hypothesis or find answers to the question.



The investigation or collecting of data leads to the creation or construction of new knowledge based on the findings and the outcomes.



The learner discusses and reflects on this newly acquired knowledge, which in turn leads to more questions and further investigation.

Nutshell of Inquiry Based Learning Process



Figure 1. Methods to carry out Inquiry Based Learning

Effectiveness of Inquiry Based Learning

1. It helps teachers to be able to actively involve their students in the learning process.
2. It leads to transformation of teacher centered instruction to a more student-centered approach which gradually help enhance the learning abilities and skills in students.
3. Inquiry based learning gives teachers a plat form to help their students learn on their own, explore and investigate on certain concepts and content they are provided with. Students create hypothesis on their own and work to find out the answers. They learn by doing and teachers support them as a guide.
4. It also provide the students with more oppourtunity to reflect on their own learning, be independent, use their skills, be creative and confident which helps them to gain a deeper understanding of the content and become critical thinkers.

Advantages of Inquiry Based Learning

1. Builds curiosity in learners.
The teacher should create an atmosphere of curiosity. Curiosity can be well fostered using Inquiry activities. Thought provoking bulletin boards is another way to arouse curiosity in learners (Jerome Bruner 2013, pg.97).
2. Students develop lifelong learning skills.
One of the goals of IBL is to develop research capacity development skills which will be helpful for life. Through IBL method, students can retain any information more easily and make use of it effectively in future. Learning outcomes based on critical thinking, the ability for independent inquiry, self-learning and intellectual growth, are some of the motivational oriented abilities that can be achieved.
3. Learners find the IBL method more enjoyable and satisfying since they are encouraged to work on their own.
4. IBL method also encourages greater understanding of any concepts or course.

Disadvantages of Inquiry Based Learning

1. Requires more time and takes away study time from other subjects.
2. Can be frustrating for participants when they are at significantly different levels of knowledge and skill.

METHOD

In order to find out the effectiveness of the teaching strategy (IBL), in a group consisting of 3 members we went to Samtse lower secondary school to teach class 7 "A" students using IBL method. The lesson we taught was on a science topic 'Chemical change. Their class teacher remained as an observer throughout the teaching session. After end of the lesson we have provided survey questions to 33 students in the class. Data collection tools are questionnaires for class 7 "A" consists of thirty-three students. The tools we used for data collection are both quantitative and qualitative tools. The quantitative tools are the survey questions. In the survey questionnaires there are fourteen statements. For each statement there are five options such as strongly agree (SA), agree (A), neutral (N), disagree (D), strongly disagree (SD) where they have to give their views honestly and sincerely by ticking one of the option. The qualitative tools are observation and interview. We distributed six open ended questions to the students and another seven open ended questions to their advisor for feedback.

After the collection of the data, we analyzed the data carefully and interpreted each of the survey questions (statements). We even provided the over view of the data in the form of pi chart. The research also consist of discussion where we kept in mind all the answers we collected for the interview as well as the data collection. We have dispense some recommendations for effective IBL to take place in this research.

RESULTS

Second data collection tool we used is semi-structured interview for the same group of students. From semi-structured interview we found out that if teachers are in position to use or implement IBL while they are teaching, there are various way to enhance the students learning. 90% of students voice "I feel interesting and fun to learn the activity from this teaching method". It is a hint to us that when teachers use different strategy for teaching, students feel different and are more motivated to learn which is supported by the answer of question number 3-Are you able to learn your lesson properly

through this type of teaching method? Justify. Question 2-How was it different from the way you learn your lesson every day? Where students voice out that they feel different and learn more from this activity through the application of IBL strategy. Hence, we can confidently point out that application of IBL in teaching can help students to increase their romance in their way of learning and exploring which is the ultimate source to acquire new knowledge.

Table 1. Data of the Survey Taken which Shows Number of Responses

Questions	Number of responses				
	SA	A	N	D	SD
Q1. I am familiarized with this teaching activity.	11	18	3	0	0
Q2. Am able to learn more from this activity.	23	8	2	0	0
Q3. This activity encouraged and motivated me to learn more.	17	12	3	0	0
Q4. I enjoyed learning from the activity	24	7	1	0	0
Q5. I found this more effective from normal teaching (chalk and talk)	9	17	4	2	0
Q6. I could actively participate in the class.	12	13	7	0	0
Q7. I faced difficulties in learning in through this activity.	4	6	9	8	5
Q8. I can share my views to other friends.	14	18	0	0	0
Q9. Our school have enough learning materials that include books and internet.	11	12	6	2	1
Q10. This activity allowed me to think and explore more.	14	14	0	2	2
Q11. I am able to learn from each other.	18	11	3	0	0
Q12. I become more engaged in the activity.	16	14	1	1	0
Q13. I can able to clear my doubt through this activity.	14	11	7	0	0
Q14. I found this activity time consuming (Need to discover).	5	12	9	4	2

Data Analysis

Table 2. Data Analysis of the Survey Taken based on Responses

Questions	Number of responses				
	SA	A	N	D	SD
Q1. I am familiarized with this teaching activity.	34%	56%	10%	0	0
Q2. Am able to learn more from this activity.	71%	25%	6%	0	0
Q3. This activity encouraged and motivated me to learn more.	53%	38%	9%	0	0
Q4. I enjoyed learning from the activity	75%	22%	3%	0	0
Q5. I found this more effective from normal teaching (chalk and talk)	28%	53%	13%	6%	0
Q6. I could actively participate in the class.	38%	41%	22%	0	0
Q7. I faced difficulties in learning in through this activity.	12%	18%	28%	8	16%
Q8. I can share my views to other friends.	44%	56%	0	0	0
Q9. Our school have enough learning materials that include books and internet.	35%	38%	18%	6%	3%
Q10. This activity allowed me to think and explore more.	44%	44%	0	6%	6%
Q11. I am able to learn from each other.	56%	35%	3	0	0
Q12. I become more engaged in the activity.	50%	44%	3%	3%	0
Q13. I can able to clear my doubt through this activity.	44%	34%	22%	0	0
Q14. I found this activity time consuming (Need to discover).	16%	37%	28%	13%	6%

Analysis of the Data and Interpretation of the Results

Question 1. Our research shows that 90% of students are familiarized with this teaching method whereas 10% were neutral with this teaching method. It indicates that IBL was implemented to student before and hence they are familiar with the particular teaching strategy.

Question 2. Out of 100%, 96% of students have learnt more from this activity whereas 4% of students are neutral. Therefore, it shows that most students are able to learn through this activity and those who are in neutral state indicates that some modification is required for this teaching method.

Question 3. Number of responses from students shows that most of students are encouraged and motivated to learn more through IBL, since 90% of students agreed on it and rest of the students are neutral.

Question 4. Since in IBL there is more involvement of students and they are allowed to do more activities. Therefore, almost all students agreed that they enjoyed the lesson and the classroom environment become livelier.

Question 5. From the student's responses, we found out that IBL is more effective than normal teaching (chalk and talk), which shows that teachers need to implement different types of teaching strategy to have their students learn better.

Question 6. In order to encourage more participation of students, it is better to implement IBL strategy. Through our survey we found out that none of the students disagree on "I could actively participate in the class?" which indicates that they felt curious about the content and therefore asked more questions to improve their understanding.

Question 7. 59% of students agree that they face difficulties while learning through this activity. Therefore, the teachers are encouraged to monitor the class very carefully while using this method and give accurate and clear instructions

Question 8. To enhance interaction among the students it is always better to teach through inquiry-based method since it is more of group activities. From our survey questions we can proof that 100%of students are able to share their views and opinions to their friends which lead to a cooperative team work.

Question 9. Through our study we can conclude that for the students to explore more and search for information on any kind of content, schools should have well equipped facilities like internet and library resources. From our data it says that Samtse Lower Secondary School is somewhat equipped with these kind facilities which can flourish IBL method.

Question 10. To increase cognitive skill, it is better to use IBL where students need to take the role of scientists. From our data it shows that maximum students are able to think and explore more through this method.

Question 11. Inquiry based learning strategy is best tool to provide the field for exchanging their knowledge and idea among students. Due to difference in learning some students are not able to learn from their teacher rather they are able to learn through their friends. So, almost all students agree that they are able to learn from each other.

Question 12. In order to increases the engagement of students; activities must be included in the lesson plan. Data confirm that students are able to engage more actively while doing activities. Whereas, in normal teaching students are passive listeners which sometimes make them lazy and sleepy.

Question 13. In IBL there is involvement of students and interaction among the students. Thus, Students are able to clear their doubts within themselves, if not teachers are there to clear their doubts and guide them in every aspect.

Question 14. Through our survey we found out that IBL activity is time consuming than the normal teaching. So, in order to have normal pace in learning, we should only create activities which are very relevant to the topic and make it more organized and systematic.

Overview of the Data

Table 3. Overview of Number of Datas Collected

Total no. of response (SA,A,N,D,SD)	448
Total no. of strongly agree.	192
Total no. of Agree	173
Total no. of Neutral.	55
Total no. of Disagree.	19
Total no. of Strongly disagree.	9

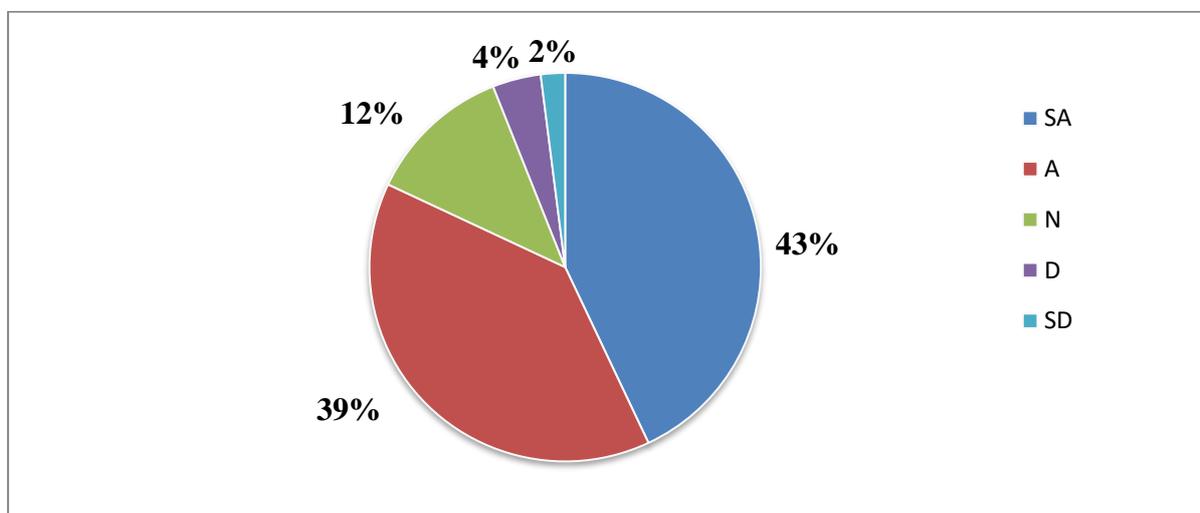


Figure 2. Overview of the Data

DISCUSSION

From the data, we can conclude that IBL method has a important effect on student's achievements in science since 82% agree that IBL help enhance students' interests, attitudes and achievement in science. IBL can provide learning opportunities that help students learn to investigate, to construct assertions and to justify those assertions in classroom community. Similarly, Williams, Hemhtreet, Liu and Smith (1998) found that IBL can help gain greater conceptual understanding in science."

82% of students also agrees that IBL methods is interesting and fun to learn and they also agree that, compare to the normal teaching method (chalk and board) which is usually practiced in classroom. Students are able to learn more from IBL since they can find themselves engaged and motivated. The use of inquiry teaching favors the students to think and explore. "Inquiry based learning is a method where a student is actively engaged in learning and exploring. They focus on questioning, critical thinking and problem-solving. It's associated with the idea involve me and I understand" (Johnson

2014: 91). Therefore, our study shows that, the conclusion of Johnson (2014) and ours are similar where students are actively engaged in learning and exploring while using IBL method.

However, 6% of students still think that IBL is time consuming compared to the normal teaching method and they also face difficulties in learning through activity. Similarly, inquiry-based teaching increases the amount of time students spent in questioning, hypothesis, investigating and reflecting on their newly acquired knowledge from investigation (as cited in Bredderman, 1983; Hattie, 2009). Moreover, due to the lack of materials such as books and internet in their school they think that IBL will not be effective. School management should be aware of all the materials necessary of students' learning and make sure it is easily accessible in the school. This is an important way through which schools can provide students with opportunities to explore ideas in greater depth. Though, the success or failure of the method will depend on the competence, enthusiasm and confidence of the teacher and the delivery of the instructions, the relative effectiveness of the approach depends on the student ability and level of conformance.

Dewey (1983) states that teacher shouldn't simply stand in front of the class and transmit information to be passively absorbed by students. Instead, teachers should provide platform for students to participate. In the view of data, IBL provides a platform of participation to all the students. 82% of students agree that during IBL students are able to work cooperatively and they are able to share their ideas and opinions to their group members.

Recommendations for Effective Inquiry Based Learning

The teachers who are using IBL strategy while teaching must be well aware of their roles from instructor to facilitator and collaborator in order to run the class smoothly. It is in hands of the teachers to determine what and how students learn from their subjects' area knowledge and from primary sources such as text book. The schools should have proper provisions of facilities/equipment which are necessary for the students to explore more for an effective inquiry strategy.

The students are capable of taking responsibility for their own learning. Therefore, teachers need to provide clear instruction on how to do activity based on IBL. Since, it emanates from a questions, problems, issues, or explorations that is significant and connects students to the world beyond the school. Since inquiry learning start by posing questions, problems or scenarios rather than simply presenting established facts or portraying a smooth path to knowledge. Therefore, teacher should be expert in framing question which need students to explore more. IBL activity requires more time. Therefore, teachers should be well organized and conscious about timing while they are teaching. They should allow more involvement of the students rather than themselves and give opportunities for students' participation.

CONCLUSION

Inquiry based learning is a teaching pedagogy which enables students to experience the processes of knowledge creations. The key attributes include learning stimulated by inquiry from a student, in which the role of a teacher is to act as a facilitator and a guide. It is a move to self-directed learning and an active approach to learning. Students should develop research skill to and be prepared for lifelong learning. They should achieve outcomes that include critical thinking, the ability for independent inquiry, responsibility for their own learning and intellectual growth and maturity (David & Friesen, 2013). The research has enlightened us on how the teaching can be more effective if instructors use different strategies and methods for teaching and learning. As agreed by most of the students, IBL is one of the strategies which energizes the learners and which helps them to retain easily whenever required. Inquiry based learning approach is for lifelong.

Moreover, IBL is the method that can be used to actively engage students in an in-depth exploration of the concepts and skills associated with their course. It provides students with strategies and experiences that empower them to become critical consumers of information and tackle authentic problems through IBL (Thoron & Myers, 2011). Furthermore, the learning environment in this situation is bounded by the sources such as technological tools, internet references and expert teachers. Hence, in IBL environments, teachers should be determined on what and how their students learn from a particular content or topic and be ready and accessible to all kinds of materials required for the process of learning (Jacinta, 2011).

The research we carried out was indeed very interesting and fun. We the researcher got perfect platform to explore ourselves as well along with the students we taught. We also understood that teaching students with new strategies everyday brightens up the teaching naturally and as a teacher we get showered with satisfaction and happiness. Inquiry based learning pedagogy is one of the best kind of students centered teaching approach a teacher can use in their teaching. IBL method helps teachers to know how much experience and prior knowledge their students have (Hutching & O'Rourke, 2003). Therefore, making use of those knowledge the students already possess and adding on it more information through inquiry can be an effective teaching method which will be beneficial throughout life time.

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Sample of Survey Questionnaires

1) School: _____

2) Gender: Female Male 3) Age: _____

4) Subject: _____ 5) Date: _____

To what extent you agree with the following statements. (Tick one correct answer)

NO	QUESTIONS	SA	A	N	SD	D
1	I am familiarized with this teaching activity.					
2	Am able to learn more from this activity.					
3	This activity encouraged and motivated me to learn more.					
4	I enjoyed learning from the activity.					
5	I found this more effective from normal teaching (chalk and talk).					
6	I could actively participate in the class.					
7	I faced difficulties in learning in through this activity					
8	I can share my views to other friends.					
9	Our school have enough learning materials that include books and internet.					
10	This activity allowed me to think and explore more.					
11	I am able to learn from each other.					
12	I become more engaged in the activity.					
13	I can able to clear my doubt through this activity.					
14	I found this activity time consuming (Need to discover).					

Interview Questions

- 1/ How do you feel about today's lesson?
- 2/ how was it different from the way you learn your lesson every day?
- 3/ Are you able to learn your lesson properly through this type of teaching method? Justify.
- 4/ Are you able to work cooperatively through this teaching methods? Justify.
- 5/ what difficulties did you face while learning through this teaching method?
- 6/ Do you think there should be any improvement in my teaching?

Interview questions for the Advisor (Observer):

- 1/ Do you use IBL in your teaching.
- 2/ If YES, how was the teaching methods effective to the students.
- 3/ Are your students able to learn through this teaching method?
- 4/ Teachers believe that IBL can't implemented until late in the student's school career. You as a teacher, is it suitable to implement IBL in pre-schooling? If YES, justify.
- 5/ What materials that you require in order to conduct effective IBL in your classroom.
- 6/ What difference did you observed in today's session?
- 7/ What benefit is there in teaching IBL way to the traditional approach in the science? In other words, how do you align your teaching style with the standards?