

Effects of Inquiry Based Learning on the Performance of students' At Elementary Level in Rawalpindi City: An Experimental Study

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ABSTRACT

This study was planned to conduct an experiment to find out the effect of inquiry based learning on the performance of students at elementary level in Rawalpindi city. The objectives of study were, to find out effect of inquiry based learning on performance of students in science, to find out effect of lecture method on students' performance in science and to compare the effectiveness of inquiry based learning and lecture method on performance of students in science. This study would help the teachers to choose innovative teaching methods which not only improve their teaching skills but also help their students to perform better academically, increase their critical thinking, make them feel more confident and make their learning more interesting and creative. Pre-test post-test control group design was used for this experimental research. Science Students of 6th class of SLS School Rawalpindi district were the population. 50 students of grade 6 from a randomly selected SLS school were the sample of the study. A simple random sampling technique was used. Students' were pre-tested, provided treatment (5E learning model-IBL) to experimental group and post tested. Questionnaire was developed as an instrument of study. Data collected was analyzed by using t-test. Results and findings have shown that inquiry based learning was more effective as compared to traditional lecture method. It was concluded that students of elementary level should be taught by innovative teaching methods like IBL for better learning of scientific concepts. This method was strongly recommended for better learning.

Keywords: Effects, inquiry based learning, students' performance, elementary, level

INTRODUCTION

Learning is something that needs focus and concentration and brings about a desired change in behavior of learner. Everyone falls in the category of learner particularly but if educational scenario is kept in mind then students who are getting formal education can be called learners in a formal setting. Learning may be defined differently depending upon situation but effect of learning in all conditions remains the same and it is a permanent change in behavior (Seifart and Sutton, 2009). Furthermore, learning is not only acquisition of subject matter but of also habits, attitudes, interests, preferences and social adjustment skills (Bernard, 1972). In the current century, when science has made its way into the lives of people making it not only luxurious and comfortable but also made people aware of surroundings. 21st century has its own demands and of many demands one is to equip students with practical knowledge which they can apply in their later lives. Only sound scientific practical knowledge can help the people to survive in this world. World today needs skillful people to bring positive transformations for better living.

The world is moved ahead dramatically while our schools remained stuck with old educational thinking and systems. Researches have shown that students' become more confident, active and better problem solvers when they experienced practical ways of learning.

For attaining objectives, instructional methods are needed to be chosen wisely. New effective learning approaches can produce positive difference in performance of students. These enable students to not only develop their understanding for the specific knowledge but also help them to apply it in their practical life later on.

Unfortunately, Larger percentage of teachers follows the same old traditional method of teaching like lecture method because of either lack of skills or lack of time required for the specific type of instruction. Moreover, students encounter problems in applying their knowledge to their practical lives. This creates uncertainty and confusion in them for their future. It is very important to create self-reliance and self-confidence in today's learner so that he/she is able to adjust himself/herself with the frequent changes in life.

On the other hand, traditional lecture method does not allow students to ask questions. It is a one way process in which teacher delivers the knowledge while students are expected to just listen thus hindering the ability of curiosity and inquisitiveness in them. Elementary level is the most crucial stage of a child. It is the age in which a child has natural curiosity about life and he observes and learns from the surroundings.

Inquiry based learning is an inductive approach to teaching and learning. It involves collaborative and cooperative learning as this kind of learning is executed in groups (Smith, 2007).

IBL is kind of learning that let students explore their ideas, put questions, make observations, comprehend knowledge and construct their own concepts (capacity building series, 2013).

Science is a conceptual and logical subject that builds its knowledge from observations derived from facts. It gives reasoning for any type of phenomenon and let people experiment with whatever they observe. Science is best understandable when students experiment with what they are learning. For example, if a teacher wants his students to understand the concept of freezing and boiling temperatures, he should let students experience hotness and coldness first and then provide students thermometers to check out temperature of two objects by themselves. This will result in permanent learning of this concept as it involves students actively in learning. Science is a basic subject that starts from the moment when a child takes birth and elementary level education is the limit at which students' need to be well equipped with basic concepts of science. This can be done when they are made to learn science in the most effective way. One of the 21st century skills is to be scientifically literate. Scientific literacy means to understand the concepts of science and to read, write, reason out and then comprehend scientific material (Pearson et al. 2010)

STATEMENT OF THE PROBLEM

The study investigated the effect of inquiry based learning on Students' performance in science at elementary level in Rawalpindi city.

OBJECTIVES OF STUDY

1. To find out effect of inquiry based learning on performance of students' in science subject at elementary level.

2. To find out the effect of traditional method (lecture) on performance of students' in science subject at elementary level.
3. To compare the effectiveness of inquiry based learning and lecture method on performance of students' in science subject.

Procedure

The present study was designed to determine the effect of IBL on the performance of students' at elementary level in Rawalpindi city-an experimental study

The experimental design took four (4) weeks to complete. It was started in SLS Montessori and school junior section main branch Tulsa road Rawalpindi. Experiment conduction was organized and progressed in following manner.

Population

There are 12 schools of SLS in Rawalpindi and Islamabad. As my study was conducted in Rawalpindi so all students of 6th grade of Rawalpindi campuses of SLS School were population of the study. Essential requirements include: a) Science learners, b) Science teachers

Sample of Study

Out of these five schools, one school SLS Montessori and School Tulsa Raod Lalazar Rawalpindi were selected as a sample of study on convenience. This campus runs seven sections of 6th grade. Out of these seven sections, two sections are randomly selected each comprised of twenty five students' both male and female. This school represents all SLS schools situated in Rawalpindi city.

RESEARCH DESIGN

Pretest posttest control group design was selected for the study. Two groups i.e. experimental and control groups were included in the study. Experimental group was administered with pre-test. After pretest it was provided with the selected treatment (IBL) and post-test was administered. On the other hand control group was also administered with pretest, taught in a traditional way (lecture method) and post test was conducted. Inquiry based learning (IBL) was an independent variable while performance of students' was a dependent variable.

REVIEW OF LITERATURE

Harold W. Bernard (1972) in Psychology of learning and teaching defined learning in a broader sense. According to him Learning includes not only the acquisition of subject matter but also that of habits, attitudes, perceptions, preferences, interest, social adjustments and skills of many types & ideals (p. 117). Learning is a change in performance through conditions of activity, practice and experience (Hilgard & Bower, 1966, p. 5). Jerome S. Bruner (1966) in The process of education wrote that the first object of any act of learning, over and beyond the pleasure it may give, is that it should serve us in future (p. 5). Students come to class with funds of knowledge based on their past experiences thus possess varying types of prior knowledge. This kind of learning requires us to view our students as knowers even before we teach them anything. They have lived several years and have their own experiences and views related to the world. These views and ideas become framework on which they try to "fit in" new ideas (Koch, 2012, p.11). It is imperative to place emphasis on students education because they are the intentional learners. They are purposeful, self directed, equipped with intellect, practical skills, well informed and responsible for their

action and civic values.(Wirth and Perkins, 2007, p.4). Elias (2011) wrote in her article learning analytics: definitions, processes and potential learning is a product of interaction (p.1). Lombardi (2007) accentuated students' expressions in her article Authenticated learning for 21st century: An overview related to learning. She found out that students are more motivated by solving real world problems and prefer to do rather listening. Learning is a very broad concept and thus has multifaceted definitions. One perspective that encompasses and covers all definitions of learning is permanent change as a result of learning. Kelvin Seifart and Rosemary Sutton (2009) defined it in Educational learning as, "a permanent change in behavior, skill knowledge or attitude is known as learning". In one of unit entitled Psychology of learning, learning alters and modifies knowledge, skills, habits, capabilities and tendencies through experience, practice or exercise. This transformation is long lasting and changeable (p.42).

Above mentioned discussion and current researches now don't promote conventional learning the way it was few years back. In 21st century, it is one of the most crucial concepts which are highly highlighted by educationists. In science, learning is more important as science learning is not about mugging up the facts and concepts rather understanding what are being created by so many theorists, checking out these by applying practically whatever learnt by them and change or mold the knowledge gained where required. Emphasis should be on intentional learning.

Bandhura theory suggests that learning is the result of personal, environmental and behavioral factors (Gregory Schraw et al., 2006, p.111). Learning also means construction of meaning which helps learner to cooperate with others and multi thinking are communicated that lead towards new and innovative ideas. This also instills a sense of motivation, confidence and achievement in social settings (Oludipe Bimbola and Oludipe I. Daniel, 2010). The process of scientific inquiry (2005) describes learning as more than listening and reading. It does not occur by absorbing facts and concepts passively. Students experience, discuss and talk about their familiarity and collaboratively thinking results in an active learning (p.6). Hermes B. Lynn (2012) declares in his research article Guided inquiry using 5E instruction , learning needs to be more relevant to student lives (p.4).

From above given references, it can be generalized that learning is related to permanent change in behavior. All definitions of learning discussed so far imply that if change does not last forever then learning is not actually taking place.

Science Learning At Elementary Level

At Elementary level, the science education plays very important role. It plays double edged role in setting foundation for science learning and developing key intellectual skills, habits of mind and attitudes. (Mark St. Jones, 2007, p.3).

It would be a loss to think that if students do not learn science at this stage they might be able to acquire conceptual framework and cannot think only scientifically but also develop scientific attitude during their adolescence.

If the science education is properly arranged and presented, there are more chances of understanding it and strengthened their broader skills and habits of mind. The skills and courage to ask questions and observe minutely to find evidences and rational arguments are the products of rich learning experiences at very initial stage. It is not the primary objective to achieve higher grades but improve their interest in the subject. (Mark St. Jones, 2007, p.7, 8).

Children are natural scientists (David Martin, 2011). They explore the world as soon as they start observing world around them. Jean Piaget in his theory says that children are at concrete

operational stage when in elementary grades. This provides ground reality that at elementary level students can be provided assistance and support to develop problem solving and critical thinking skills (Morgan Chylinski, 2004, p.4).

Elementary Science- Current Status in Pakistan

Pakistan's history of science is enriched with very prominent, glaring and flagrant faces like Abdu Salam, Atta ur Rehman, A.Q Khan and so on. It proves that youth of Pakistan has the potential to show itself and can set high standard for forthcoming generations in science. However, current status of education in general and science education in particular is pathetic and disheartening. Though schools have introduced Oxford science books at primary and elementary level and it showed little improvement but desired results couldn't be achieved so far. This is happening because of poor, out mode and old fashioned theories and practices of learning and teaching. Teachers are not well equipped with modern teaching practices thus following old trends. Students do not think out of box and according to them science is all written in their books. At elementary stage students are open to new ideas, discoveries and are at niche of explorations. They are like young plants which are needed to be trimmed to grow properly and beautifully.

Inquiry Based Learning an Introduction

Today's world is a technology ridden world and for that purpose students' minds should be very well equipped with the nature of progressions. Keeping in view the current scenario and requirements, science learning should be proactive, more plausible and credible. For this reason inquiry based learning is needed to be introduced and implemented in sciences in Pakistan at elementary level to enable students to be active and independent learners.

Inquiry means asking, challenge, to investigate, questioning, interrogation, inquisitiveness, discovery, exploration (Roget's Thesaurus, Inquiry, P.17). Collier dictionary (1986) defines inquiry as an investigation; probe denoting as active attempt to establish truth or orderly attempt to uncover facts by questioning rather than by inspection or an act of inquiring, investigation, search or examination or question or query. Inquiry is defined in the world book dictionary (1987) as, asking a question or search for information, knowledge or truth. It can also be called inquisitive ness which means curiosity. Novak (1964) described inquiry as se of behaviors involved in struggle of human beings for reasonable explanations of phenomena about which they are curious. It implies involvement that leads to understanding and involvement in learning means to possess knowledge, skills and attitudes that leads to seek resolutions to questions and issues while constructing new knowledge. Inquiry involves set of activities and skills in order to search for knowledge or understanding to satisfy curiosity (Haurey & David L. 1993). Inquiry activities are cognitive abilities that engage students intellectually and boost their rational thinking. It endorses deep understanding and involves students in scientific questions, look for evidences supporting answer, articulate explanations and after reflection communicating the ideas formulated by them. This concept was arisen during golden age of science education in 1960s and 1970s. This concept is central to National Science Education Standards that lead to publish a book by NRC with the title Inquiry and National science education standards in 2000. Students' curiosity can be provoked by putting different questions in front of them which can stir and ignite their challenging nature making them active learners. NRC (1996) put inquiry both in pedagogy and learning according to national science education standards. The learners who are engaged in inquiry based learning construct knowledge by doing, by asking technical questions, planning investigations. They have ability to use appropriate techniques and tools to collect data, develop explanations from relevant evidence, analyze their explanations keeping in

view the alternatives and then communicate and justify their proposed explanations (Nancy Trautmann et al., 2002).

Inquiry term can be coined in to three categories by Ronald D. Anderson.

1. Scientific inquiry
2. Inquiry learning and
3. Inquiry teaching

Scientific inquiry is about ways that scientists explore natural world and develop evidence based explanations (theories), descriptions (laws and principles) and products (technology). Inquiry learning is process of learning science by methods that matches that of scientific reasoning.

Inquiry teaching is actually a mean to achieve inquiry learning where by students gain understanding via scientific ways of knowing (Alfred E. Friedl, 1997).

Science is a doing thing which evolves students scientific attitudes in direct experimentation and by development of rationale, logic and critical thinking skills. The national science educational standards emphasis on students inquiry based investigations for interacting with their peers. Active science learning shift focus on students rather than teachers. (NRC, 1996, p.20).

Inquiry based learning is an approach of significant importance for science education. Dr. Alyas Qadeer Tahir , director of national institute of science and technical education (2011) in his research developing a student centered IST approach at elementary level science in Pakistan: A three year implementation cycle quantified a key concept of general science for grades IV to VII as “student centered” or “inquiry based”. Inquiry based learning/teaching provides platform for discussing and debating scientific ideas. It not only gives confidence to recall fundamental scientific principles but also develop an ability to transfer conceptual understanding and accurately interpret and evaluate texts dealing with scientific concepts (Peggy Brickman et.al. 2009, p.3). It is need of hour to make students well informed and enable them to take decisions about how science impact their lives and help them to use scientific knowledge to solve problems (p.1). Wynne Harlen et.al. (2003) in making progress in primary science debated that learning science through inquiry starts from children ideas. Learning can be described as a tool in which process/inquiry skills are used to gather evidence to test whether certain ideas can explain phenomena and events in the world around us. It is important to develop understanding that depends on learner personal experience related to concept. It also reflects the way that scientific knowledge is advanced through scientists’ activity, ideas, make predictions based on them and draw observations to see whether predictions fit the facts. When ideas are not linked, creativity plays its role resulting in an innovation but when it links with predictions, testing and interpretations are carried out rigorously (p.3). They further explained that inquiry learning involves questions asked by students to provoke their thinking which shows their relevancy to the topic, understanding by them in order to regulate their progress and control their behavior (p.27).

IBL put students in active process of thinking facilitating construction of meanings, verify the prior knowledge, involves students in collaborative learning by communicating their ideas, enriching knowledge and develop an understanding of it (Jach Hassard & Michael Dias, 2009, p.334).

Despite so many benefits of IBL science teachers feel hesitant to put inquiry based teaching in practice as for them these are time consuming henceforth difficult to manage. Others

oppose it due to unavailability of necessary equipment and material while few teachers feel that inquiry based teaching/learning work for sharp, bright and intelligent students.

Dr. Judith Sweeney Lederman proposed following Levels of inquiry include:

Exploration: at this level students have questions which they need to answer by following instructions provided by teacher. This level put students in creative experiences that increase their curiosity by creating number of questions in their minds. This level is suitable for young aged students to become familiar with what a good testable question looks like? How to design a procedure to answer questions and how to collect and analyze data to form evidence based conclusion.

Direct inquiry: at this level students are given problem and methods but they need to reach their own conclusion.

Guided inquiry: at this level students are provided with problem only and they have to devise their own method to solve the problem. Analytical skills are required here in order to investigate the problem and solve it.

Open ended inquiry: at this level, students are responsible for searching a problem to be solved, designing methods, making predictions, collecting and analyzing data and reaching evidence based conclusion by their own selves.

NRC 2000 recommends four levels of inquiry proposed by Pathway. These levels are structured inquiry, guided inquiry, open inquiry and coupled inquiry (Caitriona Rooney, 2012).

Inquiry Based Learning Model (5e Instructional Model)

Science education must develop cognitive skills while engaging students in different scientific concepts. Some cognitive skills include adaptability, communication/social skills, non-routine problem solving, and self-management/self-development and system thinking. To develop these cognitive skills, teachers need to be very careful while choosing instruction model. Exploring the intersection of science education and 21st century skills: A workshop summary (2010) narrates that to infuse new generation with knowledge, attitudes and abilities generally needed for 21st century, good instructional models must be selected in order to achieve learning objectives. 5 e instructional model is one of these which has its origin in one of several science curriculum study groups established by national science foundation in 1960s after soviet union succeeded in launching the sputnik satellite. It had 3 phases when first introduced named as explore, invent and discover. In late 1980s BSCS (biological sciences curriculum study) summoned a group of experts to review and revise learning cycle made. This group added two new phases thus making it 5 phased model starting with phase of engagement, exploration, explanation, elaboration and evaluation.

Doing science: the process of scientific inquiry explains learning never occur by passive absorption but needs an active instructional model that facilitates active learning by engaging students. While learning, students are involved in more than reading and listening. This model helps students to develop skills like analyzing and evaluating evidence, experiencing and discussing and talking to their peers about their own understanding. Students communicate and collaborate with others to solve problems and plan investigations leading them towards scientific inquiries. It also creates environment of competition that motivates students to show better performance. Furthermore, active involvement in investigations creates new questions in mind developing logical and critical thinking results in new discoveries.

Instructional model is a sequence of stages teachers may go through to help students develop a full understanding of a lesson concept. These are a form of scaffolding, a technique a teacher uses that enables students to go beyond what he or she could not do independently. 5e instructional model was first developed by Rodger W. Bybee in 1980s. it was established specifically to provide a model that promotes a constructivist approach to science education while incorporating aspects of behaviorism and cognitivism. Johann Herbart, John Dewy and Jean Piaget ideas are responsible for origination of this model. Concept behind this model is to begin with students current knowledge and make connection between current and new knowledge, provide direct instruction of ideas that students could not be able to discover on their own and provide opportunities to demonstrate understanding (Bybee, 2006). This model started implementing since 1980's in elementary, middle and high school curricula (Beverlee Jobrack, p.1, 5).

This model provides students with food for thought and actively engages them in learning. students when involved in learning, it not only provokes curiosity and inquisitiveness but also generates new ideas to reach the answers of questions. Curriculum and instruction steering committee (CISC) of California discusses that the strategies designed and implemented should help support learning to bridge the gap that too often exists between understanding science concepts, students ability to read and difficulty of text. By utilizing scientific investigation/experimentation and reading from literature to gain content knowledge, teachers can increase the achievement and motivation of all students.

Phases of 5e Instructional Model

Engage

According to “doing science: the process of scientific inquiry”, this phase checks the prior knowledge of students. It helps the teacher to get an idea which concepts need to be emphasized more. Students, on the other hand also get a chance to know his/her currents ideas and thoughts about the topic. It captures the interest of students and provokes curiosity about topic thus increasing learning capability. This phase discovers students' pre conceptions, miss conceptions or naïve conceptions (Beverlee Jobrack). It is used to uncover what students know and think about topic. Activities included at this phase can be reading, demonstration. Teachers can gain critical insight into students' ideas, level of understanding and potential misconceptions through a carefully planned engagement for unit or lesson.

Explore

Rodger W. Bybee et al. (2006) explains in the BSCS 5E instructional model: origins, effectiveness and applications that this phase becomes a common base of activities within which current concepts (misconceptions) processes and skills are identified and conceptual changes are facilitated. NSTA in BSCS 5E instructional model explains this phase and says that teacher acts as a facilitator and arranges exploration activities for students which are means to construct concepts and develop skills. In this phase, students are provided with hands on experiences used to formally introduce a concept, process or a skill later. Further material like engaging students with 5E instructional model GK-12 (2012) also suggests that this phase leads towards conduction of an inquiry based investigation in to the topic and serves as a basis for developing an understanding of concept. Equipment or material and guidance for investigation are provided to students by teacher without telling them what to do or expect later.

Explain

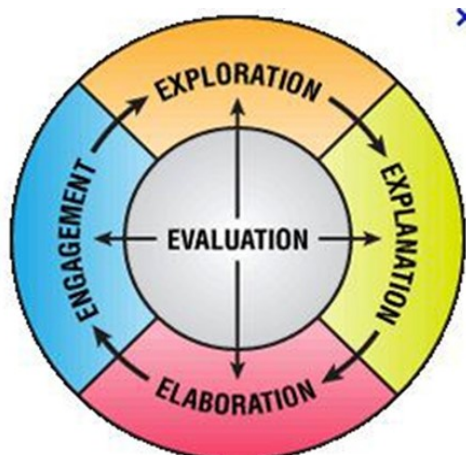
This phase is concerned with the experiences learned by students which are discussed. Students put sequential events into a logical format, think about cause and effect and reflect upon their learning during investigation (2012). This phase give chance to students to explain their understanding so far and them teacher explains their understanding in a direct and fomal manner (Jim Barufaldi, 2002).

Elaborate

This phase is concerned with elaborative activities which make students understand the concept or topic. It is a filtering phase as it filters away all remaining misconceptions regarding concepts. This phase supports the students to generalize the concepts in a broader context. Activities involved in this phase challenge students to apply, extend or elaborate upon concepts and skills in a new situation, resulting in deeper understanding (NSTA).

Evaluate

This phase is final stage in 5E instructional model and it checks the students understanding regarding a concept, process, topic or a skill. This evaluation can be formative and summative and sometimes provides snapshots of what students learn and understand. It involves assessment of students by thinking maps, rubrics, teacher observations and portfolios (NASA overview: the 5E instructional model).



Source: <http://category5tcinquirylearning.wordpress.com/2013/09/12/5es-model/>

Role of Teacher And Student In 5e Instructional Model

Role of teacher in inquiry based class room is different from teacher of conventional class room. Teacher acts as a facilitator, guide, and helper and gives students' a chance to generate their own content related questions and instructs their investigations through proper guidance. They are supposed to be responsible and committed to provide rich experiences that provoke students' curiosity. Teacher also manages multiple students' thoughts and investigations at same time, assesses progress of each student as they work towards their solution or final product and to respond in the moment to students' emerging queries and discoveries (Centre for inspired teaching, 2008).

In inquiry based learning class room students' come up with their own prior knowledge and conceptions that may be pre conceptions, initial conceptions, misconceptions or naïve conceptions. Teachers need to support their correct ideas and correct the falsified concepts through investigations to make them understand. Furthermore, teachers supposed to instruct

and guide students' to ask relevant and productive questions to avoid any detractions from topic or a concept (Pollen, June 2009).

LECTURE METHOD AT ELEMENTARY LEVEL AND SCIENCE LEARNING

Elementary students' are at the verge of exploration. Age at the level of elementary is age of experimenting new ideas and thoughts and exploring new worlds beyond imagination. These factors help students' at this level to embrace understanding with open arms. Excellence can be awarded to such pupils if they are well directed and well guided. This direction and guidance is the responsibility of a teacher who acts as a guide by facilitating his students with the most suited ways of teaching learning methods. Lecture method alone is too early to be used at this stage as it has a risk of snatching away inquisitiveness, curiosity and interest of students regarding learning of science. According to NRC (2001), students construct knowledge actively; integrate new concepts and ideas into their existing understanding. Thus educators have an opportunity and obligation to facilitate this propensity to learn and to develop receptivity to learning that will prepare students for active engagement in learning enterprise throughout their lives. To make students better performers in science at young age as well as on later stages, it is required to boost their curiosity so that they can grow up as independent learners. At this age level they need to be more confident, active and enthusiastic to flourish at their best.

DATA ANALYSIS

This chapter deals with the presentation and analysis of data. The pre-test on lecture and IBL basis have been presented in appendix A and B and the mean scores, Standard deviation, t value and significance value of pre lecture and pre IBL groups in performance along with df and t value at 0.05 have been presented in table I.

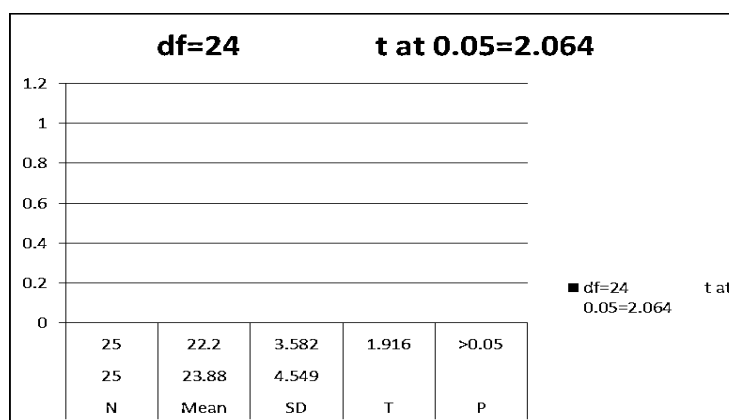
Table 1: Data on the pre-test of lecture and IBL Method

Group	N	Mean	SD	T	P
Pre-IBL	25	23.88	4.549		
Pre-lect	25	22.20	3.582	1.916	>0.05

df=24 t at 0.05=2.064

When pre-lecture was compared with pre-IBL, it showed higher mean value in IBL group as given in above table. This is also mentioned in figure below.

Comparison of pre-test of IBL and Pre lect



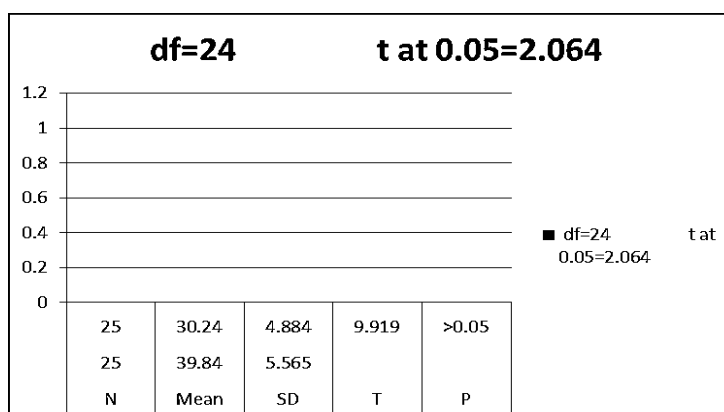
The post-test of lecture and IBL have been given in appendix C and D. The mean scores, Standard deviation, t value and significance value of post lecture and post IBL groups in performance along with df and t value at 0.05 have been shown in the table II.

Table 2: Data on post-test of lecture and IBL method

Group	N	Mean	SD	T	P
Post-IBL	25	39.84	5.565		
Post-lect	25	30.24	4.884	9.919	>0.05
df=24		t at 0.05=2.064			

Table 2 compared post lecture with post IBL, again mean value in post IBL group was greater showing better performance of participants (students) in experimental (IBL) group. It is also shown in the following figure.

Comparison of Post-test of IBL and lecture method



As regard the difference between pre and post-test of lecture method, the data has been given in appendix A and C and mean value, Standard deviation, t value and significance value of pre lecture and post lecture groups in performance along with df and t value at 0.05 have been shown in table 3.

Table 3: Data on pre and post-test of lecture method

Group	N	Mean	SD	T	P
Pre-lect	25	22.20	3.582		
Post-lect	25	30.24	4.884	-8.764	>0.05

df=24 t at 0.05=2.064

It is clear from the mean values in table 3 that the difference (d_1) between the mean values in lecture method is

$$\begin{aligned}
 d_1 &= M_2 - M_1 \\
 &= 30.24 - 22.20 \\
 &= 8.04
 \end{aligned}$$

As regard the award on the pre and post-test of IBL, the data have been shown in appendix B and D and mean values, Standard deviation, t value and significance value of pre IBL and post IBL groups in performance along with df and t value at 0.05 have been shown in table 4.

Table 4: Data regarding the pre and post-test on IBL

Group	N	Mean	SD	T	P
pre-IBL	25	23.88	4.549	-14.600	>0.05
Post-IBL	25	39.84	5.565		

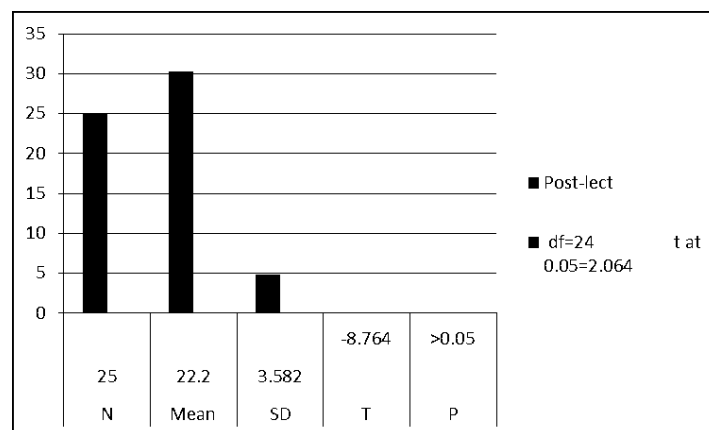
df=24 t at 0.05=2.064

It is clear from the mean values in table 4 that difference (d_2) between the mean values in IBL method is

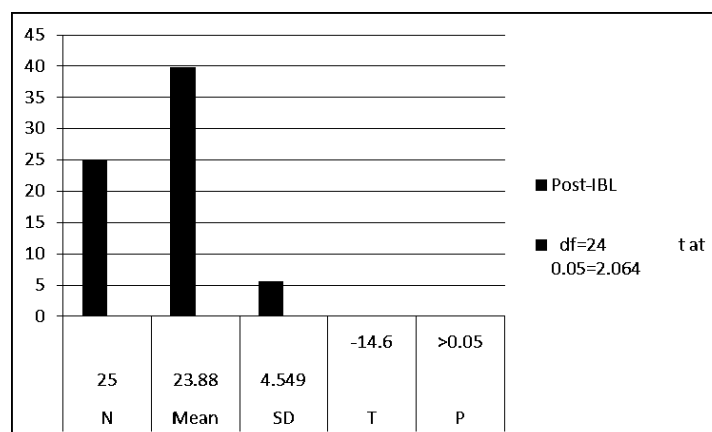
$$\begin{aligned}
 d_2 &= M_2 - M_1 \\
 &= 39.84 - 23.88 \\
 &= 15.96
 \end{aligned}$$

Table 3 has comparison of Pre lecture and post lecture with higher mean value in post lecture while in table 4, comparison was done between pre IBL and post IBL groups. This again showed higher mean value in post IBL.

Comparison of pre-test and post-test of lecture method



Comparison of pre-test and post-test of IBL



Hence, it is concluded that

$$d_1 = 8.04 \text{ and } d_2 = 15.96$$

thus,

$$\begin{aligned} D &= d_2 - d_1 \\ &= 15.96 - 8.04 \\ &= 7.92 \end{aligned}$$

Therefore, it is clear that the IBL is more effective as compared to Lecture method.

FINDINGS

Following are the findings of the study.

1. The Mean score on pre-test and post-test on experimental group were found to be 22.20 and 30.24 respectively. In the way, the difference between these two values (d1) was calculated as 8.04
2. The Mean score on pre-test and post-test of control group were found to be 23.88 and 39.84 respectively and the difference between these two values (d2) was calculated to be 15.96.
3. The difference between d1 and d2 was calculated to be 7.92 which shows the effectiveness of experimental group over the control group.

CONCLUSION

It is concluded on the basis of the mean score values of the pre-tests and post-test of the two groups that the experimental group which was taught through inquiry based learning performed better as compared to the control group which was taught through the traditional lecture method.

DISCUSSION

This study was conducted in order to investigate the effect of inquiry based learning on performance of students' at elementary level in Rawalpindi city.

Science as a subject deals with reasoning and logic. Moreover it contains scientific terms which are needed to be understood by students in context of their meaning and practical implementation. Learning of science and awareness of new inventions is crucial in current scenario where technologies are growing immensely making life easier and more comfortable. Elementary stage of students is ideal time to make them understand the scientific concepts and their implementation. It is obvious if a student at this stage comprehends scientific terms, then it is possible for him to use it in practical life with confidence. Learning is related to personal development intellectually and it continues throughout the life. Students' learning is greatly influenced by his/her interaction with the environment. More the interaction more is the learning.

First objective of the study was to check the effect of IBL on performance of students in science at elementary level. From the results it is shown that students who were instructed through IBL showed better performance as compared to those who were taught in a traditional (lecture method) way. Researches have proved that IBL gives students more insight in to concept and help them to comprehend the knowledge by themselves. This results in confidence, interest, better performance skills and problem solvers (Abdi, 2014; Haskett, 2001).

Second objective was to check the effect of traditional (lecture) method on performance of students in science at elementary level. Results have shown that it is a bit less effective as compared to IBL. Lecture method involves passive learning and thus students' performance shown is not up to mark. Moreover, students did not show active participation in learning. Elementary level students' are not capable of understanding the content by just an explanation. They need to involve in learning to gain complete understanding of scientific terminologies (NRC, 1994).

Third objective was to compare the IBL and lecture method so as to check out the effectiveness of both on performance of elementary students in science. As shown in results it is obvious that IBL is more effective for learning science at elementary level and students have shown better performance in science when taught by IBL.

RECOMMENDATIONS

1. This study was limited to only Rawalpindi city, so this study can be done on large scale taking one district.
2. This model and other innovative teaching methods need to be introduced to teachers and should be included in curriculum for developing students learning skills.
3. This way of learning enhances collaborative and cooperative learning thus recommended to be used in teaching of other school subjects.
4. Teachers may be trained to teach by using novel and innovative teaching methods. They may be well trained to execute such methods. This will enhance not only their professional skills but also involve students of elementary level in learning science actively thus showing better performance.

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