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An Experimental Study to Investigate the Effectiveness of Project-Based Learning (PBL) for Teaching Science at Elementary Level

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Abstract

Information and communication technology (ICT) covers different types enabling use to receive, share and exchange information. In project-based learning (PBL), the learners remained the center of the process by engaging, collaborating and connecting himself to the real world. Teachers can explore characteristics of project-based learning and can organize the curriculum, the classroom, technology and the students for the successful 21st century skills. This study investigated the effectiveness of project-based learning (PBL) for teaching science at elementary level. The objectives of the study were application of the project-based learning technique to teach science at elementary level and finding out the effect of project based learning on the academic achievement of the students. There was no significance difference between the mean academic achievement scores of pre-test and post-test after the treatment. The one-group pretest-posttest design was used for the present study. All grade 8 students of the Federal Government high schools of Rawalpindi and Islamabad were the population. A federal school 8th class was randomly selected for the study. This selected group was considered as experimental group. The group was pre and post tested. The experimental group was taught through project-based learning technique by the researcher. After the treatment a post test was conducted and difference of the mean academic achievement score was observed. t test was used to analyze the data and it was recommended to use PBL in classroom particularly in teaching science subjects.

Keywords: Effectiveness, Project Based Learning, Teaching, Science, Elementary Level

Introduction

Educational technology forms availability of education and improvement in quality of education. Development in technology brings about changes and shift in educational goals which, in their turn, stimulate the emergence of new technique. Information and communication technology (ICT) covers different types enabling use to receive, share and exchange information.

The masses of 21st century lived in technology and media embedded surrounding, they had access to ICT in abundance and they had skills to adopt changes and collaborate adding their own contribution in a large scale. In knowledge oriented society a learner needs to have proficiency in 21st century skills, including functional and critical thinking skills, additionally they are required to have information literacy, media literacy and ICT literacy.

A major objective of education is to keep pace and pattern with advancement in knowledge to be successful. Knowledge cannot be received passively. It is something to be actively discovered. The other objectives contained instigating curiosity, inspiration of creativity, proper interests, values and attitudes to promote independent study and competence to make judgments of one's own. It needs to provide real life skills, encourage innovation and support student talents. The development of innovation skills in complex and complicated environment demarcated a line high academic achievers and low academic achievers. The innovative skills included innovation, creativity, problem solving, critical thinking, collaboration and communication.

For developing skills to use these technologies teachers should use new methods and approaches to teaching. These new approaches can help teachers develop these skills with the help of information and communication technology and tailor learning as per required by the time. Project-based learning (PBL) is one of new approach which can help teacher making teaching according to the need of the time. It is an approach that focused students and priority is given to him for learning activities. In student-centered learning, students are carefully heard, patiently listened and considerably given preference. The classroom activities are determined and developed following their interests, abilities and needs. There is a great change in teacher and pupil roles. Now teacher role has shifted from knowledge transmitter to learning facilitator, collaborator and coach. Teacher is not a primary source of information but he or she becomes a knowledge explorer, knowledge enhancer and co-learner. The learners are provided with options and assigning them responsibilities for their own learning. There is also great change in student role with the time. Now students are not silent, passive listeners of the lecture delivered by teachers, reproduce knowledge and act as a solitary person but he or she is active participant of all the teaching learning process and providing input to knowledge and sharing it with others by collaboration and mutual understanding.

In learner-centered classroom activities, students often work together in small groups, and they decide between themselves what each member's respective role should be. Seeking solutions to real-life problems, gathering information, analyzing data - this is called project-based learning (PBL). There is nothing particularly new about this type of learning since good teachers have frequently incorporated project work, individual or group, into regular classroom activities. In project-based learning, students are at the centre of the learning process, engage in long-term studies of the topics, connect their learning to the real world and collaborate with each other. With using specific classroom seniors, teachers can explore characteristics of project-based learning and can organize the curriculum, the classroom, technology and the students for the

successful 21st century skills. Teacher can also use a variety of assessments throughout the projects and make assessment strategies for assessing students 21st century skill throughout a project. The increasing interests of the students in project-based learning depends on information and communication technology, specially the challenges and chances it provided in form of internet and other multimedia tools to beautify and the results of the projects their assembling and presentation.

Statement of the Problem

This study was designed and developed to find out the effectiveness of project-based learning (PBL) for teaching science at elementary level.

Objectives of the Study

Following were the major objectives of the study:

To get training to use project-based learning technique in class room situation.

To apply the project-based learning technique to teach science at elementary level.

To identify the effect of project-based learning techniques on the students' academic achievement.

Give suitable recommendations to teachers, administrators and future researchers.

Hypothesis

To attain these objectives, the null hypothesis was formulated:

1 there is no significance difference between the mean academic achievement scores of the pre-test and post-test after the treatment.

Significance of the Study

This study would be beneficial and significant for many people because 21st century skills are imperative for students to exhibit innovation and creativity, problem solving and critical thinking, collaboration and communication. Project-based learning (PBL) can help teachers for developing 21st century skills in the student that would empower students for lifelong learning by making them ready for solving complex life issues and improve the working environment in the 21st century. This study would not only help teachers to understand the basic concepts related to project-based learning but they will also able to use it effectively and efficiently in their class room situation.

Research Methodology

The purpose of the present study was to investigate the effectiveness of project-based learning (PBL) technique for teaching science. The study was an experimental study. Project-based learning was independent variable and students' academic achievement was dependent variable. For experimentation, one section of 8th class was selected and the one-group pretest-posttest design was used.

Population

The population consisted on the students of 8th grade in Federal Government High Schools situated in Rawalpindi and Islamabad

Sample

One of the Federal Government High Schools was randomly selected as a sample school. Then one section of 8th class was randomly selected.

Instrument of the Study

A pre-test and post-test in the subject of science for class 8th was developed to evaluate the academic achievement of students before and after the completion of the experiment. The researcher made a thorough study for the construction of the test and was developed in the light of test construction technique post test was based on Multiple Choice Item.

Pre-test

Pre-test (appendix) in the subject of science for class 8th was administered before the treatment. The chapter "Environment" from the 8th class text book of science was selected. The purpose of pre-test was to evaluate the academic performance of students before the experiment. There were 40 multiple choice items in the post-test. Test was checked by giving one mark to right answer and no mark was given to wrong answer. There was no negative marking. The total score was 40

Post-test

After the four weeks treatment (chapter "Environment was taught through project-based learning) a post-test (appendix) was administered. Result (appendix) of post test was recorded. The chapter selected from the 8th class text book of science was "Environment" The purpose of post-test was to find out the difference in the academic achievement of the students after the treatment. There were 40 Multiple Choice Items in the post test. Test was scored by giving one mark to right answer and no marks were given to wrong answers. There was no negative marking. The total score was 40.

Review of Related Literature

This study was designed to identify the effectiveness of project-based teaching for teaching science at elementary level. This review mainly focuses on the concept, elements, characteristic, development of project for project -based learning and previous research studies conducted on project-based learning.

Traditional Methods of Teaching

In Pakistan traditional methods of teaching are still prevailing in our most of the institutions. Teacher is more active and student is more passive. No emphasis is given on the learners' abilities, capabilities interest, individual differences and personality. Park Rogers et al (2010) pointed out that "Most of the classes are very dull and boring because the teacher keep on speaking without class participation, teacher comes in class, asks someone to read the topic out of the book and some time dictates the topic. Children with good listening skill and who are goods at on making notes understand but the other the left behind". In traditional methods of teaching,

teachers transmit facts, skills to the students. Students are expected to receive these facts and skills obediently. Traditional methods are teacher centered and teacher teaches all students with same material. The main objective of traditional teaching is to achieve high scores and grade.

Traditional methods of traditional approach are:

Direct instruction

Lectures

Observation

Main task of traditional teaching is memorizing facts; there is no connection between real world and subject matter. Teacher role is not a facilitator but as a controller. Students are expected to memorize and achieve high grades. Poor performer fails because of poor understanding.

Traditional methods for teaching science

For teaching science, teacher transmits concrete knowledge and facts from the text book. There is no opportunity of practical work only memorizing the content from text book. Traditional teachers play an authoritative role by controlling of the learning environment, in process of instruction and lectures and in process of contents selection. These types of teachers usually considered students as knowledge bowels required to be filled in with information and learning takes place as they want (Novak, 2002).

The teaching learning process is mostly limited with the class where a competitive environment exists. The importance is given to contents, delivery and students get command over these by drill and practice depending solely on rote learning. Context and reference with real life are minimum among the contents. (Theroux, 2004; Johnson & Johnson, 1991).

On the other hand, in students centered learning, the teachers is basically a facilitator and guide. The students learn independently, having a control on learning and feeling responsibility, they collaborate and cooperate. The processing of information remains priority on contents so learning occurs in context by engaging them and building their abilities to construct knowledge by themselves (Theroux, 2004).

Mitchell et al (2009) stated that the role of teacher is not passive because he/she remains alert and constantly move in the classroom, helping them individually and collectively. The teacher students involvement revolve round the monitoring, disciplining, guiding, modeling, questioning, suggesting, encouraging, motivating and clarifying. The teacher has to make suitable decisions regarding time, students' requirement and method of delivery to maximize efficiency.

Dewey declared that the learners are not just blanks slates throughout their learning process but they are living sole, having individual characteristics, various comprehension skills. A meta cognition process is involved in associating prior experiences, preconceptions and knowledge so the responsibility of learner is to develop an educative experience. Dewey placed much emphasis on experience, experiment and purpose for teaching learning process.

Akinoglu (2008) stated that students preferentially take in and process information in different ways: by seeing and hearing, reflecting and acting, reasoning logically and intuitively, analyzing and visualizing, steadily and in fits and starts. Teaching methods also vary. Some instructors lecture, others demonstrate or lead students to self-discovery; some focus on principles and others on applications; some emphasize memory and others understanding. Teaching style should be according to need of the time and need of students.

Preparing student for 21st century and developing 21st century skills it is need of the time that teacher should incorporate new and innovative methods with their traditional teaching. These new approaches can help teachers develop these skills with the help of information and communication technology and tailor learning according to the need of the time. Project-based learning gives student voice and choice and gives them opportunities to become self-directed and construct their own learning.

The Pedagogical Dictionary (1998) defined project methods as: "It is a teaching method which leads pupils to the solution of complex problems and experience is gained through practical activity and experiments. It is derived from pragmatic pedagogy and instrumentalism. It is also one of the most important motivational strategies and significantly supports cooperative learning. Projects can be arranged as integrated topics, practical problems or activities leading to the creation of a certain visual or written end product" (Rousova, 2008).

This approach is comprehensive tool box for operating in classroom. It is a teaching learning process designed and developed to keep learner busy in investigating of complex problems, life related issues and carefully and cautiously planned products (Blumenfeld et al., 1991). Project based learning seeks possibility of carrying out the project its related information depending on students centered activities, developing cooperative and interactive environment (Moursund, 1999). PBL is a model proposed and practiced for solving compelling problems to culminate authentic products. These projects could vary in subject matter, scope and level but they may share their features, nature and patterns. The projects emerged through challenging questions by placing students in an active role of documentarian, a problem solver, a decision maker and investigator. They cannot be labeled as diversion or addition to the real curriculum, they are very much specific and significant (Intel teach elements, 2008).

Objectives of Project-Based Learning

Barron & Darling (2007) defined five objectives of project-based learning

Development of reasoning skills

One of main objective of project-based learning is to develop reasoning skills of student. Project-based learning enables students to understand abstract and hypothetical problems. It enables learners to classify objects and ideas and try to match the pattern of information from one area to another. Through reasoning learner can see the same things of basically different things and ideas to have comprehension of them. The learners are able to create new information to express an idea.

Development of self-directed study skills

In project-based learning, the skills are developed among students to recognize information and knowledge to explain and understand the problems. They approach to appropriate source to get new information and knowledge. These might include

Library

Internet

Teachers

Peers

Learner combined new knowledge with prior knowledge and use to solve problems.

Focused of Acquired Knowledge

Through reasoning skill, learner is able to analyze the problem. Learners combine new knowledge with prior knowledge and use to solve problems.

Development of conceptual skills

Learner organizes new knowledge for overall understanding. And this understanding helps him for solving future problems.

Development of team skills

Students work in groups is the basic requirement of the project based learning. They learn to work as a team.

Characteristics of PBL

Savery (2006) described in his study “PBL is an instructional (and curricular) learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem.” Savery (2006) identify some characteristics of PBL that included tutor role in facilitating learner, learners’ requirements to be self regulated and self directed, the core elements of the design. A very serious challenge for teacher wishing to adopt PBL is transition of himself because he has to switch from knowledge provider to a manager, facilitator and tutor of learning (Ertmer & Simons, 2005).

Teaching through PBL is not a matter of simple presentation of a problem to the learners but it required more painful aspects for the teachers who have to do so many things without displaying them to the learner. It forms high expectation of students to work consistently by self monitoring and self regulation. The reality differs as new entrants could not do so they need to have significant instructional scaffolding to develop the skills like problem solving, self direction, collaboration and teamwork to reach self sufficiency that could lead to withdrawal of scaffolding. There are many other benefits of PBL leaning encompassing a sense of achievement for all member of the project because each one role and effort could be seen in tangible form at final stage. It is a very useful approach to teach diverse and multicultural classroom that consists on students of different skills, interests, needs and abilities. It included open ended and graded tasks and activities, contribution of every individual is valued and a constructive climate is easy to uphold, catering mixed abilities learners with comfort and accuracy. The learners had some limitations as they appreciate refreshment and novelty so blinded curriculum following prevent them from general enjoyment and opportunity of doing something different. Most often students welcome when a project is acknowledged and school routine breaks down and love informal way of learning (Haines, 1989).

Kiran and Rahman (2011) conducted research investigating project based learning which found out that the post-test revealed that students taught by project method performed better than students taught by lecture method. It was recommended that for the effective teaching of mathematics project based method must be followed in order to increase the leaning level of students.

Summers and Dickinson (2012) conducted research on a Longitudinal Investigation of Project-based Instruction and Student Achievement in High School Social Studies. Researchers found that students achievement in PBI versus traditional instruction at high school within rural area. The findings of the study included promotion of the students in next grade level in different subjects.

Ravitz et al (2012) stated that the teachers using PBL receiving extensive professional development reported more teaching and assessment of 21st century skills overall. The patterns were seen within subjects for nearly all of the measured skills.

Carlo et al (2005) investigated the effect of project based learning (PBL) on performance accuracy, learning approach and attitude toward the activity. It used nonequivalent and quasi experimental designs had various learning approaches which were measured before the participant were engaged in PBL activity then assessed at the end of project. The study investigated the change occurring in before and after design. Experimental group received PBL approach compared with control group, were attitude were measured the course and performance accuracy of the subjects.

Strobel and Barneveld (2009) conducted research on effectiveness of PBL by synthesizing different meta analysis, compare and contrast various conceptualization of learning and its measurement. The study identified the differences among the definition of learning and measurement of learning contributing the inconclusiveness of different meta analysis as far as effectiveness is concerned.

Hou, (2010) conducted a study that explored the behavioral patterns by online discussion, content analysis and progressive sequential analysis through project based learning as online learning is growing fast and getting more popularity. The findings of the study indicated that the learner had limitation in managing time, collecting data, data evaluation comprehensive analysis of the collected data. They problems were addressed by providing online forums for students and teachers to get good knowledge of it.

Basi & Beyhan (2009 – 2010) at Selcuk University, Turkey conducted another research on projects based learning. The research investigated the effects of multiple intelligences depending on project based learning vs traditional learning. It was conducted in school environment using pre and post test model. The achievement and attitude scale test was applied two time before and after conducting experiment. The study found that there was a significant difference was found in achievement level and the project based learning and traditional learning method. Multiple intelligence supported project based learning was more successful and interesting for their learning experiences.

Sana and Saiqa (2012) explored that the impact of PBL in teaching English was significant. The results showed that PBL improved their skills to make them independent learner and that could be fostered by making available the research facilities, time for doing projects and decreasing anxiety level through encouragement to the students. The projects showed that students learn language skills addition to like skills such as doing work as team member, working for self regulation, developing self motivation and managing time. PBL also promoted positive image, autonomy and independent learning.

The present study deals with analysis interpretation of data regarding student's academic achievement. To find out the effectiveness of project-based learning (PBL) for teaching science at elementary level, first of all obtained scores of individual students were prepared and presented in tables. Secondly the frequency distribution of raw scores was prepared and presented in both tabular form and graphic forms. Thirdly mean and standard deviation were calculated through SPSS on the pre and post scores. Finally, t test was applied to find out the difference in student academic achievement

Table 1 Mean and Standard Deviation of the Raw Scores

Categories	N	Mean	S.D
Pre test	33	17.06	4.99
Post test	33	34.39	3.93

Table 2 Frequency distribution of pre-test scores

Class intervals	F
90-11	4
12-14	7
15-17	9
18-20	5
21-23	7
24-26	2
27-29	0
30-32	0
33-35	1
N=33	

The data presented in the table provides information about pre-test and it showed that majority of students were average in respect to their academic achievement in subject of science. There were no students whose academic achievement was either extremely poor or extremely high.

Table 3 Frequency distribution of post test scores

Class intervals	f
25-27	1
28-30	6
31-33	8
34-36	4
37-39	13
40-42	1
N=33	

The above table shows the frequency distribution of post-test scores. Entries in the above table provide information about post-test. it shows that after the treatment, student's academic achievement was high, which also visible thorough figure is given below.

Table 4 Significance of difference between pre-test and post-test academic achievement scores of student.

Categories	N	Mean	sd	t	P
Pre-test	33	17.06	4.99	-18.32	.00
Post-test	33	34.39	3.93		

df=32

$t_{.05}=1.68$

The above tables shows that the actual difference between the mean of pre-test and post-test score was found to be highly significant because the calculated t value is higher than critical t value at .05 level of significance and is also significant at 0.00 level. The null hypothesis is, therefore, rejected. It can be concluded that there is a significance difference between the mean academic achievement scores of pre-test and post-test after the treatment.

Summary

The topic of present study was “An experimental study to investigate the effectiveness of project-based learning (PBL) for teaching science at elementary level. The following objectives were desired to be achieved.

To get training to use project-based learning technique in class room situation.

Apply the project-based learning technique to teach science at elementary level.

Find out the effect of project-based learning technique on the academic achievement of the students.

Give suitable recommendations to teachers, administrators and future researchers

In order to achieve the objectives, following null hypothesis was formulated: there is no significance difference between the mean academic achievement scores of pre-test and post-test after the treatment. Students of 8th class studying in all (142) Federal Government high schools situated in Rawalpindi and Islamabad was the population of the study. Random sampling technique was used to select the sample from the population. One Federal Government high school was randomly selected as a sample school. Then one section of 8th class was randomly selected for the study. The one-group pretest-posttest design was used. This selected group was considered as experimental group. The experimental group was pre-tested. The experimental group was taught through project-based learning technique by the researcher. After the treatment a post test was conducted and difference of the mean academic achievement score was observed. t test was used to analyze the data. The level of significance preset to test the null hypothesis of the study was 0.05.

Findings

On the basis of the statistical analysis of the data, the following findings are made:

The mean score of pre-test was 17.06 with 4.99 standard deviation while the mean score of post-test was 34.39 with 3.93 standard deviation.

Difference between the academic achievement score of pre-test and post-test was 17.33 which were highly significant because the calculated t value is higher than the critical t value at 0.05 level of significance. Therefore null hypothesis was rejected.

Conclusion

On the basis of the findings, the following conclusion is drawn:

Project-based learning technique (PBL) was found to be more effective teaching technique for teaching science as reflected through the difference between academic achievement scores of pre-test and post-test.

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