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Effectiveness of Problem Based Learning Approach on Students Achievement in Subject of Science at Elementary Level

Saghir Iqbal*, Muhammad Ibrahim Khalid** & Khalid Saleem***

Abstract

Teaching has always been undergoing strategic development and changes. Over the years the teacher-centered approaches are replaced by the student-centered methods. Even in the present era the individualized methods of instruction are being preferred by the educationists. Problem-based learning approach is one of the latest instructional strategies being adopted for effective and successful learning. The purpose of this research at hand was to compare students' achievement in subject of science taught with Problem-Based learning (PBL) approach and the traditional method of teaching. The experimental group comprising of 35 8th graders were treated with the independent variable problem-based learning method. The control group was not given any treatment and was taught traditionally. It was found after analysis that the experimental group who had received instruction with problem-based learning (PBL) showed better performance as compared to traditional group students.

Keywords: Problem-Based learning, constructivism, achievement test of science (ATS).

*Ph.D Scholar University of Education Lahore, Pakistan
** Dean of Education, Ali Institute Lahore, Pakistan
***Principal University of Education Lahore (Okara Campus) Pakistan

Introduction

Education plays significant role in nations' progress. The school education is the progressive investment in national planning of the countries as it is mentioned by the Jomtien Conference 1990, the report of the Jacques Delors Commission on Education for the Twenty-first Century, and the United Nations' Millennium Development Goals (MDGs). The state of Pakistan has also given great importance to education since its inception (Iqbal, 1993). In educational process, teaching is a very complicated and dynamic activity; it demands to take appropriate and flexible actions during the process of teaching. A number of steps are required for a quality teaching (Tileston, 2004).

In modern era teaching and learning process has become very complex and old methods for educating the child do not match the learners because the old ones go against brain structure of the learner in process of gathering or collecting the new information and ideas (Ronis, 2008). A quality teaching demands a number of steps e.g. curriculum, teaching techniques, and assessment techniques. The above-stated steps are necessary for a quality teaching and should be aligned (Tileston, 2004).

In contrast with lecture method, the problem-based learning is the class instructional method in which learning situates in multifaceted perspectives. Hmelo-Silver (2004) has described PBL as "it is an instructional method in which students work collaboratively to find possible solutions for a problem scenario". Here, pupils learn by way of specific experiences of solution of open-ended problems such as diagnosing medical cases or scheming playgrounds. Problem-based learning rests on the thought that individuals fashion their understanding largely through what they experience. This inquiry method of learning allows learners to process and acquire new information in the way most suited to their natural brain process (Ronis, 2008).

Ministry of Education (MoE) Pakistan developed New National Curriculum in 2006 to improve the quality of science education at elementary level. The main feature of this newly designed curriculum is "student-centered" and "inquiry-based" (Govt. of Pakistan, 2006).

The curriculum has been designed in the light of student centered approaches to improve the quality of science education and problem based learning is a student centered approach. Therefore, a study was planned to justify the relevance of problem based learning in science teaching. This study was designed to explore the "effect of problem based learning on the academic achievement of elementary students in subject of science". In Pakistan new education policy has encouraged and emphasized on using new teaching techniques in process of learning (Govt. of Pakistan, 2009).

Literature Review

Teaching has become an important challenge and complex procedure nowadays. It is not easy to define teaching because there are many things associated with teaching. In simple way teaching can be defined by discussing those teaching attitudes which are considered important to instigate learning process with respect to the learner (Blair, 1988). As problem- based learning is mainly used in teaching those subjects which have scientific basis so according to this viewpoint it seemed very appropriate to test and put into practice problem- based learning in our own background but before it, we very briefly look at the place of science education in Pakistan (Saeed, 2007). Iqbal and Mahmood (2000) have explained that "until 1950 science was not taught at primary and middle level. Mahmood (2007) has described that "Pakistani practicing science teacher's lower support for student involvement is because of the traditional trend of using lecturing as most popular teaching methodologies". Askari (1994) has discussed that the utilization of teaching aid and educational apparatus was emphasized by the Education Policy 1972-80. The Federal Ministry of Education, Islamabad introduced a program in 1974 for the development of teaching kit for primary schools. It is considered that teaching of science as a subject is very important at elementary level.

An individual plays an important role in learning process. If a learner is intrinsically motivated, the concepts will be learned in a better way. Montessori (1972) had immense esteem for the child as an individual for unprompted and autonomous learner. The children have curious and innate behavior towards learning without intervention of adults. These views are also supported by the Plowden report as discussed by Kwon (2002). Baden and Major (2004) have described the changing role of students in PBL set up "students have shifted from one primary role (listener and observer) to a multitude of overlapping and ever-changing roles".

Barrow and Tamblyn (1980) have written different reasons to use PBL in schools during teaching learning process. Teacher role is also very important in PBL class room environment. S/he should always be very conscious during the teaching-learning process (Colburn, 2000). A research has been conducted by Selcuk (2010) in Turkey in subject of physics, the findings of the study showed that PBL method motivates the students for deep approach to learning.

Gordon, et.al (2001) conducted the experiment on students of an urban minority middle school to know the effectiveness of problem-based learning method. The experimental group students(PBL method) showed better academic performance in science and better conduct over the entire period of research.

The above mentioned research studies and carefully obtained conclusions provide support to PBL to be used in different natural and social sciences classes. Some studies, however also find that PBL provides weak results in knowledge domain but it is better for advanced level skills. According to the new national curriculum "The main feature of this newly designed curriculum is "student-centered" and "inquiry-based"(Govt. of Pakistan, 2006). However, the training system in the country does not support the new teaching methods and our teacher lacks in using these teaching methods. This research study was conducted to find an opportunity to assess the need of using new teaching methodology at elementary level and to find out the way for suggesting training needs of the elementary teachers before and after induction in teaching field.

Purpose and Scope of the Study

Teaching has become a science that requires accurate and decisive measures for successful and effective instruction. With the passage of time new techniques and approaches have emerged making teaching really a scientific process. Problem based learning approach is one of such measures. In this approach the teachers deliberately create a problematic situation for their students. The students use their intellect to come out of the posed situation.

Studies, as discussed above, have shown that this approach was really helpful in teaching science and other similar subjects. The focus of the present study was to determine the effectiveness of problem-based learning in the subject of science. Although in different parts of the world, the approach has yielded positive results, yet no such example is available in Pakistani situation. No work has ever been done for determining the impact of PBL in the field of science teaching, especially about the students' academic achievements in the subject of science.

The present study was an experimental endeavor to compare the achievement level of students taught through problem based learning and by traditional method. This is emerging field of research in Pakistani perspective, and it is expected that the study will open new horizons for exploring the effectiveness of PBL in other subject areas including the science at different levels.

For carrying out the experiment, following hypotheses were tested;

H_o1: There is no significant difference of students' academic achievement between problem-based learning and traditional learning method in science subjects at elementary level

H_o2: There is no significant difference in the academic achievement of experimental group and control group at understanding level

Methodology

To determine the impact of problem based learning upon the students' achievements, an experimental study was designed. Pretest-Posttest Control group design was employed to accomplish the study.

The sample of the study consisted of 8^{th} class students from a public school. As the study at hand was focused only upon the achievements of the students in the subject of science therefore, for a total of 211 students, 70 were selected randomly for study. The selected students were assigned control and experimental group on the basis of random assignment. Seventy (70) selected students were further assigned numbers randomly and odd numbers were assigned to experimental group while even numbers were assigned to control group. The experimental group was named as 'A' whereas; group 'B' was taken as control group. The control group was taught through traditional method while the experimental group was taught through problem based learning technique. Total duration of experimentation lasted for eight weeks. Students were given projects to solve problems by themselves. Students were only guided about the main processes to complete projects. Furthermore, a guidance manual was also developed for basic requirements of the project.

The Achievement Test of Science (ATS) as pretest was administered to both the groups before starting the experiment. Achievement Test of Science was conducted on the eighth class students for pilot testing. Seventy test items were developed and pilot tested on thirty students. Finally, forty two test items were chosen and the items that were identified as ambiguous were either corrected or deleted. The same test with different arrangement of test items as post-test was administered on both the groups after treatment to obtain the achievement level of the students after treatment. A short detail of experimentation is given here. The students of the control group were taught with traditional method. In our traditional class room set up, most of the time, teacher speaks and students listen passively or one student reads the text material and the teacher explains it to students at elementary level. In contrast with traditional class room the experimental group was divided into seven heterogeneous groups of five. Problem scenarios based on two chapters were presented before the students. The students met with the problem without any prior experience in dealing with the problem scenario. Each group of students met the facilitator to discuss the problem. The facilitator presented a limited amount of information about the problem, and the

group was charged with the task to identify the different aspects of the problem. Students worked together to solve the problems' potential solution. The written account of the solutions was presented to the teacher by each group. All types of obtained data were entered in SPSS software for data analysis. To compare the achievement level of both experimental and control group, t-test was applied. Achievement level of students was taken from marks obtained from ATS conducted at the start and end of experimentation.

Findings and Results

Table 1

Test on the Achievement Scores of Control and Experimental Group in Pre-Test

Group	Number (N)	Mean	Standard Deviation	t-value	p-value
Control Group	35	18.43	2.8521	1.139	.259*
Experimental Group	35	19.34	3.7958		

*p=0.05

The results of t-test between control and experimental group in pre-test scores reflect that there is no significant difference (p=.259>0.05) between control and experimental group in pre-test. This means that participants of both control and experimental group are at the same achievement level in science.

Table 2

t-test on the Achievement Scores of Control and Experimental Group in Post-Test

Group	Number (N)	Mean	SD	t-value	P-value
Control Group	35	20.8000	4.3440	6.211	.000*
Experimental Group	35	27.0000	4.0000		

*p=0.05

A significant difference (p=.000<0.05) in the achievements of control and experimental group is observed for the post-test. Mean score of control group (20.80) and experimental group (27.00) shows that the performance of students taught through problem- based learning is better than the students taught through traditional method of teaching. P-value in the table 2 depicts the picture that there is significant difference between the achievement level of experimental and control group. This shows that the participants of experimental group have higher level of achievement in post-test than that of the control group.

The graphical description shown in the figure below also describes the difference in the students' achievements in pre-test vs. post-test of control group and pre-test vs. post-test of experimental group. Figure highlights that students of control group performed almost at the same level before and after the experimentation period, while on the other side, students of experimental group (taught through problem based learning method) performed significantly better in post-test as compared to pre-test.

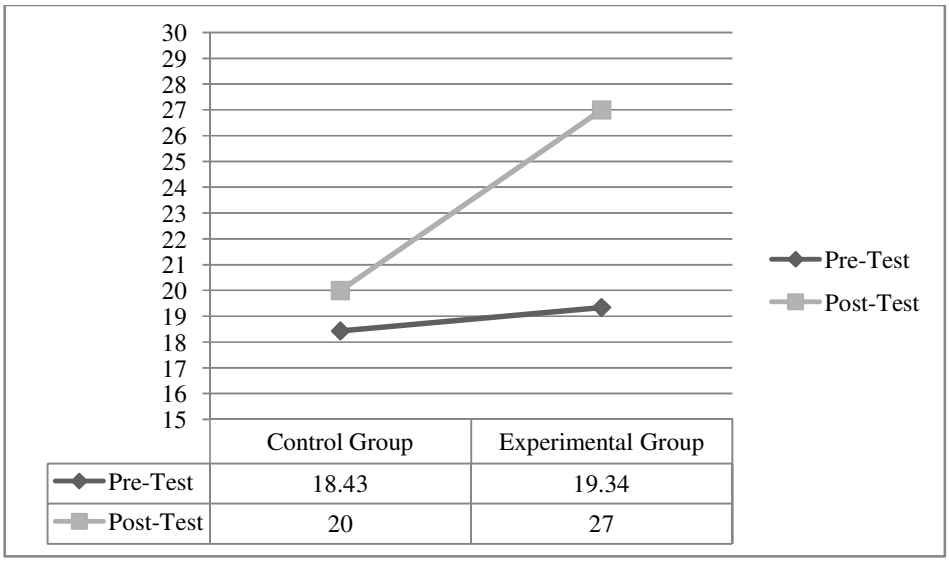

Figure 1 Comparison of control and experimental group in pre-test and post-test

Table 3
t-test on Pre-Test and Post-Test Mean Scores of Control Group in Understanding Domain

Tests	Number (N)	Mean	Standard Deviation	t-value	p-value
Pre-Test	35	6.1143	1.89071	3.443	.001
Post-Test	35	7.7714	2.12943		

*p<0.05, t= 1.96

The above analysis depicts a comparison on t-test between pre-test and post-test mean scores of students' achievement level in the understanding level according to Bloom's cognitive domain for control group. The analysis reflects that there is significant difference (p=.001<0.05) in the academic achievement in understanding level of Bloom's taxonomy for control group (taught through traditional method) at the start and at the end of manipulation in understanding domain of Bloom's taxonomy.

This means that traditional method of teaching has also improved understanding level according to Bloom's taxonomy of students in the science subject.

Table 4

t -test on Achievement of Pre-Test and Post-Test Mean Scores of Experimental Group in Understanding Domain

Tests	Number (N)	Mean	SD	t-value	p-value
Pre-Test	35	7.4286	2.22665	3.653	.001
Post-Test	35	9.0571	1.41302		

*p<0.05, t=1.96

Table 4 shows t-test value between pre-test and post-test mean scores of experimental group in the understanding domain. Mean score on pre-test is (7.43) and on post-test is (9.06) of experimental group in understanding domain. t value shows that students' achievement level of experimental group (PBL) on posttest is better than the achievement level on pre-test scores in understanding domain of Bloom's Taxonomy. This shows that students' understanding of science concepts through problem based learning has been effective.

The graphical description shown in the figure II below also describes the difference in the students' achievements in understanding level according to Bloom's taxonomy. Figure highlights that the students of both the control and experimental both groups performed significantly better in post-test as compared to pre-test.

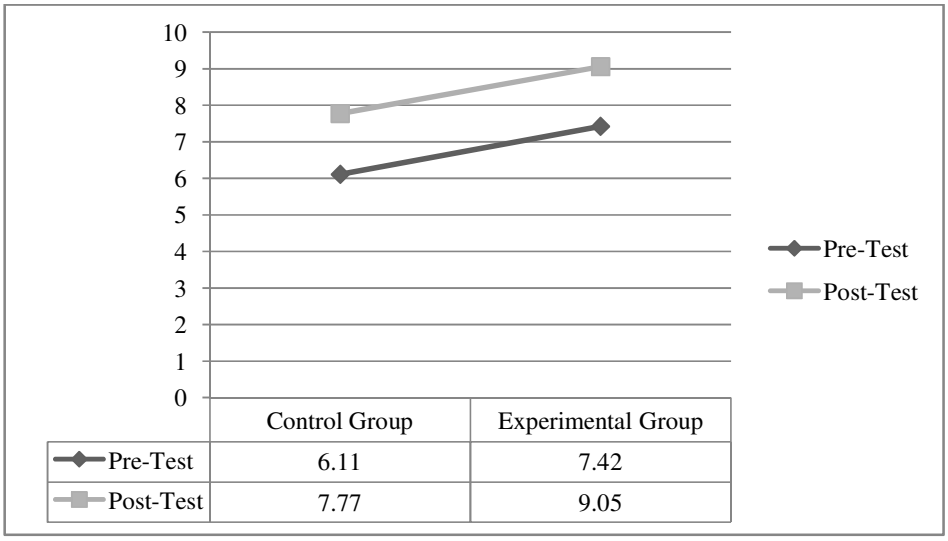

Figure 2 Comparison of control and experimental group in pre-test and post-test in understanding domain of blooms' taxonomy

Conclusions

The mean scores of control and experimental groups on post-test differ significantly in their achievement in Achievement Test of Science (ATS). Similarly, the mean score of experimental group on pre-test and posttest in understanding domain also differs significantly in its achievement.

Recommendations

1. As problem-based learning is based on students' maximum participation therefore, at school level problem based learning should be proposed for the teaching of science subjects.
2. Further, students' self-learning through multiple projects increases depth of learning according to the levels of Bloom's taxonomy.
3. As the study results have reflected that problem-based learning method produced better learning achievement in science subject as compared to traditional teaching method replication of study on science subjects and on other subjects should be conducted for authentication of problem based learning method.

References

Askari, S. H. (1994). Effectiveness of scientific kit and pupils manuals in pakistan: prospective and prospects. *Journal of Educational Research, 2*.19-27.

Baden, M.S. & Major, C.H.(2004). *Foundations of problem based learning*. New York: Society for Research into Higher Education & Open University Press.

Barrows, H. S. & Tamblyn, R. M. (1980). *Problem-based learning: an approach to medical education*. New York: Springer Publishing Company.

Blair, T.R.(1988). *Emerging patterns of teaching: From method to field experiences.* London: Merrill Publishing Company; A Bell & Howell Information Company.

Breton, G. (1996). *Some Empirical Evidence on the Superiority of the Problem-based Learning Method Accounting Education* 8. 1-12.

Colburn, A.(2000). An inquiry primer, *Science Scope, 42-44*.

Gay, L. R. (2005). *Educational Research: Competences for analysis and application*5thed. New Jersey: Prentice Hall.

Gordon, P. R., Rogers, A. M., Comfort, M., Gavula, N. & McGee, B.P. (2001). *A taste of problem-based learning increases achievement of urban minority middle school students*, *Educational Horizons,79*(4).171-175.

Government of Pakistan. (2006). *National curriculum for general science grades IV-VIII,* 2006, Islamabad: Ministry of Education.

Government of Pakistan (2009). *National education policy*, Islamabad: Ministry of Education.

Hmelo-Silver, C. E. (2004). Problem based learning: What and how students learn? *Educational Psychology Review, 16(*3), 325-266.

Hsu, J. J. F., Chen, D. & Hung, D. (2000). Learning theories and IT: The computer as a tutor. In Williams, M. D. (Ed). *Integrating Educational Technology into Teaching and Learning Concepts and Applications,* (2nd) ed. Singapore: Prentice Hall inc.

Iqbal, H.M. & Mahmood, N. (2000). *Teacher education in Pakistan: Policies and practices. Science teacher education: An international perspective.* Kluwer Academic Publisher, P.75-92.

Iqbal, M. (1993). *Education in Pakistan*, Aziz Publishers, Lahore: Urdu Bazar.

Kwon, Y. I. (2002). Changing curriculum for early childhood education in england, *Early Childhood Research and Practices,4*(2).

Low, C. H. & Ng, H. T. (2005). *Effects of problem-based learning on students self directed learning behaviors in Mathematics*. Singapore: Centre for research in pedagogy and practice, National Institute of Education.

Montessori, M. (1972). *Dr. Montessori's own handbook: A short guide to her ideas and materials.* New York: Schocken Books.

Peterson, R., & Treagust, D. (1998). Learning to teach primary science through problem-based learning, *Science Education, 82*(2) 215-237.

Robleyr, M. D. & Edward, J. (2000).*Integrating Educational Technology into Teaching*.2nd ed. Upper Saddle River: Prentice Hall Inc.

Ronis, D. L. (2008).*Problem based learning for math and science: Integrating inquiry and the internet*. London: Corwin Press.

Saeed, M. (2007). Education system of Pakistan and the UK: Comparisons in context to inter-provincial and inter-countries reflections. *Bulletin of Education & Research, 29*(2)43-57.

Selcuk, G. S. (2010). The effects of problem-based learning on pre-service teachers achievement: Approaches and attitude towards learning physics. *International Journal of Physical Sciences*,5(6), 711-723.

Tahir, A.Q. (2011). Developing a student centered inquiry based teaching approach at elementary level science in Pakistan-a three years implementation cycle. *Asian Social Science, 7*(8).

Tileston, D. W. (2004). *What every teacher should know about instructional planning*. New York: Corwin Press, Thousand Oaks.