



Effect of Using Problem Solving Method in Teaching Mathematics on the Achievement of Mathematics Students

Riasat Ali (Corresponding author)

Institute of Education & Research

University of Science & Technology, Bannu, (NWFP) Pakistan

Tel: 92-0928-621101 E-mail: drriasatali@gmail.com

Hukamdad

Department of Education

National University of Modern Languages Islamabad, Pakistan

Tel: 92-0346-9186014 E-mail: drhukamdad@gmail.com

Aqila Akhter

Regional Institute of Teacher Education, Bannu, Pakistan

Tel: 92-0333-9727993 E-mail: akila@yahoo.com

Anwar Khan

COMSATS Institute of Information Technology, Attock, Pakistan

Tel: 92-0334-5606406 E-mail: anwar_khan@comsats.edu.pk

Abstract

The major purpose of study was to investigate the effects of using problem solving method on students' achievement in teaching mathematics at elementary level. Pre-test post-test design was used in the study. Results were analyzed using mean, standard deviation and t-test. From the findings it was observed that the use of problem solving method enhanced the achievement of the students in mathematics. The result showed that there was significant difference between the effectiveness of traditional teaching method and problem solving method in teaching of mathematics at elementary level. The study recommended that the teachers should be encouraged to employ problem solving method in teaching mathematical concepts like set, information handling and geometry etc. Regular training, workshops and seminars should be arranged for teachers to give them knowledge and understanding of problem based learning.

Keywords: Mathematics, Problem based learning, Active learning process, Learning environment, Students' Achievement

1. Introduction

Merely telling is not teaching and simply listening is not learning. Again some learning process revolves around the teacher, where the students are only passive information receivers. While in students centred learning process teacher is merely facilitator or guide is the focal point of modern systems of education. In all active learning process, the learners learn according to their own needs and pace (Orhan & Ruhan, 2006). They are given the opportunities to make decisions regarding various dimensions of the learning process and to perform self regulation. In case of active learning process, learning is not a standard process but a personalized process. Human beings face a multiple dimensional problems in their lives and they try to solve these problems in a particular way in the light of their previously gained knowledge and experiences. In this regard it is essential for the students to be prepared for future or near future challenges by facing real life, or real like, problems in their learning environment, and finding appropriate solution of

these problems. Each society expects from its education system that it enables the individuals to become an effective problem solver in their real life (Walker & Lofton, 2003; Chin & Chia, 2004). The roots of problem solving learning are found in Dewy's thoughts, "that learning by experimentation or doing is more lasting" (Dewy, 1938). Actually the problem solving is how to learn independently. It is the most convenient approach to achieve the aims of teaching learning process. According to Rhem,(1998) and Herrid, (2003) in present era problem based learning is extensively used nearly in all areas including mathematics and was first implemented in medical education in 1950s. When we examine the related literature it is seen that research studies focused on the use of problem based learning in elementary, secondary and higher education have been reached by 1980s (Gallagher, 1997 & Lambros,2002).

Yager (2000) has stated that we live in a dynamic society in which social political and technological conditions are changing continuously, so educators should analyze and evaluate the trends in order to decide an appropriate curricula and method of instruction which will make students ready for real life situation. Today, it is recognized that every person must be empowered to suggest possible explanations, to propose ways to test personal or class, to collect and interpret data obtained, to communicate the process and results to others.

In this era of unprecedented breakthroughs in technology and constant change in many aspects of life, educators are challenged more than ever before with the need to develop students who will be adaptable in fast-changing environments. This calls for equipping students with better thinking skills and learning abilities. Concomitant with the quest for the development of skills pertaining to creativity and enterprise is the call for a paradigm shift in education (Seng, 2001).

1.1 Problem Based learning and Mathematics

Okereke (2006) stated that mathematics is the science of things that have a pattern of regularity and logical order and finding and exploring the regularity. Mathematics is the foundation of science and technology and the functional role of mathematics to science and technology is multifarious, that no area of science, technology and business enterprise escapes its application. Besides its importance it is observed that mathematics is one of the most poorly taught, widely hated and abysmally understood subject in elementary schools. Students particularly girls run away from the subject. He further stated attributed students' poor performance to factors such as the society view that mathematics is difficult, shortage of qualified teachers, lack of mathematics laboratory and lack of attractiveness and novelty in teaching method. Problem based learning is a model which centred on students, develops active and motivated learning, problem solving skills and broad field knowledge, and based on the deep understanding and problem solving. (Major et al, 2000) In those classrooms in which problem based learning method is used for instructional process, the students take much more responsibility of their own learning. They have become independent and long life learners, and can continue to learn in their whole life.

1.2 Problem based learning method/model

In the problem based learning model the students' turn from passive listeners of information receivers to active, free self-learner and problem solvers. It also shifts the emphasis of educational programs from teaching to learning. It enables the students to learn new knowledge by facing the problems to be solved instead of feeling boredom. Problem based learning affect positively certain other attributes such as problem solving, information acquisition, and information sharing with others, group works, and communication etc. Again problems solving is a deliberate and serious act, involves the use of some novel method, higher thinking and systematic planned steps for the acquisition set goals. The basic and foremost aim of this learning model is acquisition of such information which based on facts (Yuzhi, 2003 & Mangle, 2008).

According to Gallagher et. al,(1999) in problem based learning environment, students act as professionals and are confronted with problems that require clearly defining and well structured problems, developing hypothesis, assessing, analyzing, utilizing data from different sources, revising initial hypothesis as the data collected developing and justifying solutions based on evidence and reasoning. The practice of problem based learning is richly diverse as educators around the world and in a wide range of disciplines have discovered it as a route to innovating education, The educators used problem solving method as an educational tool to enhance learning as a relevant and practical experience, to have students' problem solving skills and to promote students' independent learning skill. Eng (2001) opined problem based learning as a philosophy aims to design and deliver a total learning environment that is holistic to student- centred and student empowerment.

1.3 Students' understanding in Problem Based Learning Environment

Presenting the students with a problem, give them opportunity to take risks, to adopt new understandings, to apply knowledge, to work in context and to enjoy the thrill of being discoverers. Tick, (2007) stated that in the student-centred learning environment that is desirable for problem based learning, the central figure of the learning-teaching process is the student. The learning objective is not the reproduction, recall and learning of passively received learning material but the active and creative engagement of students in group work and in individual study thus transferring the skills and

knowledge. The individual, autonomous self-directed learning gives the freedom to the learner to decide individually and consciously on the learning strategy and on the time scale, s/he wants to follow.

1.4 Teachers' Role in Problem Based Learning Environment

The most important achievement of a teacher is to help his/her students along the road to independent learning. In problem based learning, teacher acts just as facilitator, rather than a primary source of information or dispenser of knowledge. Roh, (2003) argued that within problem based learning environments, teachers' instructional abilities are more critical than in the traditional teacher-centred classrooms. Beyond presenting mathematical knowledge to the students, teachers in problem based learning environments must engage students in marshalling information and using their knowledge in applied and real settings.

Evidence of poor performance in mathematics by elementary school students highlight the facts that the most desired technological, scientific and business application for mathematics cannot be sustained. This makes it paramount to seek for a strategy for teaching mathematics that aims at improving its understanding and performance by students practically (Okigbo & Osuafor, 2008). Problem solving as a method of teaching may be used to accomplish the instructional roles of learning basic facts, concepts, and procedure, as well as goals for problem solving. Problem solving is a major part of Mathematics has many applications and often those applications represent important problems in, mathematics. We include problem solving in school mathematics because it can stimulate the interest and enthusiasm of the students (Wilson, 1993).

2. Objectives and Hypotheses

The major purpose of this study was to investigate the effect of using problem solving method in teaching elementary students in mathematics. Following were the main objectives of the study;

- (i) To determine the role of problem solving method in the academic achievement of students in mathematics at elementary level.
- (ii) To compare the achievement of students taught by problem solving method and students taught by traditional method.

For the achievement of the above objectives following null hypotheses were tested.

H_{01} : There is no significant difference between the achievement of the controlled and experimental group in pre-test.

H_{02} : There is no significant difference between the achievement of the controlled and experimental group in post-test.

3. Method and Procedure

The following procedure was adopted in conduction of this study.

3.1 Population and Sample

All students studying at elementary level in public and private elementary and high schools at 8th grade comprised the population of the study.

Seventy six 8th grade students' of Government Girls Higher Secondary School Ghoriwala, Bannu, Pakistan, were taken as the sample of the study. All students were divided on the basis of pre-test, into two groups as Experimental and Control group through random sampling technique. The number of students in the experimental and control group was 38. To maintain the authenticity, two mathematics teachers of equal qualification and experience instructed the both groups. The only difference was that controlled group was taught by traditional method while, experimental group was instructed by problem solving method.

3.2 Research design and Instrumentation

A pre-test, post-test design with matched experimental and control groups were used. A self-developed test was used as an instrument. The researcher developed a test after reviewing the related literature and consultation with experts. The test included 8 questions containing multiple choice questions, matching questions, fill in the blanks with correct answer and practical solutions to mathematical problems to measure students' academic achievement and performance skills respectively. All the items in the test based on the 8th grade mathematics textbook in the area of Set, Information Handling and Geometry. The test was constructed in such format that it covered the areas of knowledge, comprehension and application level. The same mathematics achievement test was used for pre-test and post-test treatment but the order or sequence of numbers of questions was changed in the pre-test. The validity of the items was assessed by the doctoral committee and two mathematics education experts. The instrument was pilot tested with 10 students in a school not participating in the study but within the same area of study.

3.3 Treatment

The traditionally-designed mathematics instruction was based upon lessons employing lecture/questioning method to teach concepts of selected topics. Teaching strategies depend upon teacher explanations, discussions and textbooks. The

teacher treated the entire class as a unit, wrote notes on the blackboard about the definition of different terminology and drew diagrams related to geometry. After the teacher explanation, the concepts were discussed, recapitulated by the teacher's questions. The direction of communication in the classroom was from teacher to student. Here the teacher is the focal point of discussion and dispenser of the knowledge.

3.4 Problem based learning task

In experimental group, before the treatment, six groups were formed in which six students in four groups and seven students in two groups were formed: these had different learning styles and academic performance. Then, students and teacher were trained to use problem based learning. During the treatment, students worked in small groups and deal with ill-structured problems. Every member of the group had some responsibilities. Students were supposed to participate actively in the group discussion. They had to share their knowledge, express their ideas and experience with each other while searching a solution to the problem. Each of them had to be sensitive to the needs and feelings of other group members. Apart from the group work, each student had to conduct an independent study and must be able to represent, communicate and evaluate his/her learning at both individual and group levels.

During the Problem based learning sessions, the teacher organised the groups and created a purposeful and co-operative atmosphere. The teacher ensured that students had control of the discussion. When guidance was needed, the teacher asked open-ended, very general questions and gave ample opportunity to students to focus on the goal. The teacher encouraged critical thinking. At the end of problem based learning implementation, students evaluated each other with respect to participation, preparation, interpersonal skills and contribution to group progress. In this way it was expected that students would become aware of the role, expected from them both individually and as a group. The experiment lasted for four weeks and it was expected that this period was long enough. After four weeks of treatment same post-test was administered. The difference between the pre-test and post-test was that the sequence of the test items was changed.

4. Results and Discussion

For acquisition of results quantitative research method was used in this study. The data collected were analysed using mean, standard deviation and t-test. It was found that there was a significant difference between the academic achievement of the students taught through traditional method and problem solving method. It was also found that the academic achievement of the students was better who were taught through problem solving method as compare to the students who were taught through traditional method. On the basis of these findings in this study, the following conclusions were drawn:

- Students taught through problem solving method achieved better than those taught by traditional method.
- There exists a significant difference in the achievement of mathematics students taught through problem solving method and traditional method.
- Difference between the achievements level is due to problem based strategy, otherwise both group have equal basic knowledge of mathematics.

5. Recommendations

The following recommendations were made on the basis of the findings of the study:

- This study proved that problem solving is more effective method of instruction for teaching and learning mathematics as compared to traditional (lecture) method of teaching. Therefore the teachers of mathematics should use problem solving method to improve the academic achievements of the students.
- Government should transform the textbooks of mathematics in problem based learning form. Because the traditional textbooks do not meet the criteria of problem solving approach.
- Extensive training program, seminars and workshops should be organized for mathematics teachers in elementary schools to employ problem solving method in the classrooms.
- Mathematics pupil teachers should be trained for using problem based learning approach.

References

- Akinoglu, O. & Ruhan, O. T. (2007). The Effect of Problem- Based active Learning in Science Education on Students' Academic Achievement, Attitude and Concept Learning. *Eurasia Journal of Mathematics, Science & Technology Education*, 3(1), 71-81.
- Chin, C. & Chia, L. G. (2004). Problem Based Learning using Students' Questions to drive Knowledge Construction, *Science Education*, 88(5), 707-727.
- Dewey, J. (1938). *Experience and Education*. A Touchstone Book, Kappa Delta Pi, New York.
- Eng, C.S. (2001). *Problem Based Learning-Educational Tool or Philosophy*. University of Newcastle, Australia. [Online] Available: <http://edweb.sdsu.edu/clrit/learning tree/PBL/PBLadvantages.html> (April 10, 2009)

- Gallagher, S. A. (1997). Problem-Based Learning: Where did it come from, what does it do, and where is it going? *Journal for the Education of the Gifted*, 20(4), 332-362.
- Gallagher, S. A., Stephien, W. J., Sher, B. T. & Workman, D. (1999). Implementing Problem-Based Learning in Science Classrooms. *School Science and Mathematics*, 95(3), 136-146.
- Herreid, C. F. (2003). The Death of Problem Based Learning. *Journal of College Science Teaching*, 32, 6.
- Lambros, A. (2002). *Problem Based Learning in K-8 Classroom: A Teacher Guide to Implementation*. California. Corvin Press Inc.
- Major, C. H., Baden, M. S. & Mackinnon, M. (2000). Issues in Problem Based learning: A Message from Guest Editors. *Journal on Excellence in College Teaching*, USA, Web Edition, 11, 3.
- Mangle, S. K. (2008). *Advanced Educational Psychology* (2nd Edi). Prentice Hall of India New Delhi. Pp.378-380.
- Okereke, S. C. (2006). Effect of prior knowledge of implementing of mathematical tasks/concepts to career types and gender on students' achievement, interest and retention. In U. Nzewi (Ed) *STAN Proceedings of the 47th Annual Conference*, 253-259.
- Okigbo, E. C. & Osuafor, A. M. (2008). Effect of using Mathematics Laboratory in Teaching Mathematics on the Achievement of Mathematics Students. *Educational Research and Review*, 3(8), 257-261.
- Rhem, J. (1999). *Problem Based Learning: An Introduction*. The national Teaching and Learning Forum, 8, 1, Orxy Press USA.
- Roh, K. H. (2003). Problem Based learning in Mathematics. *ERIC Clearing house for Science Mathematics and Environmental Education*. [Online] Available: <http://www.ericdigests.org/2004-3/math.html> (April 20, 2009).
- Tick, A. (2007). Application of Problem-Based Learning in classrooms activities and multimedia. *5th Slovakian Hungarian Joint Symposium on Applied Machine Intelligence and Informatics*. [Online] Available: http://bmf.hu/conferences/sami2007/36_Andrea.pdf (April 23, 2009)
- Walker, J. T. & Lofton S. P. (2003). Effect of Problem Based Learning Curriculum on Students' Perceptions of Self directed Learning. *Issues in Educational Research*, 13, University of Mississippi Medical Centre.
- Wilson, P.S. (1993). *Research Ideas for the Classroom: High School Mathematics*. National Council for Teachers of Mathematics, Research Interpretation Projects, Vol. 3, Macmillan: New York, USA. 154-158.
- Yager, R. E. (2000). A vision for what science education should be like for the first 25 years of a new millennium. *School Science and Mathematics*, 100, 327-341.
- Yuzhi, W. (2003). Using Problem Based Learning and Teaching Analytical Chemistry. *The China Papers*, July, 28-33.

Table 1. Scores on the achievement of the controlled and experimental group in pre-test

Group	N	M	SD	SE _D	t- value
Experimental Group	38	31.39	9.30	2.11	0.03*
Control Group	38	31.32	9.19		

*Not significant

df=74

t-value at 0.05 level=1.99

Table 1 reveals the difference of mean scores of experimental and control groups on pre-test. The calculated t-value is 0.03 which is less than the tabulated value that is 1.99. Hence the null hypothesis that, "There is no significant difference mean score of experimental and control group". Therefore the null hypothesis was accepted that both groups have equal mathematical knowledge.

Table 2. Scores on the achievement of the experimental and the control groups on post-test

Groups	N	M	SD	SE _D	t- value
Experimental Group	38	54.92	13.86	3.2	3.43*
Control Group	38	43.95	14.30		

* Significant df = 74 t-value at 0.05 level=1.99

Table 2 indicates that the difference between mean scores of the experimental and the control groups on post-test was found to be significant at 0.05 level. Hence, the null hypothesis, “there is no significant difference between the mean scores of experimental and control group on post-test”, was rejected, in the light of t-value obtained that is 3.43 which is greater than the table value i-e 1.99. The null hypothesis was therefore rejected. Hence, there was a significant difference in achievements of mathematics students taught through problem solving method and traditional method.

Table 3. Means differences between experimental and control group

	Experimental Group(n=38)		Control Group(n=38)	
	Mean	SD	Mean	SD
Pre-test	31.39	9.30	31.32	9.19
Post-test	54.92	13.86	43.95	14.30
Difference	23.53	4.56	12.63	5.11

Table 3 shows the comparison of means scores of experimental and control group. The results proved the supremacy of problem solving method over traditional method. The mean gain for the experimental group is higher than the mean gain for the control group. $M=23.53 > M=12.63$. The net difference between the mean gains 10.9.