

Comparative Study of Effectiveness of Problem Solving Approach and Expository Strategy on the Academic Achievements of Secondary School Students in Mathematics

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Abstract

A standard based mathematics education is very much essential for the knowledge-based economy of any country. In this era, the study of mathematics has become significant. In the early years of schooling, lack of proper guidance, insufficient mathematical skills and misconceptions of mathematical concepts may yield serious learning deficiencies and improper problem solving skills. This study was conducted to find out the effectiveness of expository and problem-solving approach in the subject of mathematics on the academic achievement of secondary school students of district D. G. Khan. The purpose of this study was to find whether problem solving approach is much better and effective than the expository strategy in the subject of mathematics at secondary school level. The population of the study consisted of all secondary schools students of Tehsil D .G .Khan. A sample of forty (40) students from grade 10th was selected through convenient sampling. The sample was equally divided into experimental and control group on the basis of result of Pre-Test. The Pre-test, post-test equivalent group design was used for the study. Data was analyzed by two-tailed t-test. Data analysis revealed that experimental group that was taught by problem solving approach scored significantly better than the control group that was taught by expository strategy showing effectiveness of problem solving approach over expository strategy in teaching of Mathematics.

Keywords: comparative study, secondary school mathematics, problem solving approach, expository strategy

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Introduction

Almighty Allah has bestowed the human beings the best of learning abilities to acquire knowledge, so that human beings can understand their environment and can act according to the requirements of environment through education (Zareen, 2003). According to Hargreaves & Moyles (1998), education in its authentic, perfect and imminent stage holds inevitable and inherent activities. The main purpose of teaching is to transform beneficial study, strategies and knowledgeable education to the students.

In our national education system, the secondary school education is the main and crucial stage for the youngsters. According to Iqbal (2004), modern scientific and technological developments have become possible only due to study of mathematics. The study of Mathematics have enabled human beings to explore other universe by sending satellites, launching missiles, sending aero plans without pilots to using robotics. So we can say that teaching of mathematics has entirely contributed a lot for mathematical orientation of students at secondary level.

According to Orton (1992), many people think that problem solving approach is very much valuable teaching and learning mathematics. Mathematical knowledge is essential for learning such means that are helpful in new perceptions through problem solving approach. These are the means of connecting the current strategies, skills and knowledge.

According to Husain (2004), process of learning associates almost immortal and permanent changes in behavior that affirms, expose and increase the abilities of learning new skills and expertise. These changes are obtained by guidance, observing, study and practicing. Rose (1987) emphasized that learning acquired through conventional teaching is valuable if there is purposeful concentration alongwith frequent repetition in the subject of Mathematics. New ideas for discovery are very essential for mathematical learning and through problem solving approach. Polya (1965) states that new knowledge of mathematics can be obtained by selecting a new one problem from our daily life and then solving this problem by using prior knowledge.

Literature Review

An affective learning can be made through an effective teaching technique. Various teaching techniques have been reported for effective teaching. The rapid advancements of today's world demand new techniques for the teaching as well as learning (Iqbal, 2004).

According to Skinner (1984), a strategy or a group of information that has key role in creative learning is called a problem solving approach. These set of information and instructions can reduce the difficulties and hurdles for achieving the set goals. “Successful problem solving involves coordinating previous experiences, knowledge, familiar representations and patterns of inference, and intuition in an effort to generate new representations and related patterns of inference that resolve some tension or ambiguity (Lester & Kehle, 2003, p. 510)”. Broome et al. (1995) stated that problem solving approach has key role in teaching of mathematics as this approach can be used in different stages during teaching and learning of mathematics subject.

General phase of problem solving approach includes:

- a. Understand the Problem (Enter), make a list of observations to know about the problem by using previous knowledge. According to Polya (1965), a brand new and advanced knowledge of mathematics can be achieved by choosing a relevant problem and then by using prior knowledge to solve out this problem.
- b. Planning a solution of the problem (Plan),
- c. Workout as per Plan (Attack) and
- d. Take review of the solution (Review) as showed in figure 1.

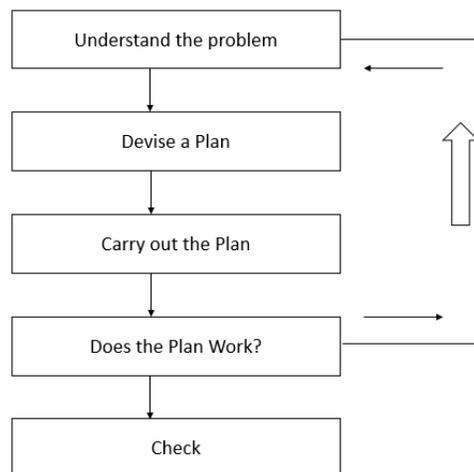


Figure 1: Phases of Problem Solving

Yellon (1977) stated that a problem in mathematics is a set of such characters that are treated and computed in a specific process to find out an alone and admissible solution. A “Problem” basically is a brand-new

place that requires the applications of combined principles studied previously in a brand-new style. Yellon described that problem solving is a process of learning new knowledge instead of merely applying the previously learned knowledge and principles. For activating the preliminary knowledge some brain storming questions will be asked to students and then problem should be placed in front of the students.

A problem appears when a humanity has some aims and objectives but they do not know how to reach these aims and objectives (Duncker, 1945, p. 1).

Keeping all this in view, this study was arranged to find the effectiveness of problem-solving technique in teaching and learning of mathematics subject. This study aimed to find out the effect of problem-solving approach as compared to expository strategy for teaching mathematics on academic achievements of secondary students.

To achieve the objective of the study following null hypotheses were formulated for testing:

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

H_{02} There is no significant difference between the post-test mean achievement scores of control group and experimental group.

After three months of the post-test a follow-up test was conducted in order to find the learning effect of this experiment for long term use. Result of follow-up test were almost equivalent to post-test showing that the learning effect in this study for long term was positive. In teaching and learning, methods adopted by the teachers for teaching have too much importance. To manage the relevancy in different part of teaching during teaching process, a teacher makes a systematic and planned effort for effective method of teaching. Basic objective of teaching is to bring change in behavior of an individual that is the demand of our society. This change is only possible through effective teaching and if based on significant principles of teaching. Effective learning of students depends upon the method adopted by the teacher. The norms of teaching methodology of mathematics are changing and developing on regular basis therefore, in the teaching, learning process of mathematics, there is vital role of problem solving approach. New mathematical skills and ideas may be possible if problem solving teaching is used for teaching mathematics. From relevancy and applicability perspective this study had a valuable and broad scope. Generally, it is neither accessible nor suggested to plane such a comprehensive study, so this experimental study was limited to

1. Only one technique (problem solving) (2) due to time limitation and other uncontrollable variables only one English medium school was selected, (3) Only single subject (Mathematics) (4) only four chapters of mathematics of grade 10th.

Methodology

Population

All the secondary school students of 10th grade of District D. G. Khan were taken as a population of this study.

Sample

By using the convenient sampling forty students of PAEC Education Centre, D. G. Khan of grade 10 boys were chosen as a sample of the study. The average age of students was approximately 15 years. These forty selected students were divided into two groups on the achievement scores of pre-test that was used to check the prior knowledge of sampled students in the subject of mathematics for grouping them into two groups named as experimental and controlled groups. Each group consisted of 20 students.

Variables

Dependent variables

Student's achievement in the subject of Mathematics was considered as depended variables in this study.

Independent variables

Problem solving approach (for experimental group) and expository strategy (for control group) were used as an independent variable in the study.

Uncontrolled variables

Due to some unavoidable circumstances some variables were out under control such as the interest of students, socio economic status, and teacher expertness in general mathematics competencies, experimental treatment period, education of parents and home environment.

Controlled variables

Time, subject, size of sample, variation in methodology, treatment duration and instructional conditions were the controlled variables in this

study. By giving special instructions and lesson plans to selected teachers to deliver the lecture for both groups, all these variables were controlled. Time duration for treatment to both groups was also equal. Classroom environments were made same for both groups.

Research Design

For the present study, true experimental design i-e pre-test post-test equivalent group experimental design was used. Gay (1992) described that by using different assignments and by taking at least two groups, this design can be developed. This design is helpful to find the effects of some type of treatment on a group. Before intervention to the experimental group, a Pre-Test was administered to both the groups. After that, an intervention was given to the experimental group. At the end of treatment, post test was executed on both groups. To evaluate the effectiveness of treatment, achievement scores of the post-test were compared.

Research Instruments

Pre-Test

For this study, a pre-test was designed in order to check the prior knowledge of experimental group and control group in mathematics. This test was developed with the help of educational experts and the paper setters of the BISE D.G. Khan. This pre-test was very essential to know the capabilities of the students and prior knowledge in mathematics. Pre-test includes MCQs, short questions and long questions to check the previous knowledge of the sampled students in the subject of Mathematics.

Post-Test

In order to develop a post test, educational experts and the paper setters of the BISE D.G. Khan were consulted. The main purpose and need of post-test was to analyze the results of both groups. Content of question paper for post-test was 100% taken from the topics and contents that were taught to the students during the time period of experiment.

Pattern of Pre-Test

70% content material of pre-test was taken from the book of 9th grade mathematics while 30% content material of pre-test was taken from the book of text book of mathematics of 10th grade.

Pattern of Post-Test

Contents of post-test were based on problem solving approach.

Procedure**School selection**

The researchers personally visited the selected school for meeting with Head Education Centre for the request to conduct experiment in his school. For this process, a committee was constituted by the Head education Centre to manage and control this process.

Allotment of groups

A sample forty (40) students was selected for this experimental study. There were 18 Multiple choice questions and 15 short questions in the test/s. Moreover, there were four (04) long Questions. These tests were based on instructions provided in Michali's test. He stated that problems solving tests were the best test to evaluate the capabilities and skills of the students. Validity of the Pre-test and Post-test validity was examined through senior subject specialist of mathematics, panel of educational expert and was approved by the panel of research committee. Content validity was tested by the correlation co-efficient and that was found 0.5. Reliability of pre-test was analyzed by the formula K-R-20 because this formula was more suitable for this test. Test reliability was also found through Cronbach Alpha.

Experiment

Two teachers were selected for teaching after making the groups with same qualification i.e M.Sc. Mathematics, B.Ed. and 8 Years of teaching experience. One teacher taught the control group and other teacher taught the experimental group. Two different teaching procedures as a treatment were applied in the experiment. For control group, traditional expository method of teaching was applied while for experimental group, problem solving method of teaching was used. Same selected four chapters of grade 10th mathematics were assigned to both teachers in both groups. This experiment was started in 3rd week of the August and was completed in five weeks.

Post-Test Administration

A self-prepared post-test was administrated to both the control group and experimental group immediately after the intervention. For this test environmental conditions were same as of pre-test. It means that the

environment of both groups was same for pre-test as well as for post-test as mentioned above e.g., same school, same examination hall and same time was allotted to both groups. Post-test was completed by both groups in allotted time of 2 hours.

Data Analysis

For the analysis of data, marks obtained from Pre-test and Post-test were tabulated. For each group, standard deviation (S.D), difference of mean and mean were calculated. Distribution of variables checked. T-test was used for significance of difference between the mean scores of both control group and experimental group. These tests were tested at 0.05 level of significance.

Results

On the basis of pre-test scores, two groups were formed naming as control group and experimental group. Students of experimental group were taught through problem solving approach while students of control group were instructed by expository strategy. Four chapters of grade 10th class in subject of mathematics were taught to both groups. After five weeks a post-test was administered to analyze the results. Following tabulation shows the analysis of data of this study.

Table 1

Mean and Standard Deviation in achievement score of Pre-Test for Control and Experimental Group

Group name	Experimental group	Control group
No. of Students	20	20
Mean Score	21.60	21.35
Standard Deviation (S.D)	4.04	4.28

Table 1 shows that mean achievement score of pre-test for control group and experimental group were 21.35 and 21.60 accordingly. The spread of scores (S.D) around the mean for both groups was 4.28 and 4.04. The average achievement marks of Pre-Test for control group was slightly less than the experimental group but spread of scores around the average marks for experimental group was less as compared to the control group. This shows that students of both control and experimental groups were almost equal in their Pre-Test achievement scores.

Table 2

Significance of difference among the mean achievement score of pre-test for experimental and control group

Group Name	Experimental group	Control group
No. of Students	20	20
Mean score	21.60	21.35
Standard Deviation	4.04	4.28
SE _D	0.1901	
t-value	1.695*	
P	> 0.10	
Degree of Freedom (df) = 18 t-value at 0.05 = 2.101 *Not Significant		

The statistical technique, t-test was applied in order to affirm whether both the groups were equal in previous knowledge of mathematics (Table 2). Statistical results of Table 2 display that the difference among the average marks of control and experimental group is non-significant at the level of 0.05 which support the null hypotheses no.1 to be accepted. This shows that both groups were found equal in the achievement score of pre-test.

Table 3

Mean and standard Deviation (SD) for achievement scores of post-test for experimental and control group

Group Name	Experimental group	Control group
No. of students	20	20
Mean	45.60	29.65
Standard Deviation	11.37	7.55

Results of Table 3 show that average marks of post-test for experimental and control group was 45.60 and 29.65 respectively that are highly significant. The spread of scores about the mean for both groups was 11.37 and 7.55. In order to check that whether the achievements of both the groups were different, a statistical technique t-test was used.

Table 4

Significance of difference among the mean achievement scores of post-test of experimental and control group.

Group Name	Experimental group	Control group
No. of Students	20	20
Mean score	45.60	29.65
Standard Deviation	11.37	7.55
SE _D	2.08	
t-value	9.24*	
P	< 0.001	
Degree of Freedom (df) = 38 t-value at 0.05= 2.101 * Significant		

Results of this t-test in Table 4 which shows that the mean difference score among the two groups is 45.60 and 29.65 and value of t-value is 9.24 that was highly significant. Thus, the null hypotheses no 2 is rejected. This result shows that achievement of experimental group students that were taught by problem solving approach were much better than the students of control group that were taught by expository strategy showing effectiveness of problem solving approach then the expository strategy.

Discussion

Student's learning is directly related and affected by the methods adopted by the teacher. Basic objective of teaching mathematics is to bring change in behaviors of individual for learning in the subject of mathematics. This behavioral change is only possible by effective teaching method adopted by the mathematics teacher. The standard of mathematics teaching is changing with respect of teaching techniques of mathematics, so to attain certain standard, the application of problem solving approach is very much essential in mathematics teaching. Problem solving approach is known as the heart of mathematics because use of this approach makes the mathematical teaching more unique and applicable in problem solving skills. On the bases of the results of this study, first null hypothesis was strongly accepted while second null hypothesis was strongly rejected. The results of this study showed that the scores of students were much better when they were taught by the problem solving method as compared to expository strategy. These

results are in line with Orlander and Robertson (1973); Luzmanud (1990); Nuzum (1983); Change el at; (2001); Worthen (1968); Farooq (1980) and Lerch and Hamilton (1966).

Conclusion

It is concluded that the achievement of the group that was taught by problem solving approach was much better than those who were taught by the expository strategy. This shows that problem solving method of teaching was much more effective than the expository teaching method. As a whole, it was concluded that problem solving approach to be cognitively and effectively more effective as compared to expository strategy in achieving teaching and learning outcomes in teaching of mathematics.

Recommendations

Following recommendations may be helpful for policy makers, administrators, curriculum developers, teachers, and for further research studies are suggested. These recommendations are on the bases of conclusions and discussion.

1. Teachers must have motivation and skills for transmitting information and knowledge through problem solving approach. In this way students can become better problem solvers.
2. Seminars, workshops, refresher courses and trainings must be arranged for teachers so that they can develop critical thinking among the students for solving mathematical problems because well-designed curriculum text-books are ineffective if content of these books is not effectively transferred to students.
3. For textbook writing, it is suggested that a panel of experts must be included by the author. This panel may consist of psychologist, educationist, subject specialist, publishers and printers because textbook writing is not effort of an individual.
4. Results of this study may help the curriculum developers as a guideline for improving and developing the syllabus at secondary level in the subject of mathematics.
5. The usefulness of problem solving method may be find out with some other variables such as such academic motivation, attitude, self-esteem, and peer relation.

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