

Effect Of The Problem-Solving Approach On Academic Achievement Of Students In Mathematics At The Secondary Level

Kousar Perveen, Kohat University and Science Technology, Pakistan

ABSTRACT

This study sought to determine the effect of the problem-solving approach on academic achievement of students in mathematics at the secondary level. The secondary school students studying mathematics constituted the population of this study. The students of 10th class of Government Pakistan Girls High School Rawalpindi were selected as a sample for the study. Sample size consisted of 48 students who were equally divided into an experimental group and a control group on the basis of pre-test. Treatment of the planned problem-solving approach is the guideline of Sherreen (2006) and Polya's (1945) heuristic steps of the problem-solving approach. After the treatment, post-test was used to see the effects of the treatment. A two-tailed t-test was used to analyze the data, which revealed that both the experimental and control groups were almost equal in mathematics base at the beginning of the experiment. The experimental group outscored the control group significantly on the post-test.

Keywords: Problem-solving approach, expository strategy, mathematics achievements

INTRODUCTION

According to Hargeaves and Molyes (1998), education, in its true sense, entails activities that are intrinsically important. The acts of teaching, which aim to provide useful knowledge, skills, and understanding, are acts of education. Malik (1992) describes secondary education, as it generally serves a dual purpose, as a terminal stage for a large number of students and as a preparatory stage for higher education for those who wish to continue their education.

Education cannot be made more effective without effective teaching. There are so many devices for effective teaching and an effective technique can ensure effective learning. It is being felt that there should be new techniques of teaching and learning (Iqbal, 2004). We, like other developing countries, still use lecturing as a major teaching method which, however, needs blending with other methods and approaches. This has been suggested by Grobbelaar (1998) when he reported on the teaching of higher education in South Africa.

Farooq (1980) points out that a "problem" usually indicates a challenge, the meeting of which requires study and investigation. Skinner (1984) states that the term "problem-solving" is defined as the frame work or pattern within which creative thinking and learning takes place. It is a process of overcoming difficulties that appear to interfere with the attainment of a goal. Polya (1945) defines problem-solving as the process used to solve a problem that does not have an obvious solution. Bay (2000) explains teaching about problem-solving is the teaching of strategies, or heuristics, in order to solve problems. One way to teach students to problem solve is to teach the four-step processes developed by Polya (1971): 1) understand the problem, 2) devise a plan, 3) carry out the plan, and 4) look back.

Several studies focus the change in knowledge and skill levels that occur with problem-solving techniques. A study was conducted by Farooq (1980) for development of critical thinking and reasoning in the pupils. The problem-solving approach is more useful than the traditional approach. Gesi and Massaro (1991) explore experiment

discovery and expository methods in teaching visual consonant and word identification. Nevertheless, performance for all three groups (discovery, expository, and no training) improved during training in the word identification task. Schultz, (1984) has examined the Average Ability Middle School Student and Concrete Models in Problem-Solving: A Look at Self-Direction. The average ability students showed the greatest gain in demonstrated problem-solving ability and the greatest use of concrete models. Blavier and Worthen (1970) examined a study of discovery and expository presentation with implications for teaching. The concept retentions tests scores showed that the discovery method produced superior results compared to the expository method. For attitude, neither comparison between the discovery method and expository method in measure of attitude reached a significant minimum acceptable level. Luzmanuel (1990) explored a study about college students' methods for solving mathematical problems as a result of instruction based on solving problems (problem-solving). These results lead to the conclusion that it takes time for students to conceptualize problem-solving strategies and use them on their own when asked to solve mathematical problems. Marilyn (1985) reported that the use of counting strategies to solve subtraction problems was also noted by Steinberg. She taught second graders to use derived fact strategies in which known number facts are used to find the solution to unknown facts. After eight weeks of instructions, children more than doubled their use of the derived facts, which involves more mature ways of thinking than relying solely on counting. Nuzum (1991) developed an instructional package for teaching arithmetic story problem skills and examined the efficiency of that method on the story problem performance of four learning disabled students. A single subject design with three replications was used. The finding of study showed that a method, which includes instruction to mastery method, task specific and procedural knowledge, was responsive to the needs of the learning disabled in this study. Each subject's problem-solving performance improved substantially. Chang *et al* (2001) investigated the pedagogical practices within primary mathematics classrooms in four Singapore schools. In all, a traditional teaching approach predominated amongst the primary teachers - expository teaching, followed by the students practicing routine exercises to consolidate the concepts, knowledge and skills. Anecdotal evidence further suggested that such an approach to teaching was prevalent in most primary schools. Somehow the emphasis on problem-solving did not quite filter through, as it were, to classroom teaching practice. Newfoundland (1980) conducted a study of the effect of teaching heuristics on the ability of 10th grade students to solve novel mathematical problems. A group of ten boys were taught by the use of self-instruction booklets to apply the heuristics of examination of cases and analogy to novel mathematical problems. At the end of a ten-day instructional period, two novel problems were presented - one algebraic and the other geometric. The data, analyzed by ANOVA, indicates that: 1) students can be taught to apply at least one heuristic to a novel problem; 2) it is better to teach heuristic alone than to combine the instruction with the teaching of mathematical content; and 3) the ability to apply at least one heuristic is independent of the vehicle used to introduce it. The evidence suggests that heuristic-oriented instruction can be an effective mode for teaching mathematical problem-solving.

METHODOLOGY

All the secondary school students constituted the population of this study. Forty female students in 10th grade of the Government Pakistan Girls High School Rawalpindi consisted of the sample for this study. The pre-test and post-test research instruments were used for this study. These instruments were used for accessing students' performance which would reflect their level of knowledge in mathematics before and after the experiment. The pre-test and post-test equivalent group design was considered to be the most useful for this study. The content validity of tests was insured by preparing chart of specification. The content validity was also checked by correlation coefficients which were found to be 0.5. Reliability of the achievement test was measured by the K-R-20 formula, and each item's scores of achievement tests correlated significantly with total scores, either at 0.01 or 0.05 levels. Test reliability was also calculated by Cronback alpha which was 0.8 for total items.

Procedure

A self-prepared pre-test was administered to sample 48 students. On the basis of achievement scores in the pre-test, the students were assigned to either the experimental group or control group through paired random sampling. Each group consisted of 24 students. Two teachers were selected - one for the experimental group and one for the control group. The control group was taught by expository strategy while the experimental group was taught by the problem-solving technique. The experimental group was taught using a series of lesson plans put together with the help of Shireen (2006) and Polya (1945) guidelines, which include heuristic steps of the problem-solving

approach. This experiment was completed for six consecutive weeks. Immediately after the treatment ended, a self-developed post-test was administered to both the experimental and control groups. Scores obtained by pre-test and post-test were presented in tabular form for the purpose of interpretation. The data analyzed by means, standard deviation and difference of means were computed for each group. Significance of difference between the mean scores of both groups on variable pre-test and post-test scores were tested at 0.05 levels by applying a t-test on the variable of the pre-test achievement in mathematics.

Results

In order to confirm whether both groups were essentially equal on previous knowledge in mathematics, the statistical technique of t-test was applied, as shown in the following table:

Table 1: Significance of Difference between Pre-Test Mean Achievement Scores of Experimental and Control Groups

Group	N	Mean	S.D	SE _D	t-value	p
Experiment	24	26.54	6.471	0.1901	1.095 *	> 0.10
Control	24	26.33	6.672			

df = 24 t at 0.005 = 2.069 *Not significant

Table 1 shows that the difference between mean achievement scores of the experimental and control groups was found to be statistically non-significant at the 0.05 level. The null hypotheses Number 1 was therefore to be accepted. Hence, both the groups were found to be equal in pre-test achievement scores.

Table 2: Significance of Difference between Post-Test Mean Achievement Scores of Experimental and Control Groups

Group	N	Mean	S.D	SE _D	t-value	P
Experimental	24	57.17	14.12	2.08	9.25 *	<.001
Control	24	37.92	10.35			

df = 24 t at 0.05 = 2.069 *Significant

It appears from Table 2 that the difference between the two means was found to be highly significant. Null hypothesis 5 is therefore to be rejected. Hence, both groups were found to be different in post-test achievement scores, the difference being highly in favor of the experimental group.

This means that the students taught by the problem-solving approach showed much better achievement compared to the control group which was taught by the expository strategy. These results support the studies of Luzmanuel (1990), Nuzum (1991) and chang *et al* (2001) that students showed good results if they were taught with the problem-solving approach.

DISCUSSION

Methods play an important role in teaching. It is a planned and systematic effort of the teacher to establish a sequence in the various parts of teaching. Due to the importance of mathematics in our life, as well as improving the standard of learning mathematics, it is necessary to develop a program of teaching mathematics by problem-solving. The art of problem-solving is the heart and essence of mathematics, because problem-solving can serve as a vehicle for learning new mathematical ideas and skills. Therefore, it was necessary to conduct a study for improving teaching mathematics at the secondary level. The study was aimed at comparing the effectiveness of the expository strategy and problem-solving approach of teaching mathematics at the secondary level.

It was concluded that when the subjects were taught by the problem-solving approach, their achievement in mathematics improved, as compared to the subjects who were taught by the expository strategy. These results are in line with those by Worthen (1968), Orlander and Robertson (1973), Nuzum (1983), Farooq (1980), Luzmanuel (1990), and Change, *et al*(2001).

The present study was conducted in the Government Girls High School Rawalpindi. If this study were conducted in another distinguished institution, like Lahore University of Management and Science, National University of Science and Technology, city schools, or Beacon House School, it would be expected that more reliable results would have been obtained. Due to different factors in government schools, the students do not accept change well; it took time for them to adjust to the problem-solving method. When asked questions by the teacher, they hesitated and had no confidence, even if they knew the correct answer.

The results indicate that the problem-solving method need not be more time consuming than the expository method of instruction at this age level. When given an equal amount of time to work on learning tasks, pupils using the problem-solving method tended to be superior to pupils taught by the expository method. There is some evidence that problem-solving experiences have become “normal” to students in mathematics classrooms (Gay, 1999).

The results of this study strongly suggest that the presentation of mathematical concepts to secondary level pupils through the problem-solving sequence causes the learner to integrate the content conceptually in such a manner that the student can retain it more readily than if the concepts were presented to him in an expository sequence. It is also concluded that both methods of instruction were fairly presented and that no factors operated would tend to give either method a significant advantage.

During the experiment, the researcher noticed that the basic concepts of mathematics were not clear to the students. The foundational stone of cognitive growth and skills takes place in the early years of childhood. Students who are lacking in growth of capabilities and skills would definitely face problems in the next class, as they are not equipped with the base they need (Khanum, 2006). A strong base of previous knowledge was required for the heuristic group instruction of solving mathematical problems. Although results of the study were in favor of the problem-solving method, it is the researcher’s opinion that if one week was spent with the sample students clarifying the basic concepts, postulates, formulas, and basic geometry knowledge of mathematics, students would have shown better results in favor of the problem-solving approach.

Moreover, for more authentic results of the study, the teacher of the problem-solving approach should have been provided training for at least one month’s duration. Moreover, factors like I.Q, home environment of students, socio-economic status of parents, and facilities of tuition were not taken into consideration in the study that might have polluted the study results.

The teaching approach used with the experimental group was, as a matter of fact, a combination of the expository strategy and problem-solving approach due to the reason that facts, rules, and action sequences (terms, formulas and procedures) had to be explained through exposition before using the heuristics.

AUTHOR INFORMATION

Kousar Perveen is presently working as Senior Science School Teacher in Department of Education, Govt. of Punjab School Wing, Pakistan. She is Ph.D. (Scholar) in Education from University Institute of Education and Research, UAAR, Pakistan.

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