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Effect of Problem Solving Teaching Strategy on 8th Graders' Achievement

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ABSTRACT

The study was aimed to analyse "Effect of problem solving teaching strategy on 8th graders' achievement ". Major objective was to compare the achievement of the 8th grade students in General Science taught through problem solving teaching strategy and traditional methods. The population of the study was 150 grade 8th students of the Federal Government Model secondary school F-8/3, Islamabad. Two groups of 30 each were selected randomly including 10 in each category of high, average and low achievers. These groups were randomly assigned as experimental and control group. A research tool 'Achievement Test in Science (ATS) for 8thgrade was developed to use as pre-test and post- test. The test was validated through peer review, expert opinion and pilot testing. In the beginning of treatment pre-test was administered, after six moths teaching through problem solving teaching strategy to experimental group only, the post-test was administered. On the collected data, t-test and ANOVA was applied. It was concluded that the students taught through problem solving teaching strategy, showed better achievement than the students taught through traditional teaching methods.

Introduction

Scientific advancement has brought prosperity and comfort in human life. Sustainability and expansion of scientific knowledge from generation to generation is the need of the time. According to Vanderwolf, Cook, Coutts, & Crop (2005) "Science offers an understanding of ourselves, of the universe, and of our own place in it. There are economic benefits, both to individuals who study science and to countries". So, it is necessary for any society to educate its coming generations with the knowledge of science.

The complex process of teaching science requires from teacher to apply any suitable type of teaching method (Patrick, 2009). Teachers' tasks are to present contents, explain difficult concepts, stimulate problem solving, and motivate students for better academic achievements. They promote both cognitive and affective learning by providing encouraging environment (Richmond, Wrench, & Gorham, 2009). But in Pakistan the science teachers only use lecture method (Iqbal, 2004) and they focus on rote learning (Chisman, 1984) while science teachers should explain the nature of science, scientific content, develop the skills of science and promote scientific attitudes in the students (Halai, 2004). According to Molnar, (1998) the major objective of education is to prepare the students for future difficulties, and unfamiliar real life problems. In the words of Tannenbaum (1983) in solving a problem, one is to use complex cognitive processing. So, the mode of instruction in schools is required to use suitable teaching method which involves the students' cognition and prepare them for future life problems. Current pedagogical practices in the advanced countries are more focused on problem solving and inquiry during instruction than content knowledge especially in teaching science subjects (Windschitl, 2004). According to Govt. of Pakistan vision 2025, "The development of problem solving ability is a key factor in creating an independent learner". So, the education system should also properly focus the development of problem solving abilities among the students (Anderson, 2000).

According to Mayer (1992) problem solving is a process in which students are to find relationships between previous experiences and the problem he is facing and then finds out a solution. Kirkley (2003) described three cognitive activities of problem solving given as under:

- Representing the problem: It includes appropriate contextual knowledge, and identification of the goal with relevant conditions to start.
- Solution search: It includes improvement of goal(s) and preparing plan for that goal.
- Implementing the solution: This step includes execution of plan and evaluating the results. But there is one 'short cut' if the learner recalls that he or she has already solved a like problem, and then they would simply recall its solution, and solve it again.

Considering these steps, problem solving as a learning strategy may be helpful in this regard. So, the problem solving learning strategy needs to be tested to find out its effectiveness in Pakistani educational institutions. The steps given by Kirkley (2003) are useful to be followed in this study due to simplicity, and short cut.

For this study, 8th grade was selected because students of this age group may have the capability of formal/higher order thinking processes. They may be able to solve the problems, if they are taught problem solving strategy.

The study was aimed to find out the effects of problem solving as a teaching strategy in the subject of science on the students' achievement. Hypotheses formulated for this study were;

H_{01}: There is no significant difference between the mean gain score of academic achievement of students in the subject of

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science taught through problem solving teaching strategy and taught through traditional teaching methods.

H_{02}: There is no significant difference between the mean gain scores of academic achievement of high achiever students in the subject of science taught through problem solving teaching strategy and taught through traditional teaching methods.

H_{03}: There is no significant difference between the mean gain scores of academic achievement of average achiever students in the subject of science taught through problem solving teaching strategy and taught through traditional teaching methods.

H_{04}: There is no significant difference between the mean gain scores of academic achievement of low achiever students in the subject of science taught through problem solving teaching strategy and taught through traditional teaching methods.

H_{05}: There is no significant difference in the mean gain scores on achievement test among the students of different academic achievement levels (i.e. High, Average & Low achievers) in the subject of science, taught through Problem solving teaching strategy.

The study may be significant for the improvement of curriculum and enhancing problem solving ability among students. The textbook writers may get guidance to include learning activities for problem solving ability. As there would be involvement of the students in learning process, it would also help to develop higher order thinking skills.

It was assumed that the contents of the General Science Textbooks for grade VIII are supportive to apply problem solving teaching strategy.

Methodology of the Study

All the male students (150) of 8th grade studying in the Federal Government (FG) Boys Model School F-8/3, Islamabad were the population. It represents all other schools of Islamabad because of students of different sectors having equivalent socio-economic and residential status get admission in this school. The results obtained from the students of this school can be generalized over the students of other schools of Islamabad. Using random sampling technique by fish bowl (picking from the hat) method, two groups of students, 30 each, were selected. Each group includes 10 students of each category i.e. high, average & low achievers. Students were categorized according to their obtained marks in 7th grade as per the following criteria.

High achievers = 70% or above marks

Average achievers= 50% to 69% marks

Low achievers = below 50% marks

Then randomly, each group was assigned as experimental and control group as recommended by Gay (2000).

In this study pre-test post-test control group design was used. The effects of teaching methodology were studied upon problem solving and reasoning abilities of the students. The intervening variables such as socio-economic status, age, gender, extra coaching etc. were equated to find out the real effect of problem solving teaching strategy. Mortality was not a problem as no student left the school or remained absent for long time.

After going through different achievement tests, it was found that they were neither suitable to the contents nor to the context of Pakistani students and do not meet the requirements of the study. So after reviewing the literature, an achievement test in Science (ATS) for 8thgrade was also developed. The test was bilingual (in English and Urdu) so that students may understand well. According to Bloom's Taxonomy two way table of specification was developed, relevant to contents of General Science textbook published by National Book Foundation, Islamabad which was being taught in all F.G. Schools situated in Islamabad Capital Territory. Topics were 'living things', 'environment', 'matter and its properties', 'motion and force', 'energy', 'electricity', 'light' and 'magnetism'. In the beginning there were 60 multiple choice (MCQ) items included in the test. After pilot testing on 80 students (not included in the sample), 40 items were selected for the final test. Overall reliability of the test was 0.822.

The duration of study was 06 months that is why in this study the same test was used as pre-test and post-test. After formulation of groups, before starting the experiment, pre-test was administered to students of experimental and control groups. The test was marked and scores were kept secret so that students may not feel any complex or competition among themselves. The experimental group was taught through problem solving teaching strategy in the subject of science, while control group was taught through traditional methods.

For experimental group, lesson plans were developed according to problem solving teaching strategy for each unit. Larger units were divided into two or three parts to remain in the limit of 40 minutes duration of class period. According to the requirements of the content, different problematic situations were developed for students to solve in the class or for home work. Afterwards solutions were discussed in the class. Lesson plan format details are as follows.

Lesson Plan Format

1. Title of Lesson
2. Subject
3. Grade Level
4. Teaching Method
5. General Objectives
6. Specific Objectives
7. Required Materials
8. Step-By-Step Procedure

a. Brain Storming (05 minutes)
b. Representing the problem (05 minutes)
c. Problem:
d. Appropriate context knowledge (20 minutes)

Time for the steps from 'e' to 'j' will be 15 minutes

e. Identifying the goal
f. Relevant starting conditions for the problem
g. Solution search
h. Developing a plan of action to reach the goal
i. Implementing the Solution
j. Evaluate the result (05 minutes)

For the steps 8 and 9, time will be 05 minutes

9. Assessment Based on Objectives
10. Home work

At the end of experiment, the post-test was administered to both the control and experimental groups to assess the domain specific (contextual) problem solving ability and achievement.

Analysis of Data and Findings

Pre-test and post-test scores along with gain scores on problem solving ability test were analyzed using software Statistical Package for Social Sciences (SPSS) and t-test for independent sample and ANOVA was applied to find out difference between the mean gain scores of the marks obtained by the students of experimental and control groups. Testing of hypothesis is given in the tables as under.

Table 1. Difference between mean gain scores of academic achievement of experimental and control groups

Group	N	Mean	*df*	t
Experimental	30	12.36	58	3.489*
Control	30	6.86		

*p<0.05

The table 1 reflects that t value (3.489) with *d*f (58) was significant at p < 0.05 and hence null hypothesis that "There is no significant difference between the mean gain scores of academic achievement of students in the subject of science taught through problem solving teaching strategy and taught through traditional teaching methods " was rejected. It is therefore interpreted that students of experimental group (mean= 12.36, SD= 6.90) taught through problem solving teaching strategy performed better than the students of control group (mean = 6.86, SD = 5.18) taught through traditional method.

Table 2. Difference between mean gain scores of academic achievement of high achievers from experimental and control groups

Group	N	Mean	df	t
Experimental	10	17.50	18	2.657*
Control	10	10.90		

*p<0.05

The table 2 shows that t value (2.657) with *d*f (18) was significant at p<0.05 level and hence null hypothesis that "There is no significant difference between the mean gain scores of academic achievement of high achievers in the subject of science taught through problem solving teaching and taught through traditional teaching methods strategy" was rejected. It is therefore evident that high achievers of experimental group taught through problem solving teaching strategy performed better (mean =17.5, SD = 6.90) than the high achievers of control group taught through traditional method (mean = 10.9, SD = 3.75).

Table 3 Difference between mean gain scores of academic achievement of Average achievers from experimental and control groups

Group	N	Mean	*df*	t
Experimental	10	12.80	18	3.676*
Control	10	5.70		

*P< 0.05

Table 3 reflects that t value (3.676) with *d*f (18) was significant at p<0.05 level, hence null hypothesis that "There is no significant difference between the mean gain scores of academic achievement of average achievers in the subject of science taught through problem solving teaching strategy and taught through traditional teaching methods " was rejected. It is obvious that average achievers of experimental group taught through problem solving teaching strategy performed better (mean = 12.8, SD = 4.80) than the average achievers of control group taught through traditional method (mean = 5.7, SD = 3.77).

Table 4. Difference between mean gain scores of academic achievement of low achievers from experimental and control groups

Group	N	Mean	*df*	t
Experimental	10	6.80	18	1.27*
Control	10	4.00		

*P< 0.05

Table 4 reflects that t value (1.27) with *d*f (18) was significant at p<0.05 level and hence null hypothesis that "There is no significant difference between the mean gain scores of academic achievement of low achievers in the subject of science taught through problem solving teaching strategy and taught through traditional teaching methods " was rejected. The mean score values show that performance of low achiever students of experimental group (mean = 6.8, SD = 4.36) taught through problem solving teaching strategy was better than that of the low achievers of control group taught through traditional method (mean = 4.0, SD = 5.43).

Table 5. One way ANOVA for different academic achievement level

	Sum of Squares	*df*	Mean Square	F	Sig.
Between Groups	575.26	2	287.63	9.615	0.001
Within Groups	807.70	27	29.91		
Total	1382.96	29			

Table 5 shows that there is significant difference in mean gain scores on achievement test among the students of high, average & low achievement level. The F value 9.615 was significant at p< 0.001. Hence the null hypothesis "There is no significant difference in mean gain scores on achievement test among the students of different achievement level" was rejected. For further exploration of the performance difference among the groups, Least Significant Difference (LSD) as post hoc test was applied. Results are given in table 6.

Table 6. Post hoc test for one way ANOVA about the performance of the students of different academic achievement levels

(I) level	(J) level	Mean Difference (I-J)	Std. Error	Sig.
High Achiever	Low Achiever	10.7	2.44601	0.000
Average Achiever	Low Achiever	6.0	2.44601	0.021

Table 6 shows only those results in which there are significant difference between the main gain scores of the students having different achievement levels. It shows that high achievers performed significantly better on the achievement test than low achievers whereas average achievers also performed significantly better on the achievement test than low achievers. But there was no significant difference between performance of high and average achievers

Conclusion and Discussion

Problem solving teaching strategy is more effective for academic achievement in the subject of science at elementary level as the experimental group taught through problem solving teaching strategy performed better in achievement test than the control group taught through traditional teaching methods. High achiever, average and low achiever students of experimental group taught through problem solving teaching strategy performed better in achievement test than the high, average and low achiever students of control group taught through traditional teaching methods. It was also concluded that within experimental group, high and average achiever students showed better achievement than the low achiever students whereas the performance of high and average achiever students was equal. The findings were also supported by Curtis and Denton (2003). They found strong positive relationship between problem-solving ability and academic achievement. The possible reason as indicated by Curtis and Denton (2003) is that in the classroom problem solving approach enhances the learning ability and in-depth knowledge of the students. So in spite of rote memorization, a student is able to grasp the basic concepts rather

than the contents and ultimately increases his academic achievements in the subject of science.

On the basis of conclusion of this study, it is recommended that science teachers must develop lesson plans according to problem solving teaching strategy and make it part of teaching learning practices in classroom.

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