EFFECTS OF INSTRUCTIONAL STRATEGIES ON ACADEMIC ACHIEVEMENT IN A HIGH SCHOOL GENERAL SCIENCE CLASS

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Abstract

Problem-based instructional strategy provides real-world, purposeful interactions to help students learn how to work with and learn from a diverse group of people laterally and horizontally within a learning community. In this study, General Science students were compared regarding their academic achievement in a three month term by giving them problem-based instructional treatment. One of these groups attended a traditional lecture-based instructional strategy based on conventional lecture, while the other attended a problem-based instructional strategy. Both groups were administered through a test to evaluate academic achievement of the students. The problem-based group reported a significantly higher level of academic achievement than the traditional lecture-based group. Statistically, there were significant differences between the two groups regarding their academic achievement.

Keyword – *Instructional Strategy, Problem-based learning, lecture-based group, real-world*

1 INTRODUCTION

The selection of proper instructional strategy ensures the achievement of the stated instructional objective effectively. Instructional strategies are used in the presentation of lesson to help the students learn by ensuring the smooth delivery of the instruction. It is a process by which an instructional module, instructional phase or an entire course is delivered. Problem-based instructional strategy (PBIS) is now emerged, as an entrenched learning method and the literature is full with the explanation of its development and implementation. It can be said that the students in problem-based instructional strategy engage themselves in finding more relevant material and benefit more from active learning process. One reason, which is repeatedly quoted for the implementation of problem-based instructional strategy, is the dissatisfaction of conventional lecture-based instructional strategy. The increasing pressure and criticism against conventional methods led the institutions and teachers to adopt problem-based instructional strategy as a new strategy. The rapid explosion of PBL created concern about the concept of problem-based instructional strategy and it would become confused if any instructional strategy, which mentioned the word "problem", was considered as PBIS. This has led to the debates about the concept of PBIS to think that what is "pure PBIS" and what is not. [1]

Merrill (2001) stated that problem-based instructional strategy involves the presentation of significant, complex, and real-world problems to students, which are structured in such a way that there is not one specific correct answer or predetermined outcome. In this approach, students work in small groups to negotiate a common understanding of the problem identify areas that need to be researched, form hypotheses, and fully develop a solution that they can present to others. [2]

Duch (1995) defined problem-based instructional strategy that challenges students to "learn to learn", working cooperatively in groups to seek solutions to real world problems. These problems are used to engage student's curiosity and initiate learning the subject matter. Problem-based instructional strategy prepares students to think critically and analytically, and to find and use appropriate learning resources. [3]

Problem-based instructional strategy (PBIS) is a student centered instructional methodology through which content and skills are taught by using carefully crafted problems as the inducement for student's activity. It challenges students to look for solutions to real world problems by themselves or in a group rather than learn through lectures or textbooks. In PBIS, problems are selected to develop natural inquisitiveness of the students by connecting learning to daily lives of the students and emphasizing the use of critical and analytical thinking skill. [4]

2 RATIONALE FOR THE RESEARCH STUDY

As a strategy for providing information and knowledge, lecture-based instructional strategy has subjugated formal education over the centuries. It has been used for large groups to convey a lot of content in relatively short time, and keep the class together on the same points as compared to the other strategies but this strategy is generally not suitable for teaching the lesson that is above the comprehension level. So the understanding of the students is not checked through this strategy. Also, this strategy is the one-way process of teaching and it does not allow students in verbal participation during the lecture.

These circumstances provided an excellent opportunity for the researcher to conduct research and compare the effectiveness of problem-based instructional strategy and lecture-based instructional strategy on student's academic achievement.

3 RESEARCH HYPOTHESES

Ho1: There is no significant difference between the post-test academic achievement scores of the students taught through problem-based instructional strategy and lecture-based instructional strategy.

4 RESEARCH METHODOLOGY

A Pretest-Posttest Non-equivalent Control Group Design was employed to measure differences in academic achievement, and retention of subject matter of students under conditions of problem-based instructional strategy and lecture-based instructional strategy at secondary school level.

The population for this study consisted of 6303 students studying the subject of "General Science" in 53 Federal Government (FG) high and higher secondary schools in Islamabad district working under the administration of Federal Directorate of Education (FDE), Islamabad. As a sample for this study, the researcher selected a rural area Sihala through simple random sampling. From this area, the researcher selected Federal Government Boys Higher Secondary School, Rawat, Islamabad through simple random sampling and the students of class 9^{th} of this school studying the subject of "General Science" constituted the sample for this research study. A total of 67 students (N=34, N=33) from Federal Government Higher Secondary School, Rawat participated in this study. Because the school had only two classes for the subject of "General Science" at secondary level so these classes were taken as intact groups to participate in this study. One class for problem-based instructional strategy (Experimental Group) and the other class for lecture-based instructional strategy (Control Group) were taken from the school.

4.1 Research Instruments

The researcher developed Academic Achievement Test (AAT) (Appendix I) as a research instruments. Achievement was measured by determining the number of correct answers to the questions through the administration of pre-test and a post-test presented to all the participants in control group and experimental group. The pre-test and post-test reported in this research study were focused on answering the multiple-choice questions (MCQ). The pre-test consisted of 80 multiple-choice questions having each MCQ of one mark.

The total marks of this test were 80. This pre-test was administered to determine baseline equivalency in prior knowledge of students in the problem-based and lecture-based treatment groups. The same test was used as post-test consisted of 80 multiple choice questions of 80 marks that required students to respond to near-transfer of information recall, and was administered to determine the differences if any in the mean performance on near transfer of information as a result of the instructional treatments (problem-based or lecture-based) administered.

4.2 Validity of Test Items

The validity of each of the instrument was established prior to data collection. Face validity of the instruments was determined by comparing the individual questions to the instructional objectives of the lesson. The instrument had to measure each lesson objective. Initially the researcher developed a test comprised of 120 test items from the selected four chapters of the textbook of "General Science" to measure the academic achievement of the students with the help of table of specification. This test was validated through pilot testing and discussion with the Test Development Specialist of "General Science" in Curriculum Wing, Ministry of Education; the Subject Specialists teaching the subject of "General Science" in Federal Government institutions for construct validity. The observations made by these experts about the quality of test items were removed and the researcher incorporated their suggestions. Finally through item analysis, 40 doggy, difficult, easy and poor items of the achievement test were deleted and 80 good items (Items with difficulty level of .40 to .70) were obtained and got approved by the supervisor of the researcher for administration. All the test items were based on the text of the units taught to the sample students. A pilot test was conducted at two schools similar to those in the main experiment to test the lesson plans and instruments. Selection for the pilot test schools had the same criteria that the selection for the schools in the study.

4.3 Independent Variables

The independent variables for this research study were as follows:

1. Lecture-based Instructional Strategy
2. Problem-based Instructional Strategy
3. Instructional Materials
4. Development of Lesson Plans
5. Selection and Training of Teachers

The lecture-based instructional treatment was centered on a combination of instructor-led lecturing and student-oriented practical activities. The instruction was initiated with a presentation of the instructional objectives for the class, and a "prior recall" activity as an event to secure the motivation of the students. Next, the instructor conducted a lecture in which the critical instructional content was presented to the students. During the lecture, the instructor continued to provide descriptions of key instructional knowledge and skills, and examples of the application of the concepts in practical contexts.

During the practical activities, the instructor provided guidance and feedback to the students in small groups and to the class as a whole. The instructor continued to provide instructional content in the lecture-based format throughout the class session. The class session was concluded with a summary activity, in which the key instructional content was summarized for the class.

In problem-based instructional strategy, the students worked in small groups to acquire the conceptual knowledge and procedural skills needed to develop one or more plausible solutions to each of the problems presented to them. Each group of students (consisting of five to six students) met with facilitator to discuss the problem. The facilitator presented a limited amount of information about the problem, and the group was charged with the task of identifying the different aspects of the problem by asking the facilitator questions to elicit information relevant to the problem.

The groups then generated and refined hypotheses related to the problem's potential solution, and determine "learning issues" that were relevant. The groups were then asked to assign the tasks to each member of the group for researching each of the different "learning issues" they had identified. After each of the group members had conducted the necessary research related to the "learning issue" they were assigned, the group members reported their findings to each other and use it to generate a formal solution to the problems.

Currently there is only one book recommended for both the 9th and 10th class in the institutions working under the umbrella of Federal Directorate of Education, Islamabad. This book consists of eleven chapters.

The subject of "General Science" at 9th class consists of five chapters (Chapter 1, 2, 5, 7 & 9) while the other six chapters (3, 4, 6, 8, 10 & 11) are for class 10th.

This research study focused on the instructional objectives for 3 months course on the subject of "General Science" class 9th. The research study was also conducted after the summer vacations so the chapter already taught (Chapter 1) was left out and the remaining four chapters were taken as an instructional material for problem-based instructional strategy and lecture-based instructional strategy.

Two versions of lesson plans were developed by the researcher. One version of lesson plans utilized the lecture-based instructional strategy while the second version of lesson plans utilized problem-based instructional strategy. Twenty lesson plans each for lecture-based instructional strategy (Appendix II) and problem-based instructional strategy (Appendix III) were developed with the respect to four chapters taught during the experiment. The content for each lesson plan, across both the lecture-based instructional strategy and problem-based instructional strategy, was based on the same educational objectives in both the experiments. All lesson plans and instruments related to the lesson plans were developed by the researcher. Format of the lesson plan was adapted from the Lesson Plan Builder Offline Template, Georgia Learning Connections, Georgia Department of Education.

Although the concept of problem-based instructional strategy is not new in the world yet in Pakistan our teachers in school do not apply this strategy. Availability of suitable teachers for teaching the experimental group through problem-based instructional strategy is not possible because most of the teachers teaching the subject of "General Science" in the school were not aware of this strategy. The researcher himself took up the responsibility to provide training to the teacher teaching the experimental group because he had been in touch with the theory and application of problem-based instructional strategy for the previous three years.

Initially four teachers from F. G. Boys Higher Secondary School, Rawat, Islamabad gave their consent voluntarily for teaching both the experimental and control groups. Out of these four teachers, 2 teachers were selected with the consultation of the concerned principal and their equivalent background knowledge and experience in teaching the subject of "General Science".

The researcher organized a training period of two weeks. The teacher / facilitator attended this twelve day professional development training program on problem-based instructional strategy before he facilitated the class. The aim of this training program was to develop in facilitator the fundamental knowledge and skills necessary to function effectively in the PBL environment.

4 PROCEDURE AND ANALYSIS

This study was an experimental in nature in which an experiment was conducted in F. G. Boys Higher Secondary School, Rawat, Islamabad. The participants in the study were assigned within sections to two treatment groups. One group was problem-based instructional group receiving the problem-based instructional strategy, and the other group was lecture-based instructional group receiving the instructor-led direct instruction. Admission test scores, grade point averages, and performance in related subject areas were already used by the administration to form the sections.

The treatments were being administered over the course of 3 months, and during each week students dedicated three hours of instructional time to participating in the study. Students in the problem-based instructional treatment and lecture-based instructional treatment received their instruction on Mondays to Saturday from 9:30 a.m. to 10:00 a.m. in F. G. Boys Higher Secondary School, Rawat, Islamabad. Both the treatment groups received their instruction in their classrooms already assigned for teaching the subject of "General Science" at F. G. Boys Higher Secondary School, Rawat, Islamabad.

During the period of data collection, students contributed about 2 hours and 15 minutes of instructional time. Instructional treatments were given for half an hour to both the treatment groups and the additional time commitment (one hour and 45 minutes) dedicated to data collection outside of the scheduled class periods.

Achievement test was administered to obtain pretest scores just before the beginning of treatments to problem-based instructional strategy group and lecture-based instructional strategy group. The experiment continued for twelve weeks. After the completion of treatments (teaching) of twelve weeks, the post-test was administered immediately to obtain posttest scores in achievement test.

5 RESULTS

There was one class of dependent variables in this study: (1) academic achievement. As a dependent variable, academic achievement was measured in terms of scores on a post-test containing near transfer of information. Mean, standard deviation and significance of difference between the mean scores on post-test in problem-based instructional group and lecture-based instructional group in the experiment was tested at .05 level by applying independent sample t-test. Group statistics on posttest academic achievement scores of problem-based and lecture-based are presented in Fig 1.

Fig 1: Group statistics on posttest academic achievement scores

Group	N	Total Mean	Mean	SD	SE_M	t-test
Control	34	51.04	45.79	5.290	.907	7.740*
Experimental	33		56.30	5.817	1.013	
Control (HA)	17	55.53	50.06	2.947	.715	10.766*
Experimental (HA)	17		61.00	2.979	.723	
Control (LA)	17	46.42	41.53	3.223	.782	8.561*
Experimental (HA)	16		51.31	3.341	.835	

As shown in Fig1, the total mean score for the near-transfer of information was 51.04%. By instructional strategy, the mean score for the lecture-based instructional strategy (45.79) was lower than the mean score for the problem-based instructional strategy (56.30). Standard deviation (5.290) on the lecture-based instructional group's scores was almost the same as standard deviation of the problem based instructional groups' scores (5.817).

An independent sample t-test was used to determine the effects of each of the types of instructional strategies on learner academic achievement in a post-test containing near-transfer of information related to the course objectives for the General Science course. With alpha set at 0.05, and with 33 and 34 participants per group, the probability of detecting a moderate effect size was 0.45.

For the scores on the post-test, a review of the distribution of the scores did not indicate any serious violation of the normality assumption. Furthermore, the F-Max value for the total scores F= (34, 33) = 0.665, a = 0.05 did not demonstrate a violation of the assumption of the homogeneity of variance. Therefore, it was decided to use the t-test for equality of means.

The t-test revealed statistically significant differences between academic achievement of the lecture-based instructional students and the problem-based instructional students on the post-tests t (65) = 7.740*, p>0.05. This result did not support the hypothesis that students in the problem-based instructional group would not performed better than the lecture-based instructional students on near-transfer post-test.

An independent sample t-test was once more used to determine the effects of the two instructional strategies on learner academic achievement of high and low achievers. An analysis of the distribution of the academic achievement of high and low achievers scores did not indicate any serious violation of the normality assumption. The t-test for high achievers scores, t(32)=10.766*, p>0.05 and t-test for low achievers scores, t(31)= 8.561*, p>0.05 revealed a statistically significant difference between the academic achievement of high and low achievers of the lecture-based instructional group and the academic achievement of the problem-based instructional group. This result did not support the hypothesis that learner academic achievement would not be higher in the problem-based instructional group than in the lecture-based instruction group.

6 DISCUSSION

A brief overview of the main findings from the research, in relation to the stated hypotheses for the research study, is presented below.

Academic Achievement

Ho1: There is no significant difference between the post-test academic achievement scores of the students taught through problem-based instructional strategy and lecture-based instructional strategy.

Statistical analysis of academic achievement data from both treatment groups did not support this hypothesis. Since instruction in the lecture-based treatment group is more consistent with a focus on transfer of knowledge and skills for stated instructional objectives, it appears sensible that the data should not reflect this hypothesis. The academic achievement of learners in the problem-based treatment group was anticipated to be more oriented toward academic performance, and it is therefore reasonable to conclude that students in this treatment group are well-equipped to perform efficiently on recall of information and skills in near transfer of information test called academic achievement test. At the end of the term, students from both treatment groups participated in far-transfer of information tests called retention test, and it is anticipated that the performance scores on that retention test was the same of performance on academic achievement test. The same performance was anticipated by high and low achievers in academic achievement test.

7 CONCLUSION

Overall, the results suggest that different instructional strategies may lead students to acquire knowledge in different ways, and at different rates throughout the term of study. The results of this study are encouraging, and suggest that it is possible for students in a problem-based instructional strategy to perform better than the students in a conventional, lecture-based instructional strategy on academic achievement. Problem-based instructional strategy seems to improve the academic achievements of 9^{th} grade students in basic general science learning. In the short term, students taught through problem-based instructional strategy showed a higher improvement in the understanding of general science concepts than the students taught through lecture-based instructional strategy. This improvement was statistically significant in the post-test academic achievement

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