EFFECTIVENESS OF CONCEPT MAPPING STRATEGY ON PROBLEM SOLVING ABILITY IN PHYSICS AMONG SECONDARY SCHOOL STUDENTS

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Abstract: The classroom is a dynamic society where we can see different personalities with diverse abilities. To satisfy students with different abilities is a much difficult tack for the teachers. We have different strategies that can be applied in the class. One among them is Concept Mapping. The present study investigates the effect of Concept Mapping Strategy on Problem Solving Ability in Physics among Secondary School Students and compares it with Constructivist Method. Concept Mapping is an excellent strategy that helps students to make connections between various scientific concepts and terms, to organize their thinking, imagine relationships between key concepts in a systematic way and reflect on their understanding. Experimental design was used for the study with pre-test and post-test measurements. The sample consisted of 80 class IX students selected from the Government Schools of Palakkad District. They were divided into "experimental" and "control" groups of 40 each. As part of the design, the "experimental" and "control" groups were subjected to Concept Mapping Strategy and Constructivist Method respectively. The result of the study indicated that the Concept Mapping Strategy is significantly more effective than the Constructivist Method in the improvement of Problem Solving Ability in Physics

Key words: Concept Mapping, Constructivist Method, Problem Solving Ability in Physics

Introduction

Education considers all round development of the organism and it entails the development of intellectual, emotional, moral, physical and sensory motor domains of the individual. The process of education should consider all levels equally for the overall development of the individual. Classrooms are miniature societies where we can see people with diverse abilities and personalities. Nurturing the abilities of each and every student according to their specific need is a difficult task as far as the teacher is considered. So the teachers have to create new innovative strategies to cater to the needs of all levels of students. By using different strategies in the classroom, the students may get a lot of experiences on how to learn concepts in order to apply in day to day life activities. The will also earn experiences like abstract to concrete generalization and vice versa, observation, reflection, and application of concepts in new situations. The use of effective strategies in the classroom may enhance student's motivation to learn and realize the subsequent subject. Because of that, teaching methods and teaching strategies have gained much importance in the field of education. Providing attractive learning environment and attractive learning strategy enhance student's active participation in the activities during the process of learning Physics and makes it more enjoyable and understandable. This paper throws light on the Concept Mapping Strategy and its effect on achievement in Physics of Higher Secondary School Students and draws a comparison with Constructivist Method.

Concept Mapping

The introduction of concept map as a systematic way of learning was done in 1960's by Novak but as a teaching strategy it was developed during early 1980's. The background for his work was based on Ausubel's assimilation theory of cognitive learning. According to this theory learning is the assimilation of new concepts and propositions into existing concepts and propositional frame works held by the learner. This knowledge structure possessed by the learner is also referred to as the individual cognitive structure.

A Concept map is a graphical representation of concepts and their interconnections. Research has shown that Concept maps reflect the student's cognitive structure, enabling both teachers and students to determine the level of understanding of material attained before, during or after instruction. It is necessary for science students to know how to organize data and connect it to previously acquired knowledge. Writing concept maps requires the active participation of the learner in the learning process and also the understanding of the content area. This removes learner's cognitive deficiencies to a limited extent and gives corrective feedback.

Lambiotte and Dancereau (1992) studied that the students who are making concept maps possess a broader knowledge base and therefore more able to solve problems compared to those students who learned by rote memorization. They also found out that, the students with low prior knowledge learned better with concept mapping than those who were taught with lecture method. Gorjian, Pazhakh, & Parang (2002) had found out that Concept mapping improved not only the learners' writing ability, but, quantity and quality of producing, arranging and relating ideas (Pishghadam & Ghanizadeh, 2006).

Constructivist method

Constructivist method is a method of learning which ensures the construction of knowledge. When teachers use lecturing in the classrooms students will get boredom and they will not acquire the necessary skills in the respective subjects. Each subject has its own skill and students should have knowledge about various skills associated with the subjects in order to understand and experiment in those subjects. So constructivist method is an apt method for developing their knowledge since students are constructing their own knowledge and they have the responsibility for their knowledge. So this is a good approach as it helps in the development of self learning among students. Modules using this method are presented to the control group.

Problem Solving Ability

Every person in daily life confronts many problems and for them problem may be a controversy, an issue, a question or a difficulty. If one wants to come out of a difficult situation, controversy, resolve the issue and answer the question one must find ways to solve those problems in an effective manner. Hence problems are part of our life. A Problem is defined as 'A doubtful or difficult matter requiring a solution and something hard to understand or accomplish or deal with' (Concise Oxford Dictionary, 1995) and Problem solving ability is the cognitive capability of the problem solver to perform physical or mental operations based upon his knowledge so as to achieve the goal of solving a problem (Praveen, M.G, 2006). It is considered as the core skill to be inculcated in the secondary education as the world needs a lot of good problem solvers for the future. Problem solving ability of a person depends on many factors like the nature of the problem solver, nature of the problem and the knowledge of the problem solver. The problem solver should use a wide variety of strategies to solve problems.

Need and Significance of the Study

Traditional classrooms are usually equipped with lecturing as the method of teaching. Lecturing usually makes children boring and they don't even pay attention to what teachers teach through lecturing. There students try to learn things by rote learning. This type of learning will not help students to develop their critical thinking, creativity and problem solving abilities. Concept mapping is an organizational strategy that may help students to develop critical thinking and it is the ability to draw the necessary connections between various concepts and their sub concepts and it also helps in long retention of knowledge. Barbara and Joyce considers concept mapping as a strategy to tackle students' knowledge construction and it also helps in reflection. Concept mapping was found to be significantly more effective than the traditional strategy in enhancing learning and the students were found to be having reduced anxiety towards the learning **(**Jegede , Alaiyemola & Peter, 1990).

Objectives of the Study

- To compare the mean pre-test scores of experimental group and control group
- To compare the mean post-test scores of experimental group and control group
- To compare the mean pre-test scores and post-test scores of control group
- To compare the mean pre-test scores and post-test scores of experimental group
- To test the difference in mean gain scores of experimental and control groups.
- To find out the adjusted mean post-test scores on Problem Solving Ability in Physics of control and experimental group by considering Pre-test score as covariate.

Hypotheses of the Study

- There exists no significant difference between experimental and control groups with respect to their pre-test scores.
- There exists no significant difference between experimental and control groups with respect to their post-test scores.
- There exists no significant difference between pre-test sores and post-test scores of control group
- There exists no significant difference between pre-test sores and post-test scores of experimental group
- There exist significant difference in the mean gain scores of experimental and control groups.
- There exists significant difference between the adjusted mean post-test scores on Problem Solving Ability in Physics of control and experimental group by considering Pre-test score as covariate.

Method of the Study

The design selected for the present study is an experimental design with pre-test and post-test non equivalent group design. Experimental group was administered Module based on Concept Mapping Strategy and control group was administered Lesson Transcript based on Constructivist Method.

Sample

The sample selected for the study consisted of 80 Secondary School Students randomly selected from Government Schools in Palakkad District. They were randomly divided into control and experimental groups consisting of 40 students each.

Tools and Techniques

- Lesson Transcript based on constructivist method developed by the investigator
- Module based on Concept mapping strategy developed by the investigator
- Standardized Problem Solving Ability Test in Physics used as pre-test and post-test**.**

Statistical Analysis

For comparing pre-test and post-test scores of experimental and control group the statistical techniques used were student t-test and ANCOVA.

Analysis and Interpretations

Differences between the mean pre-test scores of experimental and control groups

Independent sample t test was used for studying the differences in the mean pre-test scores of Problem Solving Ability in Physics between experimental and control groups. The results are given in the table: 1.

Table:1 Data and results of the analysis of significance of difference between the mean pre-test scores of Problem Solving Ability in Physics among the control and experimental groups.

Pre-test	N	M	SD	t	p
Control group	40	15.26	2.09	0.778	p >0.05
Experimental group	40	15.60	2.26		

It is clear that there is not much difference in the pre-test scores of the experimental control groups. The obtained value of 't' for the difference between mean scores of experimental and control group is 0.778 with a p-value which is greater than 0.05. It means that there is no significant difference between the mean pre-test scores of students in the experimental and the control group. So the first hypothesis is accepted.

Differences between the mean post-test scores of experimental group and control group

Independent sample t test was used for studying the differences in the mean post-test scores of Problem Solving Ability in Physics between experimental and control groups. The results are given in the table: 2.

Table: 2 Data and results of test of significance of difference in mean post-test scores of Problem Solving Ability in Physics among control and experimental groups

Post-test	N	M	SD	t	p
Control group	50	28.30	3.66	9.75^{**}	p<0.01
Experimental group	50	34.42	2.49		

Table:2 shows that the mean post-test scores of Problem Solving Ability in Physics of the experimental group is higher than that of control group. It is seen that the obtained value of't' for the difference between post-test scores of experimental and control group is 9.75. Since the obtained value of't' is greater than the table value and it is significant at 0.01 level, it is concluded that there is significant difference between the mean post-test scores of students of experimental group and the control group. Therefore the second hypothesis is rejected.

Differences in the mean pre-test and post-test scores of control group

The investigator employed paired sample t-test to determine whether there was any significant difference between scores of pre-test and post-test scores within the control group. The results are given in table: 3.

Table: 3 Data and results of test of significant of difference in mean pre-test and post-test scores of Problem Solving Ability in Physics among the control group.

Control group	N	*M*	SD	t	P
Pre-test	50	15.26	2.09	38.03**	P<0.01
Post-test	50	28.30	3.66		

**Significant at 0.01 level

Table 3 shows that the post-test scores of Problem Solving Ability in Physics is significantly higher than the pre-test score of Problem Solving Ability in Physics for the control group. It is evident that the obtained value of 't' for the difference between mean pre-test and post-test scores of the control group is 38.03 which is greater than the table value and is significant at 0.01 level. Therefore it can be concluded that there is significant difference between the means of the pre-test and post-test scores of Problem Solving Ability in Physics among students in control group. Therefore the third hypothesis is rejected.

Difference in mean pre-test and post-test scores of Problem Solving Ability in Physics among experimental group

Paired sample t-test was employed to determine whether there was any significant difference between the pre-test and post-test scores within the experimental group. The results are given in table: 4.

Table: 4 Data and results of test of significance of difference in mean pre-test and post-test scores of Problem Solving Ability in Physics among the experimental group.

Experiment group	N	M	SD	t	p
Pre-test	40	15.6	2.26	66.30**	p<0.01
Post-test	40	34.42	2.49		

**Significant at 0.01 level

The table shows that post-test scores of Problem Solving Ability in Physics is significantly higher than the pre-test score of Problem Solving Ability in Physics in the case of experimental group. It is evident that the obtained value of't' for the difference between mean pre-test and post-test scores of experimental group is 66.30 which is significant at 0.01 level. So it can be concluded that there is significant difference between the means of the pre-test and post-test scores of Problem Solving Ability in Physics among Higher Secondary School Students in experimental group. Therefore the fourth hypothesis is rejected.

Difference between the mean gain score of Problem Solving Ability in Physics among control group and experimental group

t-test was employed to determine whether there was any significant difference between the mean gain scores experimental and control group. The table: 5 given below shows the data associated with the mean gain score of Problem Solving Ability in Physics among the control and experimental groups.

Table: 5 Data and results of test of significance of difference in mean gain scores of Problem Solving Ability in Physics among the control and experimental groups.

Gain Score	N	M	SD	t	p
Control group	40	13.04	2.42	12.98**	p<0.01
Experimental group	40	18.82	2.00		

** Significant at 0.01 level

Table shows that the students of the control group have a mean gain score of 13.04 with a standard deviation 2.42 .and students of the experimental group have a mean gain scores of 18.82 with standard deviation of 2.00. The‘t’ value obtained for the test of significance of difference in the mean gain scores of is 12.98. The obtained value of‘t’ is greater than the table value and hence it is significant at 0.01 level. . So it can be concluded that there is significant difference between the mean gain scores of the experimental and control groups. Therefore the fifth hypothesis is rejected.

Difference in the adjusted mean post-test scores in the Problem Solving Ability in Physics among experimental and control groups by considering pre-test scores as covariate

The tests of significance of difference in the mean post-test scores of Problem Solving Ability in Physics among the control and experimental groups are calculated by ANCOVA. In order to nullify the effect of difference between control group and experimental group, their pre-test scores are taken as covariate and conducted ANCOVA test. The pre-test and post-test scores of the Problem Solving Ability in Physics of the control and experimental groups were subjected to the statistical technique of Analysis of Covariance. The descriptive statistics of the post-test scores of Problem Solving Ability in Physics of control and experimental groups are given in table: 6.

Table: 6 Descriptive statistics of the post-test scores of Problem Solving Ability in Physics of control and experimental groups

Group	N	M	SD
Control	40	28.30	3.66
Experimental	40	34.42	2.49

Table: 6 shows that the mean score of post-test scores of control group is 28.30 with a standard deviation of 3.66 and that of experiment group is 34.42 with a standard deviation of 2.49. The Analysis of Covariance (ANCOVA) is conducted by taking pre-test scores as covariate. Summary of ANCOVA for mean post-test scores of Problem Solving Ability in Physics among the control and experimental group is given in table: 7.

Table: 7 Result of the Test of Significance of Difference in the Adjusted Mean Scores of Problem Solving Ability in Physics

	SS	df	MS	F	P
Between groups	828.852	1	828.852	165.693**	p<.01
Within groups	485.226	77	5.002		

** Significant at 0.01 level

Note: Dependent variable: post-test scores

From table: 7, it is evident that, the calculated F value for df 1/77 is 165.693 which is greater than the table value and is significant at 0.01 level. That is, the difference in the adjusted mean score is significant at 0.01 level of confidence. That means the treatment is effective. So the mean Post-test scores can be compared after adjusting and taking Pre-test as a covariate.

After taking pre-test scores as covariate the obtained adjusted post-test scores are compared by Bonferroni method to test whether there exists any significant differences. Data and result of this analysis in the given table: 8.

Table: 8 Estimated Marginal mean scores of the post-test and pair wise comparison

Group(I)	Group(J)	Mean difference(I-J)	P
Control (28.30[a])	Experimental (34.42[a])	- 6.12**	P<0.000

a indicates the post-test means of the two groups

** Significant at 0.01 level

From table: 8 it is evident that the estimated mean post-test scores of the control group is 28.30 and that of the experimental group is 34.42. The mean difference is found to be -6.12 which is significant at 0.01 level. This means that the difference in the marginal mean score of post-test of control and experimental group is significant. The marginal mean scores of the experiment group is higher than that of the control group. So it can be concluded there exists significant difference between the adjusted mean post-test scores on Problem Solving Ability in Physics of control and experimental groups by considering Pre-test score as covariate. Therefore the sixth hypothesis is rejected.

From the results of the above experiments, it can be inferred that the teaching manual integrated with Concept Mapping Strategies used for teaching the experiment group is more effective than the Constructivist Strategy used in the control group.

Major Findings of the Study

- Concept mapping method is effective in developing Problem Solving Ability in Physics at Secondary School Students.
- The Problem Solving Ability in Physics of students who were taught through Concept Mapping Strategy in Physics was significantly higher than that of the students taught through Constructivist Method.
- There is no significant difference between the means of pre-test scores of students in the experimental and the control groups.
- There is a significant difference between the means of post-test scores of students in the experimental and the control groups.
- The mean post-test scores of experimental group were higher than that of control group.
- There is significant difference between the adjusted mean scores of Problem Solving Ability in Physics of experimental and control group by considering pre-test score as covariate.

Conclusion

The present study comes with a wonderful result that the students' Problem Solving Ability in Physics showed a significant improvement by adopting Concept Mapping Strategy in place of Constructivist Teaching Strategy. This may be because of the fact that the Concept Mapping Strategy is more interactive than the Constructivist Method. The result has a lot of implications in the educational scenario. Problem Solving Ability is a key skill to be acquired not only in Physics but in a variety of disciplines including Maths. By employing Concept Mapping Strategy one can look forward to revolutionizing the art of Problem Solving across a wide range of situations. Understanding the concepts and using them effectively is the key to success in problem solving. Concept Mapping Strategy goes a long way in achieving this goal. Students should be taught how to learn the concepts rather than teaching concepts. Concept Mapping helps children to place concepts in a logical order which help them to retrieve the required concept at the time of solving problems. This study is a small step forward in the quest for making it easy for children when it comes to problem solving.

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