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Research Paper

Modeling – Based Instructional Strategy for Enhancing Problem Solving Ability In Physics Among Students At Secondary School Level

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ABSTRACT: *The modeling-based instructional framework accommodates the physics modeling mechanism in which the learner apply the fundamental principles in physics and develop an idealized physics model of the real world situation by means of assumptions and approximations. The present study was intended to find out the effectiveness of Modeling-based instructional strategy for enhancing physics problem solving ability of students at secondary school level. The investigator adopted a quasi-experimental method with two group pre-test post-test design for the study. The sample selected for the study consisted of 242 IX standard students from three different schools of Palakkad district. The tools used for collecting the data were the Problem Solving Ability Test in Physics, lesson designs based on Modeling-based instructional strategy and activity oriented method. The findings of the study concluded that the Modeling-based instructional strategy enhanced the problem solving ability of students of secondary school level. And also the strategy scaffolded the formation of mental models of problem representations with in the cognitive structure of the learner.*
Keywords*: Modeling-based instruction, Problem Solving Ability, Physics*

I. INTRODUCTION

Problem solving is an inevitable part in almost all area of learning, especially in physics. Student's knowledge in physics is being assessed based on his or her ability to solve problems related to the learned concepts. In order to solve problems in physics students should have both the content knowledge and the procedural knowledge. Usually our physics classrooms are concentrated on the drill and practice problems demonstrated at the end of a chapter. But simply practicing these problems will not enhance the problem solving ability of students. Experience based, context rich physics models related to the concepts or principles to be learned assist the learner to build the domain specific problem representations within the cognitive structure of the learner. This initiates the need of modeling based interactive instructional framework to teach physics. Modeling based interactive instruction involves physics modeling that focused on the development of conceptual understanding of physics principles and promote problem solving ability of students (Chabay & Sherwood, 2008). Modeling-based instructional strategy allows the learner to observe the thought processes of teachers and peers while engaged in learning tasks and solving problems. Various modeling mechanisms like Disposition modeling, Task and performance modeling, Metacognitive modeling, Student centered modeling and Modeling as a scaffolding techniques encourage the development of learners mental models, the internal embodiment of integrated knowledge that constitute components of a dynamic system and their interplay which construct emergent behavior. Physics modeling consists of conscious approximation, simplifications and idealization of a complex physical system.

1.1. Objective of the Study

- To compare the mean pre-test scores of problem solving ability of experimental group and control group.
- To compare the mean post-test scores of problem solving ability of experimental group and control group.
- To find out the significance of gain scores of problem solving ability of experimental group and control group.

1.2. Hypotheses of the Study

- There exist significant difference in the mean pre-test scores of problem solving ability of experimental group and control group.
- There exist significant difference in the mean post test scores of problem solving ability of experimental group and control group.
- There exist a significant gain in the problem solving ability of experimental group and control group.

1.3. Methodology

The effectiveness of modeling-based instructional strategy was established through quasi-experimental method, with two group pre-test, post-test design. The experimental group was taught with lesson designs based on Modeling-based instructional strategy and the control group was taught through activity oriented method. The Problem Solving Ability Test was administered before and after the intervention. The data obtained were analysed using approximate statistical techniques such as descriptive statistics, independent sample 't' –test and ANOVA.

1.4. Sample Selected for the Study

The investigator selected 242 IX standard student from three different school of Palakkad district following state syllabus as the sample.

II. ANALYSIS AND DISCUSSION OF RESULT

2.1. Descriptive Statistics of Pre-test and Post-test Scores on Problem Solving Ability of Experimental and Control, Group

The mean and standard deviation of the scores of problem solving ability of the experimental and control group before and after the intervention was found out. The details are given below in table 1.

Table 1:
Descriptive Statistics of Pre-test and Post-test Scores on Problem Solving Ability of Experimental and Control Group

Statistics	Experimental Group		Control Group	
	Pre-test	Post-test	Pre-test	Post Score
Mean	9.05	32.42	8.42	10.53
S.D	3.51	2.53	3.02	2.298
Skewness	0.32	.06	.012	-.069
Kurtosis	-0.36	-.24	.010	.149

From the above table-1 the mean and S.D of the experimental group before and after the intervention was 9.05 and 3.51 respectively. The mean and S.D of the control group was 8.42 and 3.02 respectively. This indicate that the scores are not much deviated from the mean scores, after the intervention the mean and S.D of the experimental group was 32.42 and 2.53 respectively and that of control group was 10.53 and 2.298. This also shows that the scores are not much deviated from the mean scores after the intervention and their exist an observed difference in the pre-test scores of experimental group. The skewness and kurtosis values indicate that the distributions of experimental group data are positively skewed and platokurtic and that of control group in leptokurtic.

2.2. Comparison of Pre-test and Post-test Scores of Problem Solving Ability of Experimental and Control Group.

To find out the effectiveness of the modeling-based instructional strategy for enhancing the physics problem solving ability of students at secondary school level the differences in the mean pre-test and post-test scores of experimental and control group were tested using independent sample 't'-test. The details are given below in table 2.

Table 2
Comparison of the Mean Scores of Pre-test and Post-test Scores of Problem Solving Ability of the Experimental and Control Group

	Group	N	Mean	S.D	t
Pre-test	Control Group	126	8.62	3.02	.865
	Experimental Group	116	8.98	3.42	
Post-test	Control Group	126	10.98	2.13	58.34
	Experimental Group	116	28.6	2.53	

From the table 2 the mean of the scores of problem solving ability of Experimental and Control group before the intervention is 8.98 and 8.62 respectively and the value of S.D is 3.42 and 3.02 respectively. The obtained value of critical ratio 't' is .865. which is not significant at .05 level. This reveals that there is no significant difference in the mean scores of problem solving ability of experimental and control group before the intervention.

From table 2 it is also clear that the mean and S.D of problem solving ability of the experimental group after the intervention is 28.6 and 2.53 respectively while that of control group is 10.98 and 2.13 respectively. The obtained 't' value after the intervention is 58.34. Which is significant at .01 level. This reveals that there exist a significant difference in the mean scores of physics problem solving ability of experimental and control group after the intervention.

2.3. Genuineness of the Difference between the Post-test Scores of Problem Solving Ability of Experimental Group and Control Group.

The genuineness of the difference between the post-test scores of physics problem solving ability of students of secondary school level, was established using ANCOVA by taking pre-test scores as co-variate, to eliminate the effect of pre-test scores on post-test. The details are given in the Table 3

Table 3:

Summary of ANCOVA of Post-test Scores of Physics Problem Solving Ability of Experimental and Control Group when Pre-test Scores are taken as Co-variate

Source	Type III Sum of Squares	df	Mean	F	Sig	Partial Eta Square
Correlated Model	56201.33	2	28100.664	4082.214	.000	.954
Interpret	20473.674	1	20473.674	2893.172	.000	.905
Pre-PSA	53.324	1	53.324	7.676	.006	.024
Group	55452.601	1	55452.609	8067.015	.000	.958
Error	2104.940	106	19.849			
Total	239712.00	109				
Correlated Total	58325.279	108				

From the table it is clear that the F value 8067.015 is significant at .01 level. This reveals that there exist a significant difference in the post-test scores of problem solving ability of experimental and control group even after allowing variations in the scores of physics problem solving ability. The adjusted mean scores of post-test of the experimental and the control group given below in Table 4.

Table 4

Details about the Adjusted Mean Scores of Post-test of Experimental and Control Group

Group	Mean	Adjusted Mean	Standard Error
Experimental Group	32.42	32.40	.212
Control Group	10.53	10.62	.214

The above table reveals that the adjusted mean score of physics problem solving ability of experimental group is higher than that of control group. This indicate that the students of secondary school level belonging to experimental group have significantly higher problem solving ability than the control group. This findings substantiated the effectiveness of Modeling-based instructional strategy for enhancing problem solving ability in physics among students at secondary school level.

III. MAJOR FINDINGS

The major findings of the study are;

- The comparison of pre-test and post-test scores of physics problem solving ability of experimental and control group using independent sample 't'-test reveals that the experimental group have higher problem solving ability than control group.
- The analysis of covariance on problem solving ability of experimental and control group shows that there is a significant difference in the post-test scores of experimental and control group even after the effect due to pre-test scores are eliminated.
- The adjusted mean post-test scores of physics problem solving ability of students at secondary school level belongs to experimental group is higher than that of control group.

IV. CONCLUSION

The study reveals that before the intervention most of the students does not show any expert like behaviour while solving the problems in physics but after the intervention using Modeling-based instructional strategy the students were able to apply the fundamental principles in physics related to the problem task and analyse the problem qualitatively before proceeding to the mathematical calculations. Thus it is concluded that the modeling based instructional strategy enhanced the physics problem solving ability of students at secondary school level. The modeling-based instructional framework had the potential to augment the problem solving ability of learners in physics.

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