PROBLEM SOLVING MODEL IN DEVELOPING THE SKILL OF DEFINING OPERATIONALLY FOR ENHANCING INTEGRATED PROCESS SKILL IN PHYSICS AT SECONDARY LEVEL

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ABSTRACT

The present study attempts to develop a problem solving model for enhancing integrated process skill of defining operationally in physics at the secondary level. The study is concerned with finding out the effectiveness of the Problem Solving Model in enhancing Integrated Process Skill of defining operationally in Physics at Secondary Level. A sample of 528 students were selected for the study. The analysis of data for examining the significance of hypotheses formulated in this context was performed using appropriate statistical techniques. The major statistical techniques applied for the analysis of data are computation of coefficient of correlation, critical ratio, delayed post-test and analysis of covariance (ANCOVA). Findings from this study revealed that there is significant difference between the control and experimental groups with respect to the posttest scores for integrated process skill of defining operationally in physics at the secondary level. finding that the Problem Solving Model for enhancing the integrated process skill of defining operationally in physics at the secondary level is effective than the traditional method currently being practiced in the secondary schools of Kerala.

Key words : Problem solving model, defining operationally, integrated process skill

Introduction

Normah and Salleh (2006) observed that students who can successfully solve problems possess good reading skills, have the ability to compare and contrast various cases, can identify important aspects of a problem, can estimate and create analogies and attempt trying various strategies. Heller and Heller (1995) proposed the 'Logical Problem-Solving Model' which involves five steps to solve problems in Physics: '*Focus the problem*' develops a qualitative description of the problem. '*Describe the Physics'* helps to prepare a quantitative solution using ones qualitative understanding of the problem. '*Plan the solution'* helps to translate the description of physics into a set of equations. '*Execute the plan'* helps the student to execute the planned solution and finally in '*Evaluate the answer'* the work is checked to see that it is properly stated, reasonable, and has answered the question asked.

Jonassen, (1999), Lajoie, (2000), have proved that, ill structured problems could be effectively solved through intensive instructional support, such as modeling, coaching, and scaffolding. Students when provided with the cognitive tools essential to facilitate specific kinds of cognitive processing could solve the problems with easy.

In woods (1975) model 'Think about it' requires the problem solver to engage in reflective thinking so as to 'let it simmer'. Woods model provide for a stage which involves to reflective thinking wherein the problem solver is encouraged to make a logical and critical analysis of the 'tentative solutions' formulated. Hence the woods model was selected as the theoretical base are and above the models developed by polya (1957), Heller and Heller(1995), Mayer (1995) for the problem solving model in the present study for developing integrated process skills. Science is taught through problem solving, pupils will eventually develop the integrated process skills which in turn will lead to effective problem solving and achievement in life.

Problem Solving Model:

Problem solving is a planned attack upon a difficulty or perplexity for the purpose of finding a satisfactory solution (Risk, 1965). In the context of the present study, The ***Problem Solving Model for enhancing Integrated Process Skills in Physics at Secondary Level***, developed in the present study consists of four stages viz., ***Exposure***(defining the problem); ***Exploration*** (thinking about it and planning a solution), ***Execution*** (carrying out the plan) and ***Evaluation*** (looking back). These four stages were designed to enhance the integrated process skill of *defining operationally.*

NEED AND SIGNIFICANCE

Educators must teach an appropriate problem solving method and offer an opportunity for students to explore physics by preparing fun learning activities and by encouraging them to think critically and creatively (Snyder, 1998). Although much of the early implementation of problem-solving models has involved elementary schools, problem solving also has significant potential to improve outcomes for secondary school students. Therefore, it is important for secondary school administrators understand the basic concepts of problem solving and consider how components of this model could mesh with the needs of their schools and students need and significance of undertaking the present study entitled "problem solving model in developing the skill of defining operationally for enhancing integrated process skill in physics at secondary level".

Integrated Process Skill of defining operationally in secondary level:

Integrated Process Skills enable an individual to conduct objective investigation and draw conclusions. In the present study 'Integrated Process Skill of *defining operationally* is assessed on the basis of the responses of secondary school students studying in Standard VIII, Standard IX and Standard X in the Secondary Schools of Kerala to various problem-based situations in Physics, presented through the *Integrated Process Skills Test in Physics at Secondary Level*, developed by the investigators.

Hypotheses

The Problem Solving Model is effective in developing the skill of defining operationally for enhancing Integrated Process Skills in Physics at the secondary level.

Objective of the Study

To find out the effectiveness of Problem Solving Model in developing the skill of defining operationally for enhancing Integrated Process Skills in Physics at the secondary level.

Methodology

The present investigation entitled *"*problem solving model in developing the skill of defining operationally for enhancing integrated process skill in physics at secondary level*"* was designed as a quasi-experimental study was adopted for collecting the data essential for the study. Pretest-posttest Non Equivalent Group Design was adopted for the study. Stratified random sampling was the technique followed for selecting the sample for study. The experimental study was conducted on a sample of 528 students studying in the secondary schools of Kerala. Twenty lesson templates on selected topics in Physics at Secondary Level viz., *'Static electricity', 'Current electricity' and 'Electrodynamics'* developed in accordance with the Problem Solving Model for Enhancing Integrated Process Skill of defining operationally in Physics at Secondary Level developed by the investigators were used for the experimental study. The experimental treatment was conducted for a period of one month in each school. The Integrated Process Skills Test in Physics at Secondary level was administered for the experimental and control group as pretest and posttest. Delayed post test was conducted for the experimental group and control group after an interval of two weeks to examine the retention of integrated process skill of defining operationally in physics at secondary level. Appropriate statistical techniques viz., computation of mean, critical ratio, and analysis of covariance (ANCOVA) were employed for data analysis and interpretation of results.

Analysis and Interpretation

Effectiveness of problem solving model in developing the skill of *defining operationally* for enhancing integrated process skill in physics at the secondary level

Hypothesis states that "the Problem Solving Model is effective in developing the skill of *defining operationally* for enhancing Integrated Process Skills in Physics at the secondary level". To examine the statistical significance of Hypothesis the experimental group and control group were compared with respect to their pre test scores, post test scores and delayed post test scores for the skill of *defining operationally* for enhancing Integrated Process Skills in Physics at the secondary level through critical ratio tests of significance. The details of statistical analysis are presented in Table 1

Table: 1

Critical ratio test of significance for difference between control and experimental groups with respect to the skill of *defining operationally* for enhancing Integrated Process Skills in Physics at the secondary level

Defining Operationally	Control Group			Experimental Group			Critical Ratio	
	N_1	M_1	σ_1	N_2	M_2	σ_2	t	P
Pretest	264	3.48	1.48	264	3.50	2.04	0.13	.01
Post test	264	7.22	3.02	264	8.85	2.41	8.79**	.01
Delayed Posttest	264	6.82	3.04	264	7.67	2.52	4.03**	.01

** Significant at .01 level of significance.

Table 1 shows that there is no significant difference between the control and experimental groups with respect to the pretest scores (CR = 0.13; *df*=526; $P<0.01$) for the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level. Significant difference was observed between the control and experimental groups with respect to posttest scores (CR = 8.79; *df* = 526; $P<0.01$) for the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level and delayed post test scores (CR = 4.03; *df* = 526; $P<0.01$) for the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level.

Comparison of the experimental and control groups with respect to the gain scores for the skill of *defining operationally* in physics at the secondary level

Gain Score Analysis to examine difference between control and experimental groups with respect to the achievement of the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level is presented in Table 2.

Table 2

Critical ratio test of significance for difference between the experimental and control groups with respect to gain scores for the skill of *defining operationally* of integrated process skills in physics at the secondary level

Groups	N	M	σ	CR	*df*	P
Control	264	3.21	3.34	6.6**	526	0.01
Experimental	264	5.31	3.81			

** Significant at 0.01 level of significance

Table 2 shows that there is significant difference between the control and experimental groups with respect to the gain for the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level (C.R = 6.6; *df* = 526; $P<0.01$). The experimental group (M_1 = 5.31) is found to possess greater gain than control group (M_2 = 3.21) with respect to the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level.

Comparison of the experimental and control groups with respect to the Adjusted Post test scores of the skill of *defining operationally* for enhancing Integrated Process Skills in Physics at the secondary level.

The effectiveness of problem solving model in developing the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level was examined through analysis of covariance on the adjusted post test scores. The data and results of the analysis of covariance are presented in Table 3.

Table 3.

Analysis of covariance of the Adjusted Post test scores for the skill of *defining operationally*for enhancing Integrated Process Skills in Physics at the secondary level for the experimental and control groups.

Test	Mean		Source	Sum of squares	*df*	Mean Square	F	P
	Exp	Con						
Pretest (X)	3.50	3.48	Between groups	1.28	1	1.28	0.1996	.05
			Within groups	1680.23	262	6.414		
			Total	1681.51	263			
Post test (Y)	8.85	7.22	Between groups	353.445	1	353.45	23.46	.01
			Within groups	3947.79	262	15.068		
			Total	4301.24	263			
Sum of Co deviates SS_{xy}			Between groups	21.27				
			Within groups	1033.12				
			Total	1054.39				
Adjusted Post test(Y.X)	8.84	7.63	Between groups	327.52	2	163.76	12.91	.01
			Within groups	3312.56	261	12.69		
			Total	3640.08	262			

From Table 3 it is evident that the computed F_x ratio for the pretest scores for the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level (F_x = 0.1996) is less than table values (F = 6.72; P<0.01 and F = 3.87; P <0.05). Therefore there is no significant difference between the experimental group and control group with respect to the pretest scores for the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level. F_y ratio computed for the post test scores for the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level (F_y = 23.46), is greater than the statistical table value (F = 6.72; P<0.01), which shows that the experimental group and control group differ significantly with respect to the posttest scores. The analysis of covariance computed from the adjusted post test scores for the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level shows that the calculated F ratio ($F_{Y.X}$ = 12.91) is significantly greater than the table value (F = 6.72; P<0.01). Further, from the adjusted post test means it is evident that the experimental group ($M_{Y.X}$ = 8.84) differ significantly from control group ($M_{Y.X}$ = 7.63) with respect to the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level. Table 3 reveals that the ANCOVA converge to the finding that the Problem Solving Model is effective in developing the skill of *defining operationally* for enhancing Integrated Process Skills in Physics at the secondary level than the traditional method currently being practiced in the secondary schools of Kerala. The Hypothesis of the "Problem Solving Model is effective in developing the skill of *defining operationally* for enhancing Integrated Process Skills in Physics at the secondary level" is therefore valid.

Comparison of the experimental and control group with respect to retention of the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level

Retention test to analyze the delayed posttest the post test scores was conducted to compare the experimental group and control group with respect to the retention of the skill of *defining operationally* for enhancing the integrated process skills in physics at the secondary level. The details of statistical analysis are presented in Table 4.

Table 4.

Critical ratio test of significance for difference between the experimental and control group with respect to retention of the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level

Groups	N	M	σ	CR	*df*	P
Control	264	0.94	0.59	3.51	526	.01
Experimental	264	1.18	0.94			

** Significant at .01 level of significance

The critical ratio test of significance reveals that there is significant difference between the control and experimental groups with respect to retention of the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level (C.R = 3.51; *df* = 526; P<0.01). The mean scores of delayed post test for the experimental and control groups given in Table 4.21 makes it evident that the experimental group (M_1 = 1.18) has better retention of the skill of *defining operationally* integrated process skills in physics at the secondary level than the control group (M_2 = 0.94).

Major findings

1. There is no significant difference between the control and experimental groups with respect to the pretest scores (CR = 0.13; *df* = 526; P<0.01) for the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level.

2. There is significant difference between the control and experimental groups with respect to posttest scores (CR = 8.79; *df* = 526; P<0.01) for the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level.

3. There is significant difference between the control and experimental groups with respect to the gain for the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level (C.R=6.6; *df* = 526; P<0.01). The experimental group (M_1=5.31) possess greater gain than control group (M_2 = 3.21) with respect to the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level.

4. There is significant difference between the control and experimental groups with respect to the adjusted post test scores for the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level ($F_{Y.X}$ = 12.91; *df* = 262; P<0.01). The experimental group ($M_{Y.X}$ = 8.84) differ significantly from control group ($M_{Y.X}$ = 7.63) with respect to the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level.

5. There is significant difference between the control and experimental groups with respect to the delayed post test scores (CR = 4.03; *df* = 526; P<0.01) for the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level.

6. There is significant difference between the control and experimental groups with respect to retention of the skill of *defining operationally* for enhancing integrated process skills in physics at the secondary level (C.R=3.51; *df* = 526; P<0.01). The experimental group (M_1 = 1.18) has better retention of the skill of *defining operationally* integrated process skills in physics at the secondary level than the control group (M_2 =0.94).

Implications

The findings of the present study revealed that there is a positive correlation between problem solving and integrated process skill of defining operationally in physics at the secondary level among students in the secondary schools of Kerala. The findings imply the need for science educators to adopt process approach in science education along with the product approach for developing scientific concept and related scientific skills. The logical thinking patterns developed through process approach can be readily transferred to new learning situations and life through best practices in science education. Since integrated process skills tend to last longer than the learned content and influence our problem solving in day to day life, directly or indirectly, constructivist approach for teaching science may be adopted to enhance integrated process skills through problem solving.

Conclusion

Problem Solving Model for enhancing the integrated process skill of defining operationally in physics at the secondary level is effective than the traditional method currently being practiced in the secondary schools of Kerala. Teaching problem-solving to students in every field facilitates organization of ideas, development of different thought skills, and building consistent thought models. Physics courses must be taught conceptually to students through problem solving method before physics formulas and equations are taught. The studies show that interactive engagement and collaborative methods have positive effects in physics problem solving. To get expertise in physics concepts and problem-solving skills, student should get multiple exposures over extended time periods in a variety of contexts.

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