Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 3, July 2021: 5430-5440

Research Article

TEACHING AND LEARNING OF PHYSICS USING TECHNOLOGY FOR ENHANCING PROBLEM SOLVING MODEL AT HIGH SCHOOL STUDENTS

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ABSTRACT

A holistic problem solving model emphasises learning practical values to solve and survive complex problems, along with academic knowledge. The study aims to examine the competency of a problem solving model through information technology using teaching in physics at the secondary level. Sample of 98 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 technology used problem solving model in physics at the secondary level. Findings that the technology used problem solving model 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, information and computer technology, teaching and learning physics, high school students, scientific technology.

Introduction

The pandemic is the most recent example of when and how values such as resilience, patience, compassion and empathy can help us we more rational and humane through technological devices. A curriculum transaction on information and computer technology and computer technology along with the right amount of hands on practical training as well as social learning projects, is the need of the hour.

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. Other strategies should be researched, rather than relying on the problem solving method to increase success and for more understanding. The studies show that interactive engagement and collaborative methods have positive effects in physics problem

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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.

Technology is employed as a tool rather than as a pedagogical tool. However, it makes a difference when technology is used as a pedagogical tool for teaching and learning(Westera, 2015) and the pedagogical value of a tool is reflected in the level of student engagement and the nature of participation garnered (Johnson & Golombek, 2016).

Yeany, et al. (1986) reports that another major focus of science instruction over the recent years has been on the development of reasoning abilities among students. Critical thinking, problem solving, scientific thinking, logical thinking abilities and science process skills' were the terms used used to describe the different kinds of reasoning abilities to be developed through science education. When a student attempts to solve a scientific problem through the manipulation of variables or collection of data, he will be making use of some or all of these abilities.

Shepardson(1990) investigated on problem solving and identified student behavior behind each phase of problem solving. The phases and corresponding skills were identified as (1) *problem finding and refining phase* wherein the students employ the skills of focusing, analyzing, evaluating, and integrating; (2) *research designing phase* during which the students use focusing skills; (3) *data collecting phase* in which the students are using the skills of focusing, integrating and generating; (4) in the *data analyzing phase*the students use the skills of remembering, analyzing, organizing, information gathering, focusing, integrating and evaluating; finally during the (5) *evaluating phase* the skills used are organizing, focusing, integrating, and information gathering.

Binghan (1983) defines a problem as the obstacle facing the powers to be gathered by someone with a specific target. Whereas Erden and Akman (1998) considers it as a new trouble faced by the individual. Aliciguzel (1979) views a problem as the difficulties faced by individuals and communities to be solved in order to achieve success. According to Turer (1992), if a person doesn't know how to achieve his purpose then it means he is facing aproblem. If there isn't any purpose then there isn't any problem. Therefore, the desire to fulfill a need to achieve a purpose and the difficulties objecting these are the main conditions of a problem. Problem solving is a process of raising a problem in the minds of the students in such a way as to stimulate purposeful reflective thinking for arriving at a rational solution. According to Risk (1965) problem solving is a planned attack upon a difficulty for the purpose of finding a solution. It is not only finding the correct answer, but also, is an action which covers a wide range of mental abilities. Problem solving includes all the processes by which the observing and amassing of data are regulated with a view to facilitating the formation of explanatory conceptions and theories. According to Mayer and Wittrock (1996) solving a problem means to find or create new solutions for the problem or to apply the new rules to be learned.

Problem solving includes integration of concepts and skills to get over the unusual complete situations (Stones, 1994) as cited by Dogru (2008). According to Barry (1994) problem solving is mainly a purpose of primary education of science teachers. With a difference between belief and application. One of the purposes of science education is to improve critical thinking, logical responding and mainly to develop problem solving abilities of the students Lavole, (1993). The strategy for developing problem solving ability is to creates a 'pattern', through which the thinking abilities of the students shall be improved. Thus Perkins (1987) observes that creating pattern is an effective method for developing problem solving ability.

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),

Problem solving is defined as a person's ability to cope with a problem. It is also defined as "the process required overcoming the difference between the desired situation and the current situation in a situation affected by variables which were encountered or were not encountered previously" (Huitt, 1992). Additionally, problem solving requires people to construct knowledge to cope with difficulties and may require the use of some strategies to remove undesirable situations. Problem solving process, also defined as organizing cognitive and effective behavioral processes towards a specific target, is closely related to creativity.

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, ***teaching and learning of physics using technology for enhancing problem solving model 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 teaching and learning of physics using technology for enhancing problem solving model

Need and significance

Teaching for problem solving in a context- free situation has proved to be futile. It is preferable to use these stages in problem solving for developing the problem solving cycle. For facilitating effective problem solving among students, teachers should know the strengths and weaknesses of various problem solving strategies, realize what, why and how they are solving a problem, in order to understand the strategies completely and select the most appropriate ones.

Review of research studies on problem solving models conducted in India and abroad revealed that even though many significant studies as those of Suleiman (2010); Adeniran (2011); Olaniyan, Omosewo and Nwankwo (2015) were conducted abroad to examine the effectiveness of problem-solving model in science especially physics (Suleiman, 2010; Adeniran, 2011; Olaniyan, Omosewo and Nwankwo, 2015) there is a dearth of studiesto examine the effectiveness of a problem solving model for enhancing integrated process skills in physics at secondary level especially in India and particularly in Kerala. Although few studies were undertaken in the Kerala context on science process skills (Ananthalekshmi, 2007; Jayalekshmi, 2007; Vikas, 2009), not many studies were conducted to examine the development of integrated process skills in physics at secondary level, in the Kerala contest. The need and significance of undertaking the present study entitled "developing a problem solving model for enhancing integrated process skills in physics at the secondary level" is therefore well justified.

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 "Teaching and learning of physics using technology for enhancing problem solving model at Secondary Level".

Technology used problem solving model in secondary level

Technology used problem solving Skills enable an individual to conduct objective investigation and draw conclusions. In the present study 'Technology used problem solving model is assessed on the basis of the responses of secondary school students studying in the Secondary Schools of Kerala to various problem-based situations in Physics.

Hypotheses

The Problem Solving Model is effective in using technology for teaching and learning of physics at the secondary level.

Objective of the Study

To find out the effectiveness of using technology for enhancing Problem Solving Model in teaching Physics at the secondary level.

Methodology

The present investigation entitled *"*Teaching and learning of physics using technology for enhancing problem solving model 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 98 students studying in the secondary schools of Kerala. Twenty lesson templates on selected topics in Physics at Secondary Level viz., *'Alternating Current', 'Electromagnetic Waves' and 'Electromagnetic Induction'* developed in accordance with the Problem Solving Model for Enhancing Technology used problem solving model in Physics at Secondary Level developed by the investigator were used for the experimental study. The experimental treatment was conducted for a period of one month in each school. The technology used teaching physics for enhancing problem solving model 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 technology used problem solving model 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

The effectiveness of using technology for enhancing Problem Solving Model in teaching Physics at the secondary level

Hypothesis states that "The Problem Solving Model is effective in using technology for teaching and learning of 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 technology based problem solving model in physics at secondary level. 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 using technology for enhancing Problem Solving Model in teaching Physics at the secondary level

	Control Group			Experimental Group			Critical Ratio	
	N_1	M_1	σ_1	N_2	M_2	σ_2	t	P
Pretest	98	58.98	7.68	98	60.14	6.91	1.11	.01
Post test	98	113.20	8.06	98	118.54	9.69	4.19**	.01
Delayed Posttest	98	112.45	8.10	98	117.23	9.86	3.71**	.01

** Significant at .01 level of significance.

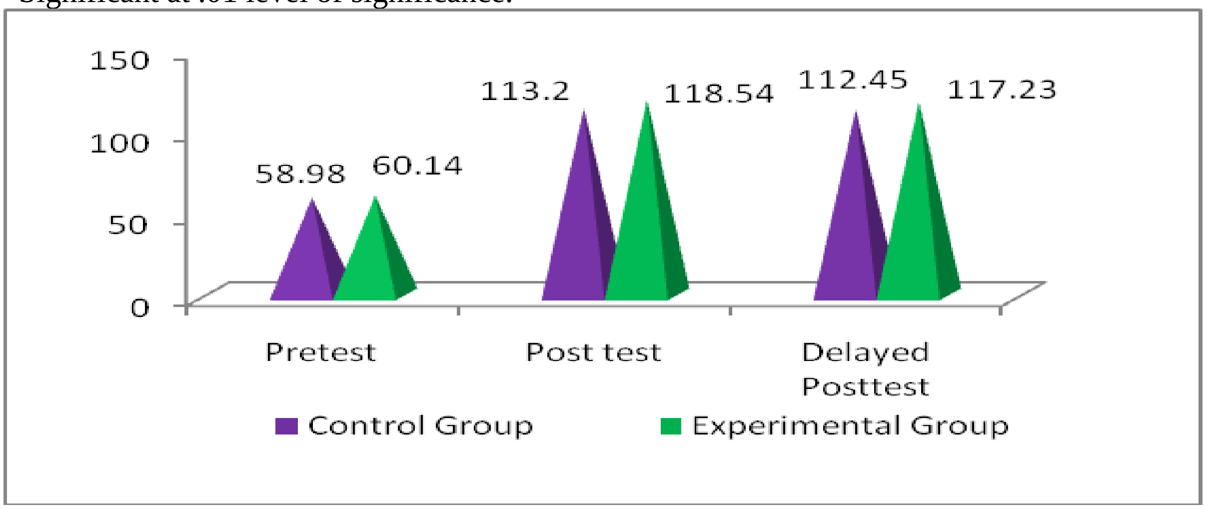


Table 1 shows that there is no significant difference between the control and experimental groups with respect to the pretest scores (CR = 1.11; *df*=194; P<0.01) for the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level . Significant difference was observed between the control and experimental groups with respect to posttest scores (CR = 4.19; *df* = 194; P<0.01) for the using technology for enhancing Problem

Solving Model in teaching Physics at the secondary level and delayed post test scores (CR = 3.71; *df* = 194; P<0.01) for the using technology for enhancing Problem Solving Model in teaching 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 using technology for enhancing Problem Solving Model in teaching 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 using technology for enhancing Problem Solving Model in teaching Physics at the secondary level

Groups	N	M	σ	CR	*df*	P
Control	98	62.18	9.38	10.02**	194	0.01
Experimental	98	77.53	11.92			

** Significant at 0.01 level of significance

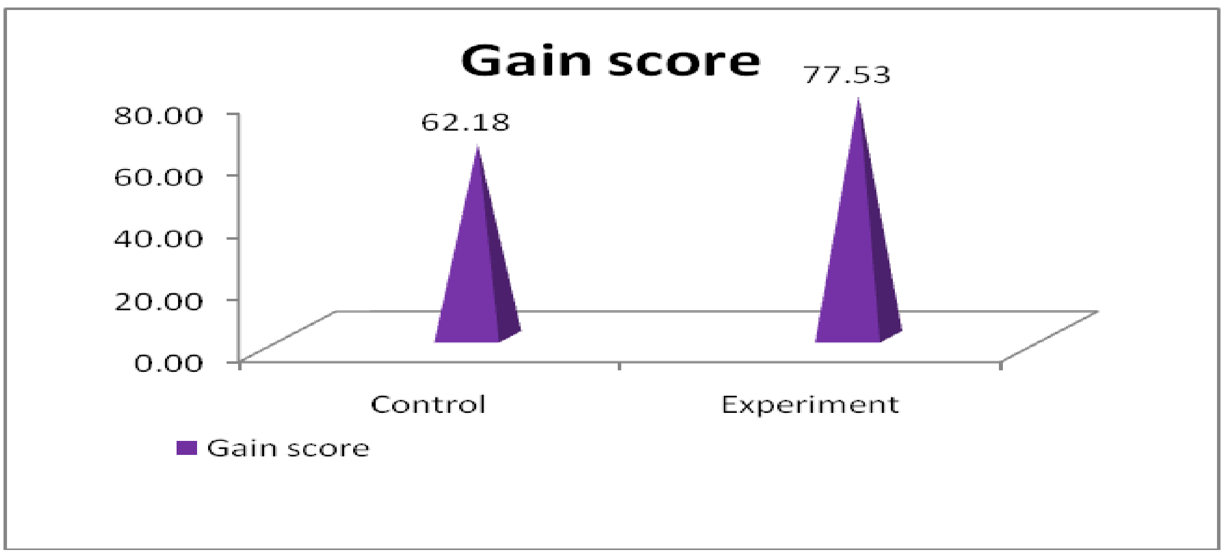


Table 2 shows that there is significant difference between the control and experimental groups with respect to the gain for the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level. (C.R = 10.02; *df* = 194; P<0.01). The experimental group (M_1 = 77.53) is found to possess greater gain than control group (M_2 = 62.18) with respect to the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level.

Comparison of the experimental and control groups with respect to the Adjusted Post test scores of the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level.

The effectiveness of using technology for enhancing Problem Solving Model in teaching 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 using technology for enhancing Problem Solving Model in teaching Physics at the secondary level for the experimental and control groups.

Test	**Mean** Exp	Con	**Source**	**Sum of squares**	***df***	**Mean Square**	**F**	**P**
Pretest (X)	60.14	58.98	Between groups	66.31	1	66.31	1.23	.05
			Within groups	10457.96	194	9.27		
			Total	10524.27	195			
Post test (Y)	118.54	113.20	Between groups	1395.56	1	1395.56	17.39	.01
			Within groups	15564.26	194	80.23		
			Total	16959.81	195			
Sum of Co deviates SS_{xy}			Between groups	304.19				
			Within groups	801.84				
			Total	1106.03				
Adjusted Post test(Y.X)	116.91	111.66	Between groups	1340.79	1	1340.79	16.69	.01
			Within groups	15502.78	193	80.33		
			Total	16843.57	194			

From Table 3 it is evident that the computed F_x ratio for the pretest scores for the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level (F_x = 1.23) is less than table values (F = 6.76; P<0.01 and F = 3.89; P <0.05). Therefore there is no significant difference between the experimental group and control group with respect to the pretest scores for the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level. F_y ratio computed for the post test scores for the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level (F_y = 17.39), is greater than the statistical table value (F = 6.76; 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 using technology for enhancing Problem Solving Model in teaching Physics at the secondary level shows that the calculated F ratio ($F_{Y.X}$ = 16.69) is significantly greater than the table value (F = 6.76; P<0.01). Further, from the adjusted post test means it is evident that the experimental group ($M_{Y.X}$ = 116.91) differ significantly from control group ($M_{Y.X}$ = 111.66) with respect to the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level. Table 3 reveals that the ANCOVA converge to the finding that the Problem Solving Model is effective in using technology for enhancing Problem Solving Model in teaching Physics at the secondary level than the traditional method currently being practiced in the secondary schools of Kerala. The Hypothesis of the "The Problem Solving Model is effective in using technology for teaching and learning of physics at the secondary level" is therefore valid.

Comparison of the experimental and control group with respect to retention of the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level

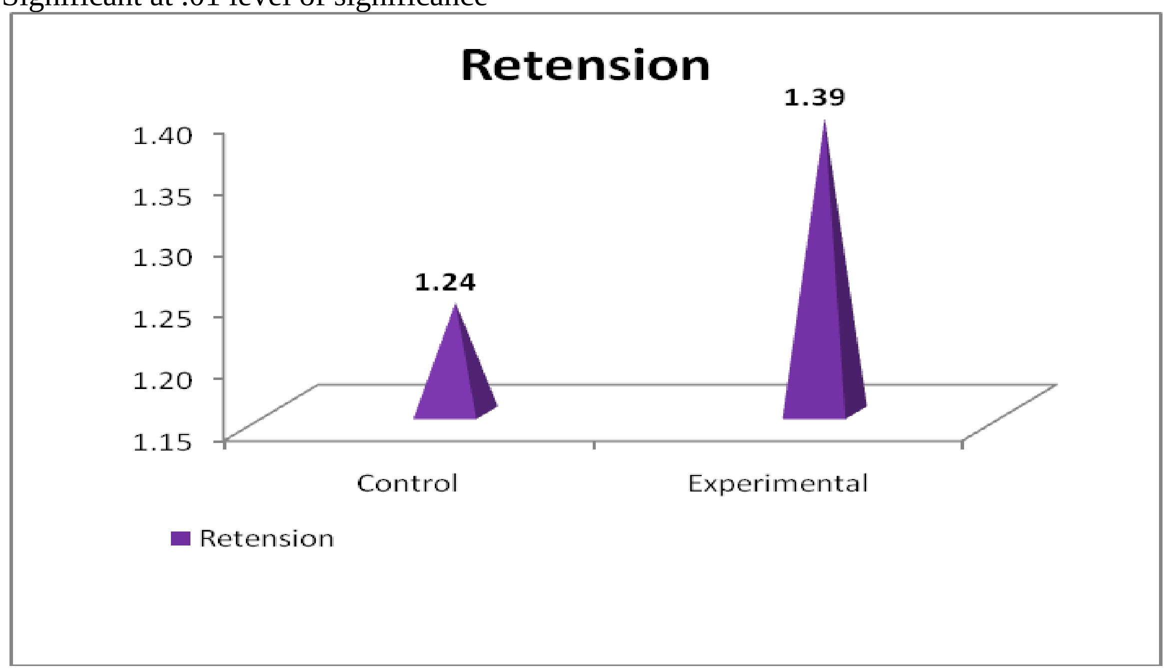
Retention test to analyze the delayed posttest the post test scores was conducted to compare the experimental group and control group with respect to the retention of **the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level** . The details of statistical analysis 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 using technology for enhancing Problem Solving Model in teaching Physics at the secondary level

Groups	N	M	σ	CR	*df*	P
Control	98	1.24	0.69	1.27	194	.01
Experimental	98	1.39	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 using technology for enhancing Problem Solving Model in teaching Physics at the secondary level (C.R = 1.27; *df* = 194; P<0.01). The mean scores of delayed post test for the experimental and control groups given in Table 4 makes it evident that the experimental group (M_1 = 1.39) has better retention of the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level than the control group ($M_2 = 1.24$).

Major findings

1. There is no significant difference between the control and experimental groups with respect to the pretest scores (CR = 1.11; *df* = 194; P<0.01) for the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level.

2. There is significant difference between the control and experimental groups with respect to posttest scores (CR = 4.19; *df* = 194; P<0.01) for the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level.

3. There is significant difference between the control and experimental groups with respect to the gain for the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level (C.R=10.02; *df* = 194; P<0.01). The experimental group (M_1=77.53) possess greater gain than control group (M_2 = 62.18) with respect to the using technology for enhancing Problem Solving Model in teaching 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 using technology for enhancing Problem Solving Model in teaching Physics at the secondary level ($F_{Y.X}$ = 16.69; *df* = 194; P<0.01). The experimental group ($M_{Y.X}$ = 116.91) differ significantly from control group ($M_{Y.X}$ = 111.66) with respect to the using technology for enhancing Problem Solving Model in teaching 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 = 3.71; *df* = 194; P<0.01) for the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level.

6. There is significant difference between the control and experimental groups with respect to retention of the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level (C.R=1.27; *df* = 194; P<0.01). The experimental group (M_1= 1.39) has better retention of the using technology for enhancing Problem Solving Model in teaching Physics at the secondary level than the control group (M_2 =1.24).

Implications

The findings of the present study revealed that there is a positive correlation between problem solving and technology used problem solving model 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. Since technology used problem solving model tends 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 technology used problem solving model.

Conclusion

Problem Solving Model for enhancing the technology used problem solving model 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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