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The Effect of Structured Problem Solving Strategy on Performance in Physics among Students Who are Enrolled in the University of Rizal System

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Abstract- "Mathematics is the language of Physics". This is the actual scenario of how Physics has to be taught by the teacher and be learned by the students through using formula, equations and analysis.

The study aimed to determine the effect of the structured problem solving strategy on performance in Physics among students who are enrolled in the University of Rizal System. There were 152 students taking up Physics I (General Physics) in the first semester of the SY 2013-2014 utilized in the study. The respondents were forty one (41) BT Drafting, forty (40) BT HRM, thirty nine (39) BT Electrical and thirty two (32) Biomedical Technician Coursestudents. Two experimental and two controlled groups were given pretest and posttest during the mid-term period covering concepts on Momentum, Work, Power and Energy together with simple machine. Specifically, the study attempted to answer questions on how do performance of the students in Physics compared when grouped according to the course and which method is more effective in teaching Physics, conventional or structured problem solving process. Dependent t-test was used to determine the significant difference on the performance in pretest and posttest of the experimental and controlled groups with respect to their courses, likewise, F-value was used to determine the significant difference on the level of performance in both groups after exposures to two different strategies.

It was then concluded that the course or program is not to be considered as a factor in the performance of the students from the controlled group and experimental group. Furthermore, the use of structured problem solving technique is an effective tool in enhancing the learning of the students regardless of the program.

Therefore, it was recommended that studies of the same process be conducted to other programs of the college and university as well to enhance the analytical thinking of the students and to increase the teaching competencies of the teachers.

Index Terms- Structured Problem Solving, Conventional Computation, Physics 1 and Experimental

I. INTRODUCTION

I understand the concepts. I just cannot do the problems". These two statements are common among Physics students. Students complain that despite the length of time they spend in Physics, they still do not seem to do well on examinations especially on problem solving. They thought that Physics is a very difficult subject which requires special skills to understand.

Many students who have already acquired a reasonably good understanding of the concepts and principles still lack higher thinking skills to enable them to solve Physics problems.

According to Williams that the basic question in Physics instruction is how to stress the process as well as the product of problem solving. Physics instructions and teachers generally accept that problem solving leads to an understanding of Physics. Increasing the problem solving abilities of students continues to be a major goal of Physics instructors.[1]

Students mimic the actions of their professors in solving problems without comprehending the structure of what is being done. They leave the course with a bundle of facts but without developing a personal problem solving strategy.

Linn pointed out that even teachers have a hard time conveying an understanding of Physics and reasoning skills, students are only concerned with passing the tests and turning in correct homework and assignments.[2]

It is important to state exactly which skills should be learned and demonstrated in Physics courses. The most common approach or problem solving involves exhibiting illustrative examples of problem solutions and then providing students with practice in solving similar problems.

However, as cited by Wright that the pioneer in the field of structured problem solving was Polya. In Polyas book "How to Solve it" he outlined a four step strategy for problem solving. The steps are description, planning, implementation and checking. In the first step, the student lists the given and desired information, draws a diagram of the situation. The second step tells the student to select the basic relations pertinent for solving the problem. The third step asks the student to execute the plan by doing all the necessary calculations. The last step tells the student to check whether the final answer makes sense.[3]

Wood has shown that special instruction in problem solving procedures can lead to substantially improved performance and these skills can be transferred to other areas of study.[4]

Furthermore, according to Reif procedural knowledge on how to execute a problem solution and conceptual knowledge of laws and principles which provide meaning or context to the procedures are both necessary for a meaningful solution to any problem.[5]

In this study, the researcher attemptedto prove that a structured problem solving if used as a part of comprehensive plan of Physics instruction can make a significant difference in the achievement of Physics students.

II. OBJECTIVES OF THE STUDY

The study determined the effect of structured problem solving strategy on performance in Physics among students enrolled in the University of Rizal System.

Specifically, the study sought answers to the following sub-problems:

1. How does the performance of the students in Physics compare when grouped according to the course?
2. Which of the following methods is more effective in teaching Physics?
   2.1 conventional problem solving
   2.2 structured problem solving

Based on the problems which the study aimed to answer, the null hypotheses were tested:

1. There is no significant difference between the pre-test and post-test scores of the experimental and control with respect to the lessons in classes of different courses.

2. There is no significant difference on the effect of the conventional teaching strategy and the structured problem solving in the performance of the students in Physics with respect to their courses.

III. METHODOLOGY

Sampling Site

The study was conducted in University of Rizal System, Morong Campus. The campus is situated in the Eastern part of Rizal Province and comprises four colleges namely, College of Industrial Technology, College of Sciences, College of Education and the College of Engineering.

The College of Industrial Technology was the focus since the researcher belongs to the College as well as the students to be utilized in the following courses, BT-Electrical, BT-Drafting, BT-HRM and BioMed Technology.

Population Frame and Sample Size

The total number of students that were utilized in the study was about 152 students all taking up Physics 1 (Gen. Physics) in the first semester of the SY 2013-2014. There will be forty-one (41) BT Drafting, forty (40) BT HRM, thirty nine (39) BT Electrical and thirty two (32) Biomed Technology students, respectively. Students were grouped accordingly, two (2) experimental group and two (2) controlled group were used for the study. Comparability test were used both in controlled and experimental group utilizing their grades in preliminary periods to establish and analyse the selection of the groupings.

Both pre-test and post-test were administered to the students grouped accordingly. The pre-test and post-test were 50 items composed of multiple choice type from the topics Work, Power and Energy. The test items were lifted from the standardized questions created by Dr. Christopher Bernido and Dr. Ma. Victoria Bernido from their book Learning Physics as One Nation written from the National Institute of Physics, University of the Philippines, Diliman, Quezon City under the sponsorship of CHED-PAFE

Teachers and Physics Educators who attended the seminar only have the copy of the test samples and books.

Sampling Technique and Research Design

The true experimental method was used in this study to determine the effect of structured problem solving strategy on performance in Physics among students of the College of Industrial Technology in the University of Rizal System, Morong Campus.

Gay thinks that this method is the only method of research which can truly test hypothesis concerning cause and effect relationship. He says further that the experimental method represents the most valid approach to the solution of problems, both practical and theoretical[6]. Arvy, et.al. add that the experiment is generally regarded as the most sophisticated research method for testing hypothesis.[7]

To minimize biased associated with teacher factor, only one teacher will handle the class. Since intact Physics classes were used in the study. A quasi-experimental design was utilized and this involved 2 experimental groups and 2 control groups. Comparability of the students' grade in the preliminary grading has been used to determine the groupings for treatment. Students are categorized as heterogeneous as observed from their grade results. The number of respondents were identified using the systematic sampling and distributes equally to experimental and controlled group.

The Conduct of the Experiment

Two-experimental groups and two-controlled groups were given pre-test before the start of the mid-term period covering the concepts on Momentum, Work, Power, Energy and Simple Machine. Immediately, as the lesson progress, the structured problem solving technique was treated to the experimental groups and the conventional strategy of solving problem was used by the controlled groups.

After the activities were done, post-test were given to both groups to determine their performance. The scores in the pre-test and post-test were treated using the t-test.

Statistical Treatment

The test results were tabulated and analysed using different statistical treatment.

Dependent t-test was used to determine the significant difference in pre-test and post-test of experimental and control groups with respect to the courses.

F-value was used to determine the significant difference on the level of performance of experimental and controlled groups after exposure to conventional teaching and structured problem solving strategy on topics Momentum, Work, Power, Energy and Simple Machine.

IV. RESULTS AND DISCUSSIONS

The Significant Difference Between the Pre-Test and the Post-Test of the Experimental and Control Groups with Respect to the Different Courses

Table 1 presents the computed t-value on the significant difference between the pre-test and post-test of the experimental group with respect to the courses.

Table 1. Computed t-value on the Significant Difference Between the Pre-test and Post-test of the Experimental Group with Respect to Their Courses

Courses	Pre-test		Post-test		Mean Diff.	df	t_c	t_t	H_o	VI
	Mean	SD	Mean	SD						
BT - HRM	2.60	1.25	5.53	1.67	2.93	29	7.42	2.045	R	S
Biomed Tech	1.97	1.14	5.47	1.23	3.50	29	13.16	2.045	R	S

R – Rejected; S - Significant

Table shows that with respect to the BT-HRM course, the computed t-value is 7.42 which is higher than the t-value of 2.045 using degree of freedom of 29 at 0.05 level of significance. The results show that there is significant difference between the pre-test and post-test of experimental group.

In Biomed Technology course, the computed t-value is 13.16 which is higher than the tabular t-value of 2.045 at 0.05 level of significance with 29 degrees of freedom. Therefore, the results show that there is significant difference between the pre-test and post-test of experimental group.

Moreover, the table revealed that there is significant difference between the pre-test and post-test results of experimental group with respect to their courses.

The results imply that structured problem solving techniques are effective tools in the improvement of the performance in Physics. The findings also show that the students in the experimental group benefitted from the experiment, hence the treatment is effective.

The results also affirm the suggestion of Bautista that supplementary materials and activities in teaching the subject ensured mastery on the part of the students.[8]

In addition, Wong affirmed the present study as cited by Castor that instructional materials in the classroom are the most effective way to catch up the interest and understanding of the pupils and help the teachers to teach better. He stressed that attractive and appropriate teaching aids stimulate action among pupils and help the teachers to teach better.[9]

Table 2 presents the computed t-value on the significant difference between the pre-test and post-test of control group with respect to two different courses.

Table 2. Computed t-value on the Significant Difference Between the Pre-test and Post-test of the Control Group with Respect to Their Courses

Courses	Pre-test		Post-test		Mean Diff.	df	t_c	t_t	H_o	VI
	Mean	SD	Mean	SD						
BT Drafting	2.90	1.45	4.57	1.56	1.67	29	4.92	2.045	R	S
BT Electrical	2.17	1.16	4.30	1.24	2.13	29	7.55	2.045	R	S

R – Rejected; S – Significant

Table shows that with respect to BT Drafting, the computed t-value is 4.92 which is higher than the tabular t-value of 2.045 using degree of freedom of 29 at 0.05 level of significance. The results show that there is significant difference between the pre-test and post-test results of control group.

In BT Electrical, the computed t-value is 7.55 which is higher than the tabular t-value of 2.045 at 0.05 level of significance with 29 degrees of freedom. Therefore, the results show that there is significant difference between the pre-test and post-test result of the control group

Moreover, the table revealed that there is significant difference between the pre-test and post-test results of control group with respect to their courses.

The results further imply that the traditional method of teaching is also effective in improving the performance of students in Physics.

The result is affirmed by the study of Belen as cited by Espiritu where she expressed that there is no best method of teaching that can be used for general pattern, but the objective, the teacher, the learner, the specific subject matter, time limitation and the availability of tools and equipment are major factors in determining the best method or technique of teaching.[10]

Table 3 presents the computed t- value on the significant difference between the pre-test of the experimental and control groups with respect to their courses.

Table 3. Computed t-value on the Significant Difference Between the Pre-test of the Experimental and Control Group with Respect to the Different Topics in Physics

Topics	Control Group		Experimental Group		Mean Diff.	df	t_c	t_t	H_o	VI
	Mean	SD	Mean	SD						
Momentum	2.90	1.45	2.60	1.25	0.3	58	0.84	2.02	A	NS
Work and Energy	2.17	1.16	1.97	1.14	0.2	58	0.66	2.02	A	NS
Power	2.37	1.20	2.87	1.26	0.5	58	1.55	2.02	A	NS
Simple Machine	2.50	1.41	1.87	1.45	0.63	58	1.68	2.02	A	NS

A – Accepted; NS – Not Significant

Table shows that with respect to BT-HRM on topics of Momentum the computed t-value is 0.84 that is lower than the tabular t-value of 2.02 using 58 degrees of freedom at 0.05 level of significance. The results show that there is no significant difference between the pre-test result of experimental and control groups.

In Biomed Technology, on Work and Energy topic, the computed t-value is 0.66 that is lower than the tabular t-value of 2.02 at 0.05 level of significance with a degree of freedom of 58.

Therefore, the results show that there is no significant difference between the pre-test result of experimental and control groups.

With respect to Power, the null hypothesis stating that there no significant difference between the pre-test result the experimental and control groups is accepted since the computed t-value 1.55 is lower than the tabular t-value of 2.02 at 0.05 level of significance with 58 degrees of freedom.

With lesson on Simple Machine, the computed t-value is 1.68 which is lower than the lower tabular t-value of 2.02 using 58 degrees of freedom at 0.05 level of significance. Thus, there is no significant difference between the pre-test results of the two groups.

Moreover, the table revealed that there is no significant difference between the pre-test results of experimental and control groups with respect to different lessons in Physics. The results imply that the two groups are equal in their performance in the different lessons in Physics at the beginning of the experiment.

Table 4 presents the computed t-value on the significant difference between the post-test of the experimental and control groups with respect to the different lessons in Physics.

The table shows that with respect to the Momentum, the computed t-value is 2.29 which is higher than the tabular t-value of 2.02 with 58 degrees of freedom at 0.05 level of significance between the post-test result of experimental and control groups.

Table 4. Computed t-value on the Significant Difference Between the Post-test of the Experimental and Control Group with Respect to the Different Topics in Physics

Topics	Control Group		Experimental Group		Mean Diff.	df	t_c	t_t	H_o	VI
	Mean	SD	Mean	SD						
Momentum	4.57	1.56	5.53	1.67	0.96	58	2.29	2.02	R	S
Work and Energy	4.30	1.24	5.47	1.23	1.17	58	10.82	2.02	R	S
Power	4.50	1.12	5.43	1.33	0.93	58	2.88	2.02	R	S
Simple Machine	4.37	1.35	5.07	1.24	0.70	58	2.05	2.02	R	S

R – Rejected; S – Significant

In Work and Energy, the computed t-value is 10.82 which is higher than the tabular t-value of 2.02 at 0.05 level of significance with a degree of freedom of 58. Therefore, the results show that there is significant difference between the post-test results of experimental and control groups.

With respect to Power, the null hypothesis stating that there is significant difference between the post-test result of experimental and control groups is accepted since the computed t-value 2.88 is higher than the tabular t-value of 2.02 at 0.05 level of significance with 58 degrees of freedom.

With lesson on Simple Machine, the computed t-value is 2.05 which is higher than the tabular t-value of 2.02 with 58 degrees of freedom at 0.05 level of significance. Thus, there is significant difference between the post-test results of the two groups.

Furthermore, the table revealed that there is significant difference between the post-test results of experimental and control groups with respect to the different lessons in Physics.

The results indicate that in teaching Physics using structured problem solving techniques yield better performance than the students who are exposed to traditional method.

The findings is supported by Arcales, according to her, self-concept toward science significantly contributes to students mastery level, it is suggested that science teacher should use varied motivating activities to make the subject appealing to the students and learn to love equations and numbers.[11]

The Significant Difference on the Level of Performance of Experimental and Control Groups after Exposure to Conventional Problem Solving and Structured Problem Solving Technique with Respect to the Lessons in Terms of Different Courses

Table 5 presents the computed F-value on the significant difference on the level of performance of experimental and control groups after exposure to conventional teaching and structured problem solving techniques with respect to lessons in Physics in terms of different courses.

Table 5. Computed F-value on the Significant Difference on the Level of Performanceof Experimental and Control Groups after Exposure to Conventional Teachingand Structured Problem Solving Techniques with Respect to Lessons inPhysics in Terms of Different Courses

Source of Variance	Ss	df	Ms	F_c	F_t	H_o	VI
Rows (Courses)	31	1	31	1.67	4.00	A	NS
Columns (Group Of Respondents)	152	1	152	12.31	4.00	R	S
Interaction (R x C)	9	1	9	0.49	4.00	A	NS
Within Groups	10.37	56	18.52				

A – Accepted; R – Rejected; NS – Not Significant; S - Significant

As shown on table 5, there is no significant difference on the interaction between the courses and the two groups of respondents since the computed F-value of 0.49 is lower than the tabular F-value of 4.00 at 0.05 level of significance along the interaction with 1/56, therefore the null hypothesis is accepted.

This implies that the courses or program is not being considered as a factor in the performance of the students from the control group and experimental group.

Significant Difference in the Pre-test and Post-test of the Experimental and Control Groups with respect to the Different Lessons in Physics according to the Courses

- In the pre-test and post-test of experimental group with respect to different lessons in Physics, the computed t-value are 7.42, 13.16, 9.29 and 10.91 respectively which are greater than the tabular t-value of 2.045 and 0.05 level of significance, therefore the null hypothesis is rejected.

- In the pre-test and post-test of control group with respect to the different lessons in Physics the computed t-values are 4.92, 7.55, 8.16 and 6.91 respectively which are greater than the tabular t-value of 2.045 and 0.05 level of significance, therefore the null hypothesis is rejected.
- In the pre-test of experimental and control groups with respect to the different lessons in Physics, the computed t-values are 0.84, 0.66, 1.55, 1.68 which are lower than the lower than the tabular t-value of 2.02 with 0.05 level of significance, therefore, the null hypothesis is accepted.
- In the post-test of experimental and control groups with respect to the lessons in Physics, the computed t-values are 2.29, 10.82, 2.88 and 2.05 which are higher than the tabular t-value of 2.02 with 0.05 level of significance, therefore the null hypothesis is rejected.

On the significant difference on the level of performance of Experimental and Control Group after exposure to Conventional Problem Solving and Structured Problem Solving with respect to the lessons in Physics in terms of different courses.

- The computed F-value of 0.49 is lower than the tabular F-value of 4.00 at 0.05 level of significance along the interaction within 1/56, thus accepting the null hypothesis.

Therefore, the use of structured problem solving techniques is an effective teaching tool in enhancing the learning of the students regardless of the course or program.

V. CONCLUSIONS

Based on the findings, the following conclusions are drawn. The study implied that the courses or program is not to be considered as a factor in the performance of the students using experimental and controlled group treatment. The use of the structured problem solving technique is an effective teaching tool in enhancing the learning of the students regardless of the program.

VI. RECOMMENDATIONS

The following recommendations are hereby offered. The same steps and procedures must be used to conduct the same study utilizing other programs of the college. The same research process must be conducted to other academic subjects such as mathematics and statistics in order to enhance the analytical thinking skills of the students. The use of other teaching tools and strategies must be used to conduct other study/research for the growth of the teachers and students in the teaching and learning process.

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