# Performance of Senior High School in Physics Problem-solving using Blended Learning Strategies

**By**

**Genaro M. Molina**
Romblon National High School Philippines
E-mail: genmmolina@gmail.com,

**Ester L Forlales**
Romblon State University, Philippines
E-mail: tingforlales@yahoo.com

## Abstract

The problem-solving skills in physics of senior high school students in Romblon, Romblon, Philippines was assessed during the pandemic period. Assessment was done with blended learning strategies utilizing internet connection to access lesson materials for self-directed learning. Lessons covered were in kinematics and students were provided with assortment of printed or digital modules, powerpoint explainer videos and lectures in google meet. Participants were twenty-one (21) students from Romblon National High School for the school year 2021-2022 and were purposively selected in the quantitative experimental research. Their performances were determined using the validated and reliable test questions in physics based on WISE problem-solving strategy. Analyses of data used the following statistical tools: Percentage, Mean, Standard Deviation, Analysis of Variance (one way), Kruskal -Wallis H test, T-test of dependent samples, Wilcoxon W-test, and Hedge's g test. The study concluded the blended learning strategies used were effective in improving the problem-solving skills. The most notable were the use of digital modules, powerpoint explainer videos and messenger for communication and support to students. Easy access to learning materials manifested to students. Difficulties in derivation of a formula by transposing the variables in equation to derive a working formula for solving the unknown were observed.

**Index Terms-** Blended Learning Strategies, Problem Solving in Physics

## I Introduction

The spread of coronavirus in the Philippines has elicited the release of advisories from the Commission on Higher Education (CHED) and Department of Education (DEPED) where schools are encouraged to prioritize students' continuous learning by utilizing all possible resources in introducing alternative modes of teaching and learning deliveries.

Blended learning was tapped to answer the issues of modular learning. Blended learning modality can be a combination of any of the following; face-to-face classes in classrooms, live e-learning, and self-paced learning modules as defined by Siemens, Gasevic, & Dawson [1]. It had an accompanying problem too such as the low accessibility of internet in rural areas aside from the gadget needed by the learners in low-income group [2], [3]. This made learners without online access are deprived of this blended learning methods.

The changing teaching strategies have profound effects to students' learning that needs to be carefully studied. Localized approaches in learning strategies in many parts of the country were important. Problems in education may vary depending on the condition of the community

which were addressed properly. In the PISA 2018 National Report of the Philippines [4] by the Department of Education (DEPED) that undertaken low performance of students in the subjects like English, Science, and Mathematics. These subjects are the foundation of Physics, which most students found to be very challenging. Low academic performance were observed in Physics of some Science, Technology, Engineering, and Mathematics (STEM) Grade 12 students of Romblon National High School (RNHS) from the school years 2017-2018 and 2018-2019 [5].

This dilemma of the STEM students was being compounded now with the lockdown of schools due to the pandemic. The usual face-to-face learning was diverted to modular and online education which all schools adopted as their method of delivery for the first quarter of school year 2020-2021 [6]. Mixing modular and online learning was the blended learning on this study. Modular learning is the use of printed self-learning modules. On the other hand, online learning uses internet and is virtual. The effectiveness of this method has not yet been assessed on its effect in the students' problem-solving skills in Romblon district.

Blended learning in this study is skills driven and enhancing blend based on the category by Valiathan [7] and Graham [8]. While the approach of the blend is medium-impact [9] as it created activities using the WISE strategy.

The numerous sub-skills (40) will make it hard for teachers in Physics to assess students' problem-solving skills [10]. For mathematical skills such as computation skills, geometry skills, algebra skills, interpretation of graphs and table skills, measuration skills, probability and statistic skills had a great impact on students Physics performance [11], [12].

There were four processes in problem solving: understanding the problem; devising a plan to solve it; implementing the plan; & reflecting on the problem [13]. It is still the most applicable process in answering physics problems now.

Enhancing strategy specially the WISE problem solving strategy had increased the math skill of students [14]. Notably, their grades improved considerably as compared to those who did not use the strategy. This can be used by the teachers and students to develop communication, increase accuracy, and promote organization in Physics.

### Ii .Objectives Of The Study

This study will determine the three (3) performances of Senior High School (SHS) in solving problems in Physics using the blended learning strategies such as: a)Digital Modular learning, online learning using powerpoint explainer video and messenger mobile application (DMLPPM) b) Digital Modular learning, online learning using Google meeting for lecture and messenger mobile application. (DMLGMM) c) Printed Modular learning, powerpoint explainer video and messenger mobile application (PMLPPM). The study specifically sought to answer 1. What is the pretest problem-solving performance of SHS STEM students in Physics at Romblon District? 2. What is the post-test problem-solving performance of SHS STEM students in Physics at Romblon District? 3. Is there a significant difference in the pre-test problem-solving performance of SHS STEM students in Physics as grouped? 4. Is there a significant difference in the post-test problem-solving performance of SHS STEM students in Physics as grouped? 5. Is there a significant difference in the pre-test and post-test problem solving performance of SHS STEM students in Physics as grouped? 6. Is there a significant difference in the mean gain in problem-solving performance of SHS STEM students in Physics?

## A. Theoretical Framework

Scaffolding theory is the basis of this research as it is the appropriate teaching method in having problem solving skill's development for students in physics. In this study, the teacher-researcher will serve as the expert who will teach the participants. The theory further asserts that when used effectively, it helps students to learn content they would not have been able to learn and process by themselves. Moreover, students will be taught and honed by an expert within a period, and afterwards letting them do the learning individually. As the time passes, the responsibility of learning will be transferred or relegated to the students when they are confident enough. As internet connection had made communication faster and easier now, Scaffolding is done between teachers and students through messenger, text, and call. Google meeting for actual lecture or communication can also be utilized. Scaffolding is a proven way of helping students in Physics problem solving but shall suit the students' needs based on their prior knowledge and skills [15].

Self-directed learning is based on the idea that a person is capable to take charge of one's own learning. Developed by Knowles [16], it starts with the learner's responsibility to identify their needs, making learning goals, creating a learning plan, finding learning resources, implement the plan, and assessing the learning process. This kind of learning is crucial for individuals to study on their own capacity as everyone struggles to cope with the pandemic. Using devices with internet access can develop learners to be in "active learning" algorithms specially in selecting their training data [17].

## B. Conceptual Framework

In this research, no face-to-face lectures was conducted due to restrictions on gatherings in the area. Digital modules were sent via internet using online platforms specifically the messenger mobile application which the learners have access to. For General Physics 1, the researcher used Google meeting for lesson discussions. Questions regarding the modules were made by students using their cellphones by text, call messages and most frequently using Messenger. Virtual classes using Google meeting application for every new lesson were conducted to help address concerns and answer questions that were asked by the participating students. PowerPoint explainer video links was also sent to participants in every lesson defending on combination of blended learning they belong.

The WISE strategy was used to achieve accuracy in problem-solving like the purpose of Wright and Williams [14]. The steps in the problem-solving were the systematic ways in solving and answering the problems in Physics. They guided the learners to the principles in the subject and provided solution using the patterned steps of the strategy. The positive results of the strategy were applied in the lessons on this study. This was also used to assess the problem-solving skills of the participants using the three blended learning.

Effects of blended learning approach used was applicable in current pandemic situation of education will determine learner's performance in solving problems in Physics. In figure 1, the independent variable are the blended learning strategies with WISE strategy on lessons conducted and the Physics problem-solving performance was the dependent variable.

| Blended learning Strategies with WISE Strategy Lessons<br>a) DMLPPM<br>b) DMLGMM<br>c) PMLPPM | ⟶ | Physics problem-solving performance |
| --- | --- | --- |

**Figure 1.** *The variables of the study*

### C. Hypotheses of the study

1. There is no significant difference in the pre-test problem-solving performance of SHS STEM students in Physics as grouped.
2. There is no significant difference in the posttest problem-solving performance of SHS STEM students in Physics as grouped.
3. There is no significant difference in the pre-test and post-test problem-solving performance of SHS STEM students in Physics as grouped.
4. There is no significant difference in the mean gain in problem-solving performance of SHS STEM students in

Physics.

## Iii. Materials And Methods

Quantitative experimental research design was employed in the study. Scores in formative test were used in statistical method to test the hypotheses. The physics problem-solving skills of the participants were assessed using the research instrument after applying the blended learning strategies. Numerical data were the scores in this test and only quantitative experimental research design was the most applicable for the study to determine the effects of the different blended learning strategies. Conducting lessons in physics were the experimental ways of determining the physics problem-solving skills. The scores of the participants in the test in lessons were analyzed to determine the effect of the blended learning strategies used. Analysis of the pretest and posttest on the test were determined in the study using the statistical tools to test the hypothesis. Only the students of RNHS-STEM strand were the participants of the study. The study was conducted from December 26, 2021, to February 10, 2022. To avoid conflict from regular online classes the lessons were conducted from 5:30 to 6:30 pm during weekdays.

### A. Subjects of the study

Purposive sampling was adopted due to very reason that only Romblon National High School offers STEM strand. Complete enumeration was employed; however, only twenty one (21) participants were reached out because of the following considerations: a.) internet connectivity issues; b.) some students were not active in social media due to the first reason cited and they don't have gadget for facebook and other social media account; and c.)

restrictions of COVID 19 hinders the researcher to reach out other expected participants.Two criteria were considered for the learners as part of this study. First was the consent of the parent/guardian and the learners. Second, they were using gadgets to access the lessons given using internet.

Groupings were based on their scores in quarter 1, module 2 in Physics 1. The module 2 is entitled "Motion" published by the DEPED Division of Romblon [18] and were used in all secondary schools of the province of Romblon. The composition of the three (3) groups were made having the same overall average scores on the module to ensure equal group performance comprising seven (7) members of each. The acronyms of the groups were based on the strategies used for them. These were DLMPPM, DLMGMM, and PLMPPM

## B. Research Instrument

The research instrument for the formative test in the lessons with different blended learning strategy used the study of Wright and Williams [14], a wise strategy for introductory physics. Twenty (20) Students of Corcuera National High School at Corcuera, Romblon, Philippines answered the created instrument for reliability test. It resulted to 43 multiple choice questions validated by Physics and Math experts. There were 13 questions for W-hat is happening (30%), 16 for I-solate the unknown (37%), 4 for S-ubstitute (10%), and 10 for E-valuate (23%).

## C. Data gathering procedure

Upon the approval of RNHS on Dec. 3,2021 and DEPED-Division of Romblon on Dec.13,2021, the conduct of the study had started. Consent of the parent/guardian and participants were also secured. On Dec. 27, 2021, the pre-test was conducted. The pre-test scores were computed for analysis of variance, and it resulted there was no significant difference in the scores of the three groups.

The three lessons were applied into the three groups of respondents. Each had different lesson under kinematics topic and had 3 strategies in blend of learning. Lessons were conducted among groups until all had completed the 3 different lessons with 3 strategy of blended learning approach. Each lesson has 2 objectives, thus, there were 18 treatments. All lessons were all made using the WISE strategy. The practice exercises of these lessons were created following this problem-solving strategy.

## D. Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) was used for the statistical analysis on the data. The prettest scores of the groups were compared using analysis of variance (ANOVA one way ). It was the comparison of mean scores between groups to determine the performance of each group. This was also used to determine the mean gain scores of the performances between groups to access if there were differences between the strategies used. The significant level ($\alpha$) of 0.05 was the acceptance value. Kruskal -Wallis H test was used to   compare the posttest ranking of each member in the groups. The mean ranks were compared with $\alpha = 0.05$ as the significance level. The mean scores in pretest and posttest of DMLPPM group and DMLGMM group were compared and determined the changes using T-test (t) of dependent samples the level of acceptance was set at $p \leq 0.05$. The data of PMLPPM used the Wilcoxon W-test to determine the changes in pretest to posttest ranks. The acceptance level was set at $p \leq 0.05$. The effect on the size in all of the groups was determined using Hedge's g test The following value of Hedge's g were used to determine the effect: 0.2 (small), 0.5 (medium), and 0.8 (large).

# Iv. Results And Discussion

## A. Pretest mean scores of the participants

Considering the pretest of the participants (Table I ) it showed that all groups attained below the passing mark (80%). When arranged from highest to lowest, PMLPPM group ranked first, followed by DMLGMM group and DMLPPM group with mean ratings of 45%, 43%, and 42% respectively.

Regarding four steps of WISE strategy, they had difficulties in "Isolate" step, this showed their existing weak mathematical skills. It includes the determination of formula and memorizing equations needed to solve the problems. Derivation of formula was the transposition of variables in each formula. This skill was part of the subject algebra taught since junior high school. In the study of Hegde and Meera [19], this difficulties in problem-solving in Physics was also observed. Without the right formula in solving problems will result to incorrect answers as shown both "Isolate" and "Evaluate" steps having low mean scores in this study.

**Table I.** *Pretest Mean Score*

| Group | W Mean (%)[a] | I Mean (%)[b] | S Mean (%)[c] | E Mean (%)[d] | Total Mean (%)[e] |
|---|---|---|---|---|---|
| PMLPPM | 8.00 (62)[a] | 6.00 (38)[b] | 2.29 (57)[c] | 3.14 (31)[d] | 19.43 (45)[e] |
| DMLGMM | 7.71 (59)[a] | 4.86 (30)[b] | 2.29 (57)[c] | 3.57 (36)[d] | 18.43 (43)[e] |
| DMLPPM | 6.86 (53)[a] | 5.29 (33)[b] | 2.43 (61)[c] | 3.57 (36)[d] | 18.15 (42)[e] |
| Over-all | 7.52 (58)[a] | 5.38 (34)[b] | 2.34 (59)[c] | 3.43 (34)[d] | 18.67 (43)[e] |

Note: Based on perfect score of a (13) , b (16) , c (4) , d (10)  for each step of WISE Strategy & e (43) total score, respectively.

## B.  Posttest mean scores of the participants

Considering the post test of the participants (Table II) it showed that all groups attained higher grades. When arranged from highest to lowest, DMLPPM group ranked first, followed by PMLPPM group and DMLGMM group with mean ratings of 77%, 71%, and 67% respectively.

In terms   of WISE strategy, the result  of DMLPPM group   passed  the "I-solate" step. This was the only group mean result that managed to pass the proficiency as the other groups had lower mean scores in all steps of the WISE strategy. A big improvement in overall performance was observed in "I-solate" step after using the blended learning strategies, from 34% (pretest) to 72% (posttest). The least increase was at "S-ubstitute" step, from 59% (pretest) to 69% (posttest).

**Table II.** *Posttest Mean Score*

| Group | W Mean (%)[a] | I Mean (%)[b] | S Mean (%)[c] | E Mean (%)[d] | Total Mean (%)[e] |
|---|---|---|---|---|---|
| DMLPPM | 10.00 (77)[a] | 12.86 (80)[b] | 2.71 (68)[c] | 7.57 (76)[d] | 33.14 (77)[e] |
| PMLPPM | 9.43 (73)[a] | 11.29 (71)[b] | 3.00 (75)[c] | 6.71 (67)[d] | 30.43 (71)[e] |
| DMLGMM | 9.14 (70)[a] | 10.43 (65)[b] | 2.57 (64)[c] | 6.71 (67)[d] | 28.85 (67)[e] |
| Over-all | 9.52 (73)[a] | 11.53 (72)[b] | 2.76 (69)[c] | 7.00 (70)[d] | 30.81 (72)[e] |

*Note: Based on perfect score of a (13), b (16) , c (4) , d (10)  for each step of WISE Strategy & e (43) total score, respectively.*

## C. Difference in the pretest of the participants

Table III showed the problem-solving performance of the participants before the conduct of the study. The computed F-value was 0.119 and significance level of 0.889. This indicated that the null hypothesis was accepted. And there was no significant difference in the groups pretest scores. It established the equal performances of members of each group at the start of the research.

**Table III.** *Anova Of Pretest*

| Source of Variance | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 6.381 | 2 | 3.19 | | |
| Within Groups | 484.286 | 18 | 26.905 | 0.119 | 0.889 |
| Total | 490.667 | 20 | | | |

## D. Difference in the posttest of the participants

Table IV showed the problem-solving performance of the participants after the conduct of the study. The computed Kruskal Wallis H was 0.679 and significance level of 0.712. This indicated that the null hypothesis was accepted. And there was no significant difference in the group's posttest scores. This proved the same performances of the three (3) groups in the research using different blended learning strategies.

**Table IV.** *Kruskal Wallis of Posttest*

| Groups | n | Mean Rank | Kruskal-Wallis H | df | Sig |
|---|---|---|---|---|---|
| DMLPPM | 7 | 11.71 | | | |
| DMLGMM | 7 | 11.86 | 0.679 | 2 | 0.712 |
| PMLPPM | 7 | 9.43 | | | |
| Total | 21 | | | | |

## E. Difference in the pretest and posttest of the participants

The computed t-value between pretest and posttest of DMLPPM group was -5.728 and p-value of 0.001 in table V. It rejected the null hypothesis, thus there was significant difference in pretest and posttest of DMLPPM group. For DMLGMM group, the t-value was -2.512 and p-value 0.046 which also rejected the null hypothesis. There was significant difference in the pretest and posttest of DMLGMM group . Lastly for PMLPPM group in table VI, W-value was 2.120 and p-value of 0.034. It also rejected the null hypothesis. There was significant difference in PMLPPM group's pretest and posttest.

**Table V.** *T-test of Pretest -Posttest of DMLPPM and DMLGMM*

| Pair | Source of variance | Mean Difference | SD | t-value | df | p-value |
|---|---|---|---|---|---|---|
| Pair 1 | Pretest DMLPPM – Posttest DMLPPM | -15.000 | 6.928 | -5.728 | 6 | 0.001 |
| Pair 2 | Pretest DMLGMM – Posttest DMLGMM | -10.429 | 10.983 | -2.512 | 6 | 0.046 |

**Table VI.** *W-test of Pretest -Posttest of PMLPPM*

| Pair | Source of variance (PMLPPM) | n | Mean Rank | Sum of Ranks | W-value | p-value |
|---|---|---|---|---|---|---|
| Pair 3 | a-Negative Ranks | 1[a] | 1.5 | 1.5 | | |
| | b-Positive Ranks | 6[b] | 4.42 | 26.5 | 2.120[b] | 0.034 |
| | c-Ties | 0[c] | | | | |
| | Total | 7 | | | | |

The significant increase on their problem-solving skills in physics was also proven using Hedges' g. The computed values (table VII ) of Hedges' g were 2.953, 1.044 and 1.961 for DMLPPM, DMLGMM, and PMLPPM groups respectively. These were all above 0.8 which means the effects of the increase in performance were large among the members of each group.

**Table VII.** *Hedges' g of DMLPPM, DMLGMM and PMLPPM*

| Pair | Source of variance | Hedges' g |
|---|---|---|
| Pair 1 | Pretest DMLPPM – Posttest DMLPPM | 2.953 |
| Pair 2 | Pretest DMLGMM – Posttest DMLGMM | 1.044 |
| Pair 3 | Pretest PMLPPM – Posttest PMLPPM | 1.961 |

### F. Difference in the mean gain of posttest of the participants

As group, DMLPPM strategy had the best improvement as it attained the highest percent mean posttest and percent mean gain of 77.0% and 34.9% (table VIII), respectively. On the other hand, the least improvement was using DMLGMM with 67.2% in posttest and 24.4% mean gain. All groups had increased problem-solving performance after using the blended learning strategies like the study of Sivakumar & Selvakumar [20].

**Table VIII.** *Percent gain of the participants*

| Blended Learning Strategy | Pre-test Score | Post-test Score | Per-cent (%) a | Change | Gain (%) b |
|---|---|---|---|---|---|
| DMLPPM | 18.1 | 33.1 | 77.0 | 15.0 | 34.9 |
| PMLPPM | 19.4 | 30.4 | 70.7 | 11.0 | 25.6 |
| DMLGMM | 18.4 | 28.9 | 67.2 | 10.5 | 24.4 |

Note: a.-Percent of Posttest based on total score of 43

### b- Percent gain based on total score of 43

The mean gain after the conduct of the study used the posttest scores in table IX. The computed F-value was 0.473 and p-value of 0.631. The null hypothesis was accepted. Thus, there was no significant difference in the mean gain in problem-solving performance of the participants on all group after having three blended learning strategies.

**Table ix.** Anova of the mean gain of posttest

| Source of Variance | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 84.667 | 2 | 42.333 | | |
| Within Groups | 1610.571 | 18 | 89.476 | 0.473 | 0.631 |
| Total | 1695.238 | 20 | | | |

The result of this study was for learners with access to internet using their gadgets. The three blended learning strategies used were effective in improving the problem-solving skills of the students in Physics as manifested by the result of the study. The most notable was the use of digital modules, PowerPoint explainer video, and messenger for communication and support to students. Most participants using this blended learning achieved better performance in problem-solving as indicated by the data gathered. The convenience of having easy access to learning materials wherever the students were had shown better performance in physics problem-solving.

In the problem-solving skills there was an observed difficulties of the STEM students in derivation of formula. It showed the importance to strengthen these skills in the junior high

school especially in Algebra subject. It hindered most of the participants to answer physics problems because they could not determine the formula needed. They had difficulties of transposing of variables in the formula by separating known and unknowns. It resulted to almost the same performances of the participants in general after the lessons were conducted.

# Acknowledgement

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