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RESEARCH PAPER

Use of visual representation and peer-assisted approach in developing students' mental models in solving physics problems

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Abstract

This study was carried out to improve students' academic performance in high school Physics. The respondents were 60 selected students from the Science, Technology, and Engineering (STE) sections of Esperanza National High School. This study focused on determining the effect of using visual representation and peer-assisted approach on students' academic performance in Physics, especially on their problem solving skills. A pretest-posttest control group design was used to analyze and interpret the data. Mean, variance, and t-test were applied to describe the collected data and make inferences as well. Findings revealed that control and experimental groups had comparable problem solving skills in Physics before the conduct of the study. After their exposure to various visual representations and peer-assisted discussions, students from the experimental group obtained higher gain scores compared to that of the control group which was not exposed to this intervention, and subjected only to the traditional chalk-and-talk teaching strategy. The developed visual representation materials in Physics had greatly influenced students' academic performance in the experimental group. It is indeed concluded that the use of visual representation and peer-assisted approach in modeling Physics problems is effective.

Keywords: Visual Representation, Peer-assisted Approach, Mental Models and Physics Problems

Introduction

Nowadays, education has become the center of system transformation locally and internationally. Dynamic trends of education system are indeed on their maximum speed. The curriculum is seeking for more strategic approaches in instruction to improve the learning process of the students. This can be a challenging yet beneficial to both teachers and students, especially in the field of science education reform. Students with steady socio-economic status have differ experience from those who hardly access the quality education due to financial constrain in sending their children to more equipped schools in the region, the students socio-economic status have strong relation to their academic achievement in school (Sirin, 2005).

In addition, it is also vital to consider that location, and the manner of instruction would have strong impact on the academic performance of the students. As stated by Levitt (2001), teaching science needs more advance techniques where the center of learning procedures is the students, that is, to develop their scientific literacy and critical thinking in a given set of topics. Learning science in school entails that instruction should be multi-approaches catering the needs of the students in understanding verbal, mathematical, and visual representations of the concepts and processes (Prain & Waldrip, 2007). As a result, students would develop their full potentials in interpreting and constructing scientific texts.

Many educators today are challenged on what strategy could cater the needs of students to increase their understanding of science concepts, particularly in the field of Physics. Teachers are spending more time for continuous effort to stay in touch of new strategies and techniques in facilitating learning inside the classroom. Tsai (2002) affirmed that by developing students' potential to integrate science in their environment and link it to their personal perceptions develops constructivist way of learning inside the classroom. More engagement of students in the learning process could also cultivate their creative thinking and way of judgment.

Getting updated and exploring new techniques in science instruction is necessary to ensure effective delivery of the lesson to the students consistent with the vision and mission of the school. Renkl and Atkinson (2010) emphasized that there is still lacking in enhancing the problem solving skills of the students particularly in Physics. Developing students' mental models in solving physics problems needs various strategies such as visual representation and peer-assisted instruction.

The more creative and advance the instruction is, the better the learning process is achieved. The visual ability of the students is a vital tool to help develop creativity in problem solving, diagrams and other visual representations are necessary tool in solving problems (Davenport et al. 2008). Beginner students who are able to solve problems are simply following step by step process and bringing together formulas following basic features of solving problem (Larkin & Reif, 2007). Students who were able to visualize the problem and draw meaningful interpretation of the situation tend to draw correction solution (Moore & Carlson, 2011). Some students are simply memorizing formula, some are totally lacked the basic skills of problem solving and scientific literacy that resulted to poor performance.

This matter pushed the interest of the researcher to develop new teaching instructions that would develop the students' creativity and cultivate their mathematical skills and mental modeling abilities in physics.

On the above premise, the researcher established the use of visual representation and peer-assisted approach in developing students' mental models in solving physics problems

Conceptual Framework

The research paradigm of this study is shown in Figure 1 below which illustrates the independent and dependent variables. The ***independent variables*** included the teaching methods in Physics for the control and experimental groups. The ***dependent variables*** involved the results of the pretest and posttest of the control and experimental groups.

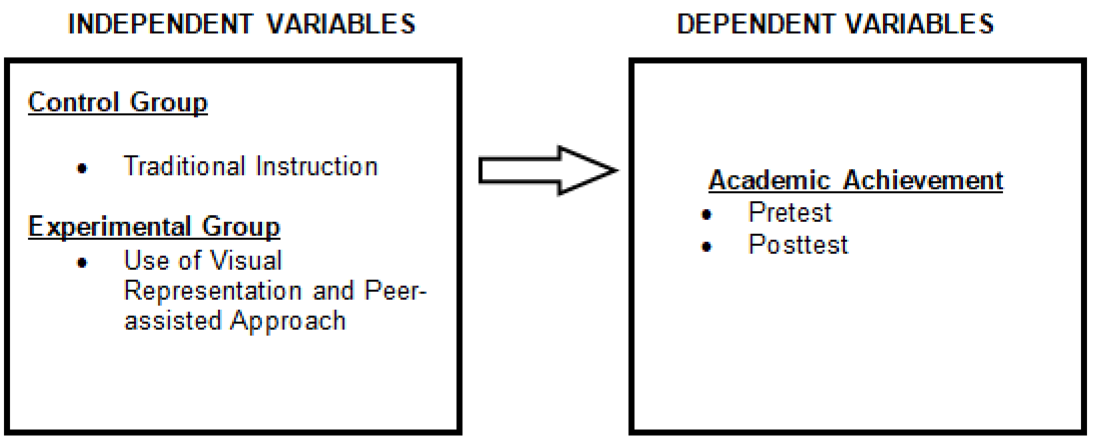

Figure 1: Research paradigm showing the independent and dependent variables of the study

Statement of the Problem

This study determined the effect of the visual representation and peer-assisted approach in developing students' mental models in solving physics problems. Specifically, it sought answers to the following questions:

1. Is there a significant difference in the pretest scores of the control and experimental groups?
2. Is there a significant difference in the pretest and posttest scores of the control group?
3. Is there a significant difference in the pretest and posttest scores of the experimental group?
4. Is there a significant difference in the posttest scores of control and experimental groups?

5. Is there a significant difference in the gain scores of control and experimental groups?

6. What are the problems encountered in the implementation of the study?

Research Hypotheses

1. There is no significant difference between the problem solving skills of the control and experimental groups before the experimentation.

2. There is no significant difference between the problem solving skills of the control group before and after the experimentation.

3. There is no significant difference between the problem solving skills of the experimental group before and after the experimentation.

4. There is no significant difference between the problem solving skills of control and experimental groups after the experimentation.

5. There is no significant difference between the gain scores of control and experimental groups

Significance of the Study

Visual representation and peer-assisted approach generates students' mental models in solving physics problems which eventually cultivate students' creativity mainly in problem solving activity. It would build interest and cooperation of students to any problem solving task in physics which is a basic problem of the teacher and also develop the confidence of students due to the collaborative approach of the said physics pedagogy. It would provide opportunities for the students to learn in their own styles knowing that each of them works best in their own techniques. Students can develop creativity in solving the given problem despite non-provision of the formula needed in the topic. It would offer a chance to explore the problem rather than solving it using conventional process that is simply following the formula given. It would increase the students' ability to examine the given problem and provide a partial visualization on the problem through mental modeling that could possibly pour out creative approach to arrive at a certain answer. Visual understanding of the problem would lead the students to discover creative techniques in solving a problem.

In any problem solving activity, teachers are only there to supervise and facilitate the learning process. The students are allowed to assist their peers to analyze the problem and come up with answers based on collaborative discussions within the group. For those students who are slow learners, they have the chance to learn the idea by the help of their peers who are assigned to give assistance to slow learners. In this way, slow learners can participate in the discussion until they get the main idea and justification of the problem. The highlight of this study is that, students would be able to develop and improve their problem solving skills. This would be carried out by giving them ideas and knowledge on how to justify their answers scientifically, providing visual representations of the problem and peer-assisted to help the students support their answer. Visual representation is basically the first step in solving a physics problem. Therefore, establishing the study would give the students a chance to explore their problem solving ability especially in developing their creative way to solve the problem.

Scope and Limitation

This study was limited to determine the possible implications of applying the use of visual representation and peer-assisted approach to develop students' mental model in solving physics problems to selected high school students. This technique was applied to enhance the problem solving skills of students and to arouse interest in learning the subject. The study was conducted at Esperanza National High School. The Grade 10 Science, Technology and Engineering (STE) students from sections A and B were the respondents of the study. Uniformly accelerated motion, projectile motion, and some selected topics in physics were discussed in both groups. The traditional instruction was used in the control group, while the use of visual representation and peer-assisted discussions and other form of visual aids were utilized in the experimental group to compare their problem solving skills.

This study did not affect the academic grades of students. Their scores were not reflected on their report cards. The purpose of the study was solely to determine the effect of visual representation and peer-assisted on the problem solving skills of high school students and the implication on their academic performance. All results obtained in this study were kept confidential and were not reflected on the formal class grades.

This study only utilized the following descriptive statistical tools such as mean, variance and inferential statistical tool such as t-test. The study was conducted at Esperanza National High School and lasted for six (6) weeks.

Methodology

Research Design

In this study, two intact classes were selected and assigned as control group and experimental group through draw lots. This was a quasi-experimental research design that utilized a pretest and a posttest with an aid of qualitative method using interviews and focus group discussions (FGDs). To ensure that the two groups were equal in terms of their prior knowledge in Physics, a standardized test adopted from the Department of Education (DepEd) National Achievement Test (NAT) Reviewer for Grade 10 students was given before giving the pretest to both groups. The result of the test revealed that the two groups were comparable in terms of knowledge and problem solving skills in Physics. Since the two groups were comparable, they could become ideal respondents for attaining the objectives of this study. A pretest was then administered to both groups carefully to avoid leakage of the test.

The figure below shows the design of this study.

Experimental Group	O_1	X	O_2
		- - - - - - -	
Control Group	O_3		O_4

O_1 = pretest of the experimental group
O_2 = posttest of the experimental group
O_3 = pretest of the control group
O_4 = posttest of the control group

X = intervention that will apply to the experimental group

The dependent variables of the study were the results of the pretest and posttest. On the other hand, the teaching methods employed in the two groups (control and experimental) were the independent variables.
The two groups had their pretest in November 2016 before the start of the experimentation process and their posttest was administered in December 2016 in the form of 50-item multiple choice questions and 2 items of problem solving.
For the experimental group, the use of visual representation and peer-assisted approach were employed during lecture classes in physics. In problem solving activities, students were allowed to group together to solve a given problem and to discuss among themselves on how to find solution to the problem. During the group activity, students were given a chance to assist their peers to develop teamwork in attaining the objective of the activity. Various visual representations such as graphs, figures, shapes, and sketch of the phenomena were utilized to solve the problem. The students were given ample time to finalize their answers and present them in class. At the end of the activity, each group representative was asked to present and justify their answers. On the other hand, the control group did not have any of the above intervention activities and was subjected to the traditional instruction using chalk-and-talk method alone.

Population

This study was conducted at Esperanza National High School, Poblacion, Esperanza, Sultan Kudarat. Sections A & B of Grade 10 STE were selected as the respondents of the study since these sections were the best in the Grade 10 level in this school. STE means Science, Technology, and Engineering.

Sample Size

The study was conducted utilizing a total of sixty (60) respondents from Grade 10 STE students of Esperanza National High School, Poblacion, Esperanza, Sultan Kudarat for the School Year 2016-2017.

Sampling Procedure

The researcher selected the Grade 10 STE sections A and B students who were enrolled in Esperanza National High School, Poblacion, Esperanza, Sultan Kudarat for the School Year 2016-2017. A simple random sampling method through draw lots was used in assigning one intact class as the experimental group and the other one as the control group. The Grade 10 STE (Section A) became the experimental Group while the Grade 10 STE (Section B) became the control group. The two groups were comparable based on the standardized test results.

Research Procedure

The validity and reliability test of the research instrument were done before the conduct of the study. This was done to ensure that the test questionnaire was valid and reliable and had passed the standards of the experts. Communication letters were sent to concerned people as protocol.
The Standardized Test was administered on November 4, 2016. The results showed that the two intact classes, Grade 10 (A and B) were comparable as shown in table below.

Table 1: Equivalence test on problem solving skills in Physics

GROUPS	n	Mean	CV (%)	t_{comp}	df	p-value
Group A	30	7.9	41.52	0.796^{ns}	58	0.429
Group B	30	8.7	40.34			

ns - not significant at 5% level since p-value = 0.429 > 0.05

Thus, draw lots were done to assign which section belongs to the experimental and control group. Finally, STE section A was drawn as the experimental group and STE section B as the control group.

The experimentation started on November 7, 2016 with the administration of the pretest to both groups. After the pretest, a series of physics lectures/activities were given to both control and experimental groups. Each class was given a series of lectures, activities, homeworks, and quizzes to monitor the progress of their learning ability. The formal class activity was conducted from Monday to Friday. Lectures were given a time of 120 minutes as prescribed by the Department of Education for all the Science subjects. During the experimentation process, there were some instances that the teacher has extended time to some activities for about five (5) to ten (10) minutes to give students a time to finish the activity particularly when they are doing the activity outside of the classroom, this time extension given to the experimental group was also given to the control group to avoid any biases of the study in terms of the time allotment that has been observed. The students in both control and experimental groups were given a chance to ask questions to clarify things that made them confused. The control and experimental groups were given the same set of examples and explanations. The only difference between the control and experimental groups was the intervention given to the experimental group.

During the experimentation, series of lectures within the same topic were conducted to the control and experimental groups for 5 days a week. The same topics were presented similarly where the particular topic was discussed. Then examples were given and explained. Activities and assignments were also given to the same group, the only difference between the groups was the intervention given to the experimental group involving the use of visual representation and peer-assisted approach. The experimental group was taught with an integration of visual representations, using of laboratory equipment like the sets of inclined plane with a metal ball to describe how uniformly accelerated motion behave in a given situation for students to have an actual view of what is happening on the object moving in a uniform motion. Improvised instruments such as a slingshot with a rubber loaded with a small tiny stone to describe the trajectory of a Projectile motion in helping students create a mental models leading to the extraction of formulas for a given situation. Using of multimedia back up to show an actual picture/video of cars collision as an aid for understanding momentum, and to show how trajectory applies when a jet fighter dropped a bomb. To arouse students' attention and participation, sometimes a real demonstration of what has been discussed is used such as asking a volunteer student or group to drop a stone from the second floor of the build to the ground and letting the remaining students or groups observe the factors affecting free falling objects at the moment of the lecture to enhance their mental models in solving Physics problems. The students from the experimental group were free to discuss with their peers the concepts and they were given ample time to explore their ideas and present their collaborative output in front of the class by presenting their visualization and mental models regarding the problems introduced. They were also given a series of assignments that require peer-assisted discussions among the group to collaboratively solicit ideas within the group. In general, the experimental group was exposed to different visual representations of the topics and students were allowed to have peer-assisted discussions within the group, demonstrate activities and share their developed mental models based on the given problems. The control group did not have any of the above intervention and was solely subjected to traditional instruction using chalk-and-talk method of teaching.

At the end of the treatment phase, a posttest was administered to both groups. The teacher- researcher himself conducted the pretest and posttest to ensure instrument validity and reliability of the pretest and posttest scores. Both groups were informed about the schedule of posttest to give them enough time to study.

Research Instrument

The researcher constructed two sets of research instruments in which the first set consisted of two parts: A 50 items Multiple Choice Questions derived from the topics of motion, Newton's Law of Motion, Free falling object and momentum which have undergone the validity and reliability test of the research instrument, and the Problem Solving Questions which was consisted of 2 problems from the topic of Projectile Motion. The second set was the interview and focus group discussion (FGD) composed of a 3 guided interview questions conducted to a group of students from the experimental group to determine the problem encountered in the implementation of the study. The instruments were shown to the experts for any improvement. Its content was pre-validated by Science experts to determine its weaknesses. Originally, an 80-item Multiple Choice Test and 5 Word Problems were prepared for the validation purposes. The first validation process was done by administering the 80-item Multiple Choice Test and 5 Word Problems to 30 Grade 11 HUMSS students. After the first administration, the instrument was refined. From 80, the Multiple Choice Test became 50 items after screening out questions which were very easy and very difficult. From 5 word problems became 2 questions only. From 5 interview guided questions, it became 3 interview questions after screening out the other questions. Some of the items and questions identified to be very difficult were reworded and modified purposely to go with the competencies covered in this study. The remaining 50-item Multiple Choice Test, 2 Word Problems and 3 Interview guided questions served as the main instrument used in the study. Following the validation was the reliability testing which involved 30 Grade 11 STEM students. The students who were used in the validation and reliability tests were not subjects of the study and had already taken and passed Physics subject.

The Multiple Choice Test included the following topics: uniformly accelerated motion, projectile, and some selected topics in Physics. The Word Problem was scored using the Problem Solving Rubric modified by the researcher. The rubric was employed in checking the result of problem solving and to validate the extent to which the use of visual representation and peer-assisted approach affect the development of students' mental model and problem solving skills. It also enhanced the students' creativity to solve problems. The research instrument which was composed of Multiple Choice, Word Problems and Interview Guided Questionnaires certainly developed students' higher order thinking skills (HOTS).

Data Collection

The results of the pretest and posttest from the control and experimental groups were then encoded in the Microsoft excel software. Before the weekdays ended, an interview was conducted to identify the issues and concerns of the students from both groups. Leakage and contamination of the teaching strategies and materials were avoided since the two STE sections were temporarily located in two different buildings to ensure the validity and reliability of the research process.

After the experimentation stage, focus group discussion (FGD) was scheduled to validate the information given by the students during the interview sessions. A strategy to solicit and gather the necessary data and information was done courteously and in a friendly approach to the students involved in the study. The researcher clearly explained the purpose of the study.

Statistical Treatment

The relevant data generated from the pretest and posttest of the control and experimental groups were collected, tabulated and subjected to appropriate statistical tools.

Primarily, descriptive statistical tools such as arithmetic mean and variance were employed in determining the mean, gain scores and spread of the scores of both groups. To determine if there is a significant difference between the pretest and posttest scores as well as the gain scores of the control and experimental groups, t-test was utilized.

Lastly, independent sample t-test was used to determine the effect of visual representations and peer-assisted approach in developing the problem solving skills of the students in Physics.

Results and Discussion

Pretest Scores of Students in Control and Experimental Groups

As presented in Table 2, the mean scores of control and experimental groups were 20.70 and 20.60, respectively. This further revealed that the mean score of the control group was little bit higher than that of the mean score of experimental group but this difference was not significant as the t-test confirmed (t-value = 0.098, df = 58, p-value = 0.9223 > 0.05). This finding leads to the confirmation that the two groups under study are comparable and students from both groups seem to be the same in terms of prior knowledge regarding the approaches they can apply to solve problems in Physics. It further explained that students in experimental group, most likely, were as good as those in control group before the start of the experimentation. Further, the experimental group were most likely heterogeneous in scores as revealed by the variance which was more spread in distribution of the scores while the control group were most likely homogenous scores as signified by the value of its variance. This revealed that the raw scores of students from control group did not differ significantly from the score of the experimental group.

Table 2: Test of difference between the pretest scores of the control and experimental groups

CHARACTERISTICS	GROUPS	
	Control	Experimental
Sample Size	30	30
Mean	20.7	20.6
Variance	14.133	17.137
t-value = 0.098^{ns}		
Degrees of Freedom = 58		
Associated Probability = 0.9223		

ns - not significant at 5% level since p-value = 0.9223 > 0.05

The finding in Table 2 is confirmed by the study of Abdullah (2020) when he stated that to have valid and reliable results of the study, same level of academic preparation of the two groups under experimentation must be ensured by giving them an IQ or standardized test before the start of an experiment. He further emphasized that students' performance in both groups under experimentation must point to the same level of knowledge. He added that students must be comparable as to their background in the subject before experimental treatment to have a better compatibility between the two groups.

Pretest and Posttest Scores of Control Group

Table 3 shows that the posttest mean score of the control group was 43.40 which was 22.70 higher compared to the pretest score of 20.70. This difference was significant as t-test revealed (t = 22.701, df = 29, p-value = 0.000 < 0.05). The table signifies that traditional approach of teaching still registered a significant increase in the students' performance. This finding is affirmed by Entera (2012) when he found out that students subjected with traditional approach also obtained a significant gain score. Further, the posttest scores of control group likely showed heterogeneous distribution result as obtained by the Variance of 20.386 with higher value of mean score that of pretest which registered a Variance of 14.133 with lower mean score.

Table 3: Test of difference between the Pretest and Posttest Scores of Control Groups

CHARACTERISTICS	SCORES OF CONTROL GROUP	
	Pretest	Posttest
Sample Size	30	30
Mean	20.7	43.4
Variance	14.133	20.386
t-value = 22.701**		
Degrees of Freedom = 29		
Associated Probability = 0.000		

** - significant at 1% level since p-value = 0.000 < 0.01

Pretest and Posttest Scores of Experimental group

As shown in Table 4, the experimental group got a posttest mean score of 56.40 from a pretest mean score of 20.60. The difference of 35.80 was significant as affirmed by the t-test result (t = 43.382, df = 29, p-value = 0.000 < 0.01) at 0.01 level. This indicates that through the exposure of students to visual representation, the experimental group garnered a high gain score of 35.80. This finding is affirmed by Renkl and Atkinson (2010) who explained that working with problem solving needs multiple approaches for the students to construct and verify the solutions. Moore and Carlson (2011) further affirmed that ability of the students to mentally construct a visual representation of related quantities are also able to produce meaningful and correct solutions to the problem. Students who are consistently producing incorrect solutions are those who are misaligned the construction of visual representation of related quantities intended to the problem. Learners can achieve better learning performance if they are exposed to modern approach of teaching such as use of visual representation and peer-assisted to enhance their mental model in problem solving skills.

Table 4: Test of difference between the Pretest and Posttest Scores of Experimental Group

CHARACTERISTICS	SCORES OF EXPERIMENTAL GROUP	
	Pretest	Posttest
Sample Size	30	30
Mean	20.6	56.4
Variance	17.137	10.455
t-value = 43..382**		
Degrees of Freedom = 29		
Associated Probability = 0.000		

** - significant at 1% level since p-value = 0.000 < 0.01

The above table shows that being exposed to any complicated Physics problems, students can be oriented of its practical, disciplinary and cultural values that motivate them to solve problems influencing their daily life activities. Dehaan (2009) stated that creative problem solving requires explicit teaching strategies and inquiry-based learning approaches such as visual representation to promote flexibility in students' cognitive skills. Paosawatyanyong and Wattanakasiwich (2010) stated that problem solving approach has long been recognized as the most effective method of enhancing students' computational and comprehension skills. They added that learning process is best achieved when teachers let their students create their own solutions while reflective thinking among students is also observed.

Posttest Scores of Control and Experimental Groups

After four weeks of experimentation process wherein the control group was exclusively taught with traditional instruction using the chalk and talk method and the experimental group was exposed with varied teaching strategies such as the use of multi-media presentation and other forms of visual representation and peer-assisted discussions, posttest was administered. Table 5 presents the t-test results on the posttest scores of control and experimental groups. It shows that control group obtained a mean score of 43.40 while experimental group garnered a mean score of 56.40. A difference of 13.00 in favor of the experimental group was proven significant as justified by the t-test result (t-value = 12.821, df = 29, p-value = 0.000 < 0.01). This revealed that higher mean score obtained by the experimental group was attributed to the use of visual representation and peer-assisted in developing mental models of students in Physics problems.

This finding is supported by Davenport et al. (2008) when he stated that instruction is easier when diagram or representation is used as an aid for learning process since slow learners are more attentive and they perform better when diagram or visual model is employed for conceptual understanding. Etkina et al. (2010) added that well-planned and appropriately designed activities integrated with scaffolded tools supported with reflective thinking can elevate the comprehension level of the students.

Table 5: Test of difference between the Posttest Scores of Control and Experimental Groups

CHARACTERISTICS	GROUPS	
	Control	Experimental
Sample Size	30	30
Mean	43.4	56.4
Variance	20.386	10.455
t-value = 12.8214**		
Degrees of Freedom = 58		
Associated Probability = 0.000		

** - significant at 1% level since p-value = 0.000 < 0.01

Gain Scores of the Control and Experimental Groups

Table 6 presents the t-test results on the gain scores of control and experimental groups. Results revealed that experimental group obtained a gain score of 35.80 while the control group registered only a gain score of 22.70. The table shows that the students solely exposed with traditional approach of teaching also registered a gain score but it was lower compared to the experimental group. Significant difference of the gain scores in favor of the experimental group was proven by the t-test result (t-value = 10.119, df = 58, p-value = 0.000 < 0.01) at 0.01 level. This means that students subjected with traditional approach obtained a smaller gain score, compared to the students exposed with variety of visual representation and peer-assisted in developing their mental models in problem solving in Physics, that registered a substantial gain score. This higher gain score obtained by the experimental group may due to the exposure of students in different visual representations that motivate them to relate the importance of current lessons in their day-to-day activities. This statistical analysis is supported by Johnson and Marx (2017) when they stated that the need to reform instructional tools and approaches in teaching must be prioritized. The study of Allen et al. (2011) found out that substantial gains in terms of student achievement and percentile scores in examination were registered by the students exposed with web-mediated approach that focuses on teacher-student interaction in the classroom. In addition to this, Abdullah (2020) found out that students confined with traditional Mathematics instruction registered a minimal progress in their academic performance compared to the students who were exposed to various modern teaching materials and strategies.

Table 6: Test of difference between the Gain Scores of the Control and Experimental Groups

CHARACTERISTICS	GROUPS	
	Control	Experimental
Sample Size	30	30
Mean	22.7	35.8
Variance	29.885	20.392
t-value = 10.119**		
Degrees of Freedom = 58		
Associated Probability = 0.000		

** - significant at 1% level since p-value = 0.000 < 0.01

As can be gleaned from Table 6, the control group registered more heterogeneous gain scores as shown by the variance compared to the experimental group. The experimental group registered a mean score of 35.8 which was significantly higher than the mean score of 22.7 earned by the control group, marking a difference of 13.10.

The above findings confirmed that the use of visual representation and peer-assisted definitely enhances students' mental model in developing their problem solving skills in Physics.

Problems Encountered During the Experimentation

This study developed teaching pedagogy using visual representation and peer-assisted to solve problems in Physics. The effectiveness of this approach was tested through experimentation. Prior to the experimentation, series of preparation such as the validity and reliability tests of the materials were conducted. The researcher himself had taken notes of the problems encountered during the experimentation process. After the experimentation, interview and focus group discussion participated by the students coming from the two groups were done to solicit ideas as to the problems the teacher-researcher himself had met. The following are some of the problems encountered during the experimentation:

1. **Inadequate teaching materials and supplies:** School facilities directly affect teaching and learning inside the classroom. Inadequate conditions of materials make it more difficult for teacher to deliver an effective instruction to the students; it has been the problem in the implementation of the study on how to utilize such materials to cope with the purpose of the study. The teacher was adversely affected by time in preparing the necessary materials to be used. Often times, the teacher improvised the materials needed so the students can perform the expected output. To address the problem, teacher have to plan ahead of time which activity is suited based on the availability of materials on that particular school, so as to this problem, teacher improvised and localized the material and planned it ahead of time so that it may not consume totally the time of the teachers in some aspects of preparing the lesson and activity, and as the experimentation progressed, it show positive implications in attaining the goal of the activity showing active participation and promising results on their outputs.

2. **Unclear organization of class work:** Lack of physical setting in the experimental group was another problem encountered by the teachers to easily look and guide the students. Class work management was difficult since the students were working in unstructured class setup. Teacher has to be more energetic and flexible in monitoring students' activity considering that the groups were not working in a same place. To address this problem, teacher-researcher strategized the classroom management by rotationally assigning student per group to act as disciplinarian and role leader looking on the proper management of the group. They were giving tasked to maintain the orderliness of the group as the activity progressed. This was a helpful strategy to maintain the orderliness inside and outside of the classroom. As what the student-respondent narrated during our interview session *"Napakaganda po ng aming activity dahil naiiwasan po yung pagkalat ng mga ka grupo namin at maka focus po sila lahat sa ginagawa naming activity, para naman po sa na assigned na leader, nagpapakita at nagbibigay po ito ng napakahalagang responsibilidad sa amin."*

3. **Lack of time to check the outputs of the students:** Sometimes, regular time allotted for Physics subject/Science subject as prescribed by the Department of Education is not enough to finish some of the given activity, During the interview session, respondents were narrating this *"May iilan activity po kami na kinukulang kami sa oras kaya minsan po ay humihingi kami ng time extension para matapos po yung binigay na activity."* so the teacher-researcher sometimes extending time to give students ample time to finish the activity. In this regard, to cope with the time allotment, teacher-researcher have to adjust and modify the designed activity suited only for the given time, preparation of venues and materials such as laboratory equipment were done before the physics class to minimize the time for classroom management. Each group number have already prepared the materials needed by the teacher-researcher including the area where they were conducting the activity. By doing these things, teacher-researcher attained the goal of the activity for a given time allowing the teacher to utilize more time in checking activities while students' outputs showed a positive remarked and obtained outstanding results in their scores for they have enough time to polish their activity. *"Mas madali po ang activity at mas nagkakaroon po kami ng maraming oras upang tapusin ang activity dahil po sa nakahanda napo lahat ng aming gagamitin sa activity pati na rin po ang aming working area."* As narrated by the respondents during the interview session.

4. **Some students are distracting to others:** Sometimes students disorderly roamed around the groups having an unrelated conversation with their peers. This is basically common situation and suddenly became a challenge to the teacher while the intervention was in progress. As a teacher, he should react accordingly to control the class in order to resolve the issue and it causes sudden interruption among the groups doing the activity. This may ruin the expected output from the students. The teacher-researcher have to strategize to address this problem, to minimize this problem, the teacher imposed a rule in which, students who were roaming around without official business relating to the activity have to be dismissed from the group. So, students were more participative now and refrained from distracting others because they know, there will be a corresponding sanction for misbehaving students during class activity and

this contributed a lot to the output of the students because they were goal-oriented now.

5. **Negative behaviors of students towards Physics:** During the first week of the class prior to the experimentation process, students' appreciation to the subject was poor. Students from both groups were not interested particularly in the mathematical approach of the subject. It was a challenging situation for both the teacher and the students who were partially unmotivated to learn. The teacher had to exert extra time to make them mentally present. As narrated by one of the respondents *"Pagkarinig po kasi namin ng Physics ay may solving problem, kaya marami po sa amin ay ang naiisip po naming ay parang mathematics din po na maraming mga numbers kaya po kami natatakot sa una, pero noong nagsimula na po kayo magturo sa amin, unti-unti po naming nagugustuhan ang subject na physics at madali lang po pala pag may ginamit na mga demonstration at napakasaya po pala ng klase sa Physics."* Little by little, students learned to appreciate the essence of Physics in their day-to-day activities. Positive attitudes of students from experimental group really improved due to the learning opportunities and interventions given. Although, positive attitudes towards Physics were implanted to both groups, students from the experimental group showed an exceptional admiration towards Physics due to the interventions.

6. **No mental model due to lack of prior knowledge:** Due to the spiral curriculum used by the DepEd, students got difficulties in connecting the previous lessons to the present topics. This was the problem arose during the activity because students seemed to be misguided in the expected output. So as to the part of the teacher, accommodating an unstructured class work quires was another challenge knowing that you have the time to comply and the teacher had to insert an explanation time to time for queries for the activity to be smooth, but this was again required extra time to do it simultaneously. As narrated by the stundent during interview Session *"Nakalimutan na po kasi namin yung ibang concepts at formula sa previous class po namin last year kaya po medyo nahihirpan po kami na e recall po yung mga topics nay un. At isa pa po, nasanay po kami noon na memorize lang po ng formula tapos e apply na po agad, dito po kasi sa klase niyo po, kailangan pa po ng mga illustrations at drawings kaya nanibago po kami, pero na realized po namin na mas maganda at mas madali po mag solve ng problems pag kaya mo po illustrate yung problem po mismo katulad po sa ginawa po natin sa klase niyo."*

7. **Students are not sure on what to do:** Unclear instruction of the teacher and often times the fault of the teacher. Confusing instruction may lead to chaos. Since the intervention itself required deep understanding of the given activity, the researcher had hard time organizing things inside the classroom, the first peer-assisted assignment given to them was failed due to lack of coordination among the group and at the same time, the instructions of the teacher was not clear. Therefore, teacher must give clear and concise instructions when using this approach so that the expected output will be attained. To address the problem, teacher have to give the most precise instruction to the students like instead of saying "class you need to finish this activity with applying visualization", it must be elaborated to them what would be the expected output, the process of doing it and how to do it. Through that approach, students have full grasped on what to be expected from them.

8. **The Lesson did not go to the direction as it was expected:** During the first week of the experimentation, implanting the soul process of the study where students have to do the activity given through the use of visualization and peer-assisted process was hard enough. It was a challenging week to the researcher in guiding the students to the right path of the experimentation, since they were not fully-oriented on the expected output considering the students were not totally engage of the new approach in processing problem solving. As narrated by one of the respondents *"Hind po kasi namin alam sa una kung ano po ang visualization at papaano po ang gagawin namin sa activity kaya po nahirapan po kami sa una, pero nang naituro po at naipalawanag na po sa amin kung ano dapat ang gagawin, unti-unti na po naming natutunan at nagustuhan na po namin yung approach po na ganito sa solving problem, kaya po ginagamit na rin po namin ito sa aming solving problem sa physics."* After embedding the strategies to the students, little-by-little, students were gradually embracing the approach and even performed better in their problem solving process. To some extent, this was a good thing to the experimental group. It cultivated students' interest, and urged them to participate in the activity. It was a productive experienced to them.

9. **Utilization of Instructional Materials:** As observed in this study, utilization of materials required extra time and even extra financial resources to make the needed materials realistic to the students. As encountered in this study, there were some activities that really pushed the creativity of the teacher to improvise materials. The burden in providing necessary materials is another challenging task to the teacher. So as to this problem, teacher-researcher have to utilize instructional materials to be used prior to the class session to make the activity possible and doable to the students without consuming much

of the time. On the other hand, students were very much interested on the topic since the visual representation and peer-assisted learning have been integrated and caught their attention. Indeed, employing the said intervention to the students, the experimental group performed better than that of the control group.

Conclusion

Based on the significant findings generated from the study, the following conclusions were drawn:

1. The pretest of control group is higher than the pretest of experimental group but this difference is not significant as the t-test confirms. This leads to the confirmation that the two groups under study are comparable in terms of prior knowledge regarding the approaches or techniques they can apply to solve problems in Physics.
2. There is a significant difference between the pretest and posttest scores of control group. This suggests that students solely exposed to traditional approach of teaching still register a significant increase in the students' performance.
3. The difference between the pretest and posttest scores of experimental group is significant as affirmed by the t-test result. This indicates that exposure to various visual representations and peer-assisted learning, students are able to develop a mental model, thus improving problem solving skills among the students gain scores.
4. A difference between the posttest scores of the two groups in favor of the experimental group is proven significant as justified by the t-test result. This means that higher mean score obtained by the experimental group was attributed to the use of visual representation such as multi-media and other forms of modern visual aids and peer-assisted approach in modeling Physics problems.
5. Significant difference of the gain scores in favor of the experimental group is proven by the t-test result. This means that students in the control group subjected to traditional approach obtained a smaller gain score compared to students in the experimental group exposed to a variety of visual representation and peer-assisted discussion.

In other words, the use of visual representation and peer-assisted discussion greatly enhanced the students' skills in problem solving through mental modelling.

Recommendations

Based on the findings, the researcher highly recommends that visual representation and peer-assisted approach shall be employed in high school physics classes and further studies be conducted to cover other topics in physics. In addition, teachers are encouraging to be creative in designing activity suited only for a specific time frame to avoid consuming extra time allotment for Physics subjects to have enough time for visual representation and peer-assisted discussion.

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