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Use of reciprocal peer tutoring (RPT) in teaching gas laws: Its effect on problem-solving performance and attitudes of grade 10 students in chemistry

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Abstract

Many educators today are challenged on what pedagogical approaches could cater the individual needs of students to increase their understanding of Chemistry concepts. To accept the challenge, this study was conducted. Quasi-experimental research design was employed and 84 students served as the subjects of the experimentation. Mean Percentage Score (MPS), weighted mean and t-test were appropriately applied to describe the collected data and make inferences as well. Prior to the start of experimentation, control and experimental groups had a comparable problem-solving performance in Chemistry. Students in both groups displayed negative attitudes towards Chemistry. After the exposures of control group with traditional instruction and experimental group with RPT instruction, mean gain scores of students in experimental group were significantly higher compared with mean gain scores of students in control group. Students in control group still showed negative attitudes towards Chemistry while students in experimental group improved their positive attitudes towards Chemistry. The use of RPT instruction had a positive effect on the problem-solving performance and attitudes of students towards Chemistry. Thus, to provide an optimal educational learning experience of students in Chemistry, teachers should intensify the use of RPT and be creative in employing other modern teaching strategies in Chemistry.

Keywords: Reciprocal Peer Tutoring (RPT), Problem-Solving Performance, Attitudes and Gas Laws

Introduction

Science education is the primary target of continuous changes in the Philippine educational system. Many educators today are challenged on what pedagogical approaches could cater the individual needs of students to increase their understanding of Chemistry concepts (Criswell & Greg, 2018; Abdullah, 2020). As part of the reform plan and a step towards globalizing the quality of basic education, the Philippines, for the first time in 2018, joined the Programme for International Student Assessment (PISA) to evaluate the status of the country's educational system in Mathematics, Science and Reading. PISA results revealed that the Philippines scored 353 in Mathematics, 357 in Science, and 340 in Reading; all belong to the bottom three (3) of the participating countries. Due to these very dismal results, the Department of Education (DepEd) will lead the national effort for quality basic education through Sulong EduKalidad by implementing aggressive reforms to improve the quality of instruction and to foster positive

attitudes towards Mathematics, Science and Reading (DepEd, 2018).

In response to the mandate of the DepEd for active involvement, cooperation, and collaboration in advancing the country's quality of basic education, teachers are spending more time for continuous improvement to stay abreast of the new teaching strategies just to emerge students' potentials in Science and Mathematics. Simpal (2016) stated that developing students' potentials to integrate scientific theory and positive attitudes in their environment and link them to their personal perceptions can give them a chance to create new knowledge out of their experiences.

The K to 12 Program envisions to hone the 21st century skills of students such as critical thinking, creativity, collaboration and communication to cope with the demands of the globalization. Burana and Dahsah (2018) stressed that it is timely for the teachers to introduce reciprocal peer tutoring (RPT) to let students learn a great deal by explaining their ideas to others and by participating class activities in which they can engage and learn from their peers. They added that RPT develops students' skills in problem solving, working collaboratively with others, communicating with their classmates through giving and receiving feedback, and being creative to identify new ways of doing things. Paculanan (2013) also emphasized that RPT increases problem-solving performance while simultaneously decreasing disruptive behavior.

Duran (2016) stated that students' problem solving performance and attitudes in Chemistry can be developed through the use of RPT. Festus (2012) added that RPT requires students to examine their own and their classmates' reaction to and analysis of the content. He emphasized that letting students to collaborate from their peers is what the K to 12 Program wants to emphasize in producing lifelong learners imbued with 21st century skills.

Further, Docktor et al. (2015) stressed that education researchers have recently given much attention on how teachers should improve their teaching competence and strategies in Chemistry. They stressed that teachers should contextualize contents and pedagogies that can improve students' positive attitudes towards Chemistry. In return, Chemistry learning opportunities can be maximized. Bordas and Valdez (2015) stated that Chemistry learning is very challenging as it requires much intellectual thought and discernment since the content is replete with many abstract concepts. Duran and Monereo (2018) added that challenges in Chemistry have pointed at the improvement of teaching strategies. Gok and Gok (2016) found out that students' poor performance in Chemistry over the years has been attributed to the fact that the subject is difficult as it involves problem solving and the teaching strategies applied are very traditional. They further stressed that these difficulties in problem solving can be simplified through collaborative teaching approaches such as RPT.

Hagos (2009) emphasized that if the abstract ideas are being concretized by the more advanced students, slow learners will be motivated to perform problem solving in Chemistry. Ismail and Alexander (2015) stated that RPT is a best teaching strategy to assist the struggling students in learning Chemistry concepts. They added that RPT consists of student partnerships, linking high achieving students with lower performing students or those with comparable problem solving skills. Mastron (2015) noted that many students have a natural tendency to ask other learners for help. However, some of them feel embarrassed to admit they need help. This is especially true with math, physics and chemistry. Utilizing best students to help other learners better understand chemistry principles particularly in gas laws which involve mathematical formulas and scientific manipulations can be done by RPT instruction that lowers the feelings of inadequacy and intimidation among struggling students to ask the teacher for help. Instead of asking questions to the teacher, these students are given opportunities to seek the help of their classmates who are more advanced in the topics. This is the major reason why RPT instruction should be adopted in teaching gas laws.

Hence, it is essential to integrate the use of reciprocal peer tutoring (RPT) to enhance the problem solving performance and attitudes of students towards Chemistry.

Statement of the Problem

This study aimed to determine the effect of reciprocal peer tutoring (RPT) in teaching gas laws on problem-solving performance and attitudes of Grade 10 towards Chemistry. Specifically, this study did the following:

1. Determined the problem-solving performance on gas laws of students exposed in RPT and Traditional Instruction before and after the experiment.
2. Determined the attitudes of grade 10 students towards Chemistry before and after the experiment.
3. Determined if there is a significant difference in the problem-solving performance of students exposed in the RPT and Traditional Instruction before and after the experiment.
4. Determined if there is a significant difference in the attitudes of students exposed in the RPT and Traditional Instruction before and after the experiment.
5. Determined if there is a significant difference in the problem-solving performance of students between the control and experimental groups after the experiment.
6. Determined if there is a significant difference in the attitudes of students in Chemistry between the control and experimental groups after the experiment.

Methodology

Research Design

This study used a quasi-experimental research design to determine the effect of the reciprocal peer tutoring (RPT) on problem-solving performance and attitudes of grade 10 students towards Chemistry. Before and after the experimentation, pre-test and post-test were

administered to determine the difference in the problem-solving performance of students. Survey questionnaire was distributed to determine their attitudes towards Chemistry. The experimental group was exposed to RPT while the control group was subjected to traditional instruction.

Locale of the Study

The study was conducted at Esperanza National High School, located at Mabolo Street, Poblacion, Esperanza, Sultan Kudarat, Region XII, Philippines. With its incessant quest for quality and relevant education, Esperanza National High School has stood as a hallmark and become the education hub in Sultan Kudarat, holding the banners as one of the Most Effective Secondary Schools in Region XII, the Regional Awardee as Hall of Famer for Most Innovative Brigada Eskwela Implementer and School-Based Management Level III Model of Excellence, and a Science Network and Division Leader School in Sultan Kudarat.

Participants of the Study

Grade 10 students of Esperanza National High School for the School Year 2019 – 2020 served as the participants of this study. There were two (2) grade 10 sections out of fourteen (14) sections in the regular curriculum. These two grade 10 sections automatically served as the control group and experimental group under study.

Sampling Technique

There were fourteen (14) Grade 10 sections that belong to the regular curriculum. These sections were heterogeneously grouped. This means that the academic performance of students from these sections was comparable. Thus, simple random sampling using fishbowl method was applied to choose two (2) sections that served as the control group and experimental group. Simple random sampling was applied to increase the generality of the results of the experimentation. Random assignment of the control and experimental groups was done. However, random selection of students was not possible since all students in both control and experimental groups were included as participants of the students.

Out of 734 students from different grade 10 sections of regular curriculum, 43 students of control group and 41 students of experimental group, a total of 84 students, were taken as total sample of the study.

Research Instrument

The quantitative data needed in the study were collected and analyzed using two sets of research instrument. The first set of research instrument was a researcher-made test to determine the problem-solving performance of students in the six topics of gas laws such as Boyle's Law, Charles' Law, Gay-Lussac's Law, Avogadro's Law, Combined Gas Law and Ideal Gas Law. Each Gas Law had ten (10) items, a total of sixty (60) items. The items of the researcher-made test were based on Philippine Secondary Learning Competencies (PSLC) of Grade 10 Chemistry during the third quarter.

A researcher-made test was shown to his adviser for any improvements. Its content was pre-validated by Science experts to determine its weaknesses. Originally, a 15-item test per topic, a total of 90-item test for the 6 topics in gas laws, was prepared for the validation purposes. First validation process was done by administering the 90-item test to 35 Grade 11 Accountancy, Business and Management (ABM) senior high school students of Esperanza National High School. After the first administration, the instrument was refined. From 15 items per topic, it became 10 items per topic, a total of 60 items for the 6 different topics, after screening out questions which were very easy and very difficult. Items that received below 0.40 index of discrimination were either be discarded or modified. Only very good items that obtained an index of discrimination of 0.40 or above were automatically accepted. Some of the items identified to be very difficult (receiving an index of difficulty of 0.30 or below) were reworded and modified purposely to go with the competencies enumerated in the Table of Specifications (TOS). The remaining 60-item test served as the main instrument used in the study.

Following the validation was the reliability testing which involved 50 students from Grade 11 Science, Technology, Engineering and Mathematics (STEM) students of Esperanza National High School. The students who were used in the validation and reliability tests were not part of the participants of the study and had already taken and passed Chemistry topics in Grade 10 curriculum. In the item analysis of the test, the researcher used U – L index method adopted from the study of Paculanan (2013) and Abdullah (2020). The index of discrimination of the test items were interpreted using the following guides:

Index of Discrimination	**Item Evaluation**
0.40 or higher	Very Good Item
0.30 – 0.39	Good Item
0.20 – 0.29	Marginal Item
0.19 or lower	Poor Item

The index of difficulty of the test items was interpreted using the following criteria:

Index of Difficulty	**Item Evaluation**
0.70 or higher	Low Difficulty
0.31 – 0.69	Moderate Difficulty
0.30 or below	High Difficulty

After the validation process, the reliability test using Kuder- Richardson Formula 20 for the researcher-made test was conducted. Kuder- Richardson Formula 20 was used in determining the correlation coefficient of the test. Correlation coefficient value (r) was used to determine the reliability of the responses as well as the measure of internal consistency or homogeneity of the measuring instrument. It also served as a basis of acceptance of the Test Instrument. The following scale was used to interpret the reliability of the researcher-made instrument.

Reliability Coefficient	Interpretation
0.90 – 1.00	Very High Reliability
0.70 – 0.89	High Reliability
0.60 – 0.69	Moderately High Reliability
0.50 – 0.59	Poor Reliability
0.00 – 0.49	Very Poor Reliability

The computed reliability coefficient (r) of the researcher-made questionnaire was 0.863 which indicates a high reliability. This means that the first set of research instrument can now determine what it intends to measure and it surely gets very reliable results.

The second set of research instrument was a modified survey questionnaire of Paghubasan (2017) to determine the attitudes of students towards Chemistry before and after the experimentation relative to positivity, relation to real world, importance of formulas, dependence on procedures, confidence in solving, exploration in problem solving, independence in learning and use of technology. Each indicator has six (6) statements, a total of forty eight (48) statements. Letter of approval from Paghubasan (2017) was secured to legalize the adoption of her survey questionnaire. Each statement of the indicator was rated by the students using the Five-Point Likert Scale such as 5-Strongly Agree; 4-Agree; 3-Moderately Agree; 2-Disagree; and 1-Strongly Disagree.

Attitude refers to the students' organized predisposition to think, feel, perceive, and behave in Chemistry. It refers to the aggregated measure or tendency of liking or disliking Chemistry. To measure students' level of attitudes towards Chemistry, survey questionnaire was used. This survey questionnaire on attitudes of students towards Chemistry had also undergone validation process, which is the most important feature of an instrument. The items were reviewed and validated by the 3 Science and Research Experts. Cronbach's alpha (α) was used to test the internal consistency of the survey questionnaire. Senior high school STEM students of Esperanza National High School were used for the reliability test of the survey questionnaire. The formula and the alpha's interval value of internal consistency taken from the study of Abdullah (2020) are as follows:

$\alpha = (k/(k - 1))(\Sigma s^2/sx^2)$ where:
α = Cronbach's alpha
k = number of items
Σs2 = sum of the variances of the scores
Sx2 = variance of all scores

The value of α was established to determine the reliability coefficient. The interpretation of the computed α was based from the scale below:

Cronbach's Alpha (α)	Descriptive Interpretation of Internal Consistency
0.90 – 1.00	Excellent
0.70 – 0.89	Highly Acceptable
0.60 – 0.69	Acceptable
0.50 – 0.59	Poor
0.00 – 0.49	Unacceptable

Students and teachers who were used for testing the validity and reliability of the two sets of research instrument were excluded in the final respondents of the study. The result was analyzed and interpreted with the help of the statistician. Validation process generated an overall mean of 4.23 which indicates a very valid research instrument. It was also found out that the computed α = 0.823 indicates a highly acceptable survey questionnaire.

Data Gathering Procedure

Upon approval and permission of the Dean of the Graduate School of Notre Dame of Marbel University, Koronadal City, South Cotabato, Region XII, Philippines and panelists to proceed with the study, a certification was secured with the information that the researcher was conducting a study entitled "Use of reciprocal peer tutoring (RPT) in teaching gas laws: its effect on problem-solving performance and attitudes of grade 10 students towards chemistry" and that he was permitted by the Schools Division Superintendent of Sultan Kudarat to conduct his experimentation in the respondent school which is Esperanza National High School.

Permission from the school principal in administering and distributing the pre-test and survey questionnaire using the Grade 10 students was also secured. The duly approved letter from the Schools Division Superintendent was attached. Orientation and administration of the pre-test to the Grade 10 then followed. Questions raised by the respondents regarding the clarity and direction of the pre-test were properly answered. Pre-test was retrieved upon the completion of the students. After the conduct of pre-test, survey questionnaire on attitudes of students towards Chemistry was administered.

Experimentation of six (6) weeks for the two sections, Grade 10 Einstein and Grade 10 Newton, started. These sections were located in different buildings. Thus, contamination of the teaching approaches was avoided. Same competencies were discussed to the two sections. Only teaching approaches differed since experimental group was subjected to reciprocal peer tutoring (RPT) and the control group was solely exposed to traditional instruction using chalk and talk method. Each class session from each group lasted for 60 minutes. To avoid bias in the conduct of the experimentation, the researcher himself served as the teacher in both the experimental group and control group. Separate session guides for the control and experimental groups were designed. Session guides served as the guide of the teacher to introduce the topic.

Traditional session guides were used for the control group and RPT session guides were utilized for the experimental group. Traditional session guides consisted of exercises that can be purely done through individual seatwork and board work. Listed in the traditional session guides were the teacher's role on how he could deliver the lesson through chalk and talk method of teaching. No RPT Activity Sheets were given to the students. Seat works and board works were the major learning activities employed by the teacher in the control group.

RPT session guides included teacher's role as facilitator of learning, tutors' functions to guide their

tutees and tutees' responsibilities to easily decode the instructions given by their respective tutors. Several RPT activities were provided in the RPT session guides so that teacher can effectively choose exercises suited to the learning interests and abilities of students. After introducing the topic, students were provided by RPT Activity Sheets. The role of the tutors and the responsibilities of the tutees were clearly indicated in the RPT Activity Sheets which coincided in the Session Guides of the teacher.

Same set of topics and competencies for the two groups were observed. Traditional Session Guides accompanied by the seatwork and board work were evident in the control group. RPT Session Guides for the teacher and RPT Activity Sheets for the students were observed in the experimental group. Both groups were allowed to use scientific calculators for their classroom activities. Students in control and experimental groups were heterogeneously grouped. Heterogeneous grouping showed that both control and experimental groups had mixed levels of students' academic preparation.

In the experimental group, there was a lecture of the basic concepts before RPT activity sheets were distributed to the students. After the session, these activity sheets were retrieved so as to avoid leakage in other sections. In these activity sheets, tasks of the tutor and tutee were comprehensively explained. Follow up discussion using interactive learning activity was observed. This means that the tutor and tutee shared their experiences how they improve their problem solving skills using the RPT activity sheets. The researcher assisted the students in the experimental group in doing the RPT activity sheets. He roamed around the groups to assist the tutors in doing their tasks and encouraging the tutees to perform what the tutors instructed to them. In the control group, no learning materials were given to them. Only chalk and talk method was observed.

After the six (6) weeks of teaching, post-test was administered and survey questionnaire was distributed to the two sections. Questions in the pre-test were different from that of post-test materials. However, the chronological order of the competencies was the same for both pre-test and post-test materials. Data analysis started immediately after the post-test and retrieval of the survey questionnaire.

Analysis of Data

Problem-solving performance of students was described using Mean Percentage Score (MPS) (SOP 1). Weighted mean was employed in determining the attitudes of students in Chemistry (SOP 2). To determine if there is a significant difference in the problem-solving performance on gas laws and attitudes of students towards Chemistry before and after the experimentation, t-test was applied (SOP's 3, 4, 5 and 6).

Problem-solving performance of students was determined using their pre-test and post-test scores which were converted into MPS and was dichotomously categorized, described and interpreted following the criteria adopted from National Educational Testing Research Council (NETRC).

Results and Discussion

Problem-Solving Performance on Gas Laws of Grade 10 Students before the Experimentation

Problem solving is the ability to translate Chemistry problem into mathematical equation. It is also the ability to connect the related concepts to find solution to a Chemistry problem in a comprehensive procedure. The development of problem-solving performance involves logical and clear procedure to ascertain students' skills in solving problems. Tables 1 and 2 present the problem solving performance of students before the experimentation.

Table 1: Level of problem-solving performance on gas laws of grade 10 students in control group before the experimentation

	Gas Laws	MPS (n = 43)	Verbal Description
1	Boyle's Law	40.50	Average Mastery
2	Gay-Lussac's Law	25.40	Low Mastery
3	Charles' Law	24.60	Low Mastery
4	Avogadro's Law	24.30	Low Mastery
5	Combined Gas Law	21.00	Low Mastery
6	Ideal Gas Law	14.00	Very Low Mastery
Overall MPS		**24.97**	**Low Mastery**

Legend: 96 – 100 – Mastered; 86 – 95 – Closely Approximating Mastery;
66 – 85 – Moving Towards Mastery; 35 – 65 – Average Mastery;
15 – 34 – Low Mastery; 5 – 14 – Very Low Mastery;
0 – 4 – Absolutely No Mastery

As shown in Table 1, control group obtained an overall mean percentage score (MPS) of 24.97% described as Low Mastery in the pre-test. This means that prior to the start of the experimentation; students in control group had a poor competence on Gas Laws. In other words, they lack prior knowledge on the said Chemistry topic before the conduct of the study.

In particular, students received the highest MPS of 40.50% with a description of Average Mastery in Boyle's Law. This indicates that students had a good foundation already in Boyle's Law before the conduct of experimentation. In layman's terms, problems applying the concept of Boyle's Law were not difficult as other Gas Laws as they obtained high scores in the said Gas Law.

In different manner, the lowest MPS of 14.00% described as Very Low Mastery was obtained by students in Ideal Gas Law. This means that students found out that problems which apply the concept of Ideal Gas Law were very difficult since they scored very low in this topic.

Paculanan (2013) revealed that control group generated a low performance in Mathematics before the conduct of his experiment. Further, Abdullah (2020) discovered that students in control group had a very minimal idea in Math topics before he started the experimentation stage of his study. The two researchers agreed that receiving low scores in the pre-test is just a

normal case of experimental research since most students have no idea yet about the topics.

Table 2: Level of problem-solving performance on gas laws of grade 10 students in experimental group before the experimentation

	Gas Laws	MPS (n = 41)	Verbal Description
1	Boyle's Law	40.40	Average Mastery
2	Gay-Lussac's Law	25.20	Low Mastery
3	Charles' Law	24.40	Low Mastery
4	Avogadro's Law	24.30	Low Mastery
5	Combined Gas Law	21.20	Low Mastery
6	Ideal Gas Law	13.80	Very Low Mastery
Overall MPS		**24.88**	**Low Mastery**

Legend: 96 – 100 – Mastered; 86 – 95 – Closely Approximating Mastery;
66 – 85 – Moving Towards Mastery; 35 – 65 – Average Mastery;
15 – 34 – Low Mastery; 5 – 14 – Very Low Mastery;
0 – 4 – Absolutely No Mastery

As revealed in Table 2, an overall mean percentage score (MPS) of 24.88% with a description of Low Mastery was registered by the experimental group during the pre-test. This implies that students in experimental group had a very limited knowledge on Gas Laws. Considering Tables 1 and 2, both control and experimental groups had the same level of problem solving performance and both groups were of low mastery before they were subjected to the experimentation.

More specifically, students in experimental group garnered a highest MPS of 40.40% described as Average Mastery in Boyle's Law. This signifies that students in experimental group had already a good foundation in Boyle's Law prior to the conduct of the study. Same result was also registered by the students in control group. In other words, both groups got a highest MPS in Boyle's Law.

On the other hand, the lowest MPS of 13.80% with a description of Very Low Mastery was acquired by students in Ideal Gas Law. Observing the two previous tables, both control and experimental groups registered a very low MPS in Ideal Gas Law. This indicates that students in both groups had the same claim that word problems which apply the concept of Ideal Gas Law were very difficult compared to other gas laws.

The study of Simpal (2016) is similar with the above data. His experimental research revealed that students in experimental group had a limited idea about the topics before the experimentation. Maliga (2018) also found out that both control and experimental groups had a little knowledge about the lessons before the start of his experimentation. The two authors reiterated that it is normal for the students to receive a low performance in the pre-test since they have no idea yet about the topics.

Problem-Solving Performance on Gas Laws of Grade 10 Students after the Experimentation

Problem solving refers to the ability to identify and define the problem, generating alternative solutions, evaluating and selecting the best alternative, and implementing the selected solution. Having good and strong problem-solving skills in Chemistry can make a huge difference to one's career in dealing with chemical reactions. Tables 3 and 4 present the problem-solving performance of grade 10 students after the experimentation.

Table 3: Level of problem-solving performance on gas laws of grade 10 students in control group after the experimentation

	Gas Laws	MPS (n = 43)	Verbal Description
1	Gay-Lussac's Law	65.80	Average Mastery
2	Avogadro's Law	60.70	Average Mastery
3	Combined Gas Law	60.40	Average Mastery
4	Boyle's Law	59.60	Average Mastery
5	Charles' Law	58.80	Average Mastery
6	Ideal Gas Law	53.00	Average Mastery
Overall MPS		**59.72**	**Average Mastery**

Legend: 96 – 100 – Mastered; 86 – 95 – Closely Approximating Mastery;
66 – 85 – Moving Towards Mastery; 35 – 65 – Average Mastery;
15 – 34 – Low Mastery; 5 – 14 – Very Low Mastery;
0 – 4 – Absolutely No Mastery

As shown in Table 3, control group acquired an overall MPS of 59.72% with a description of Average Mastery in the post-test. This statistical finding was validated by the six Gas Laws that all received the same level of Average Mastery. This means that students exposed in the traditional instruction improved their problem-solving performance on Gas Laws from Low Mastery (MPS = 24.97%) to Average Mastery (MPS = 59.72%). This implies that students who were taught with traditional instruction learned appropriate techniques in solving problems in Chemistry. In other words, students who were subjected to chalk and talk method of instruction improved their problem-solving performance on gas laws.

In particular, the highest MPS of 65.80% described as Average Mastery was obtained by Gay-Lussac's Law. This indicates that out of six Gas Laws in solving Chemistry problems, students in control group learned a lot in Gay-Lussac's Law. As a matter of fact, their scores improved from 25.40% (Low Mastery) to 65.80% (Average Mastery). These post-test results outranked the Boyle's Law which was in the top list during the pre-test.

On the other hand, students in control group acquired a lowest MPS of 53.00% with a description of Average Mastery in Ideal Gas Law. Although, students registered a lowest increase in their MPS in the said gas law, their problem-solving performance still improved to Average Mastery. In other words, majority of students subjected with direct instruction still learned various methods in solving problems in Chemistry.

The study of Paghubasan (2017) revealed that students in experimental group registered higher improvement in their performance and retention in Mathematics after their exposure to game-based and activity-oriented instruction. She also concluded that although students exposed with both traditional instruction and game-based and activity-oriented instruction recorded an increase in their Mathematics performance and retention, experimental group had a higher mean gain score compared with the control group.

Table 4: Level of problem-solving performance on gas laws of grade 10 students in experimental group after the experimentation

	Gas Laws	MPS (n = 41)	Verbal Description
1	Boyle's Law	96.00	Mastered
2	Gay-Lussac's Law	89.40	Closed Approximating Mastery
3	Avogadro's Law	84.30	Moving Towards Mastery
4	Charles' Law	83.10	Moving Towards Mastery
5	Combined Gas Law	74.10	Moving Towards Mastery
6	Ideal Gas Law	73.90	Moving Towards Mastery
Overall MPS		**83.47**	**Moving Towards Mastery**

Legend: 96 – 100 – Mastered; 86 – 95 – Closely Approximating Mastery;
66 – 85 – Moving Towards Mastery; 35 – 65 – Average Mastery;
15 – 34 – Low Mastery; 5 – 14 – Very Low Mastery;
0 – 4 – Absolutely No Mastery

As presented in Table 4, experimental group generated an overall MPS of 83.47% described as Moving Towards Mastery. This means that students' problem-solving performance in experimental group really improved and it was attributed to the use of reciprocal peer tutoring (RPT). Exposure of students to RPT session guides with practical work activities for both the tutors and tutees enhanced their problem solving-performance from Low Mastery (MPS = 24.88%) to Moving Towards Mastery (MPS = 83.47%). In other words, RPT instruction gave students great opportunities to acquire different problem solving approaches, thus, improving their problem solving performance on gas laws.

Interestingly, the highest MPS of 96.00% with an adjectival rating of Mastered proved that RPT instruction provided students excellent systems on how to apply Boyle's Law in solving problems in Chemistry. From the pre-test, experimental group increased its MPS from 40.40% (Average Mastery) to 96.00% (Mastered) in the post-test. This indicates that RPT instruction enhanced students' comprehension and solving skills, thus, developing their problem solving performance.

Remarkably, the second highest MPS of 89.40% with a verbal description of Closed Approximating Mastery was garnered by students in Gay-Lussac's Law. This indicates that students treated with RPT instruction got higher increase in their MPS compared with those students subjected with traditional instruction. In experimental group, the MPS of 25.20% (Low Mastery) increased to MPS of 89.40% (Closely Approximating Mastery). In control group, the MPS of 25.40% (Low Mastery) increased to MPS of 65.80% (Average Mastery only).

In different manner, the lowest MPS of 73.90% described as Moving Towards Mastery was obtained by students in Ideal Gas Law. Tables 1 through 4 indicate that the most difficult problems are those applying the concept of Ideal Gas Law compared with five other Gas Laws since both control and experimental groups got lowest MPS in the said gas law as revealed by the pre-test and post-test results. Although, problems that apply the concept of Combined Gas Law were very difficult, students in experimental group registered higher increase from MPS of 13.80% (Low Mastery) to MPS of 73.90% (Moving Towards Mastery) compared with students in control group that registered MPS of 14.00% (Low Mastery) to MPS of 53.00% (Average Mastery).

Similar research finding is also stressed by Maliga (2018). His study found out that students exposed with supplemental learning materials in Grade 10 Mathematics had a better Mathematics performance after the experimentation compared with the control group subjected with traditional method of instruction. He suggested that Mathematics teachers should expose their students in different modern collaborative learning approaches supplemented with contextualized instructional materials (IM's).

Attitudes of Grade 10 Students towards Chemistry before the Experimentation

Attitudes are complex psychological constructs that are acquired through experiences. They can be formed from students' past, present and future situations. Developing students' positive attitudes towards Chemistry is one of the major responsibilities of Science teachers so that every learner is given equal opportunity to improve his problem-solving skills. Before the start of the experimentation, survey questionnaire regarding the attitudes of students towards Chemistry was answered by the Grade 10 students from both control and experimental groups. Presented in Tables 5 and 6 are the results.

Table 5: Extent of attitudes of grade 10 students towards chemistry in control group before the experimentation

	Indicators	Mean (n = 43)	Verbal Description
1	Dependence on Procedures	2.68	Moderately Positive
2	Importance of Formulas	2.44	Negative
3	Exploration in Problem Solving	2.23	Negative
4	Use of Technology	2.14	Negative
5	Relation to Real World	2.04	Negative
6	Positivity	2.01	Negative
7	Confidence in Learning	1.91	Negative
8	Independence in Learning	1.82	Negative
Overall Mean		**2.16**	**Negative**

Legend: 4.20 – 5.00 – Highly Positive; 3.40 – 4.19 – Positive; 2.60 – 3.39 – Moderately Positive; 1.80 – 2.59 – Negative; 1.00 – 1.79 – Highly Negative

As shown in Table 5, negative attitudes towards Chemistry of students before the conduct of the experiment in control group was indicated by the overall mean of 2.16. This means that students in control group didn't like Chemistry subject prior to the experimentation. They already thought that Chemistry is a difficult subject since it applies Mathematics formula. These negative attitudes of students towards Chemistry were justified by the seven indicators that all received Negative remark and only one indicator receiving a rating of Moderately Positive.

More specifically, the highest mean of 2.68 described as Moderately Positive was obtained by the indicator Dependence on Procedures. This means that students in control group had a little appreciation on the systematic procedures used in solving Chemistry problems. In other words, their excitement for the procedures on how to solve problems that apply gas laws was minimal.

The second highest mean of 2.44 with a description of Negative shows that students in control group didn't appreciate the importance of formulas in solving Chemistry problems. This only manifests that they hardly memorize mathematical formulas and cannot internalize the significance of these equations in manipulating word problems in Chemistry.

In similar manner, the lowest mean of 1.82 described as Negative was acquired by the indicator Independence Learning. This signifies that students in control group were just only dependent on the examples given by the teachers and they cannot really work independently in solving Chemistry problems. In layman's terms, they indeed got difficulties in understanding word problems that apply mathematical equations and variables.

Moreover, students' confidence in learning Chemistry problems was also a problem prior to the conduct of the study and this was manifested by the second lowest mean of 1.91 with a description of Negative. Precisely, before the start of the experimentation, students had a slight self-assurance to love and understand Chemistry lessons as they were already surrounded with negative attitudes towards the subject.

This study is consistent with the finding of Garner-O'Neale and Cumberbatch (2016) who conducted a study to determine the attitudes of Chemistry students towards Mathematics. They found out that many students disliked Mathematics which triggered them to be uninterested also in quantitative Chemistry that involves problem solving using mathematical concepts. They concluded that Mathematics, Physics and Chemistry are the three abysmally disliked subjects in secondary schools. They further noted that Math and Science teachers can play a role in improving the positive attitudes of students towards Mathematics and later become very optimistic in performing problems with regards to Physics and Chemistry subjects.

Table 6: Extent of attitudes of grade 10 students towards chemistry in experimental group before the experimentation

	Indicators	Mean (n = 41)	Verbal Description
1	Dependence on Procedures	2.72	Moderately Positive
2	Positivity	2.68	Moderately Positive
3	Importance of Formulas	2.14	Negative
4	Relation to Real World	2.20	Negative
5	Confidence in Learning	2.20	Negative
6	Independence in Learning	1.96	Negative
7	Use of Technology	1.90	Negative
8	Exploration in Problem Solving	1.85	Negative
Overall Mean		**2.21**	**Negative**

Legend: 4.20 – 5.00 – Highly Positive; 3.40 – 4.19 – Positive; 2.60 – 3.39 – Moderately Positive; 1.80 – 2.59 – Negative; 1.00 – 1.79 – Highly Negative

As shown in Table 6, the overall mean of 2.21 with a description of Negative indicates that students in experimental group disliked Chemistry prior to the start of the experimentation. This means that they didn't appreciate the essence of Chemistry principles in their daily life activities. In other words, they already considered that Chemistry is like Mathematics that is a nerve-wracking subject. These negative attitudes of students in experimental group were strongly validated by the six indicators that all received a descriptive rating of Negative and only two indicators that were described as Moderately Positive.

In particular, students in experimental group had a slight appreciation towards understanding scientific procedures in solving Chemistry problems and this was evident by the highest mean of 2.72 described as Moderately Positive. In other words, students already assumed that approaches in manipulating Chemistry

problems are complicated and hard to understand. However, they still believed that the use of systematic procedures can help them a lot to solve word problems in Chemistry.

In similar situation, students in experimental group were somewhat optimistic that Chemistry is a very worthwhile and necessary subject. Although Chemistry is a difficult subject, they still showed an appreciation to the contribution of Chemistry in making their life more meaningful. This was indicated by the second highest mean of 2.68 described as Moderately Positive obtained by the indicator Positivity.

Remarkably, six indicators such as Exploration in Problem Solving (1.85), Use of Technology (1.90), Independence in Learning (1.96), Confidence in Learning (2.20), Relation to Real World (2.20) and Importance of Formulas (2.14) were all receiving a description of Negative. This means that students in experimental group had apprehensions to experience difficulty in solving word problems in Chemistry.

More specifically, students in experimental group showed highest apprehension in the indicator Exploration in Problem Solving compared with other indicators and this was indicated by the lowest mean of 1.85 described as Negative. This simply means that they were afraid that they will not be able to discover simple techniques to solve word problems in Chemistry. They hesitated that they were not able to cope up with the difficult processes in translating word problems in mathematical equations.

Simpal (2016) and Abdullah (2020) support the above finding when they emphasized that students got intimidated if lessons involved numbers. They further suggested that teachers should motivate first the students to love basic mathematics and further get interested with advanced lessons that involve numbers.

Attitudes of Grade 10 Students towards Chemistry after the Experimentation

After the experimentation, same set of questionnaire regarding the attitudes of students towards Chemistry was distributed. Findings are presented in Tables 7 and 8.

Table 7: Extent of attitudes of grade 10 students towards chemistry in control group after the experimentation

	Indicators	Mean (n = 43)	Verbal Description
1	Importance of Formulas	2.79	Moderately Positive
2	Dependence on Procedures	2.75	Moderately Positive
3	Exploration in Problem Solving	2.71	Moderately Positive
4	Use of Technology	2.68	Moderately Positive
5	Independence in Learning	2.59	Negative
6	Positivity	2.51	Negative
7	Confidence in Learning	2.35	Negative
8	Relation to Real World	2.28	Negative
Overall Mean		**2.58**	**Negative**

Legend: 4.20 – 5.00 – Highly Positive; 3.40 – 4.19 – Positive; 2.60 – 3.39 – Moderately Positive; 1.80 – 2.59 – Negative; 1.00 – 1.79 – Highly Negative

As shown Table 7, attitudes of students towards Chemistry in control group after the experimentation were still Negative as justified by the overall mean of 2.58. It was indicated by the result that students in control group increased their appreciation to the Chemistry subject after the experimentation. However, still negative attitudes towards the subject were evident. This means that traditional instruction minimally increased the positive attitudes of students towards Chemistry. As a matter of fact, before the conduct of the experimentation, students' negative attitudes towards Chemistry were evident by the overall mean of 2.16. After the exposure of students in control group with traditional instruction, a little bit rise of overall mean to 2.58 was still interpreted as Negative. In other words, although there was an increase of the mean, students' perception about Chemistry as a difficult subject was not changed by traditional instruction. Before and after the exposure of control group to traditional instruction, students displayed negative attitudes towards Chemistry. These negative attitudes of students towards Chemistry, after the experimentation, were manifested by 4 or 50% of the indicators that received a Negative rating and another 4 or 50% received a rating of Moderately Positive. This further means that traditional instruction made them realize that Chemistry is an important subject. However, they still dislike the subject due to its very complicated solutions.

More specifically, students in control group had a realization that formulas are very important in understanding word problems in Chemistry and this was indicated by the highest mean of 2.79 still described as Negative. There was an increase from MPS of 2.44 (before the experimentation) to the MPS of 2.79 (after the experimentation) due to the exposure of students in traditional instruction. This indicates that students' negative attitudes towards Chemistry turned into

Moderately Positive. In layman's terms, tradition instruction slightly increased the positive attitudes of students towards Chemistry.

Moreover, the lowest mean of 2.28 described as Negative was registered by students in the indicator Relation to Real World. This means that after the exposure of students to traditional instruction, they still perceived that Chemistry principles are not so important in their daily life activities. In other words, no realization about the essence of Chemistry in improving people's lives was made after they were taught using traditional instruction.

Kennedy (2019) has a similar research finding when she emphasized that getting students in practical work approach that encourages positive disposition as early as possible is the best way to prevent long-lasting negative attitudes towards mathematics. She also stressed that positive attitudes towards Mathematics can lead to higher achievement, and high achievement can result in more favorable attitudes.

Table 8: Extent of attitudes of grade 10 students towards chemistry in experimental group after the experimentation

	Indicators	Mean (n = 41)	Verbal Description
1	Relation to Real World	4.21	Highly Positive
2	Positivity	3.85	Positive
3	Importance of Formulas	3.78	Positive
4	Dependence on Procedures	3.74	Positive
5	Confidence in Learning	3.72	Positive
6	Independence in Learning	3.72	Positive
7	Exploration in Problem Solving	3.55	Positive
8	Use of Technology	3.39	Moderately Positive
Overall Mean		**3.75**	**Positive**

Legend: 4.20 – 5.00 – Highly Positive; 3.40 – 4.19 – Positive; 2.60 – 3.39 – Moderately Positive; 1.80 – 2.59 – Negative; 1.00 – 1.79 – Highly Negative

As shown in Table 8, experimental group obtained an overall mean of 3.75 with a description of Positive. This means that after the exposure of students in experimental group with reciprocal peer tutoring (RPT) instruction, students' positive attitudes increased from the overall mean of 2.21 (Negative) to 3.75 (Positive). In other words, RPT instruction gave the students an optimistic perception towards Chemistry. They started to love Chemistry due to the practical work activities and exercises designed for both tutors and tutees. RPT session guides motivated them to love Chemistry and appreciate its essence to the real world, thus, giving them a chance to improve their positive attitudes towards the subject.

More specifically, students in experimental group were able to appreciate the relation of Chemistry to the real world and this was manifested by the highest mean of 4.21 described as Highly Positive. This means that through the exposure of students in RPT instruction, they can relate Chemistry principles to actual scenarios in the real world. They were able to connect the concepts they learned in Chemistry in their day to day activities.

Moreover, students' positive attitudes towards the use of modern technology in solving word problems partially improved from the overall mean of 1.90 (Negative) to 3.39 (Moderately Positive). This means that there was only a minimal use of modern technology such as scientific calculator in the RPT session guides since actual manipulation of the solutions of the problems was encouraged by the RPT instruction. This was the reason behind why students had only a moderate increase in their positive attitudes towards Chemistry.

In relation to this finding, Paculanan (2013) and Simpal (2016) noted that use of modern technology should be emphasized to the students so that they will not become ignorant of the recently invented devices and mobile applications which are very relevant to the modern world. They further emphasized that concretizing abstract ideas increases the positivity of students towards mathematics.

Problem-Solving Performance on Gas Laws of Grade 10 Students Exposed in the Reciprocal Peer Tutoring (RPT) and Traditional Instruction before and after the Experimentation

To determine if there is a significant difference on the problem-solving performance on gas laws of grade 10 students exposed in the reciprocal peer tutoring (RPT) and traditional instruction before and after the conduct of the experiment, Tables 9 through 12 present the results of the t-test analysis.

Table 9: t-test analysis on the problem solving performance on gas laws of grade 10 students before the experimentation

Groups	MPS (%)	Comp t-value	Critical t-value
Control Group	24.97	0.83	1.989
Experimental Group	24.88		
MPS Difference	**0.09^{ns}**		

ns – not significant @ 0.05 level; two-tailed t-test

It is revealed in Table 9 that the mean percentage score (MPS) of control and experimental groups were 24.97% and 24.88%, respectively. It further implies that the MPS of control group is little bit higher than the MPS of experimental group and this difference of 0.09 was proven not significant as the t-test analysis affirms in which the computed t-value of 0.83 is less than the critical t-value of 1.989 @ 5% level of significance (two-tailed t-test). This finding led to the confirmation that the two groups under experimentation were not significantly different. This implies that students in experimental group, most likely, were as good as those in control group in terms of problem solving performance. Further, the data signify that experimental and control groups had

the same level of problem solving performance on gas laws before the conduct of the study.

This study is supported by Abdullah (2020) who found out that both control and experimental groups had the same level of problem solving skills in Statistics and Probability prior to the start of the experimentation.

Table 10: t-test analysis on the problem solving performance on gas laws of grade 10 students in control group before and after the experimentation

Tests	MPS (%)	Comp t-value	Critical t-value
Pre-Test	24.97	13.265	2.637
Post-Test	59.72		
MPS Gain	**34.75****		

** – significant @ 0.01 level; two-tailed t-test

As shown in Table 10, the computed t-value of 13.265 exceeds the critical t-value of 2.637 @ 1% level of significance (two-tailed t-test). This indicates that through the exposure of students to traditional instruction, control group garnered a higher MPS of 59.72% in the post-test compared with the MPS of 24.97% in the pre-test. This further means that students gained a significant increase of 34.75% in their problem solving performance on gas laws due to their exposure to traditional instruction. In other words, students solely exposed to traditional approach of teaching registered a significant gain in their mean percentage score (MPS).

The above statistical analysis is supported by Criswell and Greg (2018). They concluded that students confined with traditional Chemistry instruction registered a minimal progress in their problem solving performance compared to the students who were exposed to various modern teaching materials and strategies.

Table 11: t-test analysis on the problem solving performance on gas laws of grade 10 students in experimental group before and after the experimentation

Tests	MPS (%)	Comp t-value	Critical t-value
Pre-Test	24.88	28.057	2.637
Post-Test	83.47		
MPS Gain	**58.59****		

** – significant @ 0.01 level; two-tailed t-test

Table 11 presents the t-test result on the mean percentage scores (MPS) of experimental group in the pre-test and post-test. It is further noted in the table that the MPS Gain of 58.59 which was higher than control group (34.75%) was proven highly significant as the t-test confirms since the computed t-value of 28.057 is greater than the critical t-value of 2.637 @ 1% level of significance (two-tailed t-test). This means that students were really motivated to improve their study habits, thus, giving them a chance to significantly increase their mean percentage score (MPS) from 24.88% to 83.47%. In other words, reciprocal peer tutoring (RPT) allowed students to explore their wild imagination to apply various approaches to improve their problem solving performance on Gas Laws.

Tables 10 and 11 strongly confirmed that both traditional instruction and reciprocal peer tutoring (RPT) instruction were effective in improving the problem solving performance on Gas Laws of students. It was found out that higher MPS gain 58.59% was recorded by the experimental group compared with the control group that recorded only a MPS gain of 34.75%.

The above statistical analysis is supported by Hagos (2009). He found out that students solely confined with traditional mathematics instruction registered a significant progress in their problem solving performance. He added that traditional instruction has been proven effective in improving the academic performance of students over the years. However, he also found out that students exposed with reciprocal peer tutoring (RPT) had higher significant gain scores compared with those subjected with traditional instruction. He finally concluded that RPT instruction is more effective than traditional instruction in enhancing the academic performance of students in mathematics.

To determine if there is a significant difference on the MPS gains of control and experimental groups, Table 12 presents the results of the t-test analysis.

Table 12: t-test analysis on the problem solving performance on gas laws of grade 10 students in control and experimental groups after the experimentation

Groups	MPS (%)	Comp t-value	Critical t-value
Control Group	59.72	8.234	2.637
Experimental Group	83.47		
MPS Difference	**23.75****		

** – significant @ 0.01 level; two-tailed t-test

As revealed in Table 12, experimental group registered a mean percentage score (MPS) of 83.47% while the control group generated a mean percentage score (MPS) of 59.72% in the post-test. Experimental group's MPS is higher than the MPS of 59.72 earned by control group, marking a difference of 23.75%. This difference was proven highly significant as the t-test exhibits. The computed t-value of 8.234 is greater than the critical t-value of 2.637 @ 1% level of significance (two-tailed t-test). This means that there was a significant difference between the post- tests' MPS of the two groups in favor of the experimental group that was exposed to reciprocal peer tutoring (RPT) which encouraged both the slow and fast learners to enhance their critical thinking abilities, thus, improving their problem solving performance on Gas Laws. In short, RPT approach is more effective than traditional approach in improving the problem-solving performance of students on gas laws.

Three previous tables revealed that the two teaching approaches used in this study both improved the problem solving performance on gas laws of students. However, reciprocal peer tutoring (RPT) instruction was proven to be more effective than traditional Chemistry instruction.

This finding is consistent with the idea of Egbochuku and Obiunu (2006) who stressed that RPT allows students to actively generate factual opinion out of their personal experiences. He recommended that RPT should be applied not only by the Mathematics teachers but also the Science teachers in improving the problem solving skills of students in Physics and Chemistry problems.

Effect of Reciprocal Peer Tutoring (RPT) on the Attitudes of Grade 10 Students

To determine the effect of reciprocal peer tutoring (RPT) on the attitudes of students towards Chemistry and to validate the findings of other researchers, Tables 13 through 16 present the results of the t-test results.

Table 13: t-test analysis on the attitudes of grade 10 students towards chemistry before the experimentation

Groups	Mean	Comp t-value	Critical t-value
Control Group	2.16	0.219	1.989
Experimental Group	2.21		
Mean Difference	**0.05^{ns}**		

ns – not significant @ 0.05 level; two-tailed t-test

As shown Table 13, the computed t-value of 0.219 is less than the critical t-value of 1.989 @ 5% level of significance (two-tailed t-test). This means that the negative attitudes of students towards Chemistry in control group were comparable with the negative attitudes of students in experimental group. This further indicates that students from both groups disliked Chemistry prior to the start of the experiment. In other words, their low level of appreciation to the importance of Chemistry was of similar extent. Both students showed dismayed attitudes towards Chemistry before the experiment was conducted.

This finding is affirmed by the study of Paculanan (2013) who stressed that students might display negative attitudes towards the subject if they don't see its practical application to the real world experiences. He added that it is normal for the students to have apprehension towards the subject if they have no idea yet what to be discussed particularly in Mathematics and Science subjects.

Table 14: t-test analysis on the attitudes of grade 10 students in control group before and after the experimentation

Attitudes	Mean	Comp t-value	Critical t-value
Before	2.16	1.028	1.989
After	2.58		
Mean Gain	**0.42^{ns}**		

ns – not significant @ 0.05 level; two-tailed t-test

It can be seen in Table 14 that there was no significant difference between the attitudes of students towards Chemistry before and after the experimentation. Although, there was a little bit increase of 0.42 in the mean score of students after the conduct of the study, this mean gain was proven not significant as the computed t-value of 1.028 is less than the critical t-value of 1.989 @ 5% level of significance (two-tailed t-test). This means that traditional approach didn't help the students to improve their attitudes towards Chemistry. Although, students learned a lot in traditional instruction and it was indicated by the significant MPS gain score of 34.75% presented in Table 10, their negative attitudes towards Chemistry were still comparable with their negative attitudes before the start of the experimentation. In layman's terms, traditional instruction had nothing to do in improving the positive attitudes of students towards Chemistry.

Abdullah (2020) supports the above finding when he found out that negative attitudes towards Math and Science subjects are evident among students if Mathematics and Science teachers just only confine themselves with traditional instruction. He added that traditional instruction doesn't give students opportunities to teach their classmates since the teacher just only monopolize the task of imparting knowledge.

Paghubasan (2017) has a similar finding with the above data when she proved that traditional assessment didn't boost students' problem solving skills in Mathematics. She further recommended that modern assessment tools such as game-based and activity-oriented assessment strategies should be exposed to the students to improve their problem solving skills.

To further support the findings above, Simpal (2016) found out that lack of background in Mathematics and poor study habits were the top problems encountered during the conduct of his experimentation and these problems were easily overcome by the students in the experimental group due to the advantages given by the use of visual representations in solving problems. That's why; he suggested that Physics and Chemistry teachers should devise a teaching strategy that makes the abstract ideas concrete. By this way, interests of the students towards the subject can be observed.

Table 15: t-test analysis on the attitudes of students in experimental group before and after the experimentation

Attitudes	Mean	Comp t-value	Critical t-value
Before	2.21	25.842	2.637
After	3.75		
Mean Gain	**1.54****		

** – significant @ 0.01 level; two-tailed t-test

As shown Table 15, the computed t-value of 25.842 is greater than the critical t-value of 2.637 @ 1% level of significance (two-tailed t-test). This means that there was a significant difference (1.54) between the attitudes of students before and after the conduct of experimentation. The exposure of students in reciprocal peer tutoring (RPT) instruction significantly increased their positive attitudes towards Chemistry. In other words, there was a

positive effect of RPT instruction on the attitudes of students in Chemistry.

Further, Ding and Harskamp (2011) supports the above finding when he stressed that RPT can be used to assist the slow learners in performing problems that involve numbers. He added that RPT is an effective teaching approach in developing the problem solving skills of students in Chemistry particularly in dealing with the bahavior of gasses as it involves mathematical computation. He further intensified that Chemistry involves different practical problems that can be applied in the solutions of day- to- day undertakings.

Letting each advanced learner to teach his classmates can just only boost his self-esteem. Tutor's self-confidence and tutee's academic performance both improve. Reciprocal peer tutoring (RPT) encourages the use and synchronization of both minds and hands. Thus, RPT instruction is an effective teaching strategy since it introduces various exploratory activities that would apply the prior knowledge and skills of students.

Table 16: t-test analysis on the attitudes of students towards Chemistry after the experimentation

Groups	Mean	Comp t-value	Critical t-value
Control Group	2.58	10.258	2.637
Experimental Group	3.75		
Mean Difference	**1.17****		

** – significant @ 0.01 level

It is shown in Table 16 that the mean difference of 1.17 was proven highly significant since computed t-value of 10.258 is greater than the critical t-value of 2.637 at 1% level of significance (two-tailed t-test). This means that after the exposure of students in experimental group with reciprocal peer tutoring (RPT) instruction, their attitudes towards Chemistry significantly improved from negative to positive. Unlike with control group exposed with traditional instruction, as shown in Table 14, students' attitudes towards Chemistry didn't significantly improve. In other words, their negative attitudes remained the same after the experimentation. This t-test analysis strongly confirms that RPT instruction wis very effective in improving the attitudes of students towards Chemistry.

Henson (2009) also supports the above data when he emphasized that exposing students in reciprocal peer tutoring (RPT) instruction encourages students to maximize their engagement opportunities to their peers. Abdullah (2020) added that practical work approach (PWA) using supplemental learning materials (SLM's) increases academic achievement while it decreases disruptive behavior. The two authors strongly believed that PWA and RPT using supplemental learning materials (SLM's) both improve the academic achievement and attitudes of students towards Chemistry and Mathematics, respectively.

This study finally found out that the use of reciprocal peer tutoring (RPT) in teaching gas laws had a positive effect on problem-solving performance and attitudes of grade 10 students towards chemistry.

Conclusions

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

- Before the start of the experimentation, the students from control and experimental groups had a comparable problem solving performance. After their exposure into two respective teaching approaches, students from the experimental group subjected with reciprocal peer tutoring (RPT) instruction obtained higher Mean Percentage Scores (MPS) compared with the control group solely taught with traditional instruction.
- The use of reciprocal peer tutoring (RPT) session guides and activity sheets greatly influenced the problem solving performance of students in experimental group. RPT instruction was more effective than traditional instruction in improving the problem solving performance of students in Chemistry.
- Prior to the conduct of experiment, students from both control and experimental groups displayed negative attitudes towards Chemistry. After the experimentation, students in control group still displayed negative attitudes towards Chemistry while students in experimental group exhibited already positive attitudes in Chemistry.
- The exposure of students in reciprocal peer tutoring (RPT) instruction had a positive effect on their problem-solving performance and attitudes towards Chemistry. It is finally concluded that the use of reciprocal peer tutoring (RPT) is effective in improving the problem-solving performance and positive attitudes of students towards Chemistry.

Recommendations

Based on the findings and conclusions of the study, the researcher presents the following recommendations:

1. To provide an optimal educational learning experience in Chemistry, teachers should consider students' individual differences. In this regard, they should employ varied teaching approaches suited to the learning styles of the students particularly the use of reciprocal peer tutoring (RPT) in improving the problem solving performance and attitudes of students.
2. Teachers should always expose their students to situational problem solving which encourages both the slow and fast learners to be participative in every learning interaction. RPT instruction should be intensified to utilize the hidden talents of the advanced students in helping the low performing students boost their academic performance and attitudes towards the subject.
3. The developed RPT session guides and activity sheets in this study should be adopted as a means of enhancing the problem-solving

performance and attitudes of students towards Chemistry.

4. The RPT session guides and activity sheets developed in this study covered only the six (6) Gas Laws. It is therefore recommended that similar study which will include wider scope of important topics in Chemistry should be conducted.
5. Pre-service and in-service seminar workshops on the preparation of RPT activities geared toward helping learners to appreciate Chemistry should be conducted to foster positive attitudes and to learn the fundamentals and intricacies of Chemistry.
6. Chemistry teachers should develop RPT activities to serve as a tool in improving academic achievement and positive attitudes towards Chemistry subjects among students.

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