



EFFECTIVENESS OF GRAPHIC ORGANIZER IN COOPERATIVE LEARNING APPROACH IN TEACHING CHEMICAL EQUATIONS AND REACTIONS

¹Rona A.Idlisan, MAED

¹Senior High School Teacher II

¹Department of Education,

¹ Palo Leyte, Philippines

Abstract : This study examined the usefulness of the graphic organizer in cooperative learning (GOCoopLe) technique in science in a public secondary school in Tabango, Leyte, Philippines. This entire investigation was conducted utilizing a quasi-experimental crossover design methodology. Two groups of intact research participants were randomly assigned to the intervention group (using a graphic organizer for cooperative learning) and the control group (utilizing traditional lecture approach). After the first phase, the intervention group became the control group and the control group became the intervention group. Utilizing descriptive and inferential statistical tests, pre- and post-test data on student Science achievement were examined. Using the graphic organizer for cooperative learning, 10th graders improved their science performance to a satisfactory degree, according to the findings. In conclusion, the use of graphic organizers in cooperative learning approaches to enhance Science achievement is insufficient. Before exposing students to a new learning method, the author suggests that teachers conduct a thorough evaluation of the students' learning paradigm to ensure that the educational intervention is grounded in the students' learning area and speed.

IndexTerms - Graphic organizer, cooperative learning, science achievement, social constructivism, theory of motivation, cognitive load theory.

I. INTRODUCTION

Science education in the Philippines is committed to the growth of science literacy among Filipinos; nonetheless, in recent years Filipino students' performance on science accomplishment tests has been below average. The Programme for International Student Assessment (PISA) performed in 2018 found that the Philippines ranked last among the 79 participating nations in Science. In addition, the International Association for the Evaluation of Educational Achievement uncovered that the Philippines received low scores in the Trends in International Mathematics and Science Study (TIMSS) in 2003 (332 in Science and 358 in Math) and even lower scores in 2019 (249 in Science and 288 in Math). According to studies, pupils exhibit decreased enthusiasm in Science and more misconceptions. From 2013-2014 to 2014-2015, Science results on the National Achievement Test decreased by 0.06 percent, from 59.68 to 59.64. Biology, Chemistry, and Physics are subjects in which students' academic performance has improved very little over time (Oloyede, as cited in Udu, 2018). Teaching and learning mitosis, meiosis, chemical equations, and reactions is challenging (Oztap, Ozay and Oztap, as cited in Matillano, et al., 2016).

However, scientific education has come a long way in its pursuit of a science-literate community, as a result of advancements in the teaching-learning process in which teachers nurture learning by strategic intervention to meet the varied needs of pupils. Innovative techniques in science education can improve the academic performance of students in Science disciplines. This is consistent with Wise and Schroeder et al (as mentioned in Okwuduba and Okigbo, 2018) definition of an innovative teaching strategy as a pattern of diverse teaching approaches. New teaching practices designed to increase the efficiency and efficacy of science learning (Udu, 2018; Wora, Hadisaputro and Suharno Nugroho, 2017).

Graphic organizer in cooperative learning (GOCoopLe) approach highlights the rise in students' academic achievement in Science 10 (S10MTIVE-g-23) and increases students' connections with one another. Cooperative learning is a common method that increases the achievement of all types of students (Yaduvanshi and Singh, 2019), whereas the use of a visual organizer facilitates the nonverbal symbolism of ideas and their linkages (Sibold, as cited in Clarke, 2015). The teaching-learning process should take place in a self-regulated, self-directed, and active learning environment (Mahanal, Zubaidah, Bahri, and Dinnurriya, 2016; Isiaka, and Mudasiru, 2016), and this learning should be accomplished using the GOCoopLe strategy.

In addition, the GOCoopLe strategy is a strategic intervention that increases students' connectedness with their peers through a regulated conduct of activities that emphasizes interdependence and individual responsibility in a group context by

organizing, distinguishing, and summarizing concepts. During the process of determining the efficacy of the GOCoopLe method, the researcher utilized the Science 10 Learner's Material given by DepEd as the major source of evidence.

The majority of 10th graders at Marcelino R. Veloso National High School have pretty satisfactory quarterly grades, indicating that they have trouble mastering Science (75-79). The School Monitoring Evaluation, and Adjustment (SMEA) report for the first quarter of the 2019-2020 school year indicates that Marcelo R. Veloso National Highschool (MRVNHS) ranked in the bottom five of fifteen schools in the third district of Leyte for Science and Mathematics. In comparison to other courses, the MRVNHS mean percentage scores in science and mathematics fell short.

As an educator at the aforementioned university, the researcher decides to address this issue and creates a graphic organizer-based cooperative learning intervention to improve students' science achievement.

In picking the concepts taught in this study, the researcher selects the Science 10 competency that has been taught the least frequently over the past five years. These learning competencies were specified by the Department of Education's curriculum guide. The learning competencies are represented by a spiral development in which the degree of difficulty increases with each grade level. Science 10's chemical equations and reactions were the least-learned concepts at MRVNHS over the past five years. The tenth graders at MRVNHS are less interested in and more misinformed about this competency. According to the School Monitoring, Evaluation, and Adjustment reports for the years 2014 to 2019, the mean percentage score for Science 10 was much lower than in prior years. The percentage of 10th graders who scored at or above the national average on the National Achievement Test in 2016-2017 was 44.1 percent, a decrease from the 44.7 percent who scored at or above the national average in 2015-2016. The lack of improvement in high school students' scientific achievement is a clear indication that educational innovation should be supported. This research proposes that the use of a graphic organizer in cooperative learning (GOCoopLe) improves the academic accomplishment of students when teaching chemical equations and reactions. This method not only promotes learning, but also facilitates interactions that lead to individual participation in achieving a common objective. In addition, students' interest in critical thinking is sparked by the chronological and organized presentation of concepts.

Statement of the Problem

The investigation determined the effectivity of graphic organizer in cooperative learning (GOCoopLe) approach in teaching Chemical Equations and Reactions of Grade 10 learners for the School Year 2019-2020. Specifically, this research answered the succeeding queries:

1. What is the preliminary test achievement of the intervention and reference groups?
2. What is the aftertest achievement of the intervention and reference groups?
3. Is there a significant difference in the preliminary test achievement between the intervention and reference groups?
4. Is there a significant difference in the aftertest achievement in Science between the intervention and reference groups?
5. Is there a significant improvement from the preliminary test to the aftertest in the achievement of the intervention and reference groups?

Research Hypotheses

This study advanced the following null hypotheses:

1. There is no significant difference between the reference and intervention groups' academic performance in the preliminary test and aftertest.
2. There is no significant improvement from the preliminary test to aftertest of both groups' academic performance in chemical equations and reactions.

Theoretical framework

The GOCoopLe Approach is founded on social constructivism, motivational theory, and cognitive load theory (Alzahrani, 2016; Cleveland, 2014). The social constructivism promoted by Vygotsky (1978) focuses on social discourse exchanges that occur between people. This paradigm of social learning promotes cooperative learning in the classroom. Constructivists noticed that consciousness is created by interaction, and that mental confusion is necessary for the production of new knowledge (Slavin, 2015). According to constructivists, the use of numbered heads together (Wora, Hadisaputro, and Suharno Nugroho, 2017) and computer-assisted Jigsaw II (Isiaka and Mudasiru, 2016) enhances students' engagement and cognitive skills. Constructivism proposes that individuals should construct their own understanding from their own experiences (Cleveland, 2014), learn through group responsibility, and derive self-awareness from the group (Slavin, 2011). In a cooperative learning approach, a graphic organizer boosts student confidence in group activities while enhancing their learning experience. Through the GoCoopLe technique, information is constructed personally with peers, making it more substantial.

According to McClelland's theory of motivation (as quoted in Najmonnisa and Ismail, 2017), the students' ability to be objective and share a similar goal through group collaboration and encouragement is facilitated by their collective efforts. According to Levin, referenced by Tran (2013), the condition of tension motivates a person's conduct by kindling goals and motivating actions to reach the desired goal. The GoCoopLe strategy improves student interest in learning by motivating students to collaborate with peers and arrange information using a visual organizer.

Sweller's cognitive load hypothesis (as referenced by Cleveland, 2014) recognises the restriction of one's thinking capacity and proposes that academic activities be shortened in schools. The load hypothesis explains how cognition occurs within the human mind. When learners are given the opportunity to clarify concepts, according to Zakaria, Chin, and Daud (2010), their learning becomes more successful. When students listen to an explanation, elaboration improves their cognitive achievement; however, when they extend an explanation to their classmates, elaboration broadens their knowledge (McKeachie as cited in Tran, 2013). Using tools to organize concepts, a graphic organizer in a cooperative learning approach can reduce the amount of work required for learning. It generalizes pupils' knowledge by categorizing, summarizing, distinguishing, and sequencing material throughout the strategy.

II. REVIEW OF RELATED LITERATURE

Related Literature

The primary objective of education is to educate pupils how to think about thinking, or metacognition. Students in science classes are expected to think critically, analytically, and scientifically (Matillano et al., 2016). Science education for junior high school pupils emphasized that Science training should increase students' problem-solving skills, which are necessary in daily life (Yaduvanshi et al., 2019).

Combining Graphic Organizer and Cooperative Learning, or the GOCooPLe Approach as coined by the researcher, was utilized in this study. The two learning methodologies were no longer employed independently in the educational paradigm and were demonstrated to improve students' academic performance.

The purpose of graphic organizers (GO) is to illustrate the interconnectivity of concepts through the spatial organization of information. GO is an efficient method for the nonverbal expression of concepts and their relationships (Sibold as cited in Clarke, 2015). This was intended to help students organize knowledge by contrasting, comparing, classifying, summarizing, and demonstrating linkages (Buchanan, 2015). Labeling body organs, displaying the body system, and comprehending complex concepts such as the reactivity of chemical elements all involve the use of visuals in Science education (Stroud and Schwartz, as cited in Clarke, 2015).

A graphic organizer motivates students to recall information. This enables students to synthesize, manipulate, and arrange the curriculum's complexity (Elwood, 2018). Clarke (2015) discovered a significant positive link between the strategic intervention integrated with graphic organizer and the ninth-grade science achievement.

The study employed the idea map, research grid, thematic map, and Yes/No Sequence Map graphic organizers. According to assimilation theory, concept maps assist students connect and synthesize concepts (Mahanal, Zubaidah, Bahri and Dinnurriya, 2016). Research Grid is a question-and-answer student learning tool in which the teacher puts the question and the students investigate and write the response on the grid. Thematic maps are used to map generic information, whereas Yes/No sequence maps are sequential maps controlled by the answer to a yes or no question. Through this strategic thinking, the unique configuration of a GO enables students to identify the missing information (Buchanan, 2015).

Diverse studies (Korkmaz, 2018; Alkhathlan and Al-Daraiseh, 2017; Isiaka and Mudasiru, 2016) demonstrate the favorable effects of cooperative strategy on learners' scholastic performance and societal advancement via self-confidence, a positive attitude, and internal motivation. Conversely, conventional method enhances personal learning styles and promotes classroom competitiveness (Najmonnisa and Ismail, 2017).

Group work is an example of a cooperative learning strategy. Cooperative learning is one of the modern educational strategies that emphasizes the learner-centered classroom. A learner-centered environment encourages students to take greater responsibility for their individual growth and act as active students rather than passive recipients of knowledge (Fatima and Abdullah, 2016). Cooperative learning helps students to engage with the outside world in their learning (Alkhathlan and Al-Daraiseh, 2017). According to Slavin (as mentioned in Yaduvanshi et al., 2019), cooperative learning is indicated as a treatment for numerous academic undertakings. He asserted that the implementation of cooperative learning encourages teachers to reinforce their educational objectives.

Cooperative learning enables diverse students to rely on one another to achieve a particular purpose (Najmonnisa and Ismail, 2017). Numerous studies have demonstrated that pupils' connection improves their academic and interpersonal skills (Lau, Chong and Wong, 2014; Paul and Ray, 2014; Inuwa, Abdullah and Hassan, 2015; Phiwpong and Dennis, 2016; Alzahrani, 2016; Liu, Ba, Huang, Wu and Lao, 2017; Najmonnisa and Ismail, 2017).

According to Slavin (as described in Isiaka and Mudasiru, 2016), cooperative learning boosts students' academic progress regardless of their learning level. Ajaja and Eravwoke (as mentioned in Isiaka and Mudasiru, 2016) concluded that the cooperative learning group outperformed the traditional strategy group with significantly higher performance scores among students of varying abilities (high, medium & low). In addition, no significant interaction effects were found between gender and ability, gender and instructional method, ability and instructional strategy, and gender and achievement. Isiaka and Mudasiru (2016) emphasize that a cooperative learning technique must include personal accountability, interdependence, verbal communication, and the class assessment mechanism.

The study employed the cooperative learning strategies think-pair-share, roundtable, and numbered-heads-together. Numbered-heads-together is an approach for learning in which students' study in groups and are each assigned a number. The pupils collaborated to determine the answer. In addition, round table is a learning approach in which pupils take turns writing one word at a time. Think-pair-share involves a student-to-student and student-to-group engagement in solving a question.

Related Studies

Combining cooperative learning methodologies with diverse graphic organizers improves the cognitive learning outcomes of pupils. GOCooPLe approach was comparable to that of other researchers (Zubaidah, 2014; Pangestuti, Mistianah, Corebima, and Zubaidah, 2015) who combined reading with concept maps and different CL (Remap Coople); Remap TPS (Think, Pair, Share) (Setiawan, 2015); Remap STAD (Students Team Achievement Division) (Antika, 2015 and Hasan, 2014); and Remap TGT (Team (Pangestuti, 2014). These integrated tactics improve the analytical thinking skills, cognitive abilities, and knowledge outcomes of students.

During the experiment, the Graphic Organizer in Cooperative Learning (GOCooPLe) approach utilized several GO (idea map, research grid, theme map, and Yes/No Sequence Map) and CoopLe strategies (numbered-heads-together, roundtable, and think-pair-share).

The adoption of the numbered heads together (NHT) learning method improves classroom engagement and cognitive performance among students. ((2017). Wora, Hadisaputro, and Suharno Nugroho). Isiaka and Mudasiru (2016) conducted a study employing computer-assisted Jigsaw II to teach physics and found that students outperformed the control group (individual computer instruction) in terms of cognitive achievement and topic recall.

In addition, Yaduvanshi et al. (2019) compared the Student Team Achievement Division (STAD) strategy to the standard teaching method, and found that students who were exposed to the STAD approach had superior academic achievement than those

who were taught using the conventional method. In addition, they concluded that both knowledge and application of biological ideas have improved. Also, the cognitive achievement of students does not vary with their level of academic achievement (low achiever, average achiever, and high achievers).

Ornstein and Hunkins (2009) observed that numerous systematic approaches for personalised training have been developed in recent years. This program attempts to maximize individual learning by (a) determining the students' pre-achievement levels or learning deficiencies, (b) providing a one-to-one teacher-to-student relationship, (c) introducing sequenced and structured instructional materials, (d) allowing students to proceed and correlative activities for low achieving students, providing them with more assistance and encouragement, and (e) evaluating and assessing students' work, f) evaluating and assessing students' work, g

Reading and writing skills of a high level are required for effective science study. These abilities include the ability to comprehend scientific jargon, interpret facts, and read and compose scientific explanations (Cheng, 2019). Llosa et al. (2016) suggest that the objective of an integrated intervention should be real communication. Recent research indicates that students are accountable for developing connections while the teacher steers the discussion by posing questions, generating hypotheses, and encouraging students to draw inferences (Davis, 2018). Students apply a variety of language skills while conducting a science study, which eventually provides a basis for the development of related information and vocabulary, hence promoting academic success for English language learners.

By referencing the aforementioned review, the researcher had acquired sufficient prior knowledge regarding the study's factors. Similarly, it provides researchers with an understanding of the potential influence and how to proceed with assessing and employing graphic organizers in cooperative learning while testing the Science achievement of grade 10 students.

After discussing the relevant literature and studies, the theories tied to this research will shed further light on the topic for the readers, as they will serve as the basis for this experiment.

II. RESEARCH METHODOLOGY

Research Design

The research utilized a crossover methodology in quasi-experimental design with reference group and intervention group to examine the effectiveness of the usage of GOCoopLe Approach in teaching the chemical equations and reactions. Quasi-experimental design was suited for this analysis due to its nature in manipulation of independent variable to observe the effect on the dependent variable. During the first phase, both the intervention and control groups were given a preliminary examination. In the second phase, after the cross over, the GOCoopLe method was applied to the newly assigned intervention group. In the second phase, the traditional method was also applied to the newly designated reference group. Before the beginning of each phase, preliminary tests were conducted, and after-tests were administered at the end of each phase.

Population and Sample

The two randomized chosen sections comprised the control (58 students) and experimental (58 students) groups. The two sections were both following the Enhanced Basic Education Curriculum of the Marcelino R. Veloso National Highschool. The researcher chose two out of the three sections of Grade-10 (10-Happiness, 10-Tenderness and 10-Cheerfulness) through a simple random sampling in the intact group. The researcher used a toss coin indicating head as the control group and tail as the experimental group.

Ethical Considerations

The research study emphasized the safety of the research participants during the course of the study, and the personal information of the respondents (preliminary test scores and after test scores) were held confidential. Respondents were informed through a consent from the researcher and acknowledges voluntary participation of the research. The statements of the problem were clearly articulated. Parent's consent forms were distributed and collected from the students before the conduct of the intervention. And, no offensive, discriminatory, or other unacceptable language was used in the formulation of this study.

Research Instruments

Twenty-item teacher-made accomplishment assessments were created for both phase 1 and phase 2 of the study to assess the student's degree of proficiency on the lesson. In the first phase, a twenty-item exam was created with the following learning objectives: 1) Explain what a chemical reaction is, 2) Distinguish between reactant and product, 3) Identify the symbols used in chemical equations, and 4) Describe the six chemical processes.

In the second phase, another twenty-item exam was created with the following learning objectives: 5) Define conservation of mass and 6) Apply conservation of mass by balancing equations. Validity and dependability were evaluated through parallel pilot testing with Grade 11 students who had previously taken Grade 10 Science classes.

The difficulty/discrimination index was calculated by analyzing the evaluation questions. Items outside the difficulty index range of 0.20 to 0.80 and the discrimination index range of 0.30 to 0.80 were discarded, while those inside the limits were kept.

Validation of the Instruments

Validation was performed on a twenty-item teacher-made accomplishment test for both phase 1 and phase 2 of the project. Prior to constructing the test, the researcher created a Table of Specification (TOS) as a guide for question formulation. TOS ensured a balance between challenging and simple questions. In addition, it was guaranteed that all objectives employed in the GOCoopLe methodology were taken into account and adequately reflected in the test construction.

After constructing test items based on the TOS, the researcher recruited three science professors with at least ten years of teaching experience and publication experience to undertake an expert validity test. The science academics reviewed the exam item content and proposed modifications. The achievement exam was validated by the expert validators after rigorous test design.

Experimental Procedure

To generate a valid and a reliable result the following steps were followed:

1. A sampling procedure was conducted to the participants by establishing a comparability test using their grades in the 1st and 2nd quarter of the school year 2019-2020.
2. The two groups were assigned randomly through a toss coin, in which the head is the reference group and the tail is the intervention group.
3. The preliminary test was directed to both groups prior to the first phase of the study.
4. GOCoopLe approach was used in the intervention group and traditional lecture approach was utilized in the reference group.
5. Two different sets of lesson plans were used for each learning ability. Lesson plans for both the control and experimental groups follow the 7Es (Evoke, Engage, Explore, Explain, Refine, Evaluate, Extend).
6. In the first phase, the lesson plan used in the intervention group were injected with GOCoopLe approach in the Explore part. While the lesson plan in the reference group follows the Traditional Lecture (discussion) approach.
7. The aftertest was directed to both groups immediately after the first phase of the study.
8. A cross-over of groups was done after the first phase. The GoCoopLe approach was used by the previously assigned reference group which in the phase already became the intervention group. The traditional approach was implemented in the previously intervention group which has now become the reference group in the second phase.
9. The preliminary test was directed to both groups in the second phase of the study.
10. GOCoopLe approach was always applied to the intervention group and traditional lecture approach was utilized for the reference group.
11. In the second phase, the lesson plan used in the intervention group were injected with GOCoopLe approach in the Explore part. While the lesson plan in the reference group follows the Traditional Lecture (discussion) approach.
12. The aftertest was directed to both groups at the final stage of the second phase of the experiment.

Method of Scoring

The Learner Progress and Achievement scale adapted from the School Form 138-A provided by Department of Education (2013) were used in describing the results of the grade point average in science 9. For the achievement test, actual scores obtained by the learners during preliminary and aftertests were reported as the data for academic achievements

Statistical Treatment of Data

To ascertain if significant difference exist in the preliminary test and aftertest Science achievements between the intervention and reference groups, the t-test for two (2) independent samples was used. T-test formula is as follows:

$$T - \text{Value} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{SD_1^2}{n_1} + \frac{SD_2^2}{n_2}}}$$

where,

\bar{x}_1 = the mean of the aftertest score of the group with GO in cooperative learning

\bar{x}_2 = the mean of the aftertest group of the group without GO in cooperative learning

S_1^2 = the variance of the aftertest scores of the group with GO in cooperative learning

S_2^2 = the variance of the aftertest scores of the group without GO in cooperative learning

n_1 = the number of students in the reference group.

n_2 = the number of students in the intervention group.

The null hypothesis was tested at 0.05 level of significance.

To determine if there is a significant improvement from preliminary to the aftertest, t-test of 2 correlated samples was employed following the formula:

$$T_c = \frac{\bar{x} d}{SD d / \sqrt{N}}$$

Where:

$\bar{x} d$ = mean of the difference

SDd = Standard deviation of the difference

N = number of cases

To get the mean difference, the preliminary test was deducted from the aftertest.

IV. RESULTS AND DISCUSSION

1. Preliminary test achievement in Science of the intervention and reference groups

Table 1 exhibits the preliminary test scores in science for both sets of 10th grade students. The mean accomplishments for the reference and intervention groups were 6.26 and 6.72 for both groups, indicating a comparable level of moderately satisfactory performance. This demonstrates that the class's scientific performance will not improve in the absence of any intervention. Clearly, the children performed below the desired level in Science.

Table 1. Preliminary test achievements in Science of the intervention and reference groups (N = 58)

Group and Test	Mean	SD	Description
Preliminary Test			
Reference	6.26	1.75	Fairly Satisfactory
Intervention	6.72	2.56	Fairly Satisfactory

The value of the preliminary test results of both the intervention and reference group were distributed only in the mean of fairly satisfactory level. The scores show less variability in respect to the mean because of the small value of the standard deviation (SD). These suggests that the results of both groups were nearly similar from one another and were comparatively nearer to the achieved mean values.

Fundamentally, almost all the students' results nearly fall within three (3) to seven (7) with the mass displaying scores of 6 out of 20. These findings corroborate in the consolidated report from the School Monitoring, Evaluation, and Adjustment (SMEA) that shows significant low Science achievement among the grade 10 students in Marcelino R. Veloso National High School. This comes true in the national and international level, as Science achievement among the Filipino students were significantly low as compared to other nations. In fact, the Philippines rank at the bottom in the TIMSS 2003 and 2019.

2. Aftertest achievement in Science of the intervention and reference groups

In the post test, the achievement in Science of the Grade 10 learners for both groups were on the "satisfactory" level when they garnered scores of 10.21 and 9.47 (Table 2) for the reference and intervention groups, respectively. This confirms an elevation in the average results from the pre-test to the post-test of both study groups.

Table 2. Aftertest achievements in Science of the intervention and reference groups (N = 58)

Group and Test	Mean	SD	Description
<i>AfterTest</i>			
Reference	10.21	3.37	Satisfactory
Intervention	9.47	3.08	Satisfactory

The learners' scores in the aftertest were spread around the mean of satisfactory level with a bit large SD suggesting variability with respect to the mean. However, the mean scores still fall on the same satisfactory level. These indicate that the scores of the two groups did not vary largely from the attained mean values, though more spread than in the preliminary test. Many of the learners' scores closely fall within eight (8) to 12 (twelve) with a large number of learners obtaining scores of 10 out of 20.

Majority of the students answered the Remembering and Understanding part of the achievement test, as per stipulated by Anderson and Krathwohl (2001) through the Bloom's Revised Taxonomy used in the Table of Specification. Students have shown an increase in recalling and explaining ideas or concepts about the chemical equations and reactions.

3. Difference in the preliminary test achievement in Science between the intervention and reference groups

Before the conduct of the experiment, the 58 (N) respondents in the intervention and reference group answered the preliminary test achievement to see if there is a significant difference on their prior grasp on Chemical Equations and Reactions. Table 3 shows the difference in the preliminary test achievement in Science among the intervention and reference groups.

Table 3. Difference in the preliminary test achievement in Science between the intervention and reference groups (N = 58)

Group	Mean	SD	DF	T-Value	P-Value
<i>Preliminary Test</i>					
Reference	6.26	1.75	114	-1.43 ^{ns}	0.157
Intervention	6.72	2.56			

*N – number of cases SD – Standard Deviation DF – Degree of Freedom ns – no significant difference

The result reflects no significant difference in the preliminary test science achievement of the two groups such that the null hypothesis was not rejected. As projected in the p-value, the null hypothesis is true. This means that the two groups were at the similar point of learning capability prior to the act of experimentation.

Same observation was made, before the conduct of the experiment, when the researcher look into the 1st quarter grades of the grade 10 students. The two study groups were at the same cognitive pacing with their grades ranging from 75-79. This sameness of their science achievement makes them suitable as study respondents.

4. Difference in the aftertest achievement in Science between the intervention and reference groups

After the conduct of the experiment, the 58 (N) respondents in the intervention and reference groups answered the aftertest achievement to see if there is a significant difference on their learnt insight on Chemical Equations and Reactions. Table 4 shows the difference in the aftertest achievement in Science between the intervention and reference groups.

Table 4. Difference in the aftertest achievement in Science between the intervention and reference groups (N = 58)

Group	Mean	SD	DF	T-Value	P-Value
<i>Aftertest</i>					
Reference	10.21	3.37	114	1.24 ^{ns}	0.219
Intervention	9.47	3.08			

*N – number of cases SD – Standard Deviation DF – Degree of Freedom ns – no significant difference

Considering the mean results and standard deviation of both groups in the preliminary test, the calculated t-value was 1.24 in the pre-test with a resulting p-value of 0.219 which was higher than the level of significance set at 0.05. This means that the probability of the observed difference of the aftertest Science achievement of both groups under the null hypothesis is likely to occurred. As projected in the p-value, the null hypothesis is true.

The result suggests no significant difference in the aftertest Science achievement of intervention and reference groups such that the null hypothesis was accepted. This means that the two groups were at the similar point of learning capability after the act of experimentation. This indicates that two groups have the same understanding of the chemical equations and reactions.

Subsequently, the aftertest Science achievement result of both intervention and reference group, emphasizes their sameness of level of understanding as a group, however some students perform par ahead from other students, this is evident in the post-test results in which few of the learners' scores closely fall within thirteen (13) to sixteen (16), while many obtained the scores of ten (10) out of twenty (20).

5. Improvement from the preliminary to the aftertest in Science achievement of the intervention and reference groups

As shown in Table 5, both groups displayed improvement in their Science achievement from the pre to the aftertest. The intervention group indicated a rise of 2.75 mean points whereas the reference group registered a rise of 3.95 mean points. The computed t-value is 8.18 for the control group and 6.41 for the intervention group. The resulting p-value of 0.000 signified a highly significant improvement from preliminary test to the aftertest in the level of science achievement by both groups. Appropriately, there is

adequate evidence that the use of graphic organizer in cooperative learning was an effective approach in improving the Science achievement of the students.

Table 5. Preliminary test to aftertest mean gain in Science achievement between interventionl and reference groups (N = 58)

Group	Mean	SD	DF	T-Value	P-Value
<i>Reference Group</i>					
Preliminary test	6.26	1.75	57	8.18**	0.000
Aftertest	10.21	3.37			
<i>Intervention Group</i>					
Preliminary test	6.72	2.56	57	6.41**	0.000
Aftertest	9.47	3.08			

N – number of cases SD – Standard Deviation DF – Degree of Freedom

ns – no significant improvement

** - highly significant improvement in achievement

Although, it must be recognized that the reference group, which was under the traditional lecture method, posted highly significant improvement in the science achievement from the preliminary to the aftertest. As a matter of fact, the reference group registered mean gain was greater than the interventionl group. This result suggests that the learners exposed in the traditional lecture method from both phases were able to improve in their science achievement even without the use of graphic organizer in cooperative learning as a form of intervention. The implication of this findings shows positive regards to the use of the traditional lecture method.

However, this higher aftertest Science achievement of the reference group may result to the familiarity of the traditional teaching method. This affirms Goldstein (2011) law of familiarity that asserts that things which are familiar or meaningful tend to be clustered together. This psychological phenomenon is evident among learners where they have a tendency to build a preference for things, they are familiar with.

On the other hand, utilizing the graphic organizer in cooperative learning approach, although unfamiliar to the learners, still manage to improve students' Science achievement. This findings runs parallel with what Wora, Hadisaputro and Suharno Nugroho (2017) found in their study of the application of the numbered heads together (NHT) learning method and Isiaka and Mudasiru (2016) in their study of their computer-assisted Jigsaw II in teaching Physics. Also, current study findings acknowledged the study of Odeegard (2005) that the graphic organizer aided learners organize data about the lesson and assisted them to follow through as they solve problems. Cooperative learning let the students facilitate learning among peers and justify ways to learn the topic. Finally, both study groups achieved a mean gain score from the preliminary to the aftertest. Their individual aftertest results granted them to reach satisfactory level in Science achievement.

This study examined the impact of the graphic organizer in cooperative learning (GOCoopLe) strategy on the instruction of Chemical Equations and Reactions to 10th graders for the 2019-2020 school year. It aims to determine the pre-test and post-test achievement of the intervention and reference groups, tests for a significant difference in pre-test and post-test achievement between the intervention and reference groups, and evaluates whether there is a significant improvement in achievement from the pre-test to the post-test. This hypothesis utilized a quasi-experimental design with two independent samples. The t-test for two (2) independent samples was used to determine whether a significant difference existed between the intervention and reference groups on the pre- and post-tests of Science.

Given the available data, the research questions have been resolved. The Science achievement of both the intervention and reference groups on the pre-test was deemed satisfactory. This demonstrates that the students performed below the required level in Science. These results support the national and worldwide rankings of nations, which place the Philippines at the bottom in Science and Mathematics.

The Science achievement of 10th graders in both the intervention and reference groups on the post-test was satisfactory. This descriptive grade confirms a rise in the average outcomes of both research groups from the pre-test to the post-test. Students' ability to recall and articulate ideas or concepts regarding chemical equations and reactions has increased.

The absence of a statistically significant difference in the preliminary test Science accomplishment outcomes between the intervention and reference groups indicates that both groups were at a comparable level of learning capability prior to the experiment. This similarity in their scientific accomplishment qualifies them as research participants.

There was no significant difference between the intervention and reference groups' post-test Science achievement scores, indicating that both groups had the same comprehension of chemical equations and reactions. This demonstrates that two groups have an identical understanding of chemical equations and reactions. Both the intervention and reference groups demonstrated an increase in Science achievement between the pre- and post-tests. This demonstrates that the usage of GOCoopLe was an excellent strategy for enhancing the Science achievement of students.

Conclusion

In light of the study's findings, it can be stated that the application of GOCoopLe improves the science achievement of 10th grade students. Using a graphic organizer in a cooperative learning approach facilitates students' group work and learning. As long as competency-based design learning materials are made available, the use of graphic organizers in cooperative learning increases science accomplishment. Given the correct teaching-learning tools and reinforcement assistance, this study demonstrates that graphic organizers in cooperative learning are just as effective as the traditional lecture method. This supported constructivism, the notion of motivation, and the theory of cognitive load.

Recommendation

Using GOCoopLe is favorable for a student's science accomplishment, but it is equally important for educators to use carefully organized and inclusive rubrics that effectively evaluate the characteristics of the learning competency they wish to create in students. Before exposing students to a new learning method, the author suggests that teachers conduct a thorough evaluation of the students' learning paradigm to ensure that the educational intervention is grounded in the students' learning area and speed.

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