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Modified Frayer Model and Semantic Map Its Effectiveness in Enhancing the Performance in Science of Grade 7 Science Students

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ABSTRACT

The objective of this study was to determine the effectiveness of concept mapping using the Frayer Model and semantic map graphic organizers in promoting academic performance in science. This was conducted in Alabel National High School, the grade 7 students were the subject of study. It was conducted in two groups: the control and the experimental groups. In the control group, students were taught the non-utilization of the Modified Frayer Model and Semantic Map of instructions while in this experimental group, the Modified Frayer model and Semantic Map approach was utilized; brainstorming sessions, increasing students' vocabulary for comprehension by associating with new words related to science topics being studied are introduced into learning through graphic organizers inside the classroom and personal exploration of concepts or subject matter that helps them concentrate or focus on discussing science subjects course. After being instructed using the Modified Frayer models (MFM) and Semantic Maps (SM), the experimental group scored a mean of 41.04 (SD = 7.12) while the control group scored a mean of 16.68 (SD =7.55), with the t-value of 16.590 and a p-value of 0.000 which was less than 0.001. The outcomes revealed that the non-utilization and utilization of the Modified Frayer Model were both effective in enhancing the science subjects' performance, however, in the experimental group science performance was higher as compared to those from control groups. Therefore, the null hypothesis states that there is no significant difference in the performance in the science of the subjects in the control and experimental groups after receiving the non-utilization of the Modified Frayer Model and Semantic Map mode of teaching and instruction utilizing the modified Frayer Model and semantic map graphic organizers were rejected.

Keywords: Modified Frayer Model, Semantic Map, Graphic Organizers, and science performance

INTRODUCTION

Graphic organizers have been widely used for their ability to break down ideas into comprehensible concepts that facilitate the academic performance of students. The Frayer Model and Semantic Map have been identified as effective graphic organizers, particularly in the field of education in science subjects. In the context of science education, science has an intricate nature of scientific vocabulary that plays a role in the understanding of the subject matter. Students, often find science difficult, and encounter difficulties in studying the subject, as this is a challenging subject that requires a strong foundation in scientific vocabulary, concept understanding, and comprehension of the different concepts in scientific inquiry. Students with difficulty and struggling in comprehending scientific vocabulary should be aided with and seek help from their subject teachers, and tutors or aided with several tools, techniques, or concept models inside the classroom such as the Frayer Model and Semantic Map graphic organizers.

It has been perceived that science education is characterized by a multitude of principles, concepts, and terminologies that give complexities for the students to grasp and deepen their understanding. The quest for instructional strategies has been a perpetual quest for educators to bolster the emerging issues of vocabulary gaps in science. It has been spotlighted that the Frayer Model is a significant tool for pedagogical transformative effects on science education in the classroom. The four-quadrant graphic organizer is called the Frayer Model, this gives an understanding of the vocabulary that prompts learners to define terms, identify their characteristics and examples, and discern non-examples. In the middle grades such as grade 7 students often rely on the acquisition and application of complex concepts using graphic organizers. Several studies have highlighted the significant role of the Frayer Model in pinpointing its potential to solidify the understanding of students' scientific vocabulary that leads to scientific literacy, including those by Frayer, Frederick, & Klausmeier (1969) and Smith and Kim (2017). The Frayer model transcends traditional methods of teaching inside the classrooms, thus encouraging the students to deeply develop a multifaceted nature of terms (Robinson & Clark, 2016).

A semantic map, on the other hand, draws a visual schema to link vocabulary and concepts for the students to visualize the relationship, and discern connections, patterns, and hierarchies in a subject matter in science. Also, it enables students to interlink the important words that can be associated with the concepts comprehensively (Anderson & Nashon, 2016). With this technique, students are guided and granted an opportunity to recognize relationships between the concepts and interconnect ideas that bridge the gap between isolated facts and a holistic understanding of complex topics in science. The potential of semantic maps to foster deep understanding among learners has been a promising instructional tool for many students when it comes to comprehension and retention of the topics. The graphical information from semantic maps has been noted for its capacity to cater to diverse learning styles, allowing differentiation inside the classroom (Smith, 2018). The work of Martinez and Bennett (2018) suggested that the visual representation of a semantic map aids the conceptual clarity of the subject's vocabulary and concepts that construct a robust cognitive framework upon the integration of Semantic Maps in the instructions in teaching science in the classroom.

The recent study conducted by Cabardo (2015), as cited by Bilbao, Donguila, and Vasay (2016) indicated that the majority of the students in the Philippines belong to the Frustration level. In the study of Imam et al. (2014), high school students' reading comprehension skills and science performance were found to be at a low mastery level. The finding further revealed that the learners' reading skills such as understanding vocabulary were positively correlated with learners' science performance. However, while the challenges of teaching science in the Philippines are well-documented including lack of funds, linguistic variety, and possible perception by culture that science is unimportant or boring little is known about how appropriate these applications are. Concerning the educational strategies, there is a gap in their adaptation to local linguistic and cultural contexts, their effectiveness in improving science literacy among Filipino students, and how they address disparities of science education. In addition, it would be worth using these methods to encourage students and improve their understanding of science as far as their performance in global tests including PISA and TIMSS is very low (Bernardo, 2023). While the challenges in teaching science in the Philippines are well-documented, ranging from limited funding, linguistic diversity, and a culture that may often perceive science as unimportant or boring, the specific application and effectiveness of the Frayer Model and Semantic Maps in this context are less understood. These educational strategies can be adapted to local linguistic and cultural contexts, their effectiveness in improving science literacy among Filipino students, and their role in addressing the disparities in science education. Furthermore, given the low performance of Filipino students in global assessments like PISA and TIMSS, exploring the potential of these methods in improving student engagement and comprehension in science could be valuable (Navarro et al. 2020). From the research findings, it can be ascertained that Filipino learners' poor reading comprehension skills need to be addressed. This inspired the researcher to research integrating vocabulary instruction in teaching science lessons.

The main purpose of the researcher is to investigate the effectiveness of the Frayer model and Semantic Map graphic organizers on the students' academic performance in science and whether these graphic organizers can help improve students' academic performance in science by utilizing the specific graphic organizers as part of the instructions inside the classroom during the teaching-learning process. Also, to explore the effectiveness of the Frayer Model and Semantic Map graphic organizers on students' comprehension, engagement, and retention of scientific vocabulary terms and identify the potential benefits and drawbacks of these techniques. Above all, the ultimate goal of this research is to provide educators, students, and policymakers with insights into the influence of graphic organizers in teaching science in supporting effective learning in science subjects, through proper data analysis and interpretation, this aim is to shed light on how the utilization of graphic organizers contributes in enhancing the academic performance of the students in science education.

Objectives of the Study

This study aimed to investigate the effectiveness of Modified Frayer Model and Semantic Map graphic organizers on the performance in Science of the Grade 7 students in Alabel National High School, Sarangani Philippines during the Academic Year 2023-2024.

Specifically, this study tried to:

1. Describe the performance in Science of the subjects in the control group before and after receiving the non-utilization of the Modified Frayer Model and Semantic Map mode of teaching;
2. Describe the performance in Science of the subjects in the experimental group before and after receiving instruction utilizing the modified Frayer model and semantic map graphic organizers;
3. Find out the difference in the performance in Science of the subjects in the control group before and after receiving the non-utilization of the Modified Frayer Model and Semantic Map mode of teaching;
4. Examine the difference in the performance in Science of the subjects in the experimental group before and after receiving instruction utilizing the modified Frayer model and semantic map graphic organizers;
5. Find out the difference in the performance in Science of the subjects in the control and experimental groups after receiving the non-utilization of the Modified Frayer Model and Semantic Map mode of teaching and instruction utilizing the Modified Frayer model and Semantic Map graphic organizers.

Hypotheses of the Study

1. There is no significant difference in the performance in science of the subjects in the control group before and after receiving the non-utilization of the Modified Frayer Model and Semantic Map mode of teaching;
2. There is no significant difference in the performance in science of the subjects in the experimental group before and after receiving instruction utilizing the modified Frayer model and semantic map graphic organizers;
3. There is no significant difference in the performance in science of the subjects in the control and experimental groups after receiving the non-utilization of the Modified Frayer Model and Semantic Map mode of teaching and instruction utilizing the modified Frayer model and semantic map graphic organizers.

METHODOLOGY

Research Design

The study utilized a quasi-experimental research design. Quasi-experimental research designs, like experimental designs, test causal hypotheses. Quasi-experimental designs identify a comparison group that is as similar as possible to the treatment group regarding baseline (pre-intervention) characteristics (White & Sabarwal, 2014). The experimental subjects were assessed in their science performance using the Modified Frayer Model and Semantic Map. This quantitative study utilized a pre-survey and post-survey with the experimental group to determine if the Modified Frayer Model and Semantic Map graphic Organizers enhance students' performance Science.

This quasi-experimental quantitative study utilized a pre-test and post-test with one control and experimental groups to determine if the Modified Frayer Model and Semantic Map graphic Organizers enhance students' performance in Science. Post-tests were administered to the two experimental groups after receiving the treatment through the utilization of the Modified Frayer Model and Semantic Map Organizer. The researcher employed pre-test and post-test designs to compare two groups after only one group received treatment (Creswell, 2003). The posttest-only quasi-experimental methodology comprised two processes: a) compiling and analyzing data and information statistically, and b) completing a comparison analysis of the experimental groups (Christensen et al., 2014; Creswell, 2013).

Study Sites

This research study was conducted at Alabel National High School, located at Lalisan St. Poblacion Alabel Sarangani Province, Philippines. The school was established on July 27, 1966, thru Republic Act 5447 (Barrio Charter) by Dr. Pedro T. Orata, the founder of barrio schools. It was then put into law on May 26, 1988, by Pres. Corazon Cojuangco-Aquino, the Republic Act No. 6655, a free public act, emphasized subsidizing all barangay high schools by the national government.

The school is dedicated to offering the best educational resources to both residents of Barangay Poblacion, Alabel, and the surrounding areas by the school's vision "We dream of Filipinos who passionately love their country and whose competencies and values enable them to realize their potential and contribute meaningfully to building the nation. As a learner-centered public institution, the Department of Education continuously improves itself to serve its stakeholders better" and to its mission "To protect and promote the rights of every Filipino to quality, equitable, culture-based, complete primary education where: Students learn in a child-friendly, gender-sensitive, safe and motivating environment, Teachers facilitate learning and constantly nurture every learner", and has more than 56 years of experience in the field of education. With this, the administrators and staff maintain an environment conducive to good learning as stewards of the institution. Families, communities, and other interested parties are actively involved and co-responsible for fostering lifelong learning. Alabel National High School follows the K-12 curriculum with a whole level of secondary education from Grades 7-10 (Junior High School) to Grades 11-12 (Senior High School).

To support the existing educational facilities, Alabel National High School is equipped with various of the best facilities, including a Multifunction gym that also functions as an outdoor activity gym, a large Learning Centre field, an introduction to information technology as a medium for teaching with using computers in the computer laboratories, a learning atmosphere that is conducive and adapted to the needs of students, Chemistry, and Biology, a library equipped with computers, Indoor and Outdoor Play Area, Basketball Court and School canteen, and Parents Lounge designed explicitly for parents waiting for students to go home.

RESPONDENTS AND DATA COLLECTIONS

The subjects of this research study were grade seven junior high school students of Alabel National High School. One experimental and controlled group were identified as the subject for this research, each group was composed of fifty (50) students a total of one hundred (100) subjects took part in both pre-post-test and survey questions. The subjects of the study were both subject classes of the researcher, they were chosen not only for their accessibility and convenience but also because they are heterogeneous in terms of academic performance. Using heterogeneous classrooms as subjects in the Quasi-experimental method is advantageous. Heterogenous classes have varying abilities, backgrounds, and experiences, that can provide ample sources of data for the study (Cohen et al., 2018). Furthermore, The diverse student populations can draw applicable and more realistic conditions of the classroom set-up under treatment. This also can reflect the reality of most classroom settings, which can improve the external validity of the study, which can lead to a better capture of the complexity of the classroom environment, variations of students' abilities, attitudes, motivation, background, and learning styles (Trochim & Donnelly, 2016).

With the selected study subjects, the purposive sampling method was used. The study did not discriminate against any age segment or level of ability since the study was selected irrespective of the participant's age. The researcher chose his former school Alabel National High School to avoid biases. Purposive sampling is a powerful technique that enables the researcher to select participants intentionally, thereby promoting the inclusion of relevant persons or groups about the research focus. It is an acknowledged and used sampling method in qualitative and mixed methods research because its application cuts across many disciplines. This process works well when the researcher intends to inquire from experts within a certain cultural domain (Palinkas et al., 2013). Aykan and Yildirim (2021) also use this method in qualitative research with a larger purposive sample and in the selection of science teachers to integrate the Lesson study model into distance STEM education during the pandemic.

Before the study was conducted the researcher sought consent from the school division superintendent of the Division of Sarangani (See Appendix I). The researcher waited for the approval of the superintendent and sent a letter to the principal of Alabel National High School for the school conduct of the study (See Appendix II). Upon receipt of the approved letter, the researcher sent the Parent Consent Form (See Appendix III). The parent consent form was the basis for the Student Assent Form (See Appendix IV). The study was conducted in the first School Year 2023-2024 grading period. Participation in this research as a subject is voluntary. The instrument used in the study was assessed based on its language, format, and compliance with the Department of Education standards and was designed to assess the desired learning competencies. This test was used to measure the performance of students in science. The students were required to answer the questions using the Google sheet form. This was administered in both the two computer laboratories. The Junior High School Coordinators and Homeroom Teachers helped the researcher distribute the informed consent form and student assent form to all potential subjects for the study. The potential subjects and parents were given one week to fill out and return the forms. Furthermore, the homeroom teacher, the grade seven coordinators, and the researcher administered the pre-test before the intervention and the post-test after the intervention and the survey questionnaire.

The administration of pre and post-tests were administered online (Google Forms) which means that the researcher did not use a hard copy of the test. In Alabel National High School culture, non-academic time means the extracurricular activity time or after school, which is 4:00 p.m. This is the time that the study subjects will answer the pre-test, and post-test, on separate dates, to ensure that teaching-learning classes will not be not disrupted. Students who were identified as the subjects of the study were gathered in each room for the administration of the instruments. The homeroom teachers reminded the students that (a) they were volunteer participants and had the right to decline participation at any time without punishment, (b) their data would be kept anonymous and confidential, and (c) they could feel free to ask questions if they will not understand any part of the questionnaires. The researcher will explain the study's purpose and instruct them to complete the online survey.

Ethical Consideration

Prior to accessing the questionnaire, potential participants were informed of the study's purpose and nature through a consent form. This research study undergoes additional assurances set by CLSU dissertation committee supervision on the strict adherence to the University's Ethical Standard on research activities to seek the university’s Ethics Review Committee (ERC) approval.

The data obtained from this study was stored in the author’s data bank and shall only be shared with CLSU’s official statistician. Strict confidentiality of data and anonymizing measures shall be adhered to in all stages of the data-gathering procedure until its analysis. Results may be shared with respondents and participating institutions if requested.

Instrument Used

Instruments are the tools that a researcher uses to collect data for the research study. It comes in several forms that are often used to the needs of a specific question or field. (Kumar, 2019). Surveys and questionnaires are tools used for measuring, observing, and documenting in both quantitative and qualitative research. It can be administered in person, by phone, or on any digital platform. The design of the instrument used in research is critical and essential for the accurate representation of data-studied phenomena (Fowler, 2020).

The instrument that was used to assess the student's performance in science was adapted from the standardized test that was pulled out from the question bank of Alabel National High School- Science Department. This set of test questions was developed based on the competencies set by the Department of Education for a specific term. The scope of this instrument test was the first term of the School Year 2022-2023, it is a fifty (50) item question in multiple-choice format. To ensure the fair distribution of the questions for each competency, the table of specifications (See Appendix VIII) was made as the basis of the specific questions for the specific competency. These test questions were validated by the master teachers of the Science Department of Alabel National High School. Additionally, the test that was used during the pre-test and post-test covered the first quarter learning competencies. The first learning competency is a scientific investigation under this competency 2 lessons and 2 questions were adopted. The second learning competency was elements and compounds, there were 3 lessons and 5 questions were lifted from this unit. The third competency was mixtures and substances, there were 15 lessons and 37 questions were taken from this unit.

Lastly, the instrument used for intervention was the Modified Frayer Model and Semantic Map Graphic Organizers developed and enhanced by the researcher. The modified Frayer Model has four quadrants and in the middle of the four quadrants is the circle where a topic or term is to be written. The four quadrants represent different functions in the concept studied. The first quadrant is about, "How it Works" the second is "What it can be used for" the third is "What it can't be used for" and the last is "Diagram or label it" This model is flexible depending on the course topic since the coverage of the course topic during the conduct of this research were focused more on Chemistry therefore these sequence adapting the representation of each quadrant above. A semantic Map graphic organizer is also known as a concept map, this is a visual tool that organizes and illustrates relationships. It has a central topic at the center and branches out for ideas related to the topic. It may be connected by arrows or lines. The arrows or lines represent its relationship to the main topic and also make the visual path of the definition, description, and flow of the concept.

Data Analysis

The answers provided by the subjects through the questionnaires were analyzed by descriptive and inferential analyses. The study utilized a quantitative approach and collected information through pretest and posttest. The collected data were analyzed using Statistical Package for Social Sciences (SPSS) and MS Excel Worksheet to make the computations easier in treating the data. The researcher tabulated and summarized the collected data using Microsoft Excel. Mean and standard deviation were used to describe the performance in Science of the subjects in the control group before and after receiving the non-utilization of the Modified Frayer Model and Semantic Map mode of teaching; Describe the performance in Science of the subjects in the experimental group before and after receiving instruction utilizing the modified Frayer model and semantic map graphic organizers, respectively.

To address the third, fourth, and fifth objectives t-test was applied to examine the difference in the performance in Science of the subjects in the experimental group before and after receiving instruction utilizing the modified Frayer model and semantic map graphic organizers; ascertain the difference in the performance in Science of the subjects in the control and experimental groups after receiving the non-utilization of the Modified Frayer Model and Semantic Map mode of teaching and instruction utilizing the modified Frayer model and semantic map graphic organizers; Examine the difference in the performance in Science of the subjects in the control and experimental groups after receiving the non-utilization of the Modified Frayer Model and Semantic Map mode of teaching and instruction utilizing the modified Frayer model and semantic map graphic organizers, respectively.

RESULTS AND DISCUSSION

The data collected were analyzed and explained using statistical methods, in line with the research objectives.

Performance in Science of the Subjects in the Control Group Before and After Non-utilization of Modified Frayer Model and Semantic Map Mode of Teaching

The performance of the subjects in Science under the Control Group was assessed in a pretest and post-test which is summarized in Table 1. The data was taken from the results of the subjects' scores after taking the pre and post-test science questions.

Table 1. Performance in Science of the subjects in the control group before and after the non-utilization of the Modified Frayer Model and Semantic Map mode of teaching

Control Group	Interval Rating	Descriptive Rating	Frequency	Percentage
Before Mean = 14.10; SD = 6.12	20 – 50	Above Average	7	14
	9 – 19	Average	35	70
	0 – 8	Below Average	8	16
After Mean = 16.68;SD = 7.55	25 – 50	Above Average	9	18
	10 – 24	Average	41	82
	0 – 9	Below Average	0	0

From the table, it is evident that the control group had 35 (70%) attained an average score, 8 (16%) attained below average score, and 7 (14%) achieved above average score, before receiving the non-utilization of the Modified Frayer Model and Semantic way of instruction. There are only eight subjects in the control group who demonstrated a partial understanding of the learning competencies and limited knowledge of Science subjects. Furthermore, before receiving the non-utilization of Modified Frayer Model and Semantic Map of instruction, in the control group, thirty-five subjects displayed an average understanding of the competencies in science and seven displayed above-average knowledge and understanding of the subject matter and competencies in science, respectively. Additionally, the control group have 0-8 as below average, 9-19 average, and 20-50 above average of interval rating before the utilization of Modified Frayer and Semantic Map Mode of teaching. This is shows that the most of the subjects achieved scores of 9-19 from the test given. However, after the intervention the data shows that most of the subjects got an average interval of 10-24 slightly higher compared to their performance before the intervention. Furthermore, an interval range of 20-50 which above average is the score of the subjects which is higher than before intervention.

The result shows that most of the students from this class have an average understanding of the competencies and concepts in science. It has been shown that students, in grade seven, are freshmen at a higher level of education and deal with higher topics, concepts, and competencies in science subjects. Also, few students had an above-average understanding of the subject matter and competencies, maybe because grade seven students were new and dealing with several adjustments, especially in terms of subject lessons. Also, few students have below-average ratings signifies that these students have little understanding of the competencies and subject matter. The class is heterogeneous and has different kinds of learners in it among whom there are evident differences in knowledge of science before the non-utilization of Modified Frayer Model and Semantic Map.

On the other hand, table 1 also displays the post-test scores of the subjects under the control group, which were used to determine their performance after receiving the non-utilization of the Modified Frayer Model and Semantic way of teaching in the classroom. Among the subjects of this research study in the control group who received traditional way of instruction, the majority of them 41 (82%) earned an average score, 9 (18%) earned above average scores and no one got below average score.

The control group, who received non-utilization of the Modified Frayer Model and Semantic Map of instruction, demonstrated a little improvement in their performance in Science. This can be attributed to the ability of the teacher to maximize the class participation of the subject as a source of information during the teaching-learning process where they constructed their meanings and interpretations of the lesson.

These findings support Taningco, K. (2018) study, which has shown that traditional teaching instruction inside the classroom in Filipino high schools has little implications on the students' post-test scores. Furthermore, the study aligns with Theobald, E.J., et al. (2020) discovered that the traditional science instruction method shows potential limitations, where the educator is the primary source of information and students play a passive role in the classroom. Nguyen, K., et al. (2017) reviewed this method and offered a structured and consistent delivery of the lesson, there is a growing belief that it might not be the most effective way for students to engage and develop deep knowledge especially in science as a dynamic subject.

Performance the subjects in the experimental group before and after utilizing the modified Frayer model and semantic map graphic organizers

Table 2 displays the pretest and posttest scores of the subjects in the treatment group who were given intervention utilizing the modified Frayer Model and Semantic Map graphic organizers. These test scores were used to evaluate the science subject's performance.

The table shows that the experimental group had 25 (50%) attained an average score, 16 (32%) attained below average scores, and 9 (18%) before receiving the intervention utilizing the modified Frayer Model. Only sixteen subjects in the control group demonstrated a partial understanding of the learning competencies and limited knowledge of Science subjects. Furthermore, before receiving the non-utilization of the Modified Frayer Model and Semantic Map instruction, in the experimental group, twenty-five subjects displayed an average understanding of the competencies, and nine displayed above-average knowledge and understanding of the subject matter and competencies in science, respectively.

Prior to the utilization of the Modified Frayer Model and Semantic Map graphic organizers, subjects in the experimental group displayed a limited grasp of the syllabus and possessed only basic skills in science concepts in understanding scientific terms in Science subjects. As a result, these students retained in low level of fundamental concepts in Science, which they had learned in their previous lower years, and only managed to achieve the minimum score from the test given.

Table 2. Performance in Science of the subjects in the experimental group before and after receiving instruction utilizing the modified Frayer model and semantic map graphic organizers

Experimental Group	Interval Rating	Descriptive Rating	Frequency	Percentage
Before Mean = 19.16; SD = 6.41	25 – 50	Above Average	9	18
	14 – 24	Average	25	50
	0 – 13	Below Average	16	32
After Mean = 41.04; SD = 7.12	48 – 50	Above Average	11	22
	35 – 47	Average	31	62
	0 – 34	Below Average	8	16

Furthermore, Table 2 shows that subjects in the experimental group achieved good scores in the post-test, with 31(62%) had an average score, 11(22%) had above average score, and 8(16%) had below average scores. Their successful performance in science tests can be attributed to utilizing the Modified Frayer Model and Semantic Map graphic organizers inside the classroom during the teaching-learning process, which allows students to dissect scientific terms, visualize concepts, and clarify relationships and hierarchies between topics and ideas. Additionally, the table shows different interval rating compared to control group this is because experimental group has different ranges of score results from the test given.

The results of the research are consistent with the work of Gonzalez and Paune (2017) study, which demonstrated that the Frayer Model facilitates and engages learning to distinguish concepts and what it is not, it ensures a comprehensive understanding of learning and is highly effective in elucidating intricate science terms that might ambiguous to students to learn.

Also, according to the study of Domingo and Gavino (2016), Semantic Map graphic organizers can invigorate the learning process of the students, making the concepts more interactive and less daunting for the students to use in the classroom. Also, Gonzales and Paune (2017), added that semantic maps as a tool to promote visual learning, can boost memory significantly and have a particular relevance in the Filipino context where non-utilization of the Modified Frayer Model and Semantic ways of teaching are often employed.

This claim was also supported by Chen and Bradshaw (2021) in their study, they examined the effect of specific graphic organizers such as; the Frayer Model and Semantic Map, as the students transition from primary to secondary education they have increasingly intricate scientific concepts. These graphic organizers enhance conceptual grasp, and skills development, and improve retention by engaging students with content through these visual aids which have been linked with longer-term retention of important information, a boon for cumulative subjects like science (Marsh et al., 2020).

The difference in the performance in Science of the subjects in the control group before and after the Non-utilization of Modified Frayer Model and Semantic Map

Table 3 illustrates the comparison of the performance of the control group before and after receiving the non-utilization of the Modified Frayer Model and Semantic mode of teaching. The Mean Pre-test score of the control group was analyzed using a Paired-samples t-test to determine if there was a significant difference between the test results of the subjects in the control group.

Table 3. The difference in performance in Science of the subjects in the control group before and after receiving the non-utilization of Modified Frayer Model and Semantic Map

Control Group	n	Mean	SD	$t_{(49)}$	p-value	Interpretation
Before	50	14.10	6.12	-2.370	0.022	Difference is significant
After		16.68	7.55			

Based on the data presented in the table, the pretest scores had a mean of 14.10 and a standard deviation of 6.12, while the posttest scores had a mean of 16.68 and a standard deviation of 7.55. these results suggest that the mean post-test scores are higher than those of pre-test scores. The table also shows that the t-value is -2.37 and the p-value is 0.022, which is less than 0.05. This may explain that the performance of the subjects in Science significantly improved after receiving the non-utilization of the Modified Frayer Model and Semantic mode of teaching. This may suggest that the non-utilization of the Modified Frayer Model and Semantic way of instruction is effective in improving the performance of the subjects in Science.

However, the findings of the current study are not consistent with Freeman et al.(2014), the study examined the effects of active learning on students' performance in science and science-related courses. Traditional lecture-based methods are often criticized for promoting passivity to students, that students are in the receptive mode, where they engage in listening and taking notes but do not actively engage with the content. This will lead to a lack of engagement and reduced comprehension, retention, and application of the topics.

With the findings stated above, the null hypothesis which states there is no significant difference in the performance in science of the subjects in the control group before and after receiving the non-utilization of the Modified Frayer Model and Semantic mode of teaching, is rejected.

Difference in the Performance in Science of the Subjects in the Experimental Group Before and After Receiving Instruction Utilizing the Modified Frayer Model and Semantic Map Graphic Organizers

Table 4 presents the comparison of the performance of the subjects under the experimental group before and after receiving instruction utilizing the Modified Frayer Model and Semantic Map graphic organizers. This made possible the analysis of the difference in the pretest and posttest scores of the subjects using inferential statistics.

Table 4. Difference in performance in Science of the subjects in the experimental group before and after receiving the modified Frayer model and Semantic graphic organizers

Experimental Group	n	Mean	SD	$t_{(49)}$	p-value	Interpretation
Before	50	19.16	6.41	-15.93	0.000	Difference is highly significant
After		41.04	7.12			

According to the data presented, the mean pretest score before providing the instruction utilizing the Modified Frayer Model and Semantic Map graphic organizers is 19.16 with a standard deviation of 6.41, while the posttest mean score is 41.04 with a standard deviation of 7.12. These findings imply that the mean posttest scores had higher scores compared to the pretest scores. In addition, the table shows that the t-value is -15.93 with a p-value of 0.000, which is less than 0.001. The difference in the performance of the subjects under the experimental group before and after receiving instructions utilizing the Modified Frayer Model and Semantic Map graphic organizers can be most likely due to the fact that graphic organizers like the Frayer Model and Semantic Map enhanced comprehension, critical thinking, vocabulary development, linking prior knowledge, and encourage participation rather than passive intake as teaching strategy inside the classroom.

The results of the study support the claims made by Vasquez and Coudin (2018) who examined the impact of graphic organizers such as the Frayer Model and Semantic Map, it shows that the use of graphic organizers inside the classroom as a teaching strategy contributed to the development of critical thinking skills and resilience. It has also been found that it positively links a positive relationship between critical thinking ability and facing unfamiliar vocabulary words. Cézar et al. (2021), claim that Frayer Model and Semantic maps can have a positive impact on academic achievement in science subjects. Additionally, studies have shown that the use of concept maps in education has positive effects on academic achievement in various subjects (Ural & Ercan, 2015). Furthermore, the Frayer Model a type of concept map has been found to improve academic achievement and conceptual skills in prospective teachers and students (Akhtar & Saeed, 2022).

With the findings stated above, the null hypothesis which states there is no significant difference in the performance in science of the subjects in the experimental group before and after receiving the non-utilization of the Modified Frayer Model and Semantic mode of teaching, is rejected.

The Difference in the Performance in Science of the Subjects in the Control and Experimental Groups after the Non-utilization of the Modified Frayer Model and Semantic Map and Instruction Utilizing the Modified Frayer Model and Semantic Map

Table 5 shows the difference in the performance of the subjects in science of the control and experimental groups after receiving the non-utilization of the Modified Frayer Model and Semantic Map and utilization of the Modified Frayer Model and Semantic Map Graphic organizers, respectively, by analyzing the mean scores of the two groups using t-test as a tool.

The table reveals that the mean score of the control group was 16.68 with a standard deviation of 7.55 after the non-utilization of the Modified Frayer Model and Semantic mode of teaching, while the experimental group had a mean score of 41.04 with a standard deviation of 7.12 after the utilization of Modified Frayer Model and Semantic Map Graphic Organizers. The results show that the mean of the experimental group is significantly higher than the mean of the control group.

Table 5. Difference in performance in Science of the subjects in the control and experimental groups after the non-utilization of the Modified Frayer Model and Semantic Map and instruction utilizing the modified Frayer model and semantic map graphic organizers

Groups	n	Mean	SD	$t_{(98)}$	p-value	Interpretation
Control	50	16.68	7.55	-16.592	0.000	Difference is highly significant
Experimental		41.04	7.12			

The table also presents that the t-value is -16.590 with a p-value of 0.000 which is less than 0.001. The non-utilization and the utilization of the Modified Frayer Model and Semantic Map Graphic Organizers resulted in significant improvement in the Science performance of both groups of subjects. However, the experimental group showed a greater improvement than the control group, showing that the experimental group performed better than the control group.

It appears that the utilization of the Modified Frayer Model and Semantic Map graphic organizers was more successful in enhancing the performance of the subjects in Science than in the non-utilization of the Modified Frayer Model and Semantic mode of teaching. This may be because the subjects in the control group received direct instruction, which is the teacher-centered approach. Also, in case scenarios inside the classroom teacher delivers content in purely lectures where students are passive recipients of the information. Furthermore, subjects were more dependent on the teacher's expertise, which will give a uniform understanding of the content that students were exposed to the same material in the same manner. While in the experimental group, subjects received an intervention by utilizing the Modified Frayer Model and Semantic Map, which involved brainstorming sessions, vocabulary expansion and comprehension, interactive digital tools for graphic organizers, and personal exploration of the subject matter and its concepts, that aided in focusing, understanding and participation in the discussion of the topics in science.

The variation observed in the performance of the subjects in the experimental group before and after using the Modified Frayer Model and Semantic Map graphic organizers is probably attributed to several factors. These may include personalized learning, improved efficiency, and enhanced engagement between the learners and the instructional materials, a focus on student-centered activities, and a facilitative teaching approach where the teacher encourages learning through guidance and support. This might be the reason that the experimental group pronounced a positive impact on their science performance and outperformed the control group that was taught without utilizing the Modifies Frayer Model and Semantic Map. Therefore, this could be a potentially substantial benefit in student performance by integrating such models and organizers into teaching methodologies in the classroom.

Utilizing the Semantic Map and Frayer Model has been shown a positive impact on the students' academic performance in science and other subjects. These graphic organizers help students organize their thinking, make connections between concepts, and improve their understanding and retention of information. Additionally, the use of graphic organizers can contribute to students' self-efficacy and enhance their vocabulary knowledge. Overall, incorporating semantic map graphic organizers into science instruction can be an effective strategy for promoting students' academic achievement.

Semantic map graphic organizers, and the Frayer Model, have been widely studied for their impact on students' academic performance in various subjects, including science. The study of Shana and Abulibdeh (2020) examined the effectiveness of these graphic organizers in students' understanding and retention of scientific concepts. Additionally, the study evaluated the overall effect of practical work on students' academic attainment in science through the use of these graphic organizers. Another study by Akhtar and Saeed (2022) focused specifically on the Frayer Model as an assessment tool and its impact on the academic achievement of prospective teachers. The study concluded that concept mapping using the Frayer Model was effective in improving students' academic achievement.

Similarly, Riksadianti (2021) explored the use of the Frayer Model to enhance vocabulary learning. The study found that the Frayer Model helped students organize their thinking about terms and improve their vocabulary knowledge. In addition to its impact on academic achievement, the Frayer Model has also been studied in relation to self-efficacy. Bhati et al. (2022) found that self-efficacy positively influenced students' academic performance. While this study did not specifically focus on the Frayer Model, it suggests that interventions such as graphic organizers can contribute to students' self-efficacy and, consequently, their academic performance. Furthermore, it was discussed by Shin (2022) that the effectiveness of the graphical organizers, including concept maps and the Frayer model, helped activate and illustrate previous knowledge, which suggests helps students make connections between different scientific concepts and improve their understanding.

Considering the results presented above, the null hypothesis states that there is no significant difference in the performance in the science of the subjects in the control and experimental groups after receiving the non-utilization of the Modified Frayer Model and Semantic Map mode of teaching and instruction utilizing the modified Frayer model and semantic map graphic organizers are rejected.

CONCLUSION

Prior to the utilization of the Modified Frayer Model and Semantic Map graphic organizers, subjects in the experimental group displayed a limited grasp of the subject matter and possessed only basic skills in science concepts in understanding scientific terms in Science subjects. As a result, these students retained in low level of fundamental concepts in Science, which they had learned in their previous lower years, and only managed to achieve the minimum score from the test given. Their successful performance in science tests can be attributed to utilizing the Modified Frayer Model and Semantic Map graphic organizers inside the classroom during the teaching-learning process, which allows students to dissect scientific terms, visualize concepts, and clarify relationships and hierarchies between topics and ideas.

The results from the control group, after the non-utilization of the Modified Frayer Model and Semantic Map, indicate a significant increase in mean post-test scores compared to their pretest scores. This suggests that the subjects' performance in Science notably improved after receiving traditional instruction. This may explain why the performance of the subjects in Science significantly improved after receiving the non-utilization of the Modified Frayer Model and Semantic Map mode of teaching. This may suggest that the non-utilization of the Modified Frayer Model and Semantic way of instruction is effective in improving the performance of the subjects in Science. While, the difference in the performance of the subjects under the experimental group before and after receiving instructions utilizing the Modified Frayer Model and Semantic Map graphic organizers can be most likely due to the fact that graphic organizers like the Frayer Model and Semantic Map enhanced comprehension, critical thinking, vocabulary development, linking prior knowledge, and encourage participation rather than passive intake as teaching strategy inside the classroom.

The result reveals that the mean score of the control group was 16.68 with a standard deviation of 7.55 after the non-utilization of the Modified Frayer Model and Semantic mode of teaching, while the experimental group had a mean score of 41.04 with a standard deviation of 7.12 after the utilization of Modified Frayer Model and Semantic Map Graphic Organizers. The results show that the mean of the experimental group is significantly higher than the mean of the control group. The non-utilization of the Modified Frayer Model and Semantic mode of teaching and the utilization of the Modified Frayer Model and Semantic Map Graphic Organizers resulted in significant improvement in the Science performance of both groups of subjects. However, the experimental group showed a greater improvement than the control group, showing that the experimental group performed better than the control group. It appears that the utilization of the Modified Frayer Model and Semantic Map graphic organizers was more successful in enhancing the performance of the subjects in Science than in the non-utilization of the intervention. This may be because the subjects in the control group received direct instruction, which is the teacher-centered approach. Also, in case scenarios inside the classroom teacher delivers content in purely lectures where students are passive recipients of the information. Furthermore, subjects were more dependent on the teacher's expertise, which will give a uniform understanding of the content that students were exposed to the same material in the same manner. While in the experimental group, subjects received an intervention by utilizing the Modified Frayer Model and Semantic Map, which involved brainstorming sessions, vocabulary expansion and comprehension, interactive digital tools for graphic organizers, and personal exploration of the subject matter and its concepts, that aided in focusing, understanding and participation in the discussion of the topics in science.

Hence, utilizing the Semantic Map and Frayer Model has been shown a positive impact on the students' academic performance in science and other subjects. These graphic organizers help students organize their thinking, make connections between concepts, and improve their understanding and retention of information. Additionally, the use of graphic organizers can contribute to students' self-efficacy and enhance their vocabulary knowledge. Overall, incorporating semantic map graphic organizers into science instruction can be an effective strategy for promoting students' academic achievement in Science at Alabel National High School.

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