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Mind mapping: A learning tool for Science Grade 10

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ABSTRACT

The study aimed to identify the effectiveness of mind mapping as compared to the pen and paper note taking in learning the Science Grade 10 lessons in Mactan National High School. A one shot pre-test post-test research method was used in the study with 49 respondents assigned as control group and 50 respondents as experimental group. It was noted that the students who participated in the study were of almost equal academic performance as shown in the pre-test conducted. After the duration of the study, both groups were post-tested and it was noticed that both groups had an increase in their academic performance level. The control group had an increase of 10.55 in their mean score while the experimental group got an increase of 13.84. Thus, both learning strategies were found to be good ways for learning. However, with a 0.02 p value, mind mapping has shown to be a more effective learning strategy as compared to the pen and paper note taking. It is also very striking to note that mind mapping was seen to be more effective in male students than in females. The result showed that there was a significant difference between the two learning strategies in the males mean scores, t=(-2.57), p>0.013. For males, mind mapping was observed to be an effective learning strategy at a significance value of 0.013 while for females it was not as its significance value was at 0.900. An attitude inventory was also conducted to assess the attitude of the respondents on the use of mind mapping and pen and paper note taking. The control and the experimental groups manifested a moderately positive condition in their attitudes towards the use of pen and paper note taking and mind mapping while learning their lessons. They neither disliked it nor liked it very much. This only showed that whatever learning strategies the students will be exposed into they would have the tendency to adapt to it and use it wisely in order to gain understanding to the lessons discussed.

Keywords: Mind mapping, pen and paper note taking, academic performance, learning strategies, attitude inventory, and gender differences in learning.

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INTRODUCTION

Contemporary education has witnessed the emergence of numerous learning strategies designed to address the diverse ways in which students acquire, organize, understand, and retain knowledge. Although many strategies have demonstrated effectiveness, their value may

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vary among learners because individuals possess unique characteristics, prior experiences, interests, and learning preferences. For decades, educators and students have relied on conventional strategies such as outline note taking and concept mapping to organize information. The emergence of mind mapping, however, has introduced another approach that allows learners to generate and integrate ideas without being restricted to a prescribed linear order while engaging multiple senses in the learning process. Rather than creating confusion as learners move from one idea to another, mind mapping provides a structured visual means of capturing thoughts as they develop. Cognitive educators have long organized concepts into graphic patterns to facilitate learning and memory, and mind mapping extends this practice through visual representations, keywords, colors, images, and curved or wavy lines. Such visual organization is consistent with the view that learners understand new concepts more effectively when these are connected with previous knowledge and experiences. Visual organization techniques have been identified among effective approaches to learning, while the organization of thoughts through visual representations has been associated with improved memory retention (Yatvin, 2000). Research has likewise indicated that mind mapping can contribute to the development of thinking, memory, and learning skills.

Mind mapping is one of many learning strategies, but its emphasis on memory, creativity, comprehension, and understanding provides learners with opportunities to use cognitive processes in ways that correspond with the natural functioning of the brain. It facilitates learning by helping individuals organize information, form associations, and improve their ability to recall concepts. Esteves (2009) explained that mind mapping assists learners in using their mental capacities more effectively and in developing their potential to remember information. Similarly, Buzan (2009) emphasized the value of colors in stimulating the mind and strengthening recall. The practical value of this strategy was illustrated through the experience of Ivy Marquez, a trained mind mapping instructor whose children reportedly became more effective and motivated learners because they enjoyed drawing and using colors while studying. Their organizational skills improved, and they achieved better grades because they were able to remember and memorize their lessons more effectively. Mind mapping also stimulated their development of interconnected thoughts (Esteves, 2009). These observations illustrate how mind mapping functions as a thought processing method through which learners visually represent and organize their ideas.

The relevance of mind mapping becomes more evident when considered in relation to the predominantly linear manner in which educational information is traditionally presented. Lectures, videos, textbooks, and conventional notes commonly organize information according to a beginning, middle, and ending. Mind mapping provides an alternative visual learning technique that may deepen learning by integrating and consolidating the cognitive processes required to summarize and organize information. Berg (2015) explained that learners interact with ideas as though they were pieces of a puzzle, allowing concepts to develop as learners reflect on them and observe their relationships. Through visual and spatial manipulation of information, learners can construct knowledge in an authentic, creative, and self directed manner. This process also promotes metacognition because mind mapping provides an environment in which individuals can reflect on their own thinking. It combines linear thinking processes commonly associated with the left hemisphere with nonlinear and visual processes commonly associated with the right hemisphere. Consequently, mind mapping can provide a framework for organizing and exploring newly acquired information and developing ideas among both visually oriented and nonvisually oriented learners (Berg, 2015).

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The visual characteristics of mind mapping further strengthen its potential as a learning strategy. Creating a mind map involves images, keywords, diagrams, spatial relationships, and other visual elements that can assist students in remembering information. Visual learners have been observed to remember a considerable proportion of what they read, write, or see and to respond effectively to diagrams, charts, maps, visual projects, and presentations. When students construct visual maps, they organize their initial ideas and gradually connect these with the major concepts of the lesson. Research has also indicated that visual cues can facilitate recall even when learners are dealing with substantial amounts of information. Words alone may be difficult to remember because they can represent abstract information that is not easily imagined. Images, which constitute a major component of mind mapping, provide more concrete representations and may therefore enable the brain to retain information more effectively and for longer periods (Kouyoumdjian, 2012).

The need for effective learning strategies is particularly significant in science education, which has long been recognized as an important contributor to the academic development of learners and their preparation for real life situations. The high school National Achievement Test mean percentage score during School Year 2014 to 2015 was only 51.41 percent, which the Department of Education reported as 23.59 percentage points below the target score. During the same period, the science mean percentage score was only 41.35 percent, substantially below the expected passing percentage of 75 percent and below the basic performance standard of the Department of Education (TIMMS, 2013). Philippine performance also fell below international standards. The 2008 TIMMS results indicated that even high schools recognized for enrolling some of the brightest students in the country performed poorly. The Philippines ranked 38th, at the bottom among participating countries, in science performance in the Trends in International Mathematics and Science Study assessment. These results underscore the need to identify learning strategies that can help students understand their science lessons, remember essential concepts, and retain information in long term memory. Mind mapping was therefore considered as a potential strategy for improving students' science performance, particularly in view of the poor performance of high school students in standardized assessments such as the National Achievement Test.

This concern has become increasingly relevant with the full implementation of the K to 12 Basic Education Curriculum in the Philippines. Through internationally patterned programs and standards and the use of spiral progression in learning, the curriculum seeks the holistic development of globally competitive Filipino learners. Achieving this goal requires learning approaches that enable students to engage meaningfully with increasingly complex knowledge. The challenges confronting Philippine education therefore strengthen the need for innovative learning strategies capable of improving the quality of instruction and helping learners achieve their potential.

Within this educational context, the present study focused on evaluating the effectiveness of mind mapping and pen and paper note taking as learning tools in Science 10 lessons. Its theoretical foundation integrates the Meaningful Learning Theory of David Ausubel (2000), the Conditions of Learning Theory of Robert Gagne (2000), the Mind Mapping principles of Tony Buzan (2007), and the Constructivist Learning Theory of Jean Piaget (1977). Together, these perspectives emphasize the importance of prior knowledge, cognitive engagement, appropriate learning conditions, active construction of understanding, organization of information, and meaningful relationships among concepts. These theoretical

perspectives are particularly relevant in heterogeneous science classrooms where students differ in educational backgrounds, knowledge, abilities, and experiences. Providing students with opportunities to participate actively in learning activities allows them to express their understanding, connect concepts with experience, and construct products that represent what they have learned. Such participation can promote confidence, independence, collaboration, and engagement with tasks resembling situations encountered in the real world.

Learning involves the acquisition of knowledge or skills through experience, study, or instruction and represents a fundamental component of the teaching and learning process. Students are expected not merely to receive information but to develop understanding of the subject matter being taught. Mind mapping has been used as a learning strategy even before the early 2000s, and several studies have suggested that it can contribute to improved academic performance and increased confidence among students. Its potential derives partly from its capacity to involve different cognitive processes through the combined use of verbal and visual representations.

The importance of active involvement is particularly relevant in the Philippine classroom context, where poor academic performance has been associated with boredom and limited student participation. When teachers or academically stronger students dominate classroom activities, other learners may have fewer opportunities to engage directly with the lesson. Large class sizes resulting from limitations in classrooms and teaching personnel may further create conditions that are less conducive to active learning. Educational research during the 1980s and 1990s suggested that students are more likely to experience boredom when they are insufficiently engaged in the learning process. Students who participate directly in activities may learn more effectively because they gain firsthand experience with the subject matter (Blumenfeld et al., 1991). Csikszentmihaly et al. (1993) similarly found that even students who perform well on standardized tests can become bored, which may eventually contribute to declining knowledge when interest in the class or subject diminishes.

These findings challenge the adequacy of instructional approaches that depend heavily on lectures and passive listening. Learning through the recitation of isolated facts and information presented without meaningful context may not adequately prepare students for contemporary educational and real world demands. Learners need opportunities to encounter and use various learning approaches because they enter classrooms with different experiences, abilities, and background knowledge. Ed (2005) maintained that children demonstrate a broader range of capabilities when they are permitted to explore learning beyond traditional activities centered primarily on text. This reinforces the importance of learning strategies that encourage students to organize, process, interpret, and represent knowledge actively.

A considerable body of educational research has consequently examined strategies that assist learners in integrating and managing information. Learning strategies function as thinking tools that help students gather, organize, and retrieve the information necessary for learning. These strategies may include charts, diagrams, graphs, mnemonics, outlines, and other forms of information organization, all of which ultimately seek to improve academic performance and learners' ability to complete grade appropriate tasks in inclusive educational settings. Mind mapping belongs within this broader family of learning tools but places particular emphasis on relationships among concepts and the visual organization of knowledge.

The theoretical basis for connecting new and existing knowledge is strongly reflected in Ausubel's Meaningful Learning Theory. Ausubel (2000) stated that meaningful learning

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occurs when newly acquired knowledge is related to knowledge already possessed by the learner. Understanding therefore requires individuals to establish meaningful connections between new information and their existing cognitive structures. New information interacts with prior knowledge and becomes integrated into existing structures, making recognition of relationships among concepts essential for transferring information into long term memory. One of the critical conditions for meaningful learning is therefore the manner in which new information is incorporated into what learners already know. From this perspective, learning strategies such as mind mapping and note taking may facilitate meaningful learning by requiring students to identify, organize, and connect important ideas rather than merely receive them passively.

Gagne's Conditions of Learning Theory complements this perspective by emphasizing the cognitive effort involved in constructing knowledge through intellectual skills. Gagne (2000) proposed different categories of learning, each requiring an appropriate form of instruction. These categories include verbal information, intellectual skills, cognitive strategies, motor skills, and attitudes. Different internal and external conditions are necessary to facilitate each type of learning. Learning can also be organized from relatively simple to increasingly complex processes, beginning with stimulus recognition and response generation and progressing through procedure following, terminology use, discrimination, concept formation, rule application, and problem solving. This sequence helps identify the prerequisite knowledge and skills necessary for successful learning at progressively more advanced levels (Schunk, 2008).

From Gagne's perspective, learning can be understood through observable outcomes associated with changes in behavior and the achievement of educational goals through appropriately designed learning activities. At the same time, learners construct knowledge through cognitive processes that involve thinking about and remembering previous experiences while connecting them with new information. Mental processes therefore occupy an important place in learning, allowing Gagne's model to establish connections between cognitive and behavioral perspectives (Gagne, 2000). In relation to the present study, this theoretical position suggests that effective learning strategies should provide conditions that enable students to process information actively, retrieve relevant prior knowledge, and organize newly acquired concepts in ways that facilitate understanding and recall.

Building on the principles of connecting previous and new knowledge and identifying conditions that facilitate learning, the study incorporated Tony Buzan's modern mind mapping approach (2007) and pen and paper note taking, which was also considered in relation to Piaget's Constructivist Learning Theory (1977), as learning tools for fourth grading Science 10 lessons. These techniques were employed with the objective of improving students' academic performance, which was assessed through pretest and posttest measures. Although both strategies require learners to process and record information, they differ in the manner in which ideas are represented and organized, providing a meaningful basis for examining their relative effectiveness.

Buzan (2007) described mind mapping as a classroom learning approach capable of supporting memory and creative thinking because it engages processes associated with both hemispheres of the brain through visualization and association. The learner begins with a central concept positioned in the middle of the paper and connects related key concepts through

images, colors, curved or wavy lines, and keywords. Mind mapping therefore functions as a visualization method intended to maximize cognitive potential. Through keywords, colors, images, logic, lines, numbers, and spatial awareness, learners engage various cortical skills and gain greater freedom to explore relationships among ideas. This process may strengthen learning and support clear and critical thinking.

The neurological explanation commonly associated with mind mapping further emphasizes the integration of different cognitive functions. Different areas of the brain perform and regulate different functions, and the creation of a mind map attempts to represent visually the associative manner in which thinking occurs. The left hemisphere has traditionally been associated with logic, numbers, words, and sequences, while the right hemisphere has been associated with imagination, daydreaming, color, spatial processing, and holistic thinking. Mind mapping is proposed to engage these processes together, thereby facilitating the recall of information represented through words and images (Darouni, 2011). Its adaptability has contributed to its reported use by more than 250 million people worldwide for tasks such as organizing events and notes, brainstorming, managing projects, identifying opportunities, teaching, studying, and communicating information. Mind mapping has consequently been presented as an approach for promoting understanding in learning and training contexts (Buzan, 2009).

The constructivist perspective of Piaget (1977) provides further theoretical support for learning strategies that require active knowledge construction. Individuals learn more effectively when they construct their own understanding and reflect on both previous and present experiences. When learners encounter new ideas, they interpret these in relation to what they already know, which may lead them to modify previous beliefs or reject newly encountered information that they perceive as irrelevant. Learners therefore function as active creators of knowledge who continually reflect on experience and develop increasingly sophisticated capacities for integrating new information (Piaget, 1977). This perspective converges with Ausubel's emphasis on prior knowledge while extending the discussion toward the active role of learners in constructing meaning.

Piaget (1977) further explained that an individual's existing ideas interact with information obtained from the environment, potentially resulting in deeper understanding and more developed internal cognitive structures. Assimilation and accommodation are central processes through which new knowledge interacts with previous experience. Note taking similarly requires learners to construct representations of information presented by teachers by identifying important concepts and selecting keywords that can support subsequent recall. Thus, both mind mapping and conventional note taking can be interpreted as constructive activities, although mind mapping places greater emphasis on visual, spatial, and associative relationships among concepts.

Pen and paper note taking has remained one of the most widely used strategies for recording information that students intend to learn and remember. Mueller and Oppenheimer (2002) reported that students who took notes by hand learned more effectively than those who did not because handwriting required active participation in processing ideas and contributed to remembering them. Writing information manually requires learners to engage in cognitive processing, thereby supporting comprehension and retention. This provides a theoretical and empirical basis for retaining conventional handwritten note taking as a comparison strategy when evaluating mind mapping.

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Both strategies are also consistent with the recognition that students do not enter classrooms without prior knowledge. Learners bring existing ideas, understandings, and experiences that provide a foundation for constructing new knowledge. Previous knowledge therefore serves as a springboard for subsequent learning, while learners exercise some degree of control over the pace and processes through which they develop understanding. Recognizing learners as active participants in their own learning emphasizes the importance of providing strategies through which they can organize information in ways that correspond with their individual cognitive needs.

The selection of an appropriate learning strategy can substantially influence students' ability to achieve intended learning objectives. Without effective strategies for processing and retaining information, learners may experience academic difficulties and potentially fail to achieve expected outcomes. Learning approaches must therefore consider students' needs, interests, characteristics, and individual differences because a strategy that is effective for one learner may not necessarily produce the same results for another. Ekwensi et al. (2006) emphasized the importance of identifying appropriate learning strategies that accommodate learners' needs and support the achievement of educational objectives. Students should consequently have access to learning approaches with which they are comfortable and through which they can learn effectively.

At the same time, effective learning does not necessarily require that learning tasks become easier. Bjork (2014) argued that introducing productive difficulty into learning can strengthen the durability of information in memory. Research associated with handwritten note taking indicated that students who recorded information manually demonstrated better test performance and greater confidence throughout the learning process while also perceiving themselves as more creative. The importance of knowledge itself has long been captured in Bacon's (1597) assertion that "knowledge is power," emphasizing that access to knowledge strengthens an individual's opportunities for success. Students may encounter greater academic difficulties in secondary and higher education when they lack appropriate strategies for learning, while limited awareness of available learning approaches may make increasingly advanced academic work more difficult.

Taken together, the literature and theoretical perspectives demonstrate a common emphasis on active cognitive engagement, the organization of information, the connection of new concepts with prior knowledge, and the learner's role in constructing meaning. Ausubel (2000) emphasizes meaningful relationships between new and existing knowledge, Gagne (2000) identifies the cognitive and instructional conditions necessary for different forms of learning, Buzan (2007, 2009) provides a visual and associative framework for organizing information, and Piaget (1977) explains learning as an active process of constructing and restructuring knowledge through experience. Empirical discussions of student engagement, visual learning, memory, and handwritten note taking further suggest that how learners process information can influence comprehension, retention, motivation, and academic performance. Despite these converging perspectives, the need remains to determine whether mind mapping can produce measurable advantages over the familiar practice of pen and paper note taking when applied to actual Science 10 instruction.

In response to this need, the study examined the effectiveness of mind mapping as a learning strategy in comparison with pen and paper note taking. Two randomly selected Grade

10 sections at Mactan National High School were subjected to pretest and posttest assessments to determine the effectiveness of the learning strategies. Both groups were taught using the same teaching strategies and were provided with the same learning activities throughout the duration of the study, with the learning strategy serving as the principal variation between the groups. The experimental group used mind mapping, while the control group employed pen and paper note taking during classroom discussions. Through this comparison, the study sought to determine whether the theoretically supported visual, associative, constructive, and cognitively engaging characteristics of mind mapping could contribute to improved learning and academic performance in Science 10, thereby providing evidence for the selection of learning strategies that may respond to the continuing need to strengthen science learning among Filipino students.

Statement of the problem

The study aimed to determine the effectiveness of mind mapping as a learning tool for Fourth Grading Grade 10 Science.

Specifically, it sought to answer the following questions:

1. What is the mean gain in the pretest and posttest scores of students in terms of their academic performance level?
2. What is the mean difference between the pretest and posttest scores in the academic performance level of male and female students exposed to mind mapping and pen and paper note taking as learning strategies?
3. Is there a significant difference in the performance level of students exposed to mind mapping and pen and paper note taking?
4. What is the attitude of the students toward mind mapping and pen and paper note taking as learning strategies?
5. What relevant proposal may be developed based on the findings of the study?

METHODOLOGY

This study employed the One Shot Pre-test Post-test Design, which made use of a pre-test and post-test design to evaluate students' improvement in academic performance involving two groups randomly assigned as the control and the experimental group. The respondents were students of Mactan National High School, particularly two randomly chosen Grade 10 sections, Garnet and Ruby. Both groups were taught using the same teaching strategies and were given the same activities for the duration of the study; however, the control group (Garnet) used pen and paper note taking as a learning strategy, while the experimental group (Ruby) used mind mapping.

The study was conducted at Mactan National High School, a Philippine public institution with Fiscal Autonomy (Implementing Unit). It is an autonomous school located in Barangay Mactan, Lapu Lapu City, Cebu, under the Department of Education, Lapu Lapu City Division, and it meets the requirements set forth under DepEd Order No. 60 s. 2011. It has its own MOOE (Maintenance and Other Operating Expenses) allocations, and given this status, the school is also entitled to allocate or deploy new teaching, teaching related, and non teaching related positions under 3.a of DepEd Order No. 77 s. 2010, thus receiving its allotment directly from the Department of Budget and Management. It is a big day school with a total population of about 3,200 students for the academic year 2015 to 2016. Like other public high schools, it has a minimum of 50 students per section and a maximum of 60, and it is composed of students

from various social backgrounds. The classes are of heterogeneous grouping, so students have different learning styles and academic capabilities. The school does not have complete science laboratory equipment, so science teachers must find ways to make learning more fun and interesting. Furthermore, the results of the Grade 9 and 10 NAT (National Achievement Test) and NCAE (National Career Assessment Examination) in Science were only 52% and 58% respectively for the past three years (S.Y. 2011 to 2014), which did not meet the basic standard performance set by DepEd of 75%. For this reason, this particular school was chosen for the study.

The research respondents were the Grade 10 students of Mactan National High School for school year 2015 to 2016, composed of 12 sections with a total population of 545 students. The two sections used in the study, Ruby and Garnet, were randomly chosen. Section Ruby had 50 students, consisting of 24 males and 26 females, while section Garnet had 49 students, consisting of 26 males and 23 females, for a combined total of 99 students across both sections. Both classes had heterogeneous groupings in terms of intellectual capacity and had a mean average age of 16 years old. The two sections were of almost similar characteristics in terms of attitude and academic performance, as assessed by their different subject teachers and as shown in their anecdotal records from the previous grade level. Both sections were randomly assigned as the control and the experimental group, with the control section (Garnet) using conventional pen and paper note taking as a learning strategy and the experimental section (Ruby) using mind mapping for the duration of the study.

Two research instruments were used in the study: a 50 item multiple choice researcher made questionnaire and an attitude inventory. The researcher made questionnaire was checked by a panel of experts on the subject matter, and its questions were based on Unit 4, Modules 1 to 3, of the DepEd K12 Grade 10 Science learner's manual. The questionnaire covered three major topics, namely Behavior of Gases, Chemical Reactions, and Biomolecules, and a total of 50 multiple choice test items were prepared for the control and experimental groups to answer as their pre-test and post-test. Using Cronbach's Alpha, the 50 item multiple choice questionnaire was found to be reliable at 0.805. The attitude inventory was adopted from the Wagner A/E Scale using a Likert Scaling procedure. This scale was used to validate the attitude of the respondents toward learning the concepts in Science 10 using mind mapping and pen and paper note taking. The respondents answered each item by choosing one of five Likert alternatives, with five positive and five negative statements pertaining to attitude included in the inventory. Responses to positive items were weighted from 5 (strongly agree) to 1 (strongly disagree), and these weights were reversed for negative items, such that for positive statements, Strongly Agree was weighted 5, Agree was weighted 4, Undecided was weighted 3, Disagree was weighted 2, and Strongly Disagree was weighted 1, while for negative statements, Strongly Agree was weighted 1, Agree was weighted 2, Undecided was weighted 3, Disagree was weighted 4, and Strongly Disagree was weighted 5. The respondent's score was the sum of all weighted alternatives toward the use of pen and paper note taking and mind mapping in learning the concepts in Science 10, with the highest possible score being 50 and the lowest being 10; high scores reflected a positive response, while low scores reflected a negative response. The qualitative descriptions corresponding to the weighted scores in the attitude inventory were as follows: a weighted score range of 42-50.00 was described as Positive, a range of 34-41.99 was described as Moderately Positive, a range of 26-33.99 was described as Neutral, a range of 16-25.99 was described as Moderately Negative, and a range of 10-17.99 was described as Negative, all under the category of Attitude.

With respect to validity, the teacher made test was given to science expert teachers and the researcher's adviser for correction, after which modifications were made before the actual administration of the test to the respondents. With respect to reliability, a 75 item multiple choice test questionnaire was initially prepared by the researcher and checked by the panel of experts, and Cronbach's Alpha was used to measure the reliability of the test by identifying how closely related the set of items or questions were to one another. As a result, 50 items were found to be effective at 0.805, indicating a high correlation among the items. The test-retest method was also used to further verify the instrument, which involved administering the same test twice to the same group of students who were not part of the research respondents, after a certain time interval; the test was pilot tested on 50 non-respondent Grade 10 students of Mactan National High School who were likewise randomly chosen, and after the results of the test were verified, it was then administered to the actual research respondents. An attitude inventory descriptive questionnaire was also administered to both the control and the experimental groups at the end of the research time frame in order to identify the learning strategy that was more comfortable and easier for them to use, with respondents answering each item by choosing one of the five Likert alternatives previously described; a respondent's score was summed from all weighted alternatives toward the learning strategy used in the study, with the highest possible score being 50 and the lowest being 10, where high scores reflected a positive response and low scores reflected a negative response. Daily lesson plans were used for the duration of the study, wherein both the control and the experimental groups were taught in the same manner and were given the same daily class activities, differing only in the way they took their notes, with the control group using pen and paper note taking during class discussion and the experimental group using mind mapping. A 50 item multiple choice pre-test and post-test was given to both the control and the experimental group to determine their academic performance before and after the duration of the study.

In terms of data gathering procedure, the researcher first asked permission from the school principal to conduct the study through a formal letter, and after this was approved, the researcher furnished a copy of the letter to the Schools Division Superintendent in Lapu Lapu City Division to conduct the study in the chosen school. Before the 4th grading period commenced, the researcher taught the experimental group how to do mind mapping for a week prior to the experimentation, and the pre-test and post-test questionnaire was also pilot tested on a randomly chosen section that was not part of the study. For the actual data gathering, two randomly chosen sections of Grade 10 at Mactan National High School, a public school in Cebu, were selected as the research respondents, serving as the control and experimental groups; the control group was composed of 49 students and the experimental group was composed of 50 students, both drawn from morning session regular classes. The academic achievement test was administered during the respondents' regular class schedule as a pre-test to both the control and the experimental group, after which pen and paper note taking and mind mapping were implemented as learning strategies while class discussion was ongoing. After the duration of the study, the two groups were administered the same test again for one hour as a post-test, and the scores were recorded and compared with the pre-test scores of the students for analysis. At the end of the post-test, both the control and the experimental group respondents were also asked to answer a descriptive questionnaire to assess their attitude toward the use of pen and paper note taking and mind mapping as learning strategies, and the respondents were given 20 minutes to answer the Attitude Inventory assessment, in which they were asked to give their honest opinion as to whether they preferred to use mind mapping or pen and paper note taking.

For the treatment of data, the One Shot Pre-Test Post-Test method was used in the study, and an SPSS program was utilized to analyze the effects of the use of pen and paper note taking and mind mapping in learning Grade 10 Science concepts. The Univariate Analysis of Variance (ANOVA) was employed to determine the significant effects of the use of pen and paper note taking and mind mapping as learning tools in the 4th grading Grade 10 Science for the control and the experimental groups between male and female students. A Paired Samples t-test of mean gain was used to determine the improvement of the students' performance level between the control and the experimental group's pre-test and post-test scores. A t-test of mean difference was also conducted to determine whether there was a significant mean difference in the pre-test and post-test performance level between the control and the experimental groups. Finally, an Attitude Inventory Questionnaire adopted from the Shaufer-Wagner A/E scale was administered to the respondents in order to assess the conduct of the study, with the highest possible score being 50 and the lowest being 10.

RESULTS AND DISCUSSION

This study examined the academic performance of two intact groups of Grade 10 Science students exposed to two distinct learning strategies, namely the conventional pen and paper note taking technique used by the control group and the mind mapping technique used by the experimental group. A total of 49 students comprised the pen and paper note taking group while 50 students comprised the mind mapping group. The One Shot Pre Test Post Test research design was employed, wherein both groups were administered a pre test prior to the intervention and a post test following the duration of the study. Data were analyzed using descriptive statistics such as the mean, standard deviation, and standard error of mean, as well as inferential statistics through the Independent Sample T test to determine the significance of differences between groups. The discussion that follows is grounded entirely in the data gathered from these procedures and is interpreted in direct relation to the objectives of the study, specifically to determine whether mind mapping produced a greater improvement in academic performance than pen and paper note taking and whether such improvement varied according to gender.

The pre test and post test mean scores revealed that both groups began the study at comparable levels of prior knowledge. The pen and paper note taking group obtained a pooled pre test mean of 18.10 while the mind mapping group obtained a pooled pre test mean of 17.84, indicating that the two groups were nearly equivalent in their baseline understanding of the Science 10 concepts under study. Both pre test results were markedly below the school's performance standard of 75%, confirming that neither group possessed adequate prior mastery of the content before the intervention. Following the instructional period, the pen and paper note taking group achieved a pooled post test mean of 28.65, yielding a mean gain of 10.55 with a standard deviation of 8.24 and a standard error of mean of 1.20. The mind mapping group achieved a pooled post test mean of 31.68, yielding a mean gain of 13.84 with a standard deviation of 6.27 and a standard error of mean of 0.886. These results demonstrate that both instructional strategies contributed to measurable gains in academic performance, though the magnitude of improvement was consistently higher among students exposed to mind mapping. This pattern aligns with the assertion of Linde (2014) that learners retain information more effectively when they engage with images, symbols, colors, wavy lines, and keywords, all of which are inherent features of the mind mapping process. Comparable findings have been reported internationally. Toi (2009) found that 32% of children who used mind mapping

recalled words more effectively than those who used list based methods, while Farrand and Hennessey (2002) observed a 10% improvement in the long term memory of adult learners who used mind mapping. Zipp and D'Antoni (2005) further reported that mind mapping enhanced students' ability to organize their thoughts and integrate available resources into coursework. The visual and associative nature of mind mapping appears to actively engage learners in constructing their own understanding, in contrast to the more passive transcription involved in linear note taking, a distinction consistent with Thiaga's (2001) observation that pen and paper note taking does not by itself guarantee efficient learning.

When the mean gain scores were disaggregated by gender and examined through the Independent Sample T test, a significant difference emerged among male students, with pen and paper note taking yielding a mean of 8.27 and a standard deviation of 9.08, compared to mind mapping which yielded a mean of 14.38 and a standard deviation of 7.72, producing a t value of -2.57 and a p value of 0.013. Since this p value is less than the 0.05 level of significance, the null hypothesis of no significant difference was rejected for male students, indicating that mind mapping was significantly more effective than pen and paper note taking in improving their academic performance. Among female students, however, pen and paper note taking produced a mean of 13.09 with a standard deviation of 8.45, while mind mapping produced a mean of 13.35 with a standard deviation of 4.66, yielding a t value of -0.13 and a p value of 0.900. As this p value exceeds the 0.05 threshold, the null hypothesis was retained for female students, indicating no statistically significant difference between the two strategies for this subgroup. This divergence suggests that the effectiveness of mind mapping as a visual learning strategy may be moderated by gender. Supporting this interpretation, Dicarlo (2007) found that 87.5% of male respondents preferred multiple modes of learning compared to only 45.8% of female respondents, which may explain why the multimodal nature of mind mapping resonated more strongly with male learners. Vogel (1990) similarly reported that normally achieving males demonstrated higher visual spatial and mathematical abilities relative to females, who tended to be more verbally oriented learners. Wehrwein et al. (2007), using the VARK questionnaire among undergraduate physiology students at Michigan State University, found that male students favored varied learning modes including graphs, diagrams, charts, and audio guides, while female students tended to favor a single dominant mode. Additional physiological and psychological evidence reinforces these patterns. Rosati (1996) found that although the majority of students in a Canadian sample preferred visual learning, 89% of male participants expressed this preference compared to a smaller proportion of females, and Verma (2013) noted that men tend to exhibit stronger visual spatial and geographic memory while women tend to excel in recalling words, names, and images. Hamann and Wallen (2004) observed heightened amygdala activation among males when exposed to visual imagery relative to females, and Shuib and Azizan (2015), studying ESL learners in Malaysia, found that 67.5% of male students preferred visual aids such as pictures, images, diagrams, and demonstrations. Structural differences in brain anatomy have also been cited as a contributing factor, with the female corpus callosum reported to be approximately 20% larger than that of males, a difference associated with stronger verbal communication tendencies in females and stronger nonverbal, spatially oriented tendencies in males. Hodgins (2011) reported that 67% of males rely on visual representation as their primary mode of learning throughout their lives, while Ransom (2013) found that males outperformed females on visual recall tasks despite equal exposure time, and Silverman and Eals (1992) noted a historical pattern of superior spatial ability among males in tasks such as navigation and mental rotation. Taken together, this body of literature offers a plausible explanation for why mind mapping, as a predominantly visual and multimodal strategy, produced a statistically significant advantage for male students while showing no significant advantage for female students in the present study.

The overall comparison of mean gains between the two learning strategies, independent of gender, further substantiated the superiority of mind mapping. The pen and paper note taking group obtained an overall mean gain of 9.96 with a standard deviation of 9.65 and a standard error of mean of 1.40, while the mind mapping group obtained a mean gain of 13.84 with a standard deviation of 6.27 and a standard error of mean of 0.89. The resulting t value of -2.37 and p value of 0.020 fall below the 0.05 level of significance, leading to the rejection of the null hypothesis and the acceptance of the alternative hypothesis that a significant difference exists between the two strategies in terms of their effect on student performance in Grade 10 Science. The mind mapping group's mean gain exceeded that of the pen and paper note taking group by 3.91 points, reinforcing the conclusion that mind mapping was the more effective strategy overall. This finding does not diminish the value of pen and paper note taking, as the control group nonetheless demonstrated a genuine increase in academic performance, consistent with Millar (2003) and Valdez (2008), who maintained that learning occurs when instructional presentations are delivered clearly, whether through lecture or active classroom engagement, and with Jaime (2000) and Punzalan (2003), who emphasized that the teacher's role in delivering content remains central regardless of the specific strategy employed. At the same time, Peverly (2006) noted that the physical limitations of handwriting speed during fast paced lectures often discourage learners from recording complete notes, which may partially account for the comparatively lower gains observed in the pen and paper note taking group. The stronger performance associated with mind mapping is further supported by Mona and Khalick (2008), who found that mind mapping significantly enhanced conceptual understanding and practical reasoning among science learners, as well as by Mento et al. (1999), who documented renewed classroom enthusiasm and increased student confidence following the adoption of mind mapping, and by Budd (2004), who found that mind mapping fostered active learning that improved retention. Denning (1998) and Dorris (2008) further argued that learning becomes more durable when students construct personal meaning from instructional content, a process that mind mapping facilitates through the use of student generated keywords, images, colors, and lines.

Beyond measurable performance gains, the study also assessed students' attitudes toward the two learning strategies. The pen and paper note taking group, comprising 49 students, obtained a mean attitude score of 34.08, described qualitatively as moderately positive, while the mind mapping group, comprising 50 students, obtained a mean attitude score of 36.50, also described as moderately positive. Based on the established numerical range of cut off scores, wherein 42 to 50.00 corresponds to a positive rating, 34 to 41.99 corresponds to a moderately positive rating, 26 to 33.99 corresponds to a neutral rating, 16 to 25.99 corresponds to a moderately negative rating, and 10 to 17.99 corresponds to a negative rating, both groups fell within the moderately positive category, with neither group expressing outright dislike for its assigned strategy. Students in the experimental group reported that despite mind mapping being unfamiliar and requiring creative effort to illustrate and associate concepts, they generally came to appreciate the technique, particularly the process of drawing and coloring symbols, which they found supportive of recall. Students in the control group likewise reported a capacity to learn effectively through pen and paper note taking despite the absence of visual elements such as color, imagery, and connecting lines. Notably, the data revealed that a moderately positive attitude, whether toward pen and paper note taking or mind mapping, did not by itself guarantee high academic performance in Science 10, since both groups reported comparable levels of positive attitude despite differing performance outcomes. This

observation is consistent with constructivist theory, which holds that learners construct knowledge individually and socially through direct engagement with problems, questions, and experiences rather than through affective disposition alone. It is further consistent with Gardner's Theory of Multiple Intelligences, which recognizes that learners possess varied and often fluctuating preferences for particular modes of learning, and with Valdez's (2005) conclusion that instructional strategies must themselves be varied in order to accommodate this diversity of learning styles.

Taken together, these findings indicate that while both pen and paper note taking and mind mapping produced measurable improvements in the academic performance of Grade 10 Science students, mind mapping consistently yielded the greater mean gain, a difference confirmed as statistically significant at the 0.020 level. This advantage was particularly pronounced among male students, for whom the difference between strategies reached significance at the 0.013 level, whereas no significant difference was observed among female students at the 0.900 level, suggesting that the effectiveness of visually oriented strategies such as mind mapping may be shaped by gender based learning preferences. Both groups nonetheless exhibited moderately positive attitudes toward their respective strategies, indicating that receptiveness to a learning strategy does not necessarily correspond to the magnitude of academic gain it produces. These findings directly address the objectives of the study by demonstrating that mind mapping is a more effective strategy than pen and paper note taking for improving academic performance in Science 10, particularly among male learners, while also affirming that instructional strategies should be responsive to the diverse learning preferences of students. This body of evidence provides the empirical foundation for the instructional recommendations and the enhanced instructional plan discussed in the succeeding section, which was developed specifically to accommodate these documented differences in learning style and to further support improved academic performance among students exposed to mind mapping and pen and paper note taking alike.

CONCLUSION

This study set out to determine the effectiveness of mind mapping as a learning strategy in comparison with pen and paper note taking among students in fourth grading Science 10, and the findings drawn from the results provide a coherent basis for understanding how these two approaches shaped student performance and attitudes throughout the course of the investigation.

The pre-test results established that the control group, which used pen and paper note taking, and the experimental group, which used mind mapping, began the study with nearly equal levels of prior knowledge, indicating that neither group held an initial advantage over the other. As the study progressed, both groups demonstrated measurable gains in academic performance, with a significant mean gain observed between pre-test and post-test results as well as a significant difference in mean gain between the two groups. This outcome confirms that learning occurred under both strategies, yet it was mind mapping that yielded the more pronounced improvement, suggesting that its graphical and multisensory nature offered a distinct advantage over the more linear format of traditional note taking. This advantage becomes clearer when the strategy's underlying mechanism is considered, since mind mapping functions as a visual learning tool that integrates words, images, numbers, wavy lines, and colors, rendering information more memorable and more engaging to construct and review. By drawing on both hemispheres of the brain, mind mapping enables learners to engage more actively and creatively with the material, allowing them to identify and retain what is truly

important to remember, and it is this cognitive engagement that appears to account for its superior effectiveness relative to conventional note taking.

A further distinction emerged when performance was examined according to gender, as mind mapping proved to be particularly effective among male students compared to their female counterparts who used the same strategy. This finding implies that responsiveness to visual and spatial learning tools may vary according to gender, a possibility that carries meaningful implications for how instructional strategies are selected and applied in the classroom. At the same time, attitudinal data gathered from both groups indicated a moderately positive disposition toward their respective learning strategies, with neither group expressing strong preference for, nor aversion to, the method to which they were exposed. This pattern suggests that students are capable of adapting to varied instructional approaches, whether these involve the visual organization of images inherent in mind mapping or the sequential outlining characteristic of pen and paper note taking, and that such adaptability enables learning to take place regardless of the specific strategy employed.

Taken together, these findings affirm that both mind mapping and pen and paper note taking are viable strategies for enhancing academic performance, although mind mapping demonstrates a clear edge in effectiveness, particularly among male learners, owing to its capacity to engage multiple cognitive processes simultaneously. In light of these conclusions, it is recommended that both strategies be implemented and further enhanced within school settings to render the learning process more meaningful for students. In classrooms or schools with a predominantly male population, educators may consider adopting mind mapping as a primary strategy, given its demonstrated effectiveness among male learners, while also taking into account the broader body of research on brain differences between boys and girls when designing instruction for either gender. Educators are further encouraged to identify the specific strengths and weaknesses of mind mapping so that it may be tailored to address the individual needs of students, and to incorporate enhanced instructional plans that maximize the potential learning outcomes associated with this strategy. Finally, replication of this study across other topics, subjects, or fields within Science is recommended to establish the broader validity and reliability of these findings, thereby strengthening the evidentiary basis for the continued use of mind mapping and related visual learning strategies in diverse educational contexts.

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