Spring 5-11-2023

NOTE-TAKING IN COLLEGE MATHEMATICS: AN EXAMINATION OF THE EFFECTIVENESS OF GUIDED NOTES AND INTERACTIVE NOTEBOOKS ON STUDENT ACHIEVEMENT IN COLLEGE ALGEBRA

Verlonda Neal

NOTE-TAKING IN COLLEGE MATHEMATICS: AN EXAMINATION OF THE EFFECTIVENESS OF GUIDED NOTES AND INTERACTIVE NOTEBOOKS ON STUDENT ACHIEVEMENT IN COLLEGE ALGEBRA

by

Verlonda Nicole Hodge-Neal

A Dissertation
Submitted to the Graduate School,
the College of Arts and Sciences
and the Center for Science and Mathematics Education
at The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

Approved by:

Dr. Julie Cwikla, Committee Chair
Dr. Kendrick Buford
Dr. John Harris
Dr. Sherry Herron
Dr. Anna Wan

May 2023

ABSTRACT

The purpose of this study was to investigate how the use of interactive guided notes influences the mathematical performance of college algebra students when solving univariate linear equations. The research involved 68 students enrolled in College Algebra at a community college. The participants were divided into two groups: those who took notes using an interactive guided notes method and those who did not use the interactive guided notes note-taking method to cite instructional information. The participants were administered a test on solving univariate linear equations before and after receiving instruction to answer the research questions posed by the study. An independent samples t-test was performed to compare the pre-and post-test mean scores of the experimental and control groups.

The results revealed a significant difference in the experimental group's mathematical performance compared to the control group. The findings lend credence to implementing interactive guided notes in the classroom as a note-taking method for College Algebra. Because taking notes is a strategy used in many classrooms, teachers and students should be privy to note-taking strategies that promote academic development. Although interactive notes and notebooks are utilized at various educational levels, executing the note-taking technique at the collegiate level needs proper planning to guarantee a successful implementation.

ACKNOWLEDGMENTS

To the Highest, my Lord and Savior, Yeshua, for giving me the wisdom, strength, fortitude, and desire to explore new avenues of education, I give thanks for the guidance in helping me surpass all the trials that I have encountered and for giving me the wisdom needed to pursue and complete this task. I give you the praise. I would like to extend my deepest sincerest gratitude to everyone who guided me through this process. I would not have made it this far without the silent contributors who shared knowledge and expertise to make this dream a reality.

What has been accomplished is the product of perseverance interacting with potential. I want to express my sincerest gratitude to my advisor, Dr. Julie Cwikla. Dr. Cwikla, no words will ever be enough to convey my adoration and appreciation for you. You have guided me through so many hurdles and kept me on the right path, and for that, I thank you. To Dr. Herron, thank you for allowing me to enter the program and seeing me through many life changes. Dr. Bruford, thank you for your continuous support, patience, motivation, enthusiasm, and immense knowledge. Dr. Harris, thank you for assisting me through this process and providing me with your expertise. Dr. Wan, you are a beacon of light and a great source of encouragement and wisdom. I could not have imagined having a better team of advisors and committee members to assist me in being successful during this process.

DEDICATION

Habakukkuk 2:2-3 states: “Write the vision; make it plain on tablets, so he may run who reads it. 3 For still the vision awaits its appointed time; it hastens to the end; it will not lie. If it seems slow, wait for it; it will surely come; it will not delay.” I have walked by faith and stayed the course because the Most High saw fit for me to be the woman I am today. I am my daughter’s hope, mother’s vision, and grandmother’s wildest dream.

I dedicate this work to my believers, my late grandparents (Lee and Agnes Hodge), my mother (Verlene Hodge), my sisters (Lashandra Hodge-McClure and Lakenya Hodge-Winters), and the entire Hodge and Neal families. You have stayed with me on this journey, and your faith in my ability to succeed did not waiver. To my daughters Riley and Haley, I will forever be thankful for having you in my life and cannot wait to see the amazing women you grow up to be. To my husband, Michael, thank you for supporting my dreams. To my mother, thank you for your tenacity and encouragement. To my sisters, thank you for being my shoulders to cry on and my voice of reasoning throughout life.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

LIST OF ABBREVIATIONS

STEM	Science, Technology, Engineering, and Mathematics
SPSS	The Statistical Package for the Social Sciences
SSC	Student Success Center
SSS	Student Support Services

CHAPTER I – INTRODUCTION

For decades, mathematics teaching, learning, understanding, and subsequent achievement have been of concern for educators and key stakeholders alike. The concern surrounding student achievement has compounded for teachers and administrators continuously since the implementation of state-mandated standardized tests under the No Child Left Behind Act of 2001. Venezky (2018) asserts that far too often teaching centers on getting as much content into students' minds as rapidly as possible to reach standards and complete assessments as opposed to developing connected understanding and problem solvers. Teachers frequently "teach to the exam" rather than provide a full curriculum to boost standardized test performance. With little time allowed to deviate from the routine of teaching to the test, instructional practices have become somewhat scripted and inadequate with regard to connected mathematical thinking and application. While the issue of student achievement has historically been linked to an array of factors, as stated by Mabena et al. (2021), spanning from self-efficacy and disabilities to content and instructional pace, this research aims to focus on a critical area of classroom instruction, primarily methods of note-taking and ways physical tools and organizers can support students' learning, understanding, and achievement in meaningful ways. According to Wist (n.d.), the technique of actively engaging students in the learning process by having them take notes leads to an increase in comprehension.

While assessing student achievement is critical for predicting future success, student success in mathematics often serves as a substantial predictor of university and career success. Because arithmetic and logical thinking are prerequisites for various vocations, educational authorities place a premium on students' computational and problem-solving abilities (Yeh et al., 2019). If not addressed, a student's inability to retain basic mathematical concepts early on in their educational journey might have severe repercussions. According to Richards (2020), the latest results of an international exam administered to teens placed the United States tenth in reading and thirty-first in math literacy out of 79 nations and economies. In other words, the US is in the middle of the pack mathematically worldwide, performing with developing nations, despite its economic and social advantages.

The mathematics courses offered in the first two years of college serve as gateways to many college program degrees. Consequently, high failure rates in College Algebra across the country present significant barriers to earning degrees, especially in Science, Technology, Engineering, and Mathematics (STEM) related fields. This experimental Meaningful Learning Theory study will investigate the use of a guided interactive graphic organizer note-taking method as it relates to student performance and comprehension in College Algebra. The research will analyze an interactive foldable note-taking strategy that resembles the Four-Square method of note-taking. Students are given the opportunity to exhibit their creativity as they learn throughout the progression of the year by using interactive guided notes (Paradise, 2019).

Mathematics is one of many subject areas where new content is heavily reliant on previously learned knowledge and understanding. According to Wriston (2015), students often struggle to meet current grade-level math objectives without past grade-level arithmetic understanding. Given that mathematical topics are often a continuation of previously introduced topics, institutions and instructors are often left dependent on students' ability to tap into prior knowledge. This has paved the way for undergraduate learning supports such as tutoring, mathematics education learning centers, and computer adaptive practice.

Student-centered learning centers are staples at undergraduate institutions. The Student Success Center (SSC) is a comprehensive set of programs and services to support all students at the teacher-researcher's institution, from first semester to graduation, in setting and meeting students' instructional goals. Student Support Services (SSS), at the target community college is a TRIO federally grant funded program that strives to promote student achievement and success by providing a menu of services and activities to target academic, personal, and social development, as well as financial literacy (Student support services, n.d.). In addition, the STEM Lab typically offer free computer access, assistance with completing homework assignments, and study help. These added measures are meant to provide students with a more conducive environment to find and receive academic assistance and foster understanding.

Background

Students have taken notes during lectures or been required to do so since the beginning of formal classroom teaching and learning. Note-taking has been a constant and necessary tool in academic settings, particularly in lecture courses. However, despite its widespread use, note-taking is sometimes neglected as a critical component of the learning process (DeZure et al., 2001) and has not often been investigated. Because there is no set format in which students must record notes, it is often difficult to determine which method or methods of note-taking, if any is most effective in fostering understanding, learning and retention. This research will focus on the Four-Square method of note-taking. According to Gerrard (2013), using the Four-Square approach with students can help them improve their problem-solving abilities. By using the Four-Square method, students were able to take control of and develop their problem-solving abilities. (See Figures 1.1 and 1.2, Foldable based on the Four-Square Method Graphic Organizer).

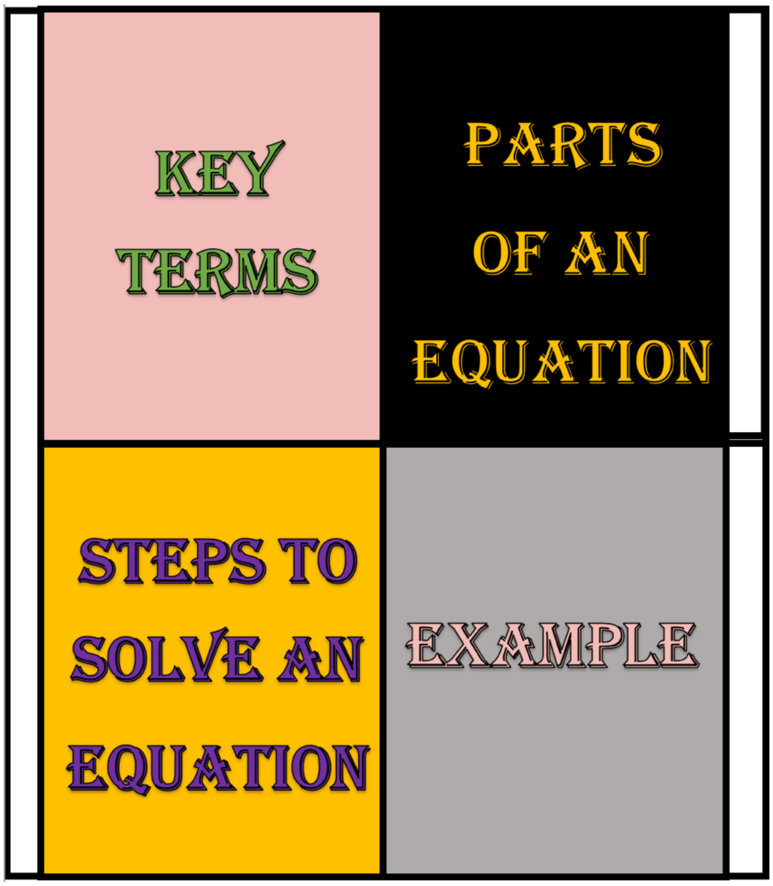


Figure 1.1 *Four-Square Interactive Graphic Organizer Cover Page*

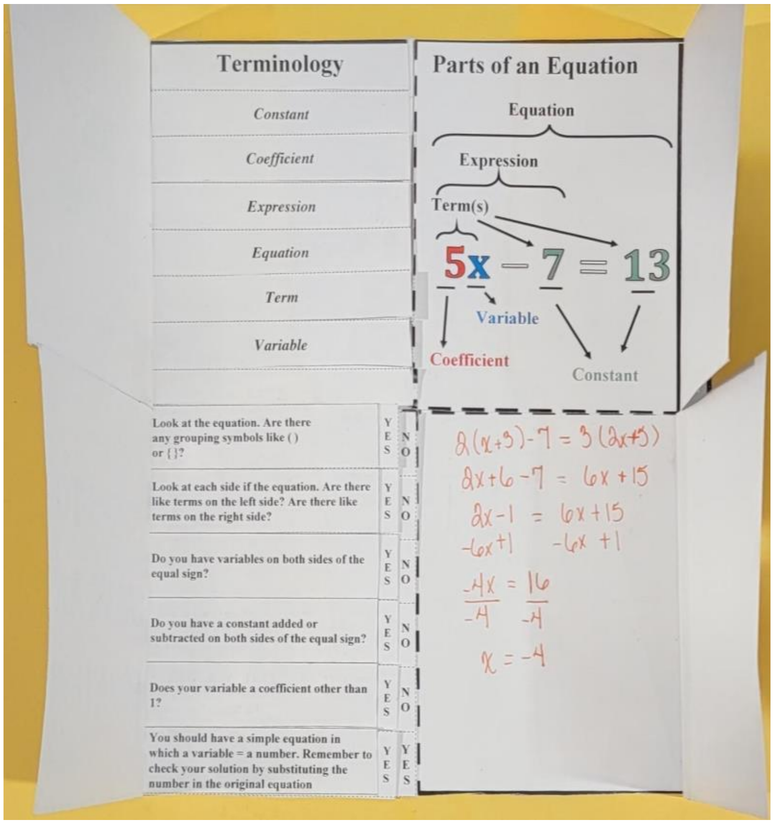


Figure 1.2 *Four-Square Interactive Graphic Organizer*

The interactive guided notes try to respond to the needs of both the teacher and the students engaged in the learning process. Notes can be arranged in an array of placements; however, it is wise to solidify an order in advance to ensure ease of implementation. On the right side, students may demonstrate what they have learned, while teachers may use the left side to provide knowledge on the subject matter. An example of the type of data that might be shown by making use of the information that is located on each side of the interactive notebook is provided in the following example. An illustration of a completed student page from an interactive guided note may be found in the file that has been included (Appendix A).

Traditionally, lecture-style teaching has been prevalent in the majority of post-secondary mathematics classes, with little inclination or motivation for modification. Numerous post-secondary schools have attempted to address low student achievement as evidenced by the increasing number of developmental courses offered. This, however, has not addressed low student performance in standard college courses such as Pre-College Algebra and College Algebra. In general, students who finish developmental math courses like Pre-College Algebra have a better chance of enrolling in College Algebra. However, college algebra has been called "the single most failed course in community colleges," with various researchers and practitioners estimating failure rates for the course around 50 percent (Ganga and Mazzariello, 2018).

Learning mathematics at the post-secondary level is vital for professional success for STEM related fields and beyond. According to Cignition (2020), the more advanced math courses a student completed, independent of national background or socioeconomic background, the more likely they would earn a bachelor's degree upon graduation. Post-secondary degrees have already surpassed high school diplomas as the required educational prerequisite for most professions and occupations. Instructors frequently employ various methods and approaches to assist students and foster learning to create a learning environment where students may contribute to their academic success. One strategy they employ to support and promote engagement in lectures and their success as learners is to provide student-centered materials such as guided notes.

Many studies examine the effect of guided notes on student progress in general. Extensive research has been conducted on the positive effects that utilizing graphic organizers can have on the quality of the textual material obtained from reading textbooks in the conventional context of a classroom in text heavy subjects such as history, literature, and biology. Proper note-taking and organizing might potentially allow students who typically struggle to grasp and make meaningful connections with mathematical courses. Yet, more information is needed on the organizational approach to note-taking in mathematics and not just on the note-taking method itself. Research on guided notes and student progress specifically at the collegiate level is sparse. While note-taking has been the most frequent technique for students to cite lecture information, only a tiny fraction of students demonstrate proficiency. Additional research is necessary to ascertain the efficacy of guided notes and organizational strategies at the collegiate level. This study will investigate the effect of note-taking and the organizational method on student success in College Algebra classes at a post-secondary school.

According to Williams (2016), most community colleges provide developmental education courses to assist underprepared students. The classes augment students' prior knowledge and prepare them for college-level work. Between 1982 and 2012, the percentage of college students majoring in mathematics declined by 25% (Vigdor, 2012), highlighting the need for more significant mathematics education reform. In recent years, there has been more focus on implementing developmental math courses, such as Pre-College Algebra, to address the issue of College Algebra preparedness at the collegiate level. It could be concerning that the performance in College Algebra directly impacts the likelihood of degree attainment, yet still, no viable remedy is available to fully prepare students for the rigor college mathematics possesses (Treisman, 2020)

Numerous variables including placement, pedagogy, and pace frequently contribute to the contentious issue of student achievement in College Algebra at community colleges and universities across the country. The goal of this study is to identify ways to improve knowledge and understanding through use of guided and interactive notes. It is critical to evaluate the delivery of the material and the learning aids used during the learning process to assist students in comprehending and retaining knowledge. Additionally, the study will investigate the effect of student fear and preparedness in determining student achievement.

Statement of the Problem

Student success in mathematics continues to be of interest and concern especially because conventional teaching and learning have been disrupted by the COVID-19 pandemic. The pandemic led to a rise in on-line education, which proved to be a difficult platform to navigate. It appears that reliance on an informal instructional method undoubtedly contributed to students' poor mathematical performance. There is an increasing push for improvement in the academic performance of post-secondary students across the nation. Williams (2016) states, the problem for institutions is finding effective techniques and methods to use to improve the success rate of students in developmental math courses. Researchers have shown that one way to achieve this is to help students become more organized in gathering and reviewing information. This study aims to investigate how and in what ways interactive notebooks impact student achievement at the collegiate level in College Algebra.

In many colleges, first-year mathematics courses show a higher mortality rate than any other course (Marshall, 1939). Depending on class size, it may be difficult for teachers to address the individual needs of all students. In most cases, many students may fall behind the standard of mathematics achievement and find it difficult to catch up. Due to feeling ill-equipped, students may lose interest in mathematics (Manza et al., 2018), which may set the stage for disinterest in learning any mathematical content, regardless of ease. Educators are constantly searching for effective strategies to assist students. If interactive notebooks are found to be useful and supportive, it might help solve the College Algebra hurdle so many students face.

Purpose of the Study

While research exists on guided notes on general learning and understanding and its influence on achievement, the focus has often been on students with learning challenges and special needs. There has been limited emphasis at the collegiate level on the benefits of guided notes and note-taking on student success, particularly in mathematics. Due to the continuous cycle of poor student performance and a low completion percentage of students enrolled in a standard college math course, more attention is research is required. The goal of this study is to find out how guided notes and interactive notebooks support and affect students' success in college mathematics classes. Using a pre-test and post-test, this study aims to explore the effect of note-taking and graphic organizers on college students' ability to solve univariate linear equations in College Algebra. To determine whether there is a significant difference between the means of the two variables, an independent-samples t-test will be employed.

Research Question and Hypothesis

One research question will be evaluated to guide the examination of the data analysis for this study. This study will compare the achievement level of students enrolled in College Algebra classes given certain types of notes. The research question and hypothesis are as follows:

Research Question

1. How does the use of guided interactive graphic organizer notes impact College Algebra students' mathematics performance when solving univariate linear equations?

Hypothesis

$RQ1 - H_o$: There will not be a significant difference in students' mathematics performance when solving univariate linear equations between students who used interactive guided notes versus students who did not use interactive guided notes in College Algebra.

$RQ1 - H_1$: There will be a significant difference in students' mathematics performance when solving univariate linear equations between students who used interactive guided notes versus students who did not use interactive guided notes in College Algebra.

A quantitative research study design will be used because there is limited evidence pertaining to post-secondary instructional practices that could have been effective in improving student retention and comprehension of the college-level mathematics curriculum. It should be noted that while additional factors may contribute to students' difficulties in college mathematics, this research will focus completely on the note-taking method employed by the participants of the study. An investigation into the Meaningful Learning Theory will provide new insights and aid in the development of ideas concerning ways to enhance students' comprehension of mathematical content. The treatment provided to both the experimental and control groups will only vary in the note-taking method employed by either group. The treatment group will use guided interactive graphic organizers as a note-taking method while the control group will use a non-interactive note. A pre- and post-test analysis will be used to analyze the significance of the note-taking method used by both groups when learning math content.

Significance of the Study

While it is evident that note-taking does impact student achievement, there is not enough research comparing the type of notes utilized and the structural method used to organize the notes for future usage This study aims to detect if the use of graphic organizers effects student academic understanding in college math. The desired outcome is that this research will provide institutions with research driven teaching aids that could support academic success and ways note-taking can support learning in college mathematics. The findings will undoubtedly contribute to the current conversation regarding how the strategic use of guided notes in conjunction with interactive notebooks could influence achievement in college-level mathematics. This study aims to present an alternative to not only how notes are taken but also how they are organized to determine if guided notes affect student success in College Algebra courses.

Complete and thorough notes help students understand the logical steps they need to solve a problem. It must be stated that while several types of note-taking methods exist the four main types are 1. Lists, 2. Outlines, 3. Concept maps, and 4. Cornell method. College Success (2015) describes the types of notes as follows:

- "Lists: A list of thoughts presented in a sequential order." Lists can be simple phrases or entire paragraphs presenting things in greater depth. This research will investigate note-taking gadgets as well as an organizer.
- Outlines: The outline approach organizes the most significant concepts in the left margin, numbered with roman numerals. Supporting ideas for these

primary themes are indented and marked with capital letters. Further detail can be given under each of these notions, denoted by an Arabic number, a lowercase letter, and so on.

- Concept Maps: When creating a concept map, start with a critical idea in the center of the page and add lines and other circles throughout the page to represent fresh concepts. Connect the various ideas with arrows and lines.
- Cornell Technique: The Cornell method has a two-column layout. The left column, which takes up less than a third of the page, is commonly referred to as the "cue" or "recall" column. The right column (approximately two-thirds of the page) is for taking notes using any of the following ways or a combination of them."

Overview of Research Design

The theory of meaningful learning will be used in this quantitative study. Better notes will aid in the retention of concepts, the development of meaningful learning skills, and the comprehension of a subject, according to Oxford Learning (2017). Assuming that taking notes during class lessons helps structure thinking and understanding, thus increasing understanding, allows students to actively engage with the material, and provide visual representations and organization of ideas and concepts. Because it assumes the integration of new material within the learners' existing cognitive structure, meaningful learning is inherently hierarchical. It differs from rote learning in that a link is established between the students' prior knowledge and the newly acquired knowledge, whereas rote learning consists of memorizing concepts without the need for understanding (Bartolomei-Torres, 2020).

The subsequent four chapters will go into more detail regarding a review of the literature, method, data analysis, and conclusions. A thorough analysis of the research on note-taking in college mathematics is in Chapter II. The research strategy and specifics of conducting the study are found in Chapter III. The subsequent chapters concentrate on the research conducted for this project. Chapter IV will present the research findings, followed by Chapter V's discussion.

Definition of Terms

The following were important open univariate linear definitions used in this study.

1. Guided Notes: These are handouts provided by the teacher that summarize teachings but leave gaps for crucial ideas, facts, definitions, and so on, which the student fills in as the session proceeds.
2. Graphic Organizers: Is a visual graphic representation of the relationships between facts, terms, and ideas in a learning task. Knowledge maps, concept maps, story maps, cognitive organizers, advance organizers, and concept diagrams are other names for graphic organizers.
3. Student Achievement: This is the quantity of academic knowledge a student learns in a specific period. It refers to how a student has met their short or long-term educational objectives.
4. Note-taking: This is the activity of capturing information from another source and recording it.
5. Interactive Notebook: This is a space where students may take knowledge from the teacher and combine it with their ideas. Interactive notebooks are not necessarily technologically based.

Assumptions

At the beginning of the module, students enrolled in College Algebra will complete a mathematics pre-unit-assessment. Students will complete the same mathematics post-test once instruction has ended. Participants are to thoroughly read and honestly reply to each question during both administrations of the tests.

Summary

To change the outlook of College Algebra success and completion rates, a holistic approach to student achievement is essential. A more direct focus on note-taking and its impact on college math, it is believed that students will be more confident as they matriculate to higher level courses, regardless of degree or professional paths. Historically mathematics is essential to both technological and social advancements. While the world has seen great technological evolution, little advancement has been made in mathematics education and the ways and methods used to teach the content.

Understanding the influence note-taking has on students' understanding and success has the potential to yield to great gains. Proper note-taking is important to the learning process because they often serve as a visual aide, and academic memory when instructors are not readily available for questioning. In other words, when confused, students can access their notes (Meldrum, 2020).

CHAPTER II – LITERATURE REVIEW

According to the National Academies, there is rising concern that the United States is falling behind its global counterparts in preparing the next generation of scientists, engineers, and mathematicians— fields found to be crucial to sustainable economic progress (2007, as cited in Lochmiller et al., 2012, p. 198). This literature review aims to examine how implementing note-taking strategies within the instructional process could impact the current state of collegiate math completion. This literature review also aims to summarize the effects of note-taking on student comprehension at the collegiate level. The first section looks at the impact of the pandemic has had on an already compromised instructional structure and the concerns found in math education and math comprehension. The literature review then discusses how note-taking affects student achievement as well as the role of graphic organizers as a note-taking strategy. It will look at how graphic organizers impact student engagement and how they may be used in mathematics education with both traditional and learning-disabled students. The overarching goal is to discuss how guided interactive notes have been used and studied in mathematics teaching and learning.

Historical Context

With the evolution of the Covid-19 pandemic the state of education in the US appeared more unbalanced than ever before. The pandemic not only exacerbated the problem of students struggling to master many academic requirements, it shone a light on the many inconsistencies that had previously been avoided in the education sector, one being student comprehension. Research has found that the pandemic significantly influenced the learning of students in grades K–12, causing students to finish the school year with an average deficit of five months in arithmetic and four months in reading. According to Dorn et al (2021), the pandemic compounded already existing disparities in opportunity and success, with historically disadvantaged students bearing the brunt of its effects.

The Covid-19 virus made it more challenging for students and instructors to ensure academic success through topic understanding, although concerns about students' math ability existed prior to the pandemic. The pandemic seemingly reversed the gains and widened the inequities, negatively affecting growth (Goldberg, 2021). According to research referenced by Ruef et al. (2022), students struggled to develop new methods to connect in online class settings, and opportunities to learn were affected by technology availability and proficiency. A previous study found that, within an online learning environment, teachers struggled to support students due to factors outside of their control (Borup et al., 2014, as cited in Leech et al. 2022). Struggles in learning highlighted through the pandemic also brought attention to other educational concerns, primarily underprepared post-secondary students.

If nothing else, the Covid-19 pandemic has shown the many inadequacies in education, primarily teaching and learning. The number of unprepared students has only become more significant with the appearance of the pandemic. From lack of resources to inadequate training for dealing with such a crisis, education has suffered immensely. The pandemic led to an unprecedented number of concerns in education. An in-depth examination of the academic areas most affected by the pandemic is required to help visualize the influence of COVID-19 on any already confused learning environment. Schools had encountered acute staff shortages, high absenteeism rates, quarantines, rolling school closures, and rising COVID-19 cases by the end of 2021 (Kuhfeld et al., 2022). They go on to state that schools and institutions were seeing a larger quantity of students in in-person and virtual lecture rooms with a more extensive academic deficit than ever before.

This research aims to identify and examine note-taking strategies that may be incorporated into the learning process to foster mathematics understanding and achievement, and equip students with the quantitative skills needed to succeed academically. In this research study, we will discuss the impact note-taking with graphic organizers has on students' ability to comprehend solving univariate linear equations at the collegiate level. It will also investigate one specific type of graphic organizer, foldables. This study will provide an overview of how foldable graphic organizers impact student comprehension. The goal is to increase understanding of the applications of graphic organizers and their various uses. It is believed that learners can have a higher level of participation in producing new ideas and information thanks to graphic organizers, which help ignite the background knowledge that is important for organizing and developing the content of a topic. (Robillos, 2022, p. 502). This is one of the primary reasons why many educators choose to utilize graphic organizers as part of the educational experience they provide for their students.

Mathematics Education

Mathematics has been an essential component of life and learning dating back centuries. Since conception, people have used the skills acquired for many reasons, ranging from commerce, and bargaining to exploring and educating. Ajayi & Lawani (2015) defines mathematics education as the practice of teaching and learning of mathematics in a way of solving problems involving learning the algorithms and formulas necessary for computations. Thompson (2018) states that math is relevant to a wide variety of academic subjects, which means that a student who does poorly in math could end up struggling in other subjects. He goes on to add, students who can't master basic arithmetic skills may struggle to read scientific charts and graphs in science. Because math is a connection based, is extremely beneficial that students master previous mathematics concepts, applications, and skills, prior to learning algebra and other higher level mathematical courses.

Throughout history, math performance and ability has served as a pivotal component for societal development and growth. Math can connect students to new opportunities never made available to them. Math provides a blueprint for both aspiring and established businesses alike to recruit new and diverse talent primed for success (Chaudhry, 2015). This lends credence to the importance of mathematics in various areas of life. According to Yadav (2019), the ability to work together on tasks with others can build various social skills. She also stated that to live a social life, mathematical knowledge is needed, because of the give and take process, business and industry depends upon the knowledge of mathematics. It is this sought-after math knowledge that has led to the steadily evolvement of mathematics education.

Despite several decades of reform efforts intended to improve STEM education a recent national landscape study found typical K-12 math and science instruction rarely provides students with opportunities to engage in STEM learning, with the fewest interdisciplinary connections occurring in high school coursework. Relatively few programs have focused on how to develop students' confidence so that they can successfully pursue careers in the discipline, how to connect instruction to career opportunities, and how to incorporate students' cultural backgrounds into instruction (Banilower et al., 2018). With educators being forced to navigate the ever-changing perception of teaching and learning, students are being lost in the traverse world of developing a conceptual and computational understanding of mathematics instead of just a procedural understanding. Mathematics computation is a skill that allows student to convey information in procedural order that may be easily understood without oral explanation. At a level of higher proficiency, students can convey content knowledge with very few steps. The ability to formulate thoughts and ideas mentally and comprehend information quickly is a skill set few math students can achieve, yet the expectation that students possess such a skill set is often expected at higher levels of education.

The requirement for students to study mathematics because of its importance can be cumbersome. It requires them to understand fundamental ideas, become proficient in mathematical operations, practice strategic knowledge, reason clearly and flexibly, and keep a positive attitude toward mathematics (National Research Council, 2001, as cited in Goke & Guner, 2021). Because mathematics is required, the instruction that goes into it must be able to accommodate students who are successful in mathematics at varying degrees of academics and professions. Very rarely is consideration given to whether attaining the goals set when teaching mathematics or whether the outcomes of mathematics education meet the expectations (Earnest, 2015). Lambert (2022) laments that mathematics has a reputation for being a challenging and complex topic. Nevertheless, to graduate from an undergraduate program, students must take at least one mathematics course. According to Hill (2021), throughout the past three decades, one of the most consistent features of the landscape of education policy has been an emphasis on improving the teaching of mathematics in grades K-8, beginning with the revised state mathematics standards of the 1990s and continuing through the Common Core educational standards that developed in 2010.

According to Shannon et al. (2002, p. 4), high schools differ in their understanding of academic preparation and student assistance initiatives. McClure et al. (2017) imply that receiving a high-quality early mathematics education may have the dual benefit of supporting the mathematics content area and encouraging the development of an executive function. They also imply that even teachers who are confident STEM leaders must know how to gauge their students' understanding and developing skills and use this knowledge to plan and modify instruction using instructional strategies linked to research. Student readiness to learn and teacher competence are linked, as stated by Kearney and Garfield (2019).

A thorough understanding of mathematical content at the postsecondary level can assist students in comprehending the curriculum of other subjects, such as science, social studies, music, and art. This understanding reinforces the much-debated notion of the necessity and value of mathematics education. Although mathematics is a globally important language, many individuals have declared themselves incapable of acquiring it due to the absence of a questionably rare math gene (Helmenstine, 2019). However, the difficulties associated with learning mathematics are not limited to college. The complexity of the current mathematics curriculum and its reliance on K-12 math proficiency gives credence to the need for additional reform.

The ACT Research and Policy (2013) stated that academic preparation for college gives students a head start on long-term college achievement and enhances the likelihood of graduating. When the K-12 educational reform began, the Commission on Higher Education devised initiatives to help elementary school graduates transfer to middle school (Wenceslao, 2022, p. 192). Despite preparations, a disparity formed between the instructional methodologies frequently used at the college level and those with which students were familiar in grades K-12. Teachers and school personnel actively monitor children in grades K-12, advising and correcting them as necessary. At the college level, however, students are expected to take responsibility for their activities with minimal scrutiny from teachers and administration. Subtle alterations such as these may not appear substantial on the surface. However, for some students, the ability to manage a lifestyle in which they have complete control over their destinies may be overwhelming, thereby exacerbating their lack of preparation for college life.

Historically, institutions have relied on non-credit-bearing developmental education to support students academically and prepare them for college-level coursework. As new research has raised questions about the efficacy of such courses, universities and states have experimented with methods that expedite the placement of students into credit-bearing coursework (What Works Clearinghouse, 2022). Although the push to place students in traditional college courses is commendable, the lack of change in student content comprehension is still quite alarming. To truly foster success further insight is needed to understand where the disparity in learning occurs. The need for understanding could lead to efforts to improve high school students’ college readiness and success. With so many students unprepared for the rigors of a standard college math course, many institutions must seek alternative ways to promote student learning. The objective is to encourage participation and assure academic success while improving college preparedness.

The idea is for students to find their rightful place in a collegiate setting as they progress through while expanding their insights in a variety of subjects. While general education covers a wide range of topics, the mathematics sector, particularly College Algebra, seems to be one which a large percentage of students struggle with. According to Shakerdge (2021), around 50% of students do not complete College Algebra with a grade of C or above. In fact, research seems that Americans' struggles with arithmetic are the greatest major Impediment to completing a degree in both STEM and non-STEM industries. In the worst-case scenario, students may get trapped in remedial programs and fall so far behind that they are forced to drop out of college.

To counteract the inability of students to get a meaningful education and a college diploma, "Remedial education programs were introduced by colleges to ensure that struggling students were prepared for higher-level coursework. Those courses are still taken by a large number of students. However, there is a growing perception that remedial math programs are harming the chances of the same individuals whom schools are trying to aid" (Sreenivasan, 2019). Many colleges and universities have recognized the importance of College Algebra, especially as an access point to mathematically intensive studies and careers, and have worked to improve and strengthen the course, with some success in increasing passing rates (Burmeister 2012 as cited in Watson, 2015).

Mathematics Comprehension

To fully understand the need for student comprehension and the benefits of note-taking in relation to student achievement in mathematics would require a deeper look into the scope of general education courses offered at post-secondary institutions, but primarily at the community college level. General education is seen as the basis for student learning and is often the source of enhancement of skills in communication, analysis, mathematical reasoning, and synthesis. It is a required component of all academic programs. Students get transferable skills in general education that equip them with the skillset needed to obtain information, develop new talents, and widen their views to better adapt to the requirements of a changing society. Many academic programs build their learning experiences and evaluations around the general education course plan. Students in these courses have the chance to participate in a shared learning experience that promotes social responsibility, scientific research, civic involvement, an appreciation of the natural world, nuanced assessments of the past, and lifelong inquiry habits. It is the shared learning experiences that signifies just why there is a need for students to thoroughly understand concepts, particularly in mathematics.

Because of the extensive number of complex topics given in each lecture and the cumulative structure of mathematics, which necessitates complete comprehension of one concept before going on to the next, reliable lecture notes are especially crucial in mathematics lectures (Cardetti et al., 2010, p. 81). According to many studies, taking notes is one of the most critical aspects of learning and performance in higher education. According to research conducted by Salame and Thompson (2020), taking strategic and comprehensive notes can help students enhance their learning and overall performance in a given lesson. Writing things down, such as taking notes, allows for a greater retention rate in our memories, aids in our comprehension of mathematical concepts, and in certain circumstances, even improves one's capacity to learn (Kobayashi, 2005, as stated in Dündar, 2015).

Understanding mathematical concepts is a prerequisite for academic success and professional accomplishment in the working world. According to Tamur et al. (2020), the purpose of student learning mathematics should develop and deepen their grasp of mathematical concepts. Although it is essential to learning, contextual information is not always straightforward to assess or track. Contextual learning assists in storing short-term memory (Chceducator, 2019). It also assists in the storage of long-term memory, which will assist students in the future when it comes time to apply these memories to the obligations of their jobs. Learning in context is also known as the contextual approach. It gets its name because it assists educators in connecting the knowledge that students learn in the classroom with real-world scenarios that typically confront students. According to Davtyan (2014), the primary reasons why contextual learning is so essential is that:

1. "It emphasizes problem-solving.
2. It recognizes the importance of education and training in various settings, including the workplace, the community, and the home.
3. It encourages students to become self-directed and independent learners by teaching them to take responsibility for their education.
4. It grounds instruction in the student's actual experiences in the world
5. Working in groups allows students to pick up helpful information from one another".

The gap between a student's mathematical competence and comprehension is often the root cause of the irregularities observed in their academic performance. According to the findings of research conducted by Bernard and Senjayawati (2019), there is no correlation between the level of mathematical aptitude and the level of comprehension possessed by students. Therefore, the student's level of skill does not substantially impact their level of comprehension. However, it is vital to remember that having great reading and comprehension skills is required to glean essential pieces of information, eliminate that which is superfluous, and arrive at conclusions (Weston, 2019).

Knowledge of broad thinking, learning, and problem-solving techniques best describes "strategy knowledge," as defined by Gurat and Muedula (2016). The authors further surmount, "Several general techniques describe the many heuristics individuals can employ to solve difficulties for problem-solving and thinking in mathematics." In problem-solving, they can include the knowledge of means-ends analysis, working background, and others. In addition, students can acquire knowledge of various metacognitive strategies that can be helpful in planning, monitoring, and regulating their learning and thinking. Strategy knowledge includes the various methodologies students may employ to recall the information and determine to learn and comprehend what is spoken or read in the class setting. According to Patterson et al. (2020), asking students to offer separate sections on the explanation of strategy and justification draws attention to this crucial distinction. It shows their comprehension of justification.

Numeracy

For several years, there has been a significant gap between the mathematical needs of academic work and the mathematical demands of the actual world. According to the State of Victoria (2021), the challenge for math educators center on how to effectively incorporate numeracy as an integral part of their teaching considering the disconnect that exists between the mathematics taught in schools and the mathematics used in the real world, which includes the career settings. According to Tout (2020), numeracy is a skill that must be specifically taught; leaving it up to providence will not ensure a successful outcome. Hogan (2000, as cited in Scott 2016) further states that to be numerate in each circumstance, an individual needs three distinctive categories of knowledge: mathematical, contextual, and strategic. The Numeracy Framework, developed by Hogan (2000, as cited in Thorton & Hogan, 2004), was presented to the educators strategically. Hogan and Thorton (2004) go on to say that "this framework explains that numeracy requires a combination of the three types of knowledge, as follows:

1. *Mathematical knowledge*-defined as the abilities, techniques, and concepts essential to solving quantitative problems that one encounters in a real-world setting;
2. *Contextual knowledg*e-defined as the awareness and knowledge of how the context impacted the mathematics that was employed; and
3. *Strategic knowledge* is defined as having the confidence, disposition, and skills necessary to determine what must be known to act "numerately".

Understanding mathematical content enables one to grasp the surroundings and efficiently cultivates mental discipline. It promotes univariate linear, critical analysis, creative thought, problem-solving skills, and effective interpersonal capabilities. Yet, the anxiety many have regarding the subject is unsettling. According to Blazer (2011) approximately 93 percent of Americans report some level of math anxiety. Math anxiety is defined as a feeling of tension and apprehension that interferes with math performance ability, the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations (Khasawneh et al., 2021). Overcoming self-diagnosed fear of mathematics is essential to student success both academically and professionally.

Students must have a strong foundation by which they can build their math content knowledge, or they will struggle continuously to understand the content. Math is a self-building language, and failure to understand its foundations is comparable to not understanding the structure of a language (Venezky, 2018). Mahanta (2019) stated that one of the most common problems while learning math is that students lack an understanding of the basic concepts. The lack of a proper analytical skill set makes it more difficult for students to compete internationally against peers. Balingit and Van Dam (2019) state the U.S. students are in trouble when it comes to how they perform in math relative to their international peers. One concern cited by researchers is that classes in the US frequently emphasize formulae and procedures rather than educating students to think creatively about solving complex problems (Richards & USA Today, 2020). To aide in the acquisition and retention of mathematical concepts, additional research will focus on the learning tools that encompass note-taking.

Note-taking and Student Achievement

Note-taking is in intricate part of the learning process. Notes are taken with the aim of a deeper understanding, long term learning and reviewing previous knowledge as well, and note-taking is applied in various fields of life such as daily life and professional life. When students actively listen and write down important information, it allows them to cognitively process it, which in turn allows them to better understand the information that they are learning (Salame & Thompson, 2020).

Note-taking is common for many reasons, including studying, memorizing material, and keeping a record of what happened (Soraya & Chen, 2022). Taking notes during lectures is widely recognized as an effective learning strategy. According to Blackbourn (2018), taking detailed notes can help you remember and comprehend what you have learned. Taking notes can be taxing but beneficial at the same time. One benefit of taking adequate notes is that it facilitates students' ability to examine previously acquired knowledge later to preserve such knowledge better. Taking notes involves writing down information gathered from an instructional source through reading, an oral discussion, or a lecture in a strategic manner to aide in understanding. As stated by Karabulut and Baran (2021), students can benefit from learning strategic note-taking. Students can benefit from strategic note-taking since it offers a structured approach to learning and can lead to higher academic achievement (Salame & Thompson, 2020). Taking notes strategically entails listening and thinking and writing down what has have heard and processed.

While note-taking is not new, the methods or strategies in which students take notes are ever-changing. For many college students, note-taking is instinctive. Students at the collegiate level spend much of the instructional experience compiling notes based on the context of in-class discussions. Students are often exposed to various alternatives while taking notes, ranging from overall note-taking methods to tools utilized for recording information to tactics for making notes of individual pieces of information (Siegel, 2022). As stated by Salame and Thompson (2020), students who take poor notes are more likely to struggle in courses and their course performance might suffer. Strategic and extensive note-taking improves students learning as well as achievement in a class. Cunff (2020) says that research shows that taking notes on what you read helps you remember it better. The ability to recall information more swiftly happens because the effort required to take notes allows one's brain to create new connections and transmits the information in such a way that helps students recall it more effectively over time. Students who do not take good notes miss out on much information pertinent to the learning process. Students can be active participants in the learning process when they take notes.

The University of Massachusetts Dartmouth (2020) implied that taking notes encourages you to focus on the content conveyed. It improves one's intelligence. Studies on learning have shown that listening to something and then writing a summary of what one has heard helps one understand and remember it later. "In general, taking notes serves two purposes: First, taking notes can help you take in and understand what you hear and see. The idea behind this is that when we take notes, we actively listen to a lecture or class, which helps us understand what is said. The second purpose is that learners are able reference their notes and incorporate them to study in their study sessions" (Nordmann et.al, 2019).

Graphic Organizers and Student Use

The use of graphic organizers can be of great use to both the students and the teachers who employ them. It not only makes the teaching and learning process more interesting and interactive for everyone, but it also makes it easier to teach and learn. According to Tureniyazova (2019), graphic organizers make it easier to assimilate textual information due to the information is presented visually. Students also benefit from the critical intellectual guardrails provided by visual organizers. There is a need for additional knowledge about student involvement, cognitive effect, and student understanding, as these are three essential components of the learning process. This is necessary to grasp the relevance of the function that graphic organizers play in education.

Students could facilitate their own learning by making use of graphic organizers that their teachers have created. According to Wise and Cooper (2019), graphic organizers equip students with the ability to discover patterns and compare perspectives, provide students with a mechanism to categorize large volumes of information, and introduce a more sophisticated lens through which to examine complex texts. In addition, graphic organizers provide students with a means to organize large amounts of information. In addition to this, they make it possible for students to organize enormous quantities of data into smaller, more comprehensible, and digestible portions. Students are provided with a viable method for organizing their thoughts, ideas, and questions, as well as more time for the application of skills they are developing. In addition, graphic organizers equip students with the ability to discover patterns and compare perspectives; they also provide a mechanism to categorize large volumes of information; introduce a more sophisticated perspective through which to examine complicated texts; and provide students with a means to compare perspectives. When there is a huge amount of information to work with in a small amount of time, they make it easier to understand the knowledge that is being worked with.

In addition to assisting students in better conceptualizing concepts, graphic organizers also provide students with a way through which they may vocalize their learning. Because graphic organizers may be considered as communication instruments, students are provided with the opportunity to do so. Depending on the kind of organizer that is used, it may be possible to illustrate not just the structure or arrangement of the concepts but also the links between the concepts. The cognitive demands placed on students are lessened when the information being studied is presented in certain arrangements that represent its structure. Students that make successful use of visual organizers have a reduced amount of semantic content that they need to absorb to comprehend the information. Students with and without learning difficulties alike can make effective use of graphic organizers for a variety of reasons, and this is one of the primary reasons why.

Students' (a) mastery of the topic, (b) thinking abilities such as the ability to structure information, and (c) certain mental habits such as inventiveness and devotion to quality can all be evaluated using graphic organizers, which can be a highly powerful tool (Traina, 2008). To get the most out of graphic organizers, educators should show them in advance of a new topic or learning sequence and at a higher level of abstraction than the learning that comes after them. This will maximize effectiveness (Reference). Despite this, "Graphic organizers can be utilized prior to a lesson to activate prior information, direct thinking, and develop vocabulary." [Citation needed] Using the visual organizer during a lesson can assist students in organizing information and maintaining their attention on the subject matter being covered. When used at the end of a lesson, the graphic organizer gives students the opportunity to check or reconsider prior information as well as tie newly learned concepts to previously covered material (Graphic organizers, n.d.).

Students can use organizers to classify, clarify, or condense relevant information. Organizers can help students improve their theoretical comprehension by guiding them through a process that investigates the links between diverse academic topics. Students need to be guided in the process of categorizing significant concepts by well-designed graphic organizers. These organizers should also reveal the interconnections between ideas and assist students in the construction of knowledge. According to Ausubel (1963), who is referenced in Alfares (2019), who felt that the ways employed by teachers to portray information might encourage learning; an appropriate organizer can allow students to build linkages between new knowledge and what they have previously acquired; Alfares (2019).

According to Ciascai (2009, page 1), the following are, in essence, the functions that graphic organizers provide in the process of education:

- “Clarifying knowledge and reasoning. The purpose of graphic organizers is to clarify the connections and relationships between various ideas. There are graphic organizers that organize information into categories, making it easier to define the many concepts being discussed. In addition, the knowledge is efficiently supported by the process of thinking thanks to the visual organization of the information.

- Improving the way in which students acquire knowledge. The process of filling out a graphic organizer is a complicated one that requires one to select regarding which graphic organizer is the best fit for the particular kind of knowledge and cognitive processes that are being considered. This decision necessitates the selection of the appropriate body of information, as well as the analysis of the strategy, as well as the preliminary, intermediate, and ultimate results. This kind of work with knowledge adds to the improvement of education in terms of students' learning comprehension and their ability to think critically.
- Incorporating the newly acquired information into the existing framework of prior knowledge A superior learning process is achieved when the new information is associated with the information that the learner already possesses.
- Locating the conceptual flaws in the argument (and misconceptions). The conceptual and perceptual errors are revealed to both the instructor and the student when a graphic organizer is filled out. Therefore, both the instructor and the student may move forward with the necessary adjustments.

Students at all grade levels can benefit from using graphic organizers as a learning resource because of their many advantages. According to Abdul-Majeed (2016, which is cited in Oladimeji, 2022), the use of graphic organizers motivates students when it comes to writing. He also maintained that the visual representation of graphic organizers provides learners with a structural framework and the actual information they are to learn.

According to Ajayi and Lawani's (2015) definition, mathematics education is the process of teaching and learning mathematics in a way that focuses on the solution of problems through the acquisition of knowledge of the algorithms and formulae required for computations. The Commission on Higher Education designed initiatives at the beginning of the K-12 educational reform to provide a seamless transition for students who were graduating from elementary school and moving on to secondary school (Wenceslao, 2022, p. 192). Although preparations were made, a disparity was discovered between the instructional methods used at the university level and those to which students had become used to in their time in grades kindergarten through twelve.

At the elementary, middle, and high school levels, educators and other staff members actively watch students, providing direction and instruction as required. On the other hand, by the time students reach the university level, they are expected to take responsibility for their activities even though there is very little control from either teachers or administration. It was presumed that students had some level of prior knowledge. For some students, the ability to navigate a lifestyle in which they are in complete control of their destinies may be overwhelming, which might compound the fact that they are not academically well prepared for college life. Subtle adjustments such as these may not seem significant in principle; however, for some students, the ability to do so might be significant.

Oladimeji (2022) discovered that teaching students with intellectual disabilities social skills with the assistance of graphic organizers led to improvements in those students' social abilities. Students who struggle academically benefit significantly from using visual organizers in the classroom, as this allows them to understand better the material covered (Lopez & Campoverde, 2018). According to Muflih (2018, page 13), the use of visual organization in the resource rooms by the teachers helps to organize the ideas and meanings contained in the unit. When combined with robust and direct instruction of mathematical concepts, graphic organizers may provide a bridge between constructivist approaches to teaching mathematics and the more direct instruction required for some students with disabilities, particularly autism spectrum disorders. These students require more direct instruction because constructivist approaches to teaching mathematics do not adequately address their needs (Flores et al., 2013, as cited in Delisio et al., 2018).

Graphic Organizers and Student Engagement

Graphic Organizers are valuable tools that can improve students' ability to think critically and foster meaningful learning in the classroom. Research provides evidence that improved achievement outcomes in writing performance among students in early childhood education and undergraduate teaching competency (Rokhaniyah, 2019). A graphic organizer is a tool that can assist in organizing and expanding one's thinking skills and processes. It is essential to carry out the implementation of a graphic organizer to determine effectiveness. Whether or not and to what extent a graphic organizer can enhance the college student's ability to generate ideas may also be utilized to identify the climate of the classroom when graphic organizers are in use. Employing visual organizers paves the way for students to achieve a more profound comprehension of the material (Wise & Cooper, 2019). Students can break down complex ideas or concepts into more manageable and readily understood illustrations using the visual representations provided in the lesson plans. Wise and Cooper (2019) further state that this visual learning device has several significant advantages, one of which is its capability to assist students with learning impairments in their academic pursuits.

Utilizing graphic organizers is a typical strategy employed to minimize unimportant cognitive burdens. (Robillos, 2021) Using graphic organizers allow for the cultivation of various cognitive abilities, including critical analysis, reflection, brainstorming, idea production, and the organization and prioritization of content. The student's active learning ability should improve due to their exposure to the numerous learning aids. These visual representations not only aid in the retention and recall of concepts and the relationships between them but also function as visual signals.

One strategy for aiding these mental processes is to present a graphic organizer alongside the document, outlining the key points and connections of the text. To ensure that students are actively engaged in these processes, it is possible to ask them to generate an organizer on their own (Colliot & Jamet, 2018). According to Wang et al. (2021), interactive graphic organizers were the most popular choice among middle school students because they allowed students to participate in more integrative cognitive processes, leading to more profound learning outcomes and improved learning experiences. Students' cognitive engagement can increase by using visual organizers in the classroom. Additionally, students may have the opportunity to build learning maps uniquely suited to their styles of instruction. When a large amount of information needs to be processed in a short amount of time, using visual organizers can help with comprehension (Praveen & Rajan, 2013, as cited in Imsa-ard, 2022).

Even if they are advantageous to the learning process, graphic organizers can sometimes have the opposite of the intended effect on the learning process. When used excessively, they have the potential to limit students' thinking to nothing more than merely filling in the boxes or diagrams. By using this changed mental process, students can sidestep the messy but crucial labor of surfacing key insights or conceptual comprehension. They also have the potential to alter the level of student involvement. Therefore, when determining the academic demands of students through the utilization of graphic organizers, attention must be given to the engagement side of the equation.

According to research, students who use graphic organizers demonstrate an improved ability to connect with and comprehend the material. According to Gallavan and Kottler (2007, cited in Mann, 2014), the use of graphic organizers helps students' motivation, short-term recall, and long-term accomplishment. The ability to recall can occur by enabling students to synthesize, manipulate, and manage the intricate social studies curriculum. According to Robillos (2021), the use of graphic organizers helps students have a higher level of engagement in generating ideas and information because it sparks their interest in the background information required for organizing and developing the content of a topic's presentation. A learner can comprehensively grasp his thoughts in his head when he writes down his thoughts visually or graphically through the process of diagramming and mapping. It allows the learner to have a better understanding of his concepts. Because of this, a learner will be able to differentiate between necessary and unneeded ideas, and errors will have the opportunity to be rectified.

Understanding the engagement implications of different note-taking practices should help students achieve extraordinary academic performance. It is because class participation connects to more in-depth cognitive processing (Shell et al., 2021, p. 6). Student engagement is a term used in education to describe the extent to which students pay attention, are curious, are interested, are optimistic, and are passionate about what they are learning or receiving. This attention, curiosity, interest, optimism, and passion extend to the extent to which students are motivated to learn and advance in their education (Great Schools Partnership, 2016). A more hands-on method of education may occur through the utilization of graphic organizers. When incorporated into the lesson, these technologies allow students to participate actively and contribute to their learning process. Both the design of the graphical organizers and the act of arranging content activate different areas of the brain, specifically the creative and logical parts (Professional Learning Board, n.d.) When done as a group exercise, it also contributes to developing healthy team dynamics.

In addition, Kanszolu (2017) found that graphic organizers significantly impacted students' academic attainment than conventional methods of instruction. Graphic organizers are beneficial in all subject areas. They can be used to instruct students on various topics, including cause and effect, taking notes, comparing and contrasting ideas, and organizational abilities. Graphic organizers allow the instructor and students to understand the subject matter clearly. Traditional graphic organizers can be just as helpful in boosting student performance as technology-driven graphic organizers may be. It is because they help teach the acquisition and development of social skills.

Graphic Organizers and Mathematics Education

Students frequently regard mathematics as one of the topics presenting the most significant amount of difficulty. According to Richards and USA Today (2020), the most recent results of an international exam given to teens rated the United States of America ninth in reading and 3^{1s}t in math literacy out of 79 countries and economies. This ranking stems from the results of the test given to teenagers. The ranking is a result, in part, of the inconsistencies that occur due to the lack of mathematical knowledge that students possess. According to Rittle-Johnson (2017), having a solid foundation in mathematics is essential for success in school, the workforce, and life in general; however, many youngsters do not acquire the skills necessary to become effective in mathematics. Mathematics is a fantastic instrument for establishing mental discipline because it encourages logical reasoning and mental rigor. Doing so in a way that is both entertaining and effective is a great way to achieve it. Having a solid foundation in mathematics is essential to comprehending the material covered in various other academic disciplines, including the social sciences, natural sciences, and even the arts, such as music and theater (International Math Union,2022).

Schudde and Keisler (2019), found that over fifty percent of community college students do not fulfill college-readiness standards in mathematics. Students' inability to complete the academic standards of traditional math courses has led to increased placements in developmental math courses. A college preparedness test in the state of Mississippi determined that just about 18 percent of grade 11 public high school students at the time possessed the skills needed for success in college mathematics (Davis & Koon, 2019). Conley (2007) explains that college readiness is the amount of preparation a student must have to enroll in and succeed in a credit-bearing general education course at a university or community college without remediation. Studies indicate that even when students enroll in college-level math courses, such as College Algebra, they struggle to complete them due to their low arithmetic skills (New study seeks remedies for poor math performance in community colleges, 2017).

The successful completion of college-level mathematics courses such as College Algebra can serve a dual purpose by serving as a potential indicator of both academic and career success in the years to come. For students of any race or socioeconomic background, the higher the level of mathematics coursework they took in high school, the greater the likelihood that they would go on to get a bachelor's degree after attending college (Cignition, 2020). Math concepts, such as those covered in developmental algebra and collegiate algebra, are notoriously difficult to grasp for a significant number of students. According to Shakerdge's research, approximately fifty percent of students do not successfully complete collegiate algebra with a grade of C or higher (2021).

According to the blog (2020), College Algebra has the highest failure rate of any course, with around half of all students failing the course with a grade of D, F, incomplete, or dropping altogether. According to the data that has been collected, the most important obstacle that stands in the way of Americans completing degrees in STEM and non-STEM industries is their difficulty with arithmetic. Math students frequently do poorly because they are unable to comprehend how to analyze the information provided. Ozkan and Kettler (2022) propose that students can achieve specific learning goals, configure newly acquired knowledge, build self-management and self-confidence skills by participating in hands-on activities, interactive conversations, autonomous work, and cooperation as part of the STEM process. In the process of finishing their projects, students not only acquire research skills but also develop their relationships with both their classmates and the adults in their lives, and they work together in groups to experience the good impacts of their efforts.

Graphic organizers are a type of visual communication tool, makes use of visual symbols to convey meaning by expressing ideas and concepts. Students are given the opportunity to visually digest knowledge in a way that is organized, clear, and manageable by using graphic organizers. This, in the long term, will aid in the retention of information. Graphic organizers can be traced back to David Ausubel's, "Meaningful Learning Theory". Advance organizers, which were made popular by the psychologist David Ausubel, give the conceptual framework that is necessary for the assimilation and retention of new knowledge.

Graphic organizers are described as "a visual representation of knowledge, a technique of structuring information, and of grouping significant parts of a concept or topic into a pattern using labels," according to Egan (1999, as referenced in Alfares, 2019). Graphic organizers are a research-based tool that are always being improved upon, even though they have been utilized as a resource in classrooms across the board in all fields of education for approximately forty years. Graphic organizers, depending on how they are implemented, have the potential to mold the structure in which new information is presented and can have either a positive or negative impact on learning, depending on how relatable they are to the material that is presented in the classroom by the instructors. Despite this, graphic organizers are a versatile component of the learning process since they assist students in visually conceptualizing what they are learning.

According to Wise (2022), visual arrangement of information, such as when it is given through use of graphic organizers, helps make the material more concrete for students, making it easier for them to absorb and recall. Visual and verbal learning can be brought together in a graphic organizer. Students become more involved and immersed in the learning process because of both verbal and visual processing, and as a result, their retention rates increase (Sousa, 2016, p.157). This merging of concepts improves comprehension and assists candidates for teaching jobs in developing constructive evaluation processes. The process of visually representing information can be an extremely helpful strategy for those who struggle with learning.

Muflih (2018, page 13), suggests the use of visual organizations by the teachers of the resource rooms helps to organize the ideas and meanings contained in the unit by organizing the knowledge of students with learning disabilities and deepening their understanding of the subject material. This is because it reflects the visual logical, psychological, and cognitive structure, and it includes a series of popular steps. In addition, it helps to organize the knowledge of students with learning disabilities, which in turn helps to organize the ideas and meanings contained in the graphic organizers help users visualize the relationship between various pieces by using a variety of colorful shapes, symbols, and connectors. Students shift the intellectual responsibility by asking students to design their own visual representation, which is made possible via the use of graphic organizers (Wise & Cooper 2019).

It is important to equip students with learning methods and tools for independent, active learning rather than giving them ready material for memorization to raise a generation that is capable of critical thinking, making decisions quickly, and finding a way out in critical life situations. This is because it is important to raise a generation that can think critically, make decisions quickly, and find a way out in critical life situations (Tureniyazova, 2018). To accomplish this pedagogical task, effective learning technologies are required. These technologies must instill in the learner the ability to analyze the educational information that is received (from the teacher, from the textbook, from the Internet), to extract from the total amount of information the necessary and reliable piece, and to teach how to use the information found to solve specific problems.

Interactive Notebooks

The purpose of interactive notebooks is for professors to provide students with various materials, such as notes, information, or other helpful content. Students can receive a variety of visuals to help them better understand the concepts they are studying in class. They can also participate in engaging activities if they use an interactive notebook. The students have two options: either formulate their understanding of it, or they can incorporate it into their thought processes in a way that enables them to understand it. After that, the students may demonstrate their knowledge and comprehension of the content by producing a product. The student can fulfill this outcome by addressing any identified subgroups that make up the theory of multiple intelligences developed by Howard Gardner.

According to Gordon (2017), Gardner detailed a more complex paradigm in which human intelligence consists of eight relatively autonomous intellectual capacities. These intellectual capacities include logical-mathematical, musical, linguistic, bodily-kinesthetic, spatial, interpersonal, intrapersonal, and naturalist intelligence. Interactive notebooks are excellent for involving all students in the learning process since they cater to all the various bits of intelligence recognized. Incorporating interactive notebooks and foldables into the learning process is an effective method that may authentically engage the intelligence already present in students.

Students can draw connections prior to beginning new learning, modify their ideas, and expand their understanding of the world around them by using a tool called an interactive notebook. It is the culmination of a student's effort over the school year that demonstrates both the subject that was studied (the input) and the reflective knowledge obtained (the output) (Marcarelli, 2010). In the 1970s, a teacher named Lee Swenson from California began using what would later be known as the interactive student notebook with the assistance of his fellow social studies educators (Mallozzi, 2012). The interactive notebook is like a composition or spiral-bound notebook but has more features than just a place to take notes. Students can develop knowledge and skill connections according to their preferred method of learning, and interactive notebooks allow them to demonstrate that learning in a manner that is unique to them (Neely, 2019).

Foldables are multi-dimensional graphic organizers that can be used for skills reinforcement, practice, and/or information organizing (Zikes, 2003). There are several advantages to employing interactive notebooks, graphic organizers, or foldable in the learning process. These advantages include, according to the research presented by Zikes (2003), the graphic organizers should be used to:

- "Efficiently organize, show, and arrange information to make it simpler for students to comprehend mathematical concepts and become proficient in related abilities.
- lead to the creation of study guides by the students themselves. These guides compile as students work through new concepts and procedures, listening for main ideas, reading for main ideas, and working their way through the material.

- as an alternative to the conventional poster board or math fair formats, give students various imaginative frameworks within which they can show their ideas, research, and computations.
- have students take over the task of writing on photocopied pages or replacing writing done by the teacher.
- incorporate the application of abilities such as comparing, understanding cause and effect, and finding similarities and differences in daily work and projects that will last longer. For instance, one might use these foldables to compare individual students' explanations and strategies to solve problems with the explanations that other students and teachers offer.
- continue to "immerse" students in previously learned words and concepts, providing them with a solid foundation upon which they can develop by adding new observations, experiences, and knowledge. It allows students and teachers to quickly communicate data through graphs, tables, charts, models, and diagrams, including Venn diagrams. Either group can utilize this functionality.
- allow students to create their math journals in which they can write the primary ideas, problem-solving strategies, examples, questions during classwork, and personal experiences that arise throughout learning.
- give students have the potential to serve as alternate assessment tools that the instructors can use to evaluate the development of students or that the students themselves can use to evaluate their progress.

- include the study of mathematics and the humanities, natural sciences, and social sciences.
- equip students with a sense of responsibility for the mathematical content of the curriculum".

According to West (n.d.), the literature on brain research, multiple intelligences, and note-taking all support the classroom use of interactive notebooks. Interactive notebooks mirror the brain's information processing, so they can help students better retain the information they are learning (Fajardo et al., 2019). Students can spend more time digesting and consolidating their knowledge, leading to higher academic accomplishment. This is made possible through interactive notebooks, which reduce the time spent on direct instruction (Halverson, 2021). According to Wilson (2015), using resources such as interactive notebooks in conjunction with such critical thinking practices enables students to draw from their store of creative potential to acquire knowledge in a coherent, consistent, and significant way to them.

Summary

More research is needed to further understand students' comprehension of mathematics at the post-secondary level when using notes to aide in the learning process. The problems facing college level students in mathematics are certainly bigger than any one person, institution, or company. Many strategies and programs have been implemented to aid in the math deficit. It is what happens once students are in the classroom setting that remains troublesome. Although developmental class were enacted to alleviate the disproportionate number of students not fully prepared to tackle college math, little has changed in the completion and success rate.

As stated by Hodara (2013), a fundamental difficulty students face today when seeking a post-secondary degree is a lack of academic readiness for college-level arithmetic, as indicated by high referral rates for developmental math and poor college math completion rates, especially at 2-year institutions. When Bailey, Jeong, and Cho (2010) looked at referrals to developmental education by topic, they discovered that 59 percent of entering community college students enrolled in developmental math. In contrast, only 33 percent enrolled in developmental English. One must speculate why the discrepancy between the two fields is so drastic.

CHAPTER III – METHODOLOGY

The purpose of this study is to investigate the impact of graphic organizers on post-secondary math students' abilities to solve univariate linear equations. It will focus on how teaching metacognitive strategies using graphic organizers like the Frayer Model (as shown in figure 3.1) to college students can benefit the students' academic performance in College Algebra.

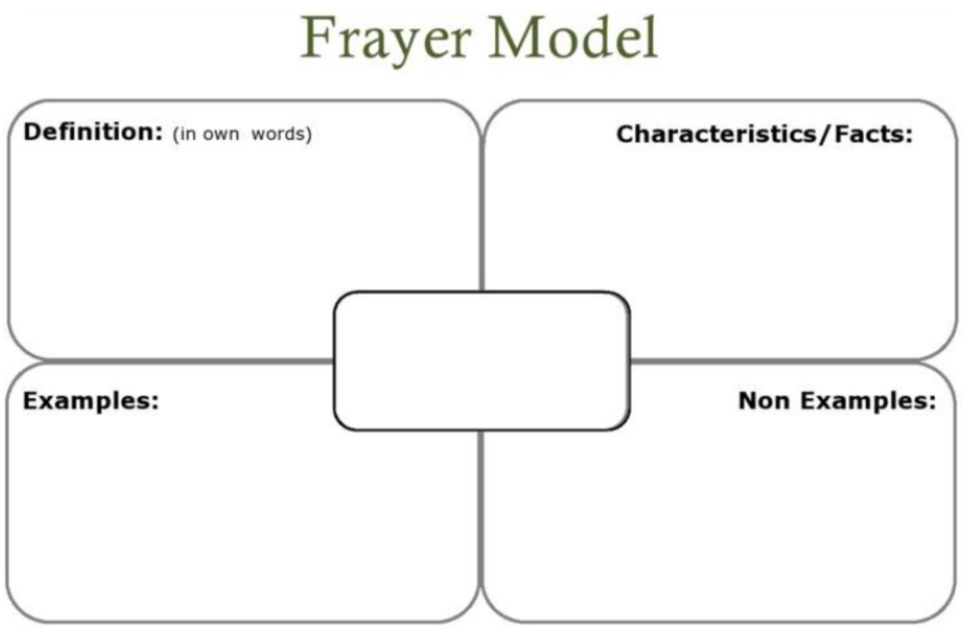


Figure 3.1 *Frayer Model Example*

The study will compare the performance of students who use guided interactive graphic organizers to solve univariate linear equations during class and those who do not. This chapter will detail the research setting, the participants, the instruments, procedures to collect data, and the planned analyses.

Methodology Selected

This quantitative study uses inferential statistics to analyze the data under the principles of experimental research. According to Taber (2019), experimental studies are frequently used to evaluate the efficacy of new pedagogical approaches, curricula, or learning tools developed for the classroom. An excellent experimental design guides the study's methodology, illuminating for the reader more precisely how the data were collected and, as a result, facilitating the reader's ability to perform an appropriate analysis of the findings (Knight, 2010).

Theory of Meaningful Learning

According to the hypothesis put forth by Ausubel, for individuals to acquire new information in a way that is useful to them, they must make connections between that information and relevant concepts that they already possess. The new information needs to engage with the learner's existing knowledge framework. Students are significantly more likely to retain information if they are engaged in meaningful learning experiences (Primary Paradise, 2021). "Recognizing how new material connects with previous knowledge and "makes sense" gives considerably more gratifying intrinsic motivation, an essential component of meaningful learning. In addition, when learning is an essential part of some action and contributes to directing and elucidating the activity, there is typically a higher level of good emotion (Bretz, 2001). She explained that Ausubel had stated that meaningful learning necessitates three components, and she used Figure 3.2 to illustrate how this differs from rote learning.

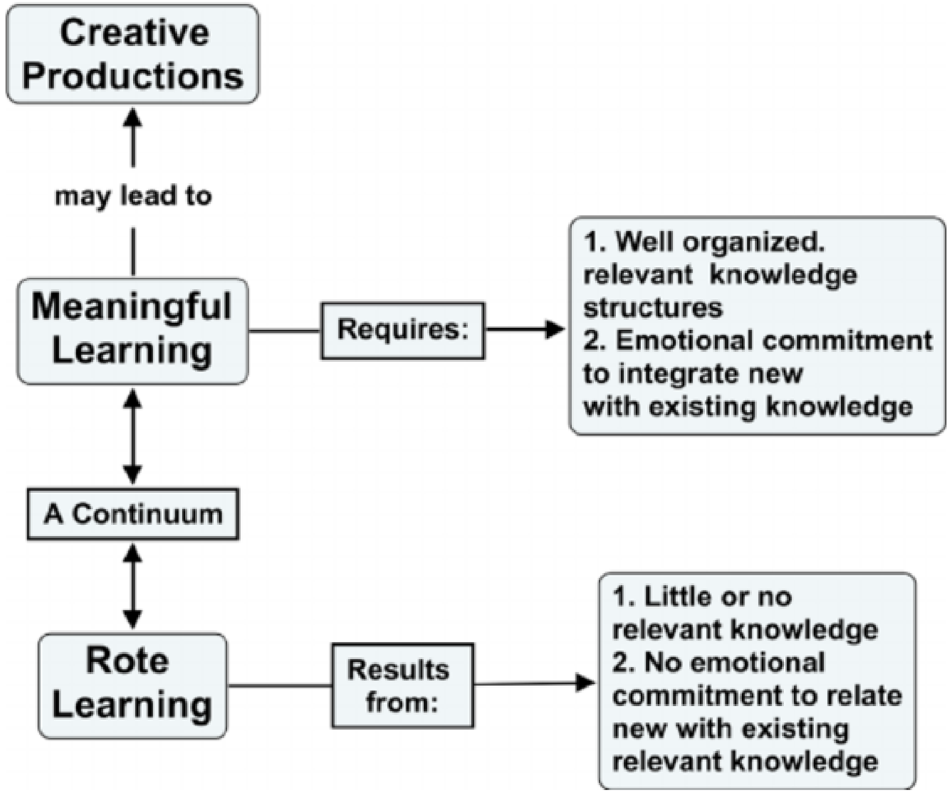


Figure 3.2 *The Rote-Meaningful Learning (Novak & Cañas, 2006).*

According to Arden (2021), a practical teaching approach must possess all five of the following characteristics to be considered meaningful learning: active, collaborative, authentic, and goal-focused. She gives the following descriptions of each:

- Students engage in active learning when they use technology independently and consistently or when they are self-directed.
- Students work together in groups to accomplish tasks utilizing traditional forms of digital technology as part of collaborative learning.
- The utilization of various forms of modern technology to construct new information on top of previously gained knowledge is at the heart of the constructive learning approach.

- Using digital tools to connect activities outside the traditional classroom is required for authentic learning.
- To complete homework assignments, goal-directed learning integrates activities and goals into supervised tasks.

Research Design

This study will be carried out at a higher education institution located in the Southeastern part of the United States that offers both developmental and traditional students enrolled in post-secondary math courses. In this study, the independent variable will be the note-taking method. The dependent variable is defined as students' performance on the post-test. Students will be placed in either a control group or a treatment group and will receive similar instruction with the note-taking method used during instruction serving as the differentiation. Students who are in the control group will not receive graphic organizers as an instructional learning aid. Students who are in the experimental group will receive graphic organizers to aid in understanding and will be classified as guided learners.

Guided learning is a process in which learners initiate and advance their learning with the assistance of more experienced partners and socially derived sources such as tools, text, or other artifacts (Billet, 2012). This frequently takes the form of the traditional classroom, in which a teacher instructs or facilitates education through projects, laboratories, or group learning. In addition, guided learning can include a student using learning aids like graphic organizers in collaboration with a teacher to learn about a topic. The Statistical Package for the Social Sciences (SPSS) will be used to compare the graphic organizer group and the independent learning group's test scores on univariate linear equations to determine if the graphic organizer group had a better understanding of solving univariate linear equations.

A pre-test of short answer questions will be administered to both groups of students prior to the implementation of graphic organizers. The cores earned by all students will be used to calculate a mean score for future comparison. During the first instructional unit, students will be asked to answer content related questions prior to receiving instruction from the teacher. this unit will last two weeks and cover the follow topics: Combining like terms, solving univariate linear equations with integer coefficients, and solving univariate linear equations with rational number coefficients and binomial numerators. At the end of the unit, a post-test will be given to both the experimental group and the control group to assess students' learning and capture differences. Data will be collected to measure growth in both groups.

Participants

The participants will be community college students enrolled in College Algebra and include traditional and non-traditional students. The community college is a public institution in the Southeastern United States and has six campuses spread across five counties. The researcher is a mathematics instructor at one of the six campuses and the students in her courses will be the participant pool. Participants will be asked to volunteer for the study with no penalty and no extra credit or grades distributed. The only requirement is that students be enrolled in the non-traditional College Algebra course during the study. Both College Algebra students in the control group and experimental group received traditional instruction covering the process of solving. univariate linear equations. In addition, the control group will use their own note-taking method while the treatment group will use teacher generated graphic organizer(s) for note-taking.

The non-traditional College-Algebra course is arranged in a co-requisite instructional format. Students enrolled in the course are students who demonstrated a lack of preparation for the traditional 3 hours College Algebra course. College Algebra prerequisites differ slightly: MAT 1234 (or MAT 1133 or MAT 1134 with a “C” or higher, or ACT® Math sub-score of 17-18, or ACCUPLACER Math score of 59-75, or Next-Generation ACCUPLACER Math score of 250-262). Inequalities; functions; linear and quadratic equations, circles, and their graphs; univariate linear, radical, and higher-order equations; applications; polynomial and univariate linear functions; logarithmic and exponential functions; and systems of equations are all covered in this course.

Instrumentation

The primary data collection instrument will be pre-and post-test assessments (Appendix B). The pre-assessment created by mathematics teachers at the college will consist of 20 questions. Eight of the 20 questions will assess student understanding of terminology. Combining like terms will be the focus of questions nine and ten, which are skills used throughout the remainder of the assessment. Questions 11 through 15encompass distributing constants on at least one side of the equation. Questions 16 through 20 contained questions with rational coefficients.

Prior to implementing guided interactive graphic organizer as the instructional method for teaching equation solving, all participants will take a pre-test. The guided interactive graphic organizer pedagogy will be used throughout the unit of instruction for the experimental group of College Algebra students. Participants will complete three guided interactive graphic organizer entries: Parts of an equation, Terminology, and Steps to solving an equation. The control group will not use guided interactive graphic organizer as a learning aid and will rely on their own note-taking methods. The post-test will be the same as the pre-test and will be administered to the participants at the end of the unit. Participants will be expected to complete the pre-and post-tests to the best of their abilities and provide work to support the solution to each problem. Each item will be scored based on completion requirement, providing partial credit when warranted.

Data Collection

Although qualitative research methods could be used, it was determined quantitative methods, specifically a pre-test-post-test design, would be best to begin this exploratory work. After the post-test, an independent sample t-test will be conducted using SPSS to compare the student groups and their performance. At the end of the unit all participants were given an identical post-test to assess growth. The average mathematics scores participants achieve on the pre-tests will be compared to post test scores from the same participants. Test responses will be analyzed using an independent sample t-test.

Data was obtained from four classes, which I have classified as groups one, two, three, and four, respectively. Group one consisted of 11 traditional and dual enrolled students. The students were enrolled in a night College-Algebra course and represented a portion of the control group. Group two consisted of 17 traditional and dual enrolled students. The students were enrolled in a morning College-Algebra course and represented the remaining participants of the control group, bringing the total number of control group participants to 28. Group three consisted of 20 traditional and dual enrolled students. The students in group three were enrolled in a morning College-Algebra course and represented a portion of the experimental group. Group two consisted of 17 traditional students. The participants in group four were also enrolled in a morning College-Algebra course and represented the remaining participants of the experimental group, bringing the total number of experimental group participants to 40.

Data Analysis

The purpose of this study is to explore the effect of note-taking through use of graphic organizers on participants' performance in College Algebra specifically when solving univariate linear equations. Following data collection, a t-test will be performed using SPSS to answer the study's research question. The class that does not receive graphic organizers will be the independent variable for the question. The dependent variable will be the note-taking strategy used, such as traditional self-regulated notes (non-graphic organizers), graphic organizers, and course classification. Finally, the scores obtained from the pre-test and post-test results will be assessed as the learning criterion. Descriptive statistics (mean, standard deviation, and percentage) and inferential statistics of independent and paired t-test will be used for data analyzing.

Limitations

The statistical community represents a single department within the college, which is a limitation of this study; consequently, it is recommended that future sampling be conducted from a more extensive community. In addition, the research should be carried out with participants enrolled in the conventional three-hour College Algebra course. Another limitation is that the two groups may not be equally balanced because the researcher did not randomly assign students to each group. The two control groups had fewer enrolled students; thus, the sample size was smaller than that of the experimental group.

The study was limited to a Southeastern, public, comprehensive community college. The study results may not be generalized to an institution of a different size, one located in a different geographic location, or one that contains a substantially diverse population in terms of student demographics. To address the study's research questions, a comparison of students who used guided interactive graphic organizers to those who did not was made.

CHAPTER IV – RESULTS

This study assessed whether guided interactive graphic notes had a favorable impact on the academic achievement of mathematics students enrolled in College Algebra at a community college. The study's goal was to discover if the note-taking technique made a substantial impact in enhancing student performance in College Algebra. This was done by comparing the performance of College Algebra students who used interactive guided notes to record material during teaching to the performance of College Algebra students who used their way of note-taking. Students who chose to participate in the research experiment and provided their informed consent were given a test on solving univariate linear equations before and after participating in the project. The study was conducted using SPSS version 29 to determine whether there was a statistically significant difference between the two sets of results. The results of the data analysis are presented in this chapter in the following order: sample population descriptive analysis, inferential statistics, and decisions about the study hypothesis.

Sample Population

The study's overarching question is stated in chapter one: 1. How does the use of guided interactive graphic organizer notes impact College Algebra students' mathematics performance when solving univariate linear equations, as measured by a pre-and post-test? The researcher in this study knew that graphic organizers and interactive notes were valuable instructional resources, so she set out to see whether the two might be combined for an even more significant impact in a college-level mathematics course. To that purpose, she chose a sampling strategy, a suitable device for measurement, a study design, and data collection and analysis techniques.

A convenience sampling method was used to identify students interested in participating in this study. Participants in the study were all college algebra students at a community college in western Mississippi. A substantial number of the participants had dual classification because they were enrolled in community college and the local K–12 school district. Participants consisted of students from four pre-existing college algebra classrooms. Therefore, random assignment was not an issue. During the research phase of the study, in addition to the researcher, two college teachers were given research materials to distribute to participants. Each instructor was responsible for one of the classes representing the control groups. Each of the instructors for the control group has over 20 years of teaching experience and taught mathematics at varying levels of K-12 beginning at the middle school level. The researcher instructed the treatment group, which was comprised of the remaining two classes.

The control group consisted of 16 dual enrolled early college students and 2 traditional students. The experimental group consisted of 36 dual enrolled early college students and 4 traditional students. The control and treatment groups were taught the same objectives using the same instructional platform. The only variation in the lessons taught was the note-taking method used by each group. the control group's lessons and assignments did not include guided interactive graphic organizers, but the students had the option of using teacher generated notes, see Appendix B, or their own note-taking method.

Prior to the beginning of instruction, all participants were given a pre-test. All participants received instruction using the same instructional platform. A post-test was administered at the end of the instruction. The statistical findings from the pre-test for both the control and experimental groups were significantly different. According to the data observed, through a comparison of mean score difference for both groups, using guided interactive graphic organizer notes in college mathematics was useful. As a consequence, the researcher discovered that, while both groups gained, the experimental group gained far more, thus the null hypothesis was rejected.

Strategy

The premise for the study was to examine the influence of note-taking on student achievement when solving univariate linear equations. While the control group was allowed to use any notetaking method, they were comfortable with, they were also provided teacher-generated notes (see Appendix B). The teacher generated notes included mathematical procedures students could use to solve equations. The notes also include multiple example problems that either the teacher or students may use for conveying and understanding information.

Students in the experimental group were required to use the note-taking strategy that included construction, terminology, procedures, and examples as can be seen in Figures 4.1, 4. 2, 4.3, 4.4, and 4.5. It should be noted that the design of the note pages is flexible and may encompass an array of styles. A complete version of a student generated example can be seen in Appendix B.

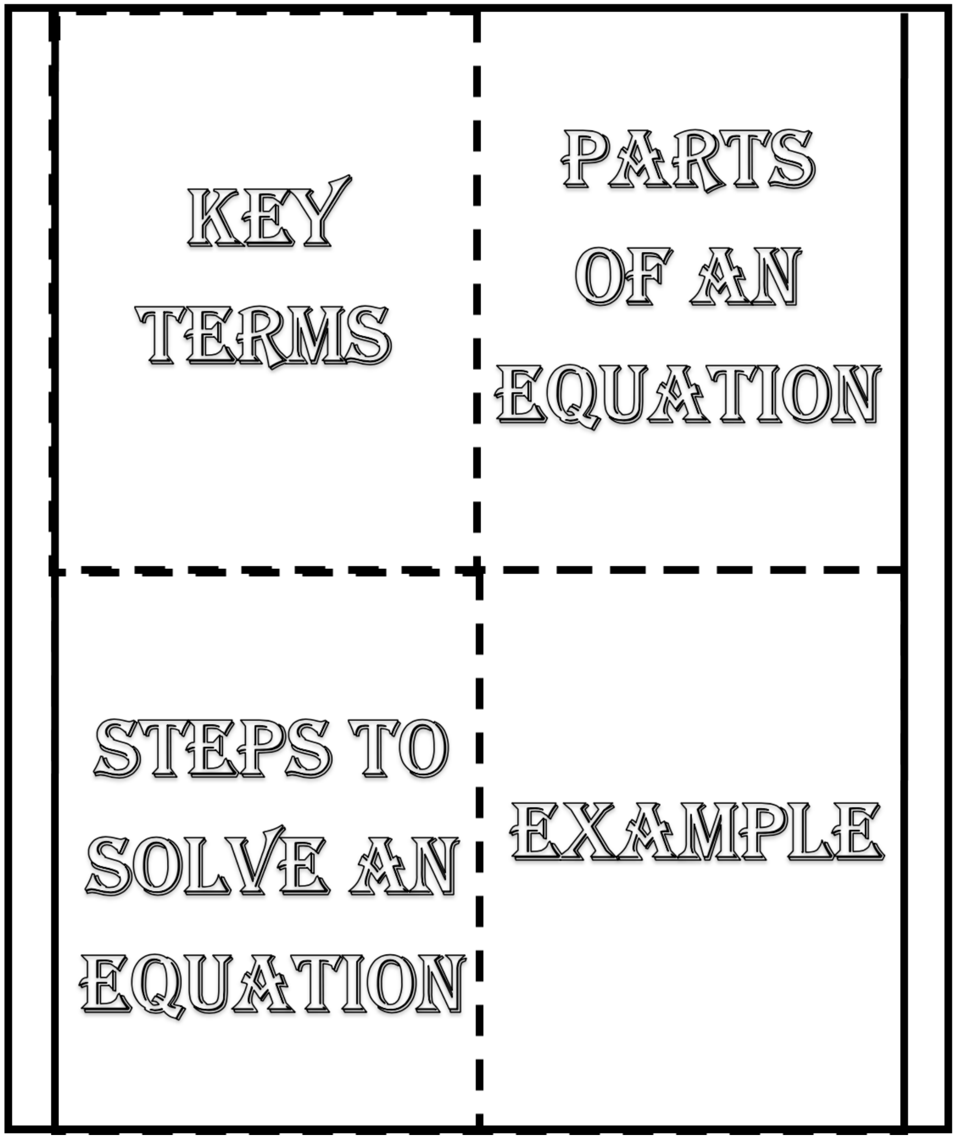


Figure 4.1 *Interactive Notebook Cover Page*

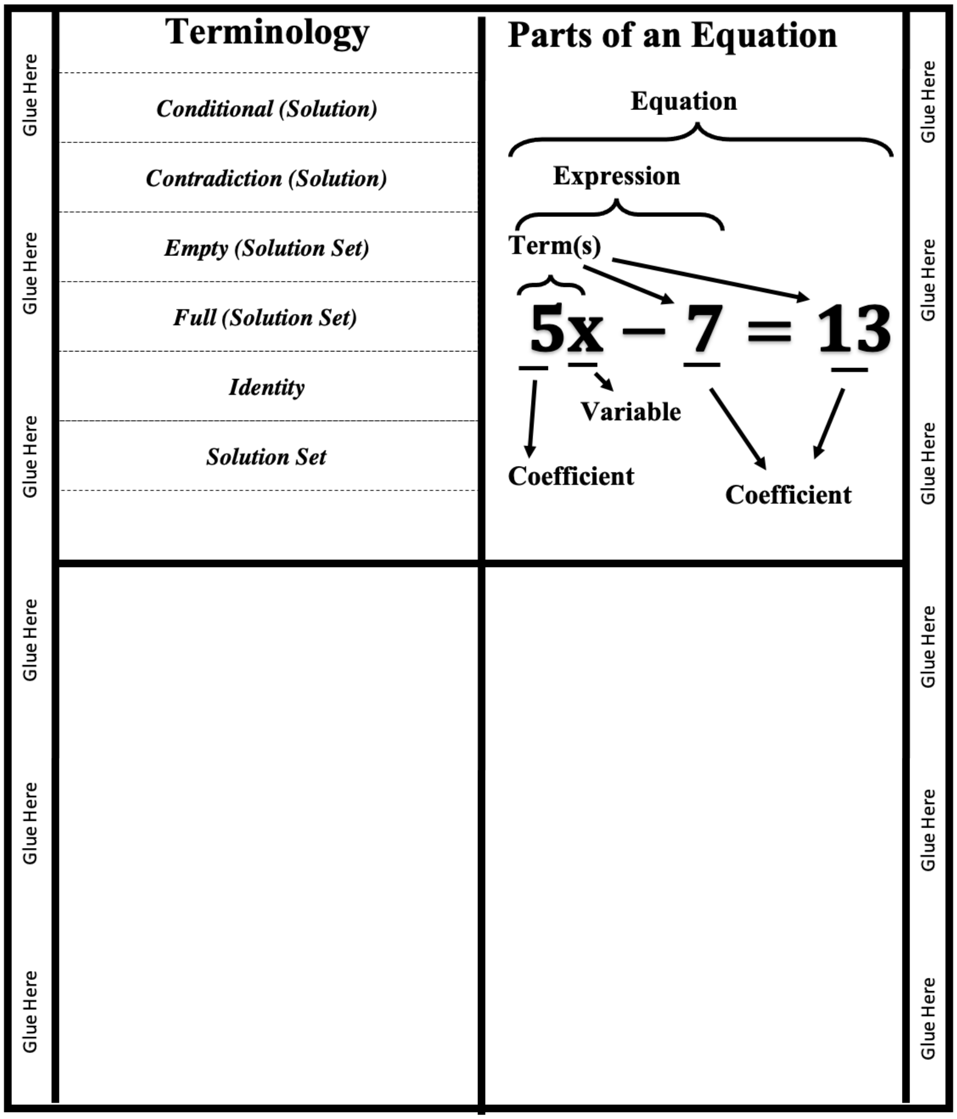


Figure 4.2 *Interactive Note Page Inner Sheet*

Solving Equations Bottom	There are no grouping symbols. Go to the next step	NO
	Each side of the equation is simplified, no terms can be combined. Go to the next step	NO
	The variables are only on one side of the equation. Go to the next step	NO
	The constant values are only on one side of the equation. Go to the next step	NO
	The variable has a coefficient of 1. Go to the next step	NO
	My solution checks in the original equation	YES

Figure 4.3 *Interactive Note Page Procedure Sheet 1*

Middle	**Use the distributive property to multiply the number outside of the parentheses by every term inside of the parentheses:** $5(x^2+2x-4)$ **is the same as** $5x^2+10x-20$ **Or** $-(x-4)$ **is the same as** $-x+4$	YES
	Combine like terms on both side of the equal sign. $6x+3x$ **is the same as** $9x$ $12x^2-7x^2$ **is the same as** $5x^2$	YES
	Combine variable terms by adding the inverse of the term with the smallest coefficient to both sides of the equation. $2x+5=3x-7$ **Add** $-2x$ **to both sides of the equation.**	YES
	Isolate the variable term by moving all constant terms to the opposite side of the equal using additive inverse. $-12=3x+9$ **Add** -9 **to both sides of the equation.**	YES
	Use the multiplicative inverse to reduce the coefficient to 1. $2x=-10$ **Divide both sides by** 2 | $\frac{x}{3}=12$ **Multiply both sides by** 3	YES
	Solution: $x=-6$ **Original Equation:** $4(x+4)=x-2$ $4((-6)+4)=(-6)-2$ $4(-2)=-8$ $-8=-8$	YES

Figure 4.4 *Interactive Note Page Procedure Sheet 2*

Solving Equations	**Look at the equation. Are there any grouping symbols like ( ) or { }?**
	Look at each side if the equation. Are there like terms on the left side? Are there like terms on the right side?
	Do you have variables on both sides of the equal sign?
	Do you have a constant added or subtracted on both sides of the equal sign?
	Does your variable a coefficient other than 1?
	You should have a simple equation in which a variable = a number. Remember to check your solution by substituting the number in the original equation

Figure 4.5 *Interactive Note Page Procedure Sheet 3*

Once students gather all required note pages, they are to begin by cutting along the perforated edges. Once the parts are cut out, students would begin assembling the pages based on the instructions provided by the instructor. Coloring of the pages can take place either prior to or at the end of instruction.

Descriptive Analysis

The invitation was extended to all college algebra students enrolled in an in-person math course. However, there were only three students who declined to take part in the research and were therefore excluded from the analysis. The participants in the study were both traditional and dual enrolled college students. Although, the age range of the participants span several years, students in the 15–19-year-old age group represented approximately 76.47% of the study's participants. The ages of all the participants are listed in Table 4.1. Gender classification of the participants is presented in Table 4.2. Participants who self-identified as male comprised 38.24% of the sample, while individuals who self-identified as female made up 61.76% of the total sample. Table 4.3 displays the ethnicity of the participants.

Table 4.1

Demographic Information for Participants' Age

Demographic Information	Frequency	Percent
15 – 19	52	76.47%
20 – 24	11	16.18%
25 – 29	3	4.41%
30 – 34	2	2.94%
Total	68	100%

Table 4.2

Demographic Information for Participants' Gender

Demographic Information	Frequency	Percent
Male	26	38.24%
Female	42	61.76%
Total	68	100%

Table 4.3

Demographic Information for Participants' Ethnicity

Demographic Information	Frequency	Percent
African American	35	51.47%
Asian	4	5.88%
Caucasian	25	36.76%
Hispanic/Latino	2	2.94%
Other	2	2.94%
Total	68	100%

The sample size for this study was 68. There were 28 students in the control group and 40 students in the experimental group. There was no difference between the number of students who took the pre-tests and post-tests for both groups. The composition of the groups was as follows: 13 males, 15 females, 12 African Americans, 3 Asian Americans, 10 Caucasian Americans, 1 Hispanic Americans, and 2 students who identified as other in the control group and 13 males, 27 females, 23 African Americans, 1 Asian

Americans, 15 Caucasian Americans, 1 Hispanic Americans, and 0 students who identified as other in the experimental group.

The primary source of information for this study was the pre-test and post-test that the 68 people who participated in the research were required to take on the topic of solving univariate linear equations. The research data was supported by the demographic data collected. The subjects in each group are evaluated at two different points in time: before instruction and after instruction. All participants in the experimental group were provided with an identical treatment.

While the control group received the same instruction and access to teacher prepared notes, they were not required to use or take notes as part of the instructional phase. The participants were free to employ the same manner of notetaking throughout the study as they had prior to the study. The treatment provided for the experimental group consisted of introducing and making use of interactive guided notes. The instruction itself provided was not altered and did not encompass information that would yield bias test results. The pre- and post-test administered were scored, and each participant was given a score that ranged from 0 (the lowest possible) to 100 (the highest possible) score. After the completion of each test, a data set was produced for both the control and experimental groups and entered in the SPSS statistical analysis software to allow for further comparisons.

Inferential Statistics

Before the participants were given any kind of instruction on how to solve univariate linear equations, they were given a test in the form of a pre-test so that the researchers could evaluate their prior knowledge. As part of a research project, participants were given a post-test that was the same as before once instruction and treatment had concluded. To establish whether there were any changes that could be attributed to the treatment that was offered, the participants were given the same items on both the pre-test and the post-test. The tests consisted of twenty questions and covered topics such as terminology, combining like terms, solving univariate linear equations, using the distributive property to solve univariate linear equations, and solving univariate linear equations with rational coefficients. Accuracy was measured on a scale from 0 to one 100. The first eight questions tested commonly used terminology for the topic observed. Combining like terms was the focus of Problems nine and ten, which were skills used throughout the remainder of the assessment. Questions 11 through 15 included distributing on at least one side of the equation. Questions 16 through 20 contained questions with rational coefficients.

Scores or the data for each participant on each test were entered into SPSS and descriptive statistics were computed. Scores on the pre-test ranged from zero to 90 and post-test scores ranged from 10 to 85. The control group had a mean of 31.43 with a standard deviation (SD) of 21.032 for the pre-test and a mean of 38.04, with a SD of 19.923 for the post-test. For the experimental group, the mean and SD for the pre-test were 23.50 and 12.669, respectively. The experimental group had a post-test mean of 41.50 with a SD of 21.303. Table 4.4 summarizes basic descriptive statistics for the solving univariate linear equations test for the control group and the experimental groups independently and collectively.

Table 4.4

Descriptive Statistics Solving Univariate Linear Equations Test

Groups/Method		N	Min	Max	Mean	SD	VAR
Control	Pre-Test	28	0	90	31.43	21.032	
Experimental Interactive	Pre-Test	40	5	50	23.50	12.669	
Control	Post-Test	28	10	75	38.04	19.923	
Experimental Interactive	Post-Test	40	10	85	42.38	21.303	
Both	Pre-Test	68	0	90	26.76	16.945	287.14
Both	Post-Test	68	10	85	40.59	20.706	428.75

Figure 4.6 shows a comparison of group means for the *solving univariate linear equations test*. The algebra score pre-test mean ($M = 31.43$) for the control group was higher than the algebra score pre-test mean ($M = 23.50$) for the experimental group. However, the post-test mean ($M = 38.04$) for the control group was lower than the post-test mean ($M = 41.50$) for the experimental group. Both groups increased from pre- to post- tests for the mean algebra scores. There was homogeneity of variances, as assessed by the Levene's test for equality of variances, for competence, p > .05. Both the pre-test and post-test yielded p values of .095 and .057, respectively.

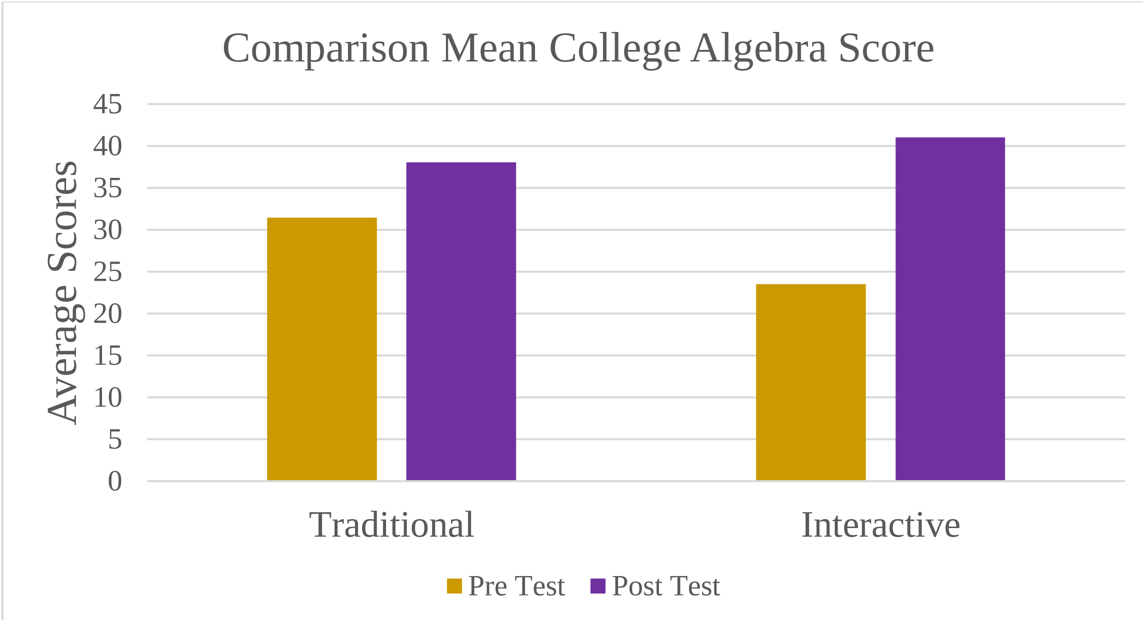


Figure 4.6 *Comparison Mean College Algebra Score*

Figure 4.7 shows a comparison of pre- and post-test means for each course observed. The pre-test means for the control groups were greater than the pre-test means for the two experimental groups. While all groups experienced growth on the post-test, the experimental groups had a significantly larger gain than the control groups. Control Group 1 had a pre-test mean ($M = 37.73$) which increase by 6.36 points to secure a greater post-test mean ($M = 44.09$). Control Group 2 had a pre-test mean ($M = 27.35$) which increase by 6.76 points resulting in a greater post-test mean ($M = 34.12$). Experimental Group 1 had greater post-test mean ($M = 45.00$) 19.25 points greater pre-test mean ($M = 25.75$). Experimental Group 2 also had greater post-test mean ($M = 39.75$) 18.50 points greater pre-test mean ($M = 21.25$).

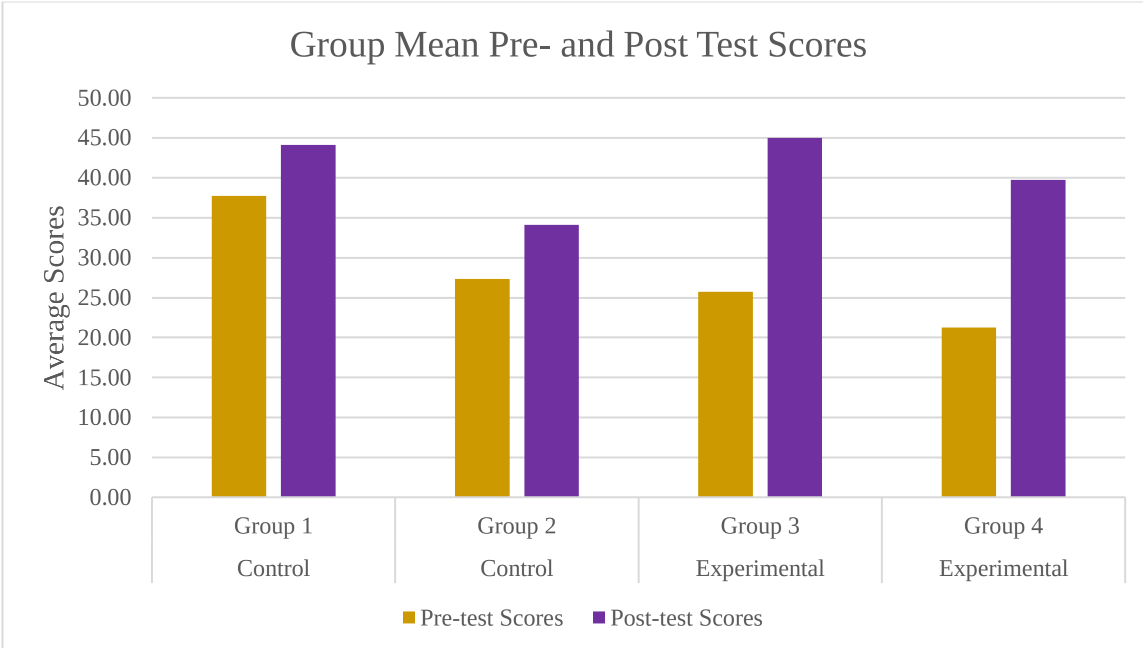


Figure 4.7 *Comparison Group Mean Pre- and Post-Test Scores*

The purpose of this study was to compare students who used the interactive guided notes note-taking method in College Algebra to students who used a non-interactive guided notes note-taking method in College Algebra to determine whether there was a difference in student performance when solving univariate linear equations. Participants in the study completed a pre- and post- unit test. The differences of the pre- and post-tests were analyzed using SPSS, and decisions were made concerning the research hypotheses. The hypotheses of the study were tested using an independent samples t-test at an alpha of $p < 0.05$ level of significance.

A paired samples t-test was used to compare the pre-test of all 68 participants to the post-test scores of the participants. The *t* statistic obtained was highly significant at p<0.001 with a degree of freedom of 67 (see table 4.5)

Table 4.5

Inferential Statistics Paired Samples Test

Paired Samples Test									
	Mean	SD	SEM	95% CI		*t*	df	Significance	
				Lower	Upper			One-sided p	Two-sided p
Pretest-Posttest	-13.8	19.1	2.322	-18.46	16.95	-5.95	67	$< .001$	$< .001$

A standard deviation of 16.945 and 20.706 was reported for the Control Group and Experimental Group, respectively. The post-test scores obtained by experimental and control groups were analyzed using the SPSS software package using the independent sample T-test to establish whether there were significant differences between two groups of participants at the 0.05 alpha level. The analysis of the data as revealed indicates that the null hypothesis was rejected. There was a significant difference in students' mathematics performance when solving univariate linear equations between students who used interactive guided notes versus students who did not use interactive guided notes in College Algebra. Table 4.6 represents these results (See Table 4.6, p. 65).

Table 4.6

Post-Test Results

Groups	N	Min	Max	Mean	SD	SEM	F	T	df	Sig
Control	28	0	90	26.76	16.945	3.765	7.411	1.938	67	.008
Experimental	40	10	85	40.59	20.706	3.368				

The analysis conducted to answer the research question found significant effects associated with the method of note taking employed. The significance level was considerably lower than the alpha level set at 0.05. The 40 participants who used guided interactive notes (M=49.59, SD 20.706) compared to the 28 participants in the control group (M=26.76, SD=16.945) demonstrated a significantly higher post-test score, $t(67) = 1.938,\ p = .008$. This enabled us to reject the null hypothesis, which led to the conclusion that there was a significant difference in the mathematical performance of students when solving univariate linear equations in College Algebra between students who used interactive guided notes and students who did not use interactive guided notes.

CHAPTER V – DISCUSSION

This research was conducted with the objective of determining whether guided interactive graphic organizer notes are more beneficial to students' overall performance in College Algebra. The purpose of the study was to evaluate how the technique used in note taking impacted student performance in College Algebra. For the study, students who recorded notes using guided interactive graphic organizer notes were compared to students who did not use interactive guided notes. This chapter provides a synopsis of the study, a discussion of the findings, limitations, and suggestions for further future research to aid in answer the research question:

1. How does the use of guided interactive graphic organizer notes impact College Algebra students' mathematics performance when solving univariate linear equations?

Summary

Taking notes is a strategy and practice used rather frequently for retaining knowledge, particularly in academic settings. Although taking notes is a common thing for students to do, many of them don't fully understand the role it plays in the learning process. According to Garbutt (2021), many students have difficulty taking notes, although doing so is essential to the learning process. Participants in this study were assigned to groups that used either guided interactive graphic organizers or groups wherein the method of note-taking used was not decided for them. A comparison of the participants' means scores on the pre-and post-tests revealed that those in the experimental group had significantly higher levels of comprehension than those in the control group. This could be at least partially explained by the approach to note-taking that was used, although other elements could be at play here.

The findings of the research are noteworthy for a variety of different reasons. It exhibits both the requirement for instructional aids and the value of utilizing strategic ways when taking notes in mathematics. It also reveals that there is space for interactive learning resources at the collegiate level. This is also of tremendous significance because the majority of students are typically expected to take notes while listening in order to demonstrate their level of comprehension. It is important to emphasize that students have complete autonomy in selecting the approach of note-taking that they feel would be most advantageous to them. However, students enrolled in mathematics courses at the college level would benefit more from using a method of note-taking that is more structured and centered on the student. One such method is the interactive guided notes method, presented in implementing the method. The findings of the study imply that students can retain a greater quantity of information with the use of guided interactive graphic organizers. Interactive notes allow students to be creative in the learning process. If interactive notes are maintained systematically, as Park (2020) recommends, they have the potential to dramatically improve mathematics instruction as we know it.

Students have complete control over how they organize the essential information acquired from lectures when they take notes using the interactive guide note method. Students and teachers alike have a lot to gain from using interactive notebooks in a variety of different ways. Students' ability to organize the material they are learning logically while using interactive notebooks increases classroom productivity. Students will have an easier time maintaining organization thanks to the inclusion of a table of contents at the beginning of the lesson, numbered pages, and a sample notebook for teachers (Wist, n.d).

The sample included 68 students from community colleges around the US who had signed up for College Algebra during the spring semester of 2023. There were 28 students in the Control (non-interactive notes) class and 40 in the Experimental interactive notes class. Levene's test for homogeneity of variance concluded that the variances were indeed equal. Each participant was required to finish a mathematics test before and after the experiment to acquire the necessary data. The test that was utilized to determine whether a student was prepared for algebra was a 20-item matching and constructive answer test produced by teachers employed in the mathematics department of the participating community college. The scale for determining a student's score on the algebra readiness test ranged from 0 to 100, with higher scores indicating more comprehension of the material.

One research topic served as the primary driver of this study's focus and direction. The purpose of the research question was to ascertain whether there was a statistically significant difference between the two groups concerning the structure of the method of note-taking that was applied. To answer the research question posed by the study, an independent samples t-test was conducted. A statistically significant difference could be seen between the two groups when comparing their pre- and post-scores on a test that involved the solution of univariate linear equations, as shown by the findings of a study of the difference in those scores.

The findings for this study will greatly assist students in improving their scores in Math. The use of guided interactive graphic organizer notes had a positive effect on student achievement. Based on pre- and post-test data obtained, students were able to retain information that further assisted them in increasing their scores on tests. To this, the first implication of this study is students who utilized guided interactive graphic organizer notes had higher achievement.

Discussion of Findings

Teachers that have an awareness of different learning styles and intelligence and different ways of instructing students can positively influence their students' academic success. Using a guided interactive graphic organizer note method was the subject of this study, which looked at ways in which teachers might help students improve their academic success. The research concentrated on the various cognitive theories that might be utilized to justify the utilization of guided interactive graphic organizer notes.

Students may find that the guided interactive graphic organizer notes were a helpful tool for assisting them in remembering content and reviewing it before tests. In addition to having a grasp of the research that supports the usage of guided interactive graphic organizer notes, it is beneficial for teachers to be familiar with how to set up interactive note sheets and books. The left side of the notebook is reserved for the teacher's notes, and it is this side of the notebook that students are expected to study in preparation for an examination. If information is given to the students to write on the left side of the notebook, they can use the right side of the notebook to put the material they have learned into their own words, illustrate it, or do something else they choose.

The depth of mathematical understanding college students possess has always been a critical concern. The quality of the experiences that students have when building their knowledge through classroom instruction is the most crucial aspect that determines the level of knowledge possessed (Singh et.al., 2016, p. 67). Although research has shown that 99 percent of college students take notes while attending lectures, professors only focus on the importance of note-taking as a skill (Banke, 2016). Because taking good notes has a direct bearing on students' overall success in the classroom, it is imperative that students identify ways to enhance their note-taking strategies. Thus, one of the goals of this research was to establish whether using interactive guided notes would improve academic performance among college algebra students.

According to the findings of research on taking notes, taking notes during class and reviewing those notes (either in class or subsequently) favorably impact the amount of information that students retain. It should not come as a surprise that most studies have found that students are able to retain more information from lectures if they write it in their notes (Bligh, 2000). Students who take notes achieve greater scores on tests of recall and synthesis, both immediately and after some delay, compared to those who do not take notes (Kiewra et al., 1991). In addition, research has shown that the more students record, the more information they retain, and the better they do on tests (Johnstone & Su, 1994). In conclusion, taking notes is beneficial since it makes recalling previously learned information easier and synthesizing and applying newly acquired information, which is especially true when notes are examined just before tests.

The findings of this study showed a significant difference in students' mathematical performance when they solved univariate linear equations between students who used interactive guided notes and students who did not use interactive guided notes in College Algebra. The students who did not use interactive guided notes performed significantly lower than those who used interactive guided notes. This study's results supported the research hypothesis that stated there was a significant difference between the two groups. The research hypothesis was based on the idea that there was a significant difference between the two groups. When results were compared within and between subjects, it was found that participants in the Experimental groups had a more considerable improvement in test scores.

Similarly, participants in the control group had a performance improvement. However, it was less significant than the improvement seen by people in the experimental group. The findings of this research provide credence to the concept of employing interactive guided notes in college mathematics classes as a type of pedagogical assistance to enhance student comprehension and performance.

According to the results of this research, guided interactive graphic organizer notes have the potential to be an effective tool for both instructors and students to employ in the classroom. This is backed up by the several theories that were investigated during the research. Using guided interactive graphic organizer notes comes with a few benefits and drawbacks that classroom instructors must be privy to before determining whether to implement them in their instructional strategy.

Limitations

This study presented a few limitations, the first being the sample size and the second being varying academic abilities of the participants. The small number of participants limited the scope of the findings for this research. The small sample was partly due to the convenience sampling method used to conduct this study. While the researcher did not have control over the number of available participants for the study, it could have benefitted from a larger pool.

While limited academic level studies were available, all the available research on the effects of guided notes on post-secondary students' achievement involved studies with students in non-mathematics settings. TO fully grasp the effectiveness of the note-taking method, the participants achievement levels needed to be observed. It should be noted that there is a large amount of information on student achievement in the K–12 educational system. Nevertheless, this study focused on post-secondary education. Because of the population of the participants, it would be interesting to observe a cohort of participants over an extended period, preferably beginning at either the middle or high school levels.

Future Research

This research aimed to determine if using guided interactive graphic organizer notes affected increasing student achievement. Future research on this topic is necessary because a convenience sampling method was utilized to conduct this study. The sample size of the participants was not large enough to determine if the effect was truly a result of the use of interactive notebooks. Due to the limited sample size, the results cannot be generalized across other areas. Thus, increasing the number of participants from various areas is necessary.

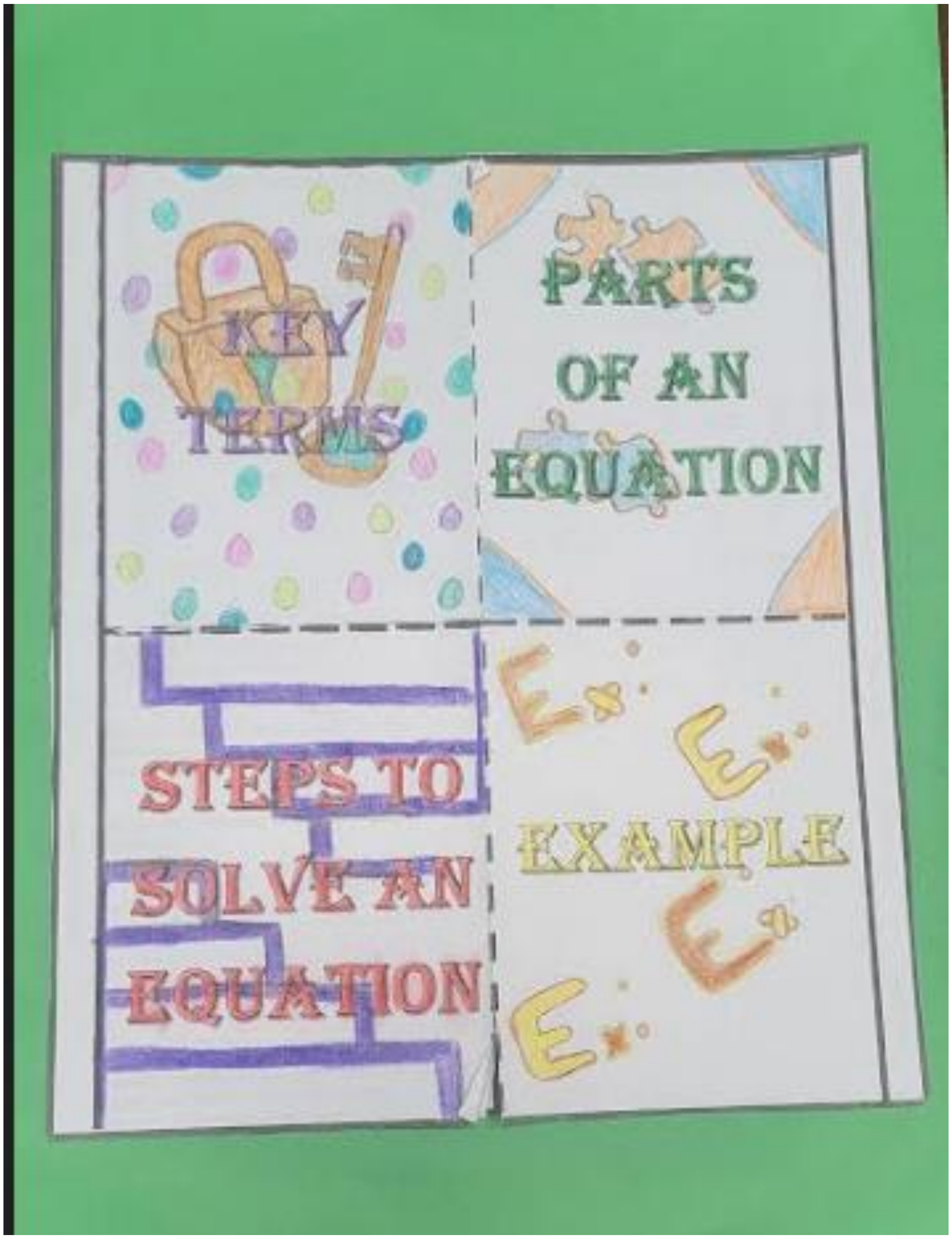
Next, this study used data from individuals enrolled in College Algebra. Although some demographic information was taken, the researcher did not consider the students' educational level. Were the students low, average, or high-performing student? Developing a criterion would have to be outlined to place students into various categories. Further research about how well students achieved based on their current academic performance compared to the use or non-use of interactive notebooks. This information could shed some light on how well certain resources could assist some of the students who are lower performing.

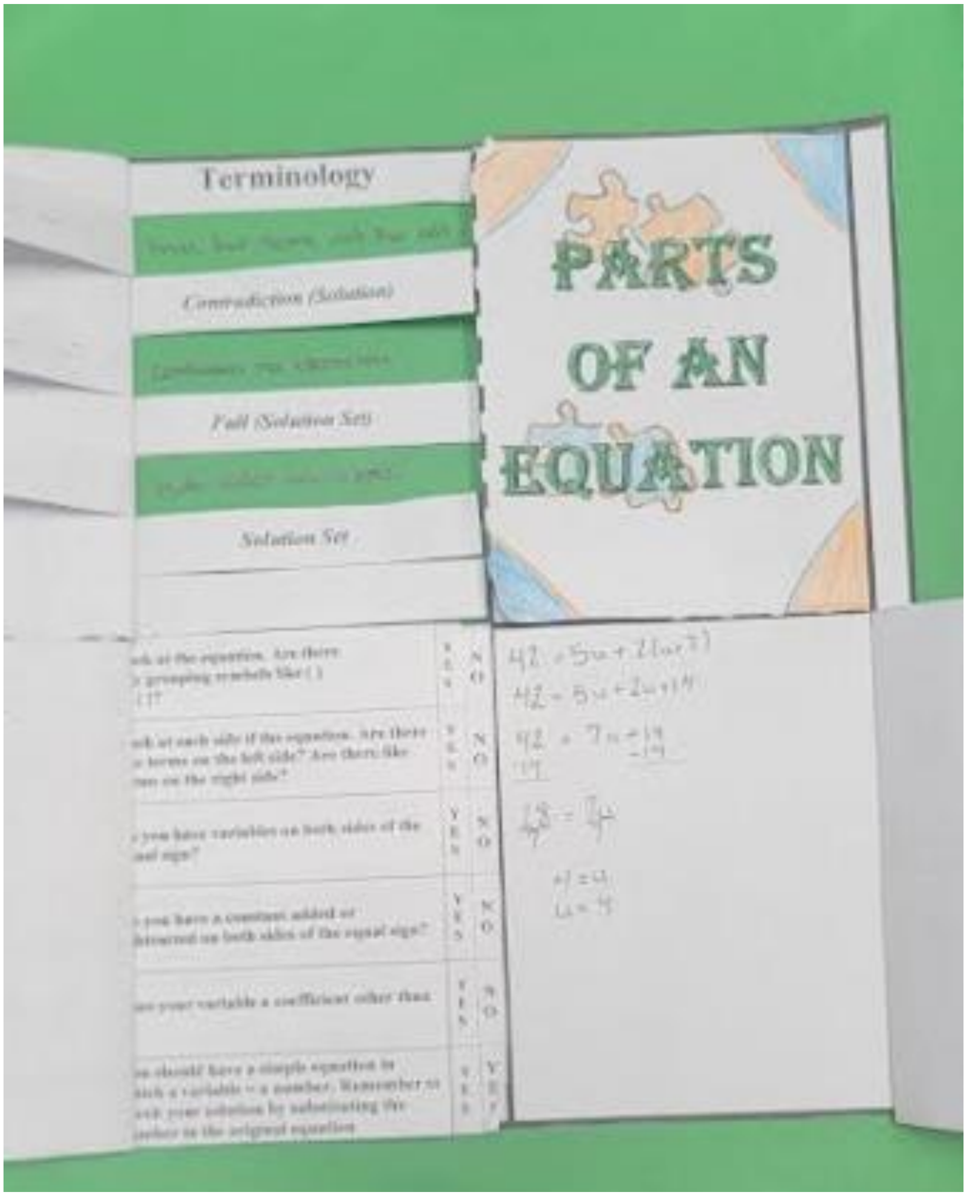
Lastly, future research could be conducted as a longitudinal study. How well does using guided interactive graphic organizer notes affect student achievement over several years? Students who enter middle school could begin by documenting their usage of interactive notebooks and continue documenting the use through high school.
The data collected could assist in projecting how well the students will do in postsecondary.

The post-secondary classroom can strongly impact student achievement. Several studies have hypothesized that a rise in student engagement is the cause of the rise in student accomplishment (Austin et al., 2002). To completely comprehend if and how the usage of guided notes affects student engagement, a more empirical study is required. Also, although engagement is the mechanism by which guided notes have a favorable effect on student accomplishment (Heward, 1994), more study is required to understand this link fully.

This leads to an additional worry over choosing variables for a potential meta-analysis study. Investigating factors like gender or student characteristics (traditional versus non-traditional) would have been an interesting factor to include in the study. Doing so would have revealed more nuance, complexity, and moderator effects regarding the impact of guided notes on student performance. These variables, however, could not be analyzed because the necessary data was not readily accessible.

APPENDIX A – Student Guided Interactive Note Sample





Terminology
Contradiction (Solution)
Full (Solution Set)
Solution Set
PARTS
OF AN
EQUATION

APPENDIX B –Teacher Generated Notes Sample

College Algebra MAT 1314
Unit 1 Section 1.1 Linear Equations and Rational Equations 1
Name________________________________

Objective: In this section our focus will be on solving three types of equations: linear equations, rational equations, and formulas for a specific variable.

Key Terms: Variable Term, Constant Term, Coefficient Term, Conditional Equation, Identity, Contradiction, Additive Inverse, Multiplicative Inverse.

1. **Solve linear equations.** Equations can be categorized by a number of different aspects. In this section, we study three categories of equations <u>based on the *number of solutions*</u> the equations may have.
   - ❖ **Steps for Solving a Linear Equation in One Variable:**
     1. Simplify the expression on both sides of the equation.
     2. Use the addition or subtraction properties of equality to collect the variable terms on one side of the equation and the constant terms on the other.
     3. Use the multiplication or division properties of equality to make the coefficient of the variable term equal to 1.
     4. Check your answer by substituting your solution into the original equation
     5. Identify the type of solution obtained.

a. Solve and check:

1. $3x - 4 = 3x + 7$	
2. $2(x + 7) = 6x + 9 - 4x$	

3. $2(3x+2)=2(2x+2)+2$	
4. $4x+4(2x+2)=2+3(4x+2)$	
5. $3x-5=2x+7$	
6. $5x-(2x+2)=x+(3x-5)$	

Key Terms: Least Common Denominator (LCD), Restrictions/Extraneous Solution

2. **Solve rational equations**. Before solving the equation, *consider what values of the variable might make the denominator of any term equal to zero.*
   - **Steps for solving Rational Equations:**
     1. Find the common denominator and check for restrictions.
     2. To solve a rational equation, **clear fractions** from the equation, multiplying each term on both sides of the equation by the least common denominator (LCD). This will to obtain an equivalent equation without fractions.
     3. Simplify.
     4. Check the answer(s) to make sure there isn't an extraneous **solution**.

a. Solve and check:

1. $\frac{x+1}{4}=\frac{1}{6}+\frac{2-x}{3}$ State any restrictions on the variable: $x \neq$ ______ LCD:________________	2. $\frac{3}{x+3}=\frac{5}{2x+6}+\frac{1}{x-2}$ State any restrictions on the variable: $x \neq$ ______ LCD:________________
3. $\frac{2}{x+1}+\frac{3}{x-1}=\frac{6}{(x+1)(x-1)}$ State any restrictions on the variable: $x \neq$ ______ LCD:________________	4. $\frac{4+3a}{a^2+12+7a}-\frac{3-4a}{a^2-12+a}=\frac{7a-3}{a^2-9}$ State any restrictions on the variable: $x \neq$ ______ LCD:________________

APPENDIX C – Pre- and Post-test

College Algebra ID______________________
Post-Assessment
Solving Linear Equations of One Variable

Matching
Directions: Match column A with the corresponding item in Colum B. Write the letter of your answer for each number.

Answer	Column A	Column B
_____	1. A value of the variable that makes the equation a true statement.	a Cubic
		b Conditional
_____	2. A statement that indicates that two expressions are equal.	c Contradiction
_____	3. An equation that can be written in the form $ax + b = c \text{ where } a \neq 0$ is called	d Empty or Null
		e An equation
_____	4. The set of all solutions to an equation is called the__________	f An expression
		g Full
_____	5. A solution to an equation that is true for some values of the variable, but false for other values.	h Identity
		i Infinity
_____	6. An equation that has no solution is called __________	j Linear
_____	7. The set containing no elements is called the __________	k Quadratic
		l A solution
_____	8. An equation that has all real numbers as its solution set is called __________	m Solution set

Solve each problem according to the instructions indicated for each. Write the final answer in the corresponding column to the left.

9. Clear parentheses and combine *like* terms.
   $-4(-6+2w)-9w+2(w-1)$

9.

10. Solve the equation. Simplify your answer if possible.
   $-7b+7=-14$

10.

11. Solve the equation. Simplify your answer if possible.
   $10=7+3(3z+2)$

11.

12. Solve for y.
   $2y-39=-3(y+3)$

12.

13. Solve for u.
$30 = 6u + 7(u + 8)$

13.

14. Solve the equation. Simplify your answer if possible.
$-5(n - 5) + 4 = 13 - (n + 4)$

14.

15. Solve for w.
$-3(-6w + 7) - 6w = 6(w - 3) - 1$

15.

16. Solve the equation. Simplify your answer if possible.
$\frac{1}{15}t + \frac{4}{3} = 1$

16.

17. Solve for x.
$\frac{1}{2}x - \frac{1}{2} = -\frac{1}{3}x - 2$

17.

18. Solve for x.
$-\frac{5}{3} = \frac{2}{7}x - \frac{3}{2}$

18.

19. Solve for x.
$\frac{y}{3} + \frac{1}{12} = \frac{y}{4}$

19.

20. Solve the equation. Simplify your answer if possible.
$\frac{8v - 3}{7} + \frac{7v + 9}{6} = 8$

20.

APPENDIX D – USM IRB Approval Letter

Office of Research Integrity

THE UNIVERSITY OF SOUTHERN MISSISSIPPI.

118 COLLEGE DRIVE #5116 • HATTIESBURG, MS | 601.266.6756 | WWW.USM.EDU/ORI

Modification Institutional Review Board Approval

The University of Southern Mississippi's Office of Research Integrity has?received the notice of your modification for your submission *Note taking in college mathematics: an examination of the effectiveness of guided notes and interactive notebooks on student achievement in College Algebra.* (IRB #:22-1608).

The project below has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services regulations (45 CFR Part 46), and University Policy to ensure:

- The risks to subjects are minimized and reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered involving risks to subjects must be reported immediately. Problems should be reported to ORI via the Incident submission on InfoEd IRB.
- The period of approval is twelve months. An application for renewal must be submitted for projects exceeding twelve months.

PROTOCOL NUMBER:	22-1608
PROJECT TITLE:	Note taking in college mathematics: an examination of the effectiveness of guided notes and interactive notebooks on student achievement in College Algebra.
SCHOOL/PROGRAM	Center for STEM Education
RESEARCHERS:	PI: Julie Cwikla Investigators: Cwikla, Julie~Hodge-Neal, Verlonda~
IRB COMMITTEE ACTION:	Approved
CATEGORY:	Expedited Category
PERIOD OF APPROVAL:	08-Feb-2023 to 15-Dec-2023

Donald Sacco Jr.

Donald Sacco, Ph.D.
Institutional Review Board Chairperson

APPENDIX E – HINDS COMMUNITY COLLEGE IRB Approval Letter

HINDS COMMUNITY COLLEGE

P.O. BOX 1100 • RAYMOND CAMPUS • RAYMOND, MISSISSIPPI 39154-1100

Office of Institutional Research and Effectiveness

February 15, 2023

Verlonda Neal, Primary Researcher
verlonda.neal@hindscc.edu
104 Huneysuckle Lane
Raymond, MS 39154

Re: "Note Taking in College Mathematics: An examination of the effectiveness of guided notes and student achievement in College Algebra"

The Human Subjects Committee of the Institutional Review Board (IRB) has reviewed your protocol and approved your request to pursue data collection at Hinds Community College for your research project.

This permit will expire on February 15, 2024. Thereafter, continued approval is contingent upon the annual submission of a renewal form to this office. If you have any questions, please contact the IRB Office or Dr. Roddrick Jones at (601) 857-3357 or by email at roddrick.jones2@hindscc.edu.

Best wishes with your study.

Sincerely,

Roddrick D. Jones, Ph.D.
Chair, IRB
Director, Office of Institutional Research and Effectiveness
Hinds Community College
608 Hinds Blvd.
Raymond, MS 39154
601-857-3357
roddrick.jones2@hindscc.edu

APPENDIX F –VICKSBURG WARREN SCHOOL DISTRICT IRB Approval Letter

Mr. Chad Shealy
Superintendent
cshealy@vwsd.org

Mr. David Campbell
Deputy Superintendent
dcampbell@vwsd.org

Dr. Cedric D. Magee
Associate Superintendent
cmagee@vwsd.org

VICKSBURG WARREN
SCHOOL DISTRICT
BRIDGING EDUCATION TO EMPLOYMENT

January 9, 2023

Mrs. Hodge-Neal,

I serve as the superintendent's designee to approve requests to conduct research in the Vicksburg Warren School district. Your request to acquire data ("Note taking in college mathematics: an examination of the effectiveness of guided notes and interactive notebooks on student achievement in College Algebra") is approved under the condition that the administrators, teachers, students and parents understand that the pre-test and post-test are voluntary and confidential. You will be responsible for contacting the principal.

Please contact me if you need further assistance or if you need clarification.

Best Regards,

Cedric D. Magee

Cedric D. Magee, Ph.D.

1500 Mission 66 P.O. Box 820065 Vicksburg, MS 39182
601-638-5122 www.vwsd.org Fax 601-619-2338

APPENDIX G – PARENTAL CONSENT FORM

CONSENT FORM

Principal Investigator: Verlonda Hodge-Neal
Faculty Advisor: Dr. Julie Cwikla
Study Title: Note taking in college math: an examination of the effectiveness of guided notes and interactive notebooks on student achievement in College Algebra

Dear Parents and Guardians:

I am a Ph.D. candidate at The University of Southern Mississippi. I am conducting a research study on college student note taking methods and the effect it has on student understanding and achievement. You are being asked to allow your child to participate in a research project. Should you allow your child to participate, they will be asked to complete a pre- and post- unit test on a predetermined objective as well as a post unit survey.

Both tests contain identical questions about a topic taught in class and will be completely anonymous. Each test will take no more than 30 minutes. The survey will take approximately 15 minutes to complete and too will be anonymous. Students will not miss any instruction time by participating in the research study.

If you decide to allow your child to participate, you will be asked to allow the data from the student's journal assignments, which will be given in the class, to be used as data for a research project. The objectives will be covered over a 2-week period during the months of January and February. There are no known risks for participating in this program and the data collected from your child will be kept confidential and will not include any student names.

There are no known risks to your child from participating in this study. Their grades and class standing will not be affected in any way if they do, or do not, participate. Your child will not directly benefit from this research; however, their participation may benefit others by informing development of future instructional materials. Participation is voluntary and you may withdraw your child at any time without penalty. If you agree to allow your child to participate, please indicate this decision by signing below. If you have any questions about this research project, please contact me, Verlonda Neal via phone at (601) 460-0302 or Verlonda.hodge@usm.edu, at any time during or after the project.

This project and this consent form have been reviewed by the Institutional Review Board, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-5997

Sincerely,

Verlonda Hodge-Neal, Ed. S.
Mathematics Instructor
Please complete the section that best represents your preference.

Notification of Participation (Complete only if you do wish to participate):

- I DO give permission for my child to participate in the study described above.

Student Name: ____

Parent's Signature: __________________________________ Date: _______________

Notification of Refusal (Complete only if you do not wish to participate):

- I DO NOT give permission for my child to participate in the study described above.

Student Name: ____

Parent's Signature: __________________________________ Date: _______________

APPENDIX H – DEBRIEFING FORM

Debriefing form

Note taking in college mathematics: an examination of the effectiveness of guided notes and interactive notebooks on student achievement in college algebra

Thank you for your participation in this research study. For this study, it was important that I withhold some information from you about some aspects of your participation. Now that your participation is completed, I will describe the withheld information to you, why it was important, answer any of your questions, and provide you with the opportunity to make a decision on whether you would like to have your data included in this study.

What you should know about this study

1) The study was completely voluntary and span several classes. Due to the nature of the research a percentage of the participants identified were a part of the experimental group who received an alternate note taking method during instruction
2) This was necessary, as information was needed to determine the effectiveness of the note taking method used in relation to student understanding of the content presented
3) Those participants in the control group were not privy to the note taking method being observed and were simply participating in the study as a one would expect in a normal instructional setting.

Right to withdraw data

You may choose to withdraw the data you provided prior to debriefing, without penalty or loss of benefits to which you are otherwise entitled. Please initial below if you do, or do not, give permission to have your data included in the study:

______I give permission for the data collected from or about me to be included in the study.

______I DO NOT give permission for the data collected from or about me to be included in the study.

If you have questions

The main researcher conducting this study is Verlonda Hodge-Neal a graduate student at The University of Southern Mississippi, Center for STEM Education. If you have any questions about this research project, please contact Verlonda Hodge-Neal via phone at [redacted] or [redacted], at any time during or after the project. If you have any questions or concerns regarding your rights as a research participant in this study, you may contact the Institutional Review Board (IRB) Chairperson at [redacted] or [redacted]

Your signature below indicates that you have been debriefed, and have had all of your questions answered.

________________	________________	________
Name of Researcher	Signature	Date
________________	________________	________
Name of Participant	Signature	Date

Please sign both copies, keep one and return one to the researcher.

REFERENCE

5 critical issues in mathematics education. (2021, April 12). *Barry University Online*. https://online.barry.edu/articles/education/critical-issues-in-math-education.aspx

Abin, A., Núñez, J. C., Rodríguez, C., Cueli, M., Carcia, T., & Rosário, P. (2020). Predicting Mathematics Achievement in Secondary Education: The Role of Cognitive, Motivational, and Emotional Variables. *Frontiers in Psychology*, *11*(876), 2-10. https://doi.org/ 10.3389/fpsyg.2020.00876

Acosta, A., Johnson, E., & Romo-González, L. (2021, January 27). What students and colleges faced during the pandemic. *New America*. https://www.newamerica.org/education-policy/edcentral/what-students-and-colleges-faced-during-pandemic/

ACT Research and Policy. *Readiness Matters: The Impact of College Readiness on College Persistence and Degree Completion*. (2013). ACT Research and Policy. https://www.act.org/content/dam/act/unsecured/documents/Readiness-Matters.pdf

Ajayi, K. O., & Lawani, A. O. (2015). Handbook of Research on Enhancing Teacher Education with Advanced Instructional Technologies. In *In N. Ololube, P. Kpolovie, & L. Makewa (Ed.), Handbook of Research on Enhancing Teacher Education with Advanced Instructional Technologies* (pp. 304-318). IGI Global. https://doi.org/10.4018/978-1-4666-8162-0.ch017

Alfares, N. (2019). EFL teachers' perceptions of using graphic organizers in the language classroom. *Advances in Social Sciences Research Journal*, *6*(2), 131-150. https://doi.org/10.14738/assrj.62.6045

Alrajeh, T. S., & Shindel, B. W. (2020). Student engagement and math teachers support. *Journal on Mathematics Education*, *11*(2), 167-180. https://doi.org/10.22342/jme.11.2.10282.167-180

Ashraf, T. (2019). *Experiences and Impact: The Voices of Teachers on Math Education Reform in Ontario, Canada*.

Austin, J. L., Lee, M. G., Thibeault, M. D., Carr, J. E., & Bailey, J. S. (2002). Effects of Guided Notes on University Students' Responding and Recall of Information. *Journal of Behavioral Education*, *11*(4), 243-254. https://doi.org/10.1023/a:1021110922552

Austin, L. (2017). *The impact of an elementary algebra course on success in a college-level liberal arts math course and persistence in college* [Doctoral dissertation]. https://www.proquest.com/docview/1883356404

Bailey, T., Jeong, D. W., & Cho, S. (2010). Referral, enrollment, and completion in developmental education sequences in community colleges. *Economics of Education Review*, *29*(2), 255-270. https://doi.org/10.1016/j.econedurev.2009.09.002

Banilower, E. R., Smith, P. S., Malzahn, K. A., Plumley, C. L., Gordon, E. M., & Hayes, M. L. (2018). *Report of the 2018 NSSME+*. Chapel Hill, NC: Horizon Research, Inc.

Banke, R. (2016, January 23). *Note-taking in the college classroom « notes on teaching and learning*. Notre Dame Sites. https://sites.nd.edu/kaneb/2016/01/23/note-taking-in-the-college-classroom/

Bartolomei-Torres, P., & Ph.D. (2020, March 28). *Meaningful learning and its implications in the classroom*. Learning. https://www.learningbp.com/meaningful-learning-ausubel-theory/

Bernard, M., & Senjayawati, E. (2019). Developing the students' ability in understanding mathematics and self-confidence with VBA for Excel. *JRAMathEdu (Journal of Research and Advances in Mathematics Education), 4*(1), 45-56. https://doi.org/10.23917/jramathedu.v4i1.6349

BetterHelp Editorial Team. (2022, August 22). *Why rote memory doesn't help you learn*. BetterHelp | Professional Therapy With A Licensed Therapist. https://www.betterhelp.com/advice/memory/why-rote-memory-doesnt-help-you-learn/

Bhandari, P. (2022, October 10). *Correlational research | When & how to use*. Scribbr. https://www.scribbr.com/methodology/correlational-research/

Billet, S. (2012). *Guided Learning. In: Seel, N.M. (eds) Encyclopedia of the Sciences of Learning. Springer, Boston, MA*. Springer. https://doi.org/10.1007/978-1-4419-1428-6_34

Blackbourn, N. (2021, September 9). Why is note taking important? *Nick Blackbourn*. https://nickblackbourn.com/blog/why-is-note-taking-important/

Blazer, C. (2011). *Strategies for reducing math anxiety. Information Capsule*.

Bligh, D. A. (2000). *What's the use of lectures?* San Francisco: Jossey- Bass.

Boaler, J., & Zoido, P. (2016, November 1). *Why math education in the U.S. doesn't add up*. Scientific American. https://www.scientificamerican.com/article/why-math-education-in-the-u-s-doesn-t-add-up/

Brathwaite, J., Fay, M. P., & Moussa, A. (2020, November). *Improving developmental and college-level mathematics: Prominent reforms and the need to address equity*. Community College Research Center. https://ccrc.tc.columbia.edu/media/k2/attachments/improving-developmental-college-level-mathematics.pdf

Brewer, E. W., & Kubn, J. (2010). *Causal-comparative design. In N. J. Salkind (Ed.), Encyclopedia of research design (pp. 125-131).*. SAGE Publications, Inc., https://dx.doi.org/10.4135/9781412961288.n42.

Camera, L. (2016, April 27). *High School Seniors Aren't College-Ready*. www.usnews.com. https://www.usnews.com/news/articles/2016-04-27/high-school-seniors-arent-college-ready-naep-data-show

Cardetti, F., Khamsemanan, N., & Orgnero, M. C. (2010). Insights regarding the usefulness of partial notes in mathematics courses. *Journal of the Scholarship of Teaching and Learning*, *10*(1), 80-92.

Castro, D. (2021, May 26). *Eliminate Remedial Courses: Implement AB 705 and EO 1110*. The Education Trust - West. https://west.edtrust.org/

Chaudhry, M. (2015, May 8). *College Success Starts In Math Class*. Forbes. https://www.forbes.com/sites/schoolboard/2015/05/08/college-success-starts-in-8th-grade-math-class/?sh=3fb2ba3c248e

Chceducator. (2019, July 12). *Contextual learning and how it benefits students*. EIPCS-Main. https://www.educatorsinc.org/post/contextual-learning-and-how-it-benefits-students

Ciascai, L. (2009). Using Graphic Organizers in Intercultural Education. *Acta Didactica Napocensia*, *2*(1), 9-18.

Cignition. (2020, February 13). What's one of the greatest predictors of college and career success? Math. *Cignition Home*. https://fs.cignition.com/cblog/whats-one-of-the-greatest-predictors-of-college-and-career-success-math

Colliot, T., & Jamet, É. (2020). Improving students' learning by providing a graphic organizer after a multimedia document. *British Journal of Educational Technology*, *52*(1), 252-265. https://doi.org/10.1111/bjet.12980

Conley, D. T. (2007, March). *Redefining College Readiness*. ERIC - Education Resources Information Center. https://files.eric.ed.gov/fulltext/ED539251.pdf

Conley, D. T. (2007). *Redefining college readiness. Educational Policy Improvement Center*. ERIC - Education Resources Information Center.

Cunff, A. L. (2020, May 26). *The science of note-taking*. Ness Labs. https://nesslabs.com/note-taking

Daily, S. (2021). "Productive Struggle" as an Effective Strategy in Elementary Math Classrooms. *International Journal of the Whole Child, 6*(2), 85-95. https://libjournals.mtsu.edu/index.php/ijwc

Davis, M., & Koon, S. (2019). *Math Course Sequences in Grades 6-11 and Math Achievement in Mississippi*. Regional Educational Laboratory Southeast. https://ies.ed.gov/ncee/rel/Products/Publication/3910

Debue, N., & Van de Leemput, C. (2014). An empirical contribution to the cognitive load theory. *Frontiers in Psychology*. https://doi.org/ 10.3389/fpsyg.2014.01099. PMID: 25324806

Delisio, L. A., Bukaty, C. A., & Taylor, M. (2018). Effects of a graphic organizer intervention package on the mathematics word problem solving abilities of students with autism spectrum disorders. *Journal of Special Education Apprenticeship, 7*(4).

DeZure, D., Kaplan, M., & Deerman, M. A. (2001). *Research on student notetaking: Implications for faculty and graduate student instructors*. CRLT. https://crlt.umich.edu/sites/default/files/resource_files/CRLT_no16.pdf

Dorn, E., Hancock, B., Sarakatsannis, J., & Viruleg, E. (2021, July 27). *COVID-19 and education: The lingering effects of unfinished learning*. McKinsey & Company. https://www.mckinsey.com/industries/education/our-insights/covid-19-and-education-the-lingering-effects-of-unfinished-learning

Doyle, C. S. (1999). *The Use of Graphic Organizers To Improve Comprehension of Learning Disabled Students in Social Studies* [Unpublished doctoral dissertation]. Kean University.

Dündar, S. (2016). Does writing have any effect on mathematics success? *Journal of Education and Training Studies, 4*(1). https://doi.org/10.11114/jets.v4i1.989

Ernest, P. (2015). The social outcomes of learning mathematics: Standard, unintended or visionary? *International Journal of Education in Mathematics, Science and Technology*, *3*(3), 187. https://doi.org/10.18404/ijemst.29471

Fuhrman, J. (2017, June 6). *Cognitive load theory: Helping students' learning systems function more efficiently*. Online College & Nonprofit Accredited University | Franklin University. https://www.franklin.edu/institute/blog/cognitive-load-theory-helping-students-learning-systems-function-more-efficiently

Ganga, E., & Mazzariello, A. (2018). MATH PATHWAYS: Expanding options for success in college math. *The Center for the Analysis of Postsecondary Readiness*.

Garbutt, L. (2021, July 5). *Why is note taking so challenging? We'll tell you*. The Leading Note Taking Platform for Learning | Glean. https://glean.co/blog/why-is-note-taking-so-challenging

Gerrard, A. S. (2013). *Using the Four square strategy to enhance math problem-solving* [Unpublished master's thesis]. Rowan University.

Gokce, S., & Guner, P. (2021). Forty years of mathematics education: 1980-2019. *International Journal of Education in Mathematics, Science and Technology*, *9*(3), 514-539. https://doi.org/10.46328/ijemst.1361

Goldberg, S. (n.d.). *Education in a pandemic: The disparate impacts of COVID-19 on america's students*. Office of Civil Rights. https://www2.ed.gov/about/offices/list/ocr/docs/20210608-impacts-of-covid19.pdf

Gordon, L. M. (2017, January 26). *Howard Gardner*. Encyclopedia Britannica. https://www.britannica.com/biography/Howard-Gardner

Graphic organizers. (n.d.). Special Connections. https://specialconnections.ku.edu/instruction/universal_design_for_learning/teacher_tools/graphic_organizers

Great Schools Partnership. (2016, February 18). *The glossary of education reform*. https://www.edglossary.org/student-engagement/

Gunstone, R. (2015). Meaningful learning. *Encyclopedia of Science Education*, 625-625. https://doi.org/10.1007/978-94-007-2150-0_121

Gurat, M., & Medula Jr, C. T. (n.d.). Metacognitive Strategy Knowledge Use through Mathematical Problem Solving amongst Pre-service Teachers. *American Journal of Educational Research*, *4*(2), 170-189.

GÜR, T. (2021). The effect of verbatim and generative notes taken by hand and keyboard at University level on success and persistence. *The Education Quarterly Reviews*, *4*(3), 132-141. https://doi.org/10.31219/osf.io/dw5q7

Haghverdi, H. R., Biria, R., & Karimi, L. (2010, April). *Note-taking strategies and academic achievement | Haghverdi | Journal of language and linguistic studies*. Journal of Language and Linguistic Studies. https://www.jlls.org/index.php/jlls/article/view/91/91

Halverson, K. (2021, September 1). 9 reasons your students will love interactive notebooks. *Education to the Core*. https://educationtothecore.com/2021/09/9-reasons-your-students-will-love-interactive-notebooks

Helmenstine, A. M. (2019, June 27). Why mathematics is a language. *Expert Customized Math Tutor Program - Mathnasium*. https://www.mathnasium.com/blog/why-mathematics-is-a-language

Heward, W. L. (1994). Three "low-tech" strategies for increasing the frequency of active student response during group instruction.In R. Gardner III, D. M. Sainato, J. O. Cooper, T. E. Heron, W. L. Heward, J. W. Eshleman, & T. A. Grossi (Eds.). *Behavior analysis in education: Focus on measurably superior instruction*, 283-320.

Heward, W. (n.d.). *Improving the effectiveness of your lectures*. University of Nevada, Las Vegas. https://www.unlv.edu/sites/default/files/page_files/3/Faculty-Tip-Sheet-Guided-Notes.pdf

Hill, H. C. (2022, March 9). After 30 years of reforms to improve math instruction, reasons for hope and dismay. *Brookings*. https://www.brookings.edu/blog/brown-center-chalkboard/2021/02/04/after-30-years-of-reforms-to-improve-math-instruction-reasons-for-hope-and-dismay/

Hodara, M. (2013, October). *Improving students' college math readiness*. Education Northwest. https://educationnorthwest.org/sites/default/files/resources/improving%20college%20math%20readiness_0.pdf

Hüseyin, Ö. (2019). Impact of note taking during reading and during listening on comprehension. *Educational Research and Reviews*, *14*(16), 580-589. https://doi.org/10.5897/err2019.3812

Imsa-ard, P. (2022). Reading Better?: Enhancing Thai EFL Secondary School Students' Reading Comprehension Abilities with the Use of Graphic Organizers. *English Language Teaching*, *15*(5), 1-13.

InnerDrive. (2020, April 20). How to become an independent learner. *Release Your Inner Drive*. https://blog.innerdrive.co.uk/become-independent-learner

Johnstone, A. H., & Su, w. Y. (1994). Lectures-alearning experience? *Education in Chemistru*, *31*(1), 75-76,79.

Kansızoğlu, H. B. (2017). The Effect of Graphic Organizers on Language Teaching and Learning Areas: A Meta-Analysis Study. *Education and Science/Egitim ve Bilim,*, *42*(191), 139-164. https://pdfs.semanticscholar.org/38d1/656ecdce7c229e52ac6c2c547f5d047c5c72.pdf

Karabulut, A., & Baran, B. (2021). Teaching note-taking skills to students with learning disabilities: CUES+CC strategy. *Education Quarterly Reviews*, *4*(1), 542-555. https://doi.org/10.31014/aior.1993.04.02.265

Kearney, W. S., & Garfield, T. (2019). Student readiness to learn and teacher effectiveness: Two key factors in middle grades mathematics achievement. *RMLE Online*, *42*(5), 1-12. https://doi.org/10.1080/19404476.2019.1607138

Kern, S. (2020, February 3). Two reasons why students don't succeed in college — Kern counseling. *Kern Counseling*. https://kerncounseling.com/blog/two-reasons-why-students-dont-succeed-in-college

Khasawneh, E., Gosling, C., & Williams, B. (2021, February 25). *What impact does maths anxiety have on university students?* BMC Psychol 9, 37. https://bmcpsychology.biomedcentral.com/articles/10.1186/s40359-021-00537-2

Kiewra, K. A., DuBois, N., Christian, D., McShane, A., Meyerhoffer, M., & Roskelley, D. (1991). *Note-taking functions and techniques*. Journal of Educational Psychology, 83 (2), 240-245.

Klemm, W. (2007). What Good Is Learning If You Don't Remember It? *The Journal of Effective Teaching*, *7*(1), 61-73.

Knight, K. L. (2010). Study/Experimental/Research design: Much more than statistics. *Journal of Athletic Training*, *45*(1), 98-100. https://doi.org/10.4085/1062-6050-45.1.98

Kuhfeld, M., Soland, J., Lewis, K., & Morton, E. (2022, March 3). *The pandemic has had devastating impacts on learning. What will it take to help students catch up?* Brookings. https://www.brookings.edu/blog/brown-center-chalkboard/2022/03/03/the-pandemic-has-had-devastating-impacts-on-learning-what-will-it-take-to-help-students-catch-up/

Lambert, E. (2022, August). *Mathematicians as professors: Narrative accounts of their teaching experiences and conceptions of teaching*. Digital Collections at Texas State University. https://digital.library.txstate.edu/handle/10877/15990

Leech, N. L., Gullett, S., Howland Cummings, M., & Haug, C. A. (2022). The challenges of remote K–12 education during the COVID-19 pandemic: Differences by grade level. *Online Learning*, *26*(1). https://doi.org/10.24059/olj.v26i1.2609

Little, W., & McGivern, R. (2014, November 6). *Chapter 16. Education – Introduction to sociology – 1st Canadian edition*. BCcampus Open Publishing – Open Textbooks Adapted and Created by BC Faculty. https://opentextbc.ca/introductiontosociology/chapter/chapter16-education/

Lochmiller, C. R., Huggins, K. S., & Acker-Hocevar, M. A. (2012). Preparing Leaders for Math and Science: Three Alternatives to Traditional Preparation. *Planning and Changing*, *43*(1/2), 198-220.

Lopez, J., & Campoverde, J. (2018). Development of Reading Comprehension with Graphic Organizers for Students with Dyslexia. *Journal of Technology and Science Education*, *8*(2), 105-114.

Loveless, B. (2022, March 17). *Cognitive load theory - The definitive guide*. Education Corner. https://www.educationcorner.com/cognitive-load-theory/

M. Fajardo, M. T., Bacarrissas, P. G., & Castro, H. G. (2019). The Effects of Interactive Science Notebook on Student Teachers' Achievement, Study Habits, Test Anxiety, and Attitudes towards Physics. *TURKISH SCIENCE EDUCATION*, *16*(1), 62-76.

Mabena, N., Mokgosi, P. N., & Ramapela, S. S. (2021). Factors contributing to poor learner performance in mathematics: A case of selected schools in mpumalanga province, South Africa. *Problems of Education in the 21st Century*, *79*(3), 451-466. https://doi.org/10.33225/pec/21.79.451

Mahanta, P. (2019, November 20). 4 reasons why students struggle with math and how to overcome it. *Prodigy Education | Math & English | Prodigy Education*. https://www.prodigygame.com/main-en/blog/4-reasons-why-students-struggle-with-math-and-how-to-overcome-it/

Maheshwari, V. K. (2018, January 23). *Causal-comparative research*. https://www.vkmaheshwari.com/WP/?p=2491

Mallozzi, F. N. (2012). *The Effects of using interactive student notebooks and specific written feedback on seventh grade students' science process skills* [Doctoral dissertation]. https://westcollections.wcsu.edu/bitstream/handle/20.500.12945/165/Mallozzi_Dissertation_Final_Copy.pdf?sequence=3&isAllowed=y

Marcarelli, K. (2010). *Teaching science with interactive notebooks*. Corwin Press.

Marco-Bujosa, L. (2021). Prospective secondary math teachers encountering STEM in a methods course: When math is more than "Just math". *International Journal of Technology in Education*, *4*(2), 247-286. https://doi.org/10.46328/ijte.41

Marshall, M. V. (1939). Some factors which influence success in college algebra. *The Mathematics Teacher*, *32*(4), 172-174. https://doi.org/10.5951/mt.32.4.0172

Mazana, M. Y., Montero, C. S., & Casmir, R. O. (2018). Investigating students' attitude towards learning mathematics. *International Electronic Journal of Mathematics Education*, *14*(1). https://doi.org/10.29333/iejme/3997

McClure, E. R., Guernsey, L., Clements, D. H., Bales, S. N., Nichols, J., Kendall-Taylor, N., & Levine, M. H. (2017). *STEM starts early: Grounding science, technology, engineering, and math education in early childhood. Executive summary*. National Science Foundation (NSF).

Meldrum, A. (2020, April 24). *Why math notes are just as important as history notes (and how to write them)*. Made for Math. https://madeformath.com/writing-math-notes/

Muflih, M. K. (2018). The extent to which resource room teachers making use of visual organizations to teach students with learning disabilities. *International Education Studies*, *11*(12), 12-25. https://doi.org/10.5539/ies.v11n12p12

Nayak, S. (2017, December 26). *Transforming college algebra*. College of Science | Oregon State University. state.edu/IMPACT/2017/12/transforming-math-111

Neely, K. (2019, November 5). Using interactive notebooks with studies weekly. *Studies Weekly*. https://www.studiesweekly.com/interactive-notebooks/

Nelson, G., & McMaster, K. L. (2019). Factors that may influence treatment effects: Helping practitioners select early numeracy interventions. *Learning Disabilities Research & Practice*, *34*(4), 194-206. https://doi.org/10.1111/ldrp.12208

New study aims to find solutions for poor math performance at community colleges. (2017, September 6). School of Education and Human Development | University of Virginia. https://education.virginia.edu/news/new-study-aims-find-solutions-poor-math-performance-community-colleges

Nordmann, E., Kuepper-Tetzel, C. E., Robson, L., Phillipson, S., Lipan, G., & Mcgeorge, P. (2020). Lecture capture: Practical recommendations for students and instructors. *Scholarship of Teaching and Learning in Psychology*. https://doi.org/10.31234/osf.io/sd7u4

Novak, J., & Cañas, A. (2006). The origins of the concept mapping tool and the continuing evolution of the tool. *Information Visualization*, *5*, 175-184. https://doi.org/10.1057/palgrave.ivs.9500126

Núñez-Peña, M., Suárez-Pellicioni, M., & Bono, R. (2013). Effects of math anxiety on student success in higher education. *International Journal of Educational Research*, *58*, 36-43. https://doi.org/10.1016/j.ijer.2012.12.004

Oladimeji, O. O. (2022). Effects of graphic organizers and socio-economic status on acquisition of social skills among pupils with intellectual disability in Ibadan. *Turkish International Journal of Special Education and Guidance & Counseling*, *11*(1), 10-18.

OneClass. (2020, October 8). How many students fail college math and science classes? *OneClass*. https://oneclass.com/blog/featured/182664-how-many-students-fail-college-math-and-science-classes3F.en.html

Oxford Learning. (2017, April 24). *How to take study notes: 5 effective note taking methods*. https://www.oxfordlearning.com/5-effective-note-taking-methods

Ozkan, F., & Kettler, T. (2022). *Effects of STEM education on the academic success and social-emotional development of gifted students*. Journal of Gifted Education and Creativity,9(2), 143-163.

Paradise, P. (2019, October 31). *Interactive math notebooks: Why and getting started*. - Making Teaching a Breeze. https://www.myprimaryparadise.com/2017/03/19/interactive-math-notebooks-why-and-getting-started/

Park, J. (2020, November 28). *Using interactive notebooks in math class!* Blogs @ MU. https://blogs.millersville.edu/earlychildhoodeducation/2020/11/28/using-interactive-notebooks-in-math-class

Patterson, C. L., Parrott, A., & Belnap, J. (2020). Strategies for assessing mathematical knowledge for teaching in mathematics content courses. *The Mathematics Enthusiast*, *17*(2-3), 807-842. https://doi.org/10.54870/1551-3440.1504

Polman, J., Hornstra, L., & Volman, M. (2020). The meaning of meaningful learning in mathematics in upper-primary education. *Learning Environments Research*, *24*(3), 469-486. https://doi.org/10.1007/s10984-020-09337-8

Professional Learning Board. (n.d.). *Why use Graphic Organizers in the Classroom?* https://k12teacherstaffdevelopment.com/tlb/why-use-graphic-organizers-in-the-classroom/

Richards, E. (2020, February 28). *Math scores stink in America. Other countries teach it differently - and see higher achievement*. USA TODAY. https://www.usatoday.com/story/news/education/2020/02/28/math-scores-high-school-lessons-freakonomics-pisa-algebra-geometry/4835742002/

Rittle-Johnson, B. (2017). Developing Mathematics Knowledge. *Child Development Perspectives*, *11*. https://doi.org/10.1111/cdep.12229

Robillos, R. J. (2022). Impact of LoiLooNote digital mapping on University students' oral presentation skills and critical thinking dispositions. *International Journal of Instruction*, *15*(2), 501-518. https://doi.org/10.29333/iji.2022.15228a

Rokhaniyah, H. (2019). *Enhancing College Students' Ability to Generate Ideas in Writing Using Graphic Organizer*. Conference: The 63rd TEFLIN International ConferenceAt: Surabaya Indonesia.

The role of mathematics in the overall curriculum. (2022). International Mathematical Union (IMU). https://www.mathunion.org/icmi/role-mathematics-overall-curriculum

Salame, I. I., & Thompson, A. (2020). Students' Views on Strategic Note-taking and its Impact on Performance, Achievement, and Learning. *International Journal of Instruction*, *13*(2), 1-16.

Salim Nahdi, D., & Gilar Jatisunda, M. (2020). Conceptual understanding and procedural knowledge: A case study on learning mathematics of fractional material in elementary school. *Journal of Physics: Conference Series*, *1477*(4), 042037. https://doi.org/10.1088/1742-6596/1477/4/042037

Sanchez, O. (2022, April 6). *After the pandemic disrupted their high school educations, students are arriving at college unprepared*. The Hechinger Report. https://hechingerreport.org/after-the-pandemic-disrupted-their-high-school-educations-students-are-arriving-at-college-unprepared/

Schneeweiss, N., & Gropengiesser, H. (2021). The Zoom Map: A New Graphic Organizer to Guide Students' Explanations across the Levels of Biological Organizationn. *Journal of College Biology Teaching*, *47*(1), 3-13.

Shakerdge, K. (2021, April 8). *High failure rates spur universities to overhaul math class*. The Hechinger Report. https://hechingerreport.org/high-failure-rates-spur-universities-overhaul-math-class/

Shannon, L., Cosby, A., Rentz, B., Henschel, M., Arens, S., & Crowder, M. (2002). Demographic and academic characteristics associated with college readiness and early college success in the Republic of the Marshall Islands (REL 2021–072). U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Pacific.

Shell, M. D., Strouth, M., & Alexandria, A. M. (2021). Make a Note of It: Comparison in Longhand, Keyboard, and Stylus Note-Taking Techniques. *Learning Assistance Review*, *26*(2), 1-21. http://www.nclca.org/tlar

Shell, M. D., Strouth, M., & Reynolds, A. M. (2021). Make a Note of It: Comparison in Longhand, Keyboard, and Stylus Note-Taking Techniques. *Learning Assistance Review*, *26*(2), 1-21.

Siaw, E. S., Shim, G. T., Azizan, F. L., & Shaipullah, N. M. (2021). Understanding the Relationship Between Students' Mathematics Anxiety Levels and Mathematics Performances at the Foundation Level. *Journal of Education and Learning*, *10*(1), 47-54. https://doi.org/10.5539/jel.v10n1p47

Singh, P., Hoon, T. S., Rasid, N. S., Md Nasir, N. A., Han, C. T., & Rahman, N. A. (2016). Teaching and learning of college mathematics and student mathematical thinking: are the lines of the same track? *Asian Journal of University Education*, 65-78.

Sousa, D. A. (2016). *How the Brain Learns* (5th ed.). Corwin Press. https://perpustakaan.gunungsitolikota.go.id/uploaded_files/temporary/DigitalCollection/ZDdhMTYzZDY2OWJjYmU3OWRlYTk3MDVhZDllYjQ5MjhmNDFmNmMxNQ==.pdf

Sreenivasan, H. (2019, May 14). *Many college students struggle to pass remedial math. Do they need to?* Https://www.pbs.org/newshour/show/many-college-students-struggle-to-pass-remedial-math-do-they-need-to

State of Victoria. (2021, August 12). *Issues and challenges in addressing connections between numeracy and mathematics in schools*. Department of Education and Training Victoria. https://www.education.vic.gov.au/school/teachers/teachingresources/discipline/maths/Pages/research_connectionsbetweennumeracyandmaths_issues.aspx

Student support services. (n.d.). Hinds Community College. https://www.hindscc.edu/student-support-services

Taber, K. S. (2019). Experimental research into teaching innovations: Responding to methodological and ethical challenges. *Studies in Science Education*, *55*(1), 69-119. https://doi.org/10.1080/03057267.2019.1658058

Tamur, M., Jedadus, E., Nendi, F., Mandur, K., & Murni, V. (202). Assessing the effectiveness of the contextual teaching and learning model on students' mathematical understanding ability: a meta-analysis study. *Journal of Physics: Conference Series, 1657*, 1-9. https://doi.org/10.1088/1742-6596/1657/1/012067

Thompson, V. (2018, June 25). *How is mathematics used in other subjects?* Sciencing. https://sciencing.com/how-is-mathematics-used-in-other-subjects-9861185.html

Thornton, S., & Hogan, J. (2004). *Orientations to numeracy: Teacher's confidence and disposition to use mathematics across the curriculum*.

Tout, D. (2020, October 21). *Why numeracy and mathematics both count*. Teacher Magazine. https://www.teachermagazine.com/au_en/articles/why-numeracy-and-mathematics-both-count

Traina, A. (2008). *Unit three- Utilizing graphic organizers in the classroom*. KNILT. https://knilt.arcc.albany.edu/Unit_Three-_Utilizing_Graphic_Organizers_in_the_Classroom

Treisman, U. (2020, October 24). *Math pathways*. Complete College America. https://completecollege.org/strategy/math-pathways/

Tureniyazova, A. I. (2019). Using graphical organizers in the teaching process of ICT. *Research in Social Sciences and Technology, 4*(2), 31-40. https://doi.org/10.46303/ressat.04.02.3

Ufheil-Somers, A. (2019, June 24). *Math education impacts equity and college success*. College Futures Foundation. https://collegefutures.org/insights/finding-new-formulas-math-education-impacts-equity-and-college-success/

University of Massachusetts Dartmouth. (2020, December 2). *Why take notes?* UMass Dartmouth. https://www.umassd.edu/dss/resources/students/classroom-strategies/why-take-notes/

Veerasamy, A. K., Laakso, M., & D'Souza, D. (2021). Formative assessment tasks as indicators of student engagement for predicting at-risk students in programming courses. *Informatics in Education*. https://doi.org/10.15388/infedu.2022.15

Venezky, E. (2018, May 4). Why U.S. students are bad at math. *U.S.News*. https://www.usnews.com/news/best-countries/articles/2018-05-04/commentary-heres-why-the-united-states-is-so-bad-at-math

Vigor, J. L. (2012). *Solving America's mathematics education problem. American Enterprise Institute for Public Policy Research* [Doctoral dissertation]. Eric Institute of Education Sciences.

Vinikas, I. (2022, July 12). Independent learning: What it is and how it works. *Video Platform | Kaltura*. https://corp.kaltura.com/blog/independent-learning/

Wang, X., Mayer, R. E., Zhou, P., & Lin, L. (2021). Benefits of interactive graphic organizers in online learning: Evidence for generative learning theory. *Journal of Educational Psychology*, *113*(5), 1024-1037. https://doi.org/10.1037/edu0000606

Watson, K. L. (n.d.). *Examining the effects of College Algebra on students' mathematical dispositions* [Master's thesis]. https://scholarsarchive.byu.edu/cgi/viewcontent.cgi?article=6600&context=etd

Waude, A. (2017, January 17). *Cognitive load theory: How 'Cognitive load' affects memory*. Psychologist World | Psychology News, Tests, Theories and Guides. https://www.psychologistworld.com/memory/cognitive-load-theory

Wenceslao, P. (2022). Mathematical readiness of freshmen engineering students (K-12 2020 graduates) in eastern Visayas in the Philippines. *Asian Journal of University Education*, *18*(1), 191-204. https://doi.org/10.24191/ajue.v18i1.17187

Weston, E. (2019, February 12). *Reading and math connection • Children's educational consulting LLC*. Children's Educational Consulting LLC. https://cecsolution.com/reading-literacy-and-math-are-connected/

What Works Clearinghouse, Institute of Education Sciences, U.S. Department of Education. (2022, January). Growth Mindset Interventions for Postsecondary Students. https://whatworks.ed.gov

Williams, S. P. (n.d.). *Math emporium model: Preparing developmental students for College Algebra* [Doctoral dissertation]. ttps://aquila.usm.edu/dissertations/417

Williams, T. (2021, June 14). Why is quantitative research important? *GCU*. https://www.gcu.edu/blog/doctoral-journey/why-quantitative-research-important

Wilson, K. E. (2015). *THE IMPACT OF INTERACTIVE SCIENCE NOTEBOOKS ON MIDDLE SCHOOL STUDENTS* [Unpublished master's thesis]. California State University, Stanislaus.

Wise, M., & Cooper, C. (2019, January 22). *Increasing the value of graphic organizers*. Edutopia. https://www.edutopia.org/article/increasing-value-graphic-organizers

Wise, R. (2022, April 9). *How to use graphic organizers to improve academic skills*. Education and behavior. https://educationandbehavior.com/how-to-use-graphic-organizers-to-improve-reading-comprehension-writing-listening-note-taking-and-study-skills/

Wist, C. C. (n.d.). *Putting it all Together; Understanding the Research Behind Interactive Notebooks* [Master's thesis]. https://knilt.arcc.albany.edu/images/d/d0/Interactive_Notebooks_Research.pdf

Wriston, J. (2015). *The importance of a strong mathematical foundation*. Honors Research Projects. 177. ideaexchange.uackron.edu/honrs_research_projects/177

Yadav, S. (2019). ROLE OF MATHEMATICS IN THE DEVELOPMENT OF SOCIETY. *IJRAR INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS*, *6*(4), 295-298. https://ijrar.org/papers/IJRAR19S1037.pdf

Yeh, C. Y., H. Cheng, H. N., Chen, Z. H., Y. Liao, C. C., & Chan, T. W. (2019, March 11). *Enhancing achievement and interest in mathematics learning through math-island*. Research and Practice in Technology Enhanced Learning. https://telrp.springeropen.com/articles/10.1186/s41039-019-0100-9

Zakrajsek, T. (2021, October 4). *Cognitive load: A fundamental key to student learning*. scholarlyteacher. https://www.scholarlyteacher.com/post/cognitive-load-a-fundamental-key-to-student-learning

Zike, D. (2003). *Dinah Zike's teaching mathematics with foldables*. Glencoe/McGraw-Hill.