Effective Note-Taking Strategies In The High School Math Classroom

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EFFECTIVE NOTE-TAKING STRATEGIES IN THE HIGH SCHOOL MATH CLASSROOM

by

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A capstone submitted in partial fulfillment of the requirements for the degree of Masters of Arts in Education.

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CHAPTER ONE

Introduction

Overview

Whenever I envision a classroom, I see desks full of students, a teacher at the blackboard or whiteboard, and student engagement in what is being taught. One common theme among many of my visions and many of the pictures that are out there of classrooms is that the students are writing down what is being taught. Students may be using a chalk slate, a piece of paper, a notebook, or an iPad; however, they are writing down what is being taught. Note-taking is such a common event in classrooms yet so many students dread taking notes. The other day I mentioned taking notes to my Algebra students and they gave me the “Do we have to do this look?” Note-taking is a part of every class in high school and over the years, I have heard many negative comments about it.

My goal for this research is to answer the question: *How can I implement effective note-taking strategies to improve my students’ performance on assessments?* I believe this will help my students develop better attitudes towards mathematics as well as other subject areas. I also believe effective note-taking will also improve student recall of important vocabulary.

Throughout the following sections of this chapter, I will discuss my personal history with note-taking as a student, and as an educator. I will discuss strategies I have used, as well as strategies used by other educators within my department and within my school.
Personal History with Note-Taking

I remember taking notes in middle school and high school. I never recall being told to go back and study them or pair up in groups of two or three to discuss them with other classmates. This was especially true in math class. The overhead projector was where the teacher modeled note-taking. We were told to place the date in the upper right-hand corner and the section number on the top of the page. Sometimes the objectives of the day’s lesson were given under the lesson heading, but this was rare. Definitions and theorems were either underlined or had asterisks placed next to them for emphasis to indicate they were important and that the students would be using those items on a regular basis. Sometimes examples were shown under the definitions and theorems and sometimes referenced before tests or quizzes.

In English class we had Cornell notes. This was my first real experience of what note-taking should look like. The notes were organized and could easily be studied when reviewing for a test. My English teachers really pushed good note-taking. However, my math and science teachers did not. This left me wondering whether or not good note-taking was really important in math and science? Classmates of mine never talked much about reviewing their notes. Notes seemed like an abbreviation of the material that was covered in the books. I had it in my mind that I would only go to my notes when I wanted a quick reference.

My notes were never very neat or organized. Most of the time I had a hard time deciphering my own notes. I had a notebook but there was not a separate section for notes. Notes and assignments got mashed together into one big mess. This caused great confusion for me and upset a number of my teachers when they had to correct homework
assignments. This process continued well into my college years. In college, professors assumed their students knew proper note-taking and therefore did not stress notes. I never kept my notes from any of my classes. Notes felt like a way to key in on what the teacher wanted, but they never felt very personal to me. Even the definitions given in the notes felt very contrived. Notes were the last thing to come out of my bag and the first thing to go into the trash can after the chapter was completed or the course was finished.

**My Use of Note-Taking in the Classroom**

In the fall of 2007, I started teaching at the same high school that I had attended. That first year many of my teaching techniques were taken from the very same teachers who had taught me years earlier. This was especially true when it came to giving notes. Notes were given out via the overhead projector. However, I made some minor adjustments. The date was placed in the upper right-hand corner of the page. Instead of listing the section number on the top of the page, I gave the main topic that we would be covering that day. Underneath the main topic, there were two or three main objectives to serve as guides for the students. These objectives were and still are to this day, based on the Minnesota State Mathematics Standards. The definitions and theorems were, and still are, underlined to place emphasis so that students realize they will be using them frequently.

When I started teaching, definitions were taken out of the book. This has changed over the years to a more student-driven or class-led definition. Underneath the notes, I would give out one or two example problems to show the class. This was, and still is, followed by a “You Try” problem. By giving students a “You Try” problem, I found that it forces them to go back and look at their notes to see and understand how a particular
problem is solved. The “You Try” problem also keys me in on which students get the material and which ones need more one-on-one assistance. I navigate the room and help as many students as possible. This process works, but it is very time consuming. I have also found there is a time lag between students who understand how to do the problems quickly and those who need that one-on-one attention.

Student recall when it comes to definitions and problem solving algorithms has been very low. The definitions and the algorithms are in the student notes, but students are not referencing their notes. Currently, in my Algebra classes, recall on important definitions given in notes one day and referenced the next day is very low. I have seen this both in class and on exams when students are asked to match definitions with the correct word or theorem.

In addition, I notice that student interaction regarding methods of solving with their notes is extremely low. They will go through the motions of taking notes in class; however, I seldom see students referencing these notes. Top students will go back through their notes, but my average or lower ability students will not. What is very frustrating is when students ask whether they need to save their notes from the previous unit. Many students want to discard notes immediately. This originally came as a shock until I reflected back to my own feelings on note-taking as a student. If I had the same feelings as a student, why should my students’ feelings be no different. Notes seem to be just a way to place information into their short-term memory for a particular unit. I knew something had to be done to get my students more engaged in using their notes.
AVID Training and Presentation on Note-Taking

In 2013, our school was introduced to the AVID (Advancement Via Individual Determination) program (AVID, 2012). The program stresses holding students to high standards while providing academic and social support. During the summer of 2015, I was asked to go to AVID training in St. Paul. There were many great strategies that were stressed there, but the one that I remember most was on note-taking. The presenter told me that average students would forget what is being taught to them unless they interact with their notes multiple times. The more times students interact with their notes, the greater the chance they will remember the material. These interactions could include think-pair-share with a partner, highlighting parts of the notes, or having the students give summaries at the end of the note-taking process. This idea of good note-taking was further emphasized by our AVID coordinator the following fall during teacher workshop. Many of my major concerns about student recall and interaction in note-taking were addressed. The presentation also had some research and graphs to back up the fact that effective note-taking was crucial in getting students to recall the material. I was immediately hooked and knew I had to do everything I could to effectively use note-taking in my classroom.

This work with AVID led me to this capstone question: What effective note-taking systems for mathematics have been researched? My main goal is to explore the written literature and find the proper strategies that will increase student achievement. This literature will also inform me as to ways to properly implement the strategies in the classroom.
Benefactors of My Research

There are many people who will benefit from my research, but one of the most important will be me as a teacher. I will grow as an educator because I will become better at delivering and teaching note-taking. I will also, as a result, become a better note-taker myself. These are some of the reasons I chose this as an action research project. The students will benefit in that they will now become better note-takers. They can now confidently use their notes for immediate success in my class. This will spill over to other classes. In college, my students may continue to use my strategies to maximize their success. Students can gain a new mindset when it comes to taking notes and see it as a method to reflect on what they have learned for the day. Perhaps, they can use it as a short five-minute review of what they talked about that day.

Younger siblings of my students will benefit in watching their older brother or sister use class notes. This may, in turn, get them to start using their notes in a similar way. Before they get into high school, they will be using effective note-taking strategies.

My colleagues in the math department will benefit from this research as well. I have seen a number of different strategies used throughout my department. However, in-depth research on how to use note-taking strategies effectively has not been done. My peers will be interested in what I am doing and may use my research as a platform to launch into other possible studies on note taking. I foresee my colleagues tweaking my research to fit the needs of their students.

My school will benefit from my research on note-taking. Effective note-taking in the classroom is an intervention strategy, a test improvement method, and a possible way to help close the achievement gap between our students. This research will be something
that can be presented at staff meetings at the beginning of the year. The other
departments may modify the research to fit the needs for their respective subject areas.
The entire school therefore benefits.

**Summary of the Chapter**

Throughout this chapter, I outlined my history with note-taking both as a student and professionally as a teacher. I introduced my thinking that note-taking is many times viewed as a mundane activity by students. They think they are simply copying what is in the text. This does not have to be the case. The students can get a deeper appreciation for taking notes they will use to study for tests, not just in math class, but in other classes as well. In the following chapters, I will investigate how to use note-taking effectively in the classroom. I will do this by researching different forms of note-taking, the action steps I must take to get students to buy into note-taking, and what other teachers have done with note-taking strategies that have worked well to improve student performance on assessments.

Chapter Two will look at the important literature pertaining to note-taking. The chapter will begin by looking at the benefits of note-taking. It then will discuss multiple note-taking strategies including Cornell notes, various graphic organizers, and guided notes. The final part of the chapter dives into how to properly implement note-taking in the “before-during-after” classroom process.
CHAPTER TWO

Literature

Introduction

This chapter discusses literature that answers the question, *How can I implement effective note-taking strategies to improve my student's performance on assessments?* This research will be used to develop an action research plan for this capstone. It combines information from top researchers in the area of note-taking as well as published teachers who give notes on a routine basis in their courses.

This chapter explores the research on note-taking in the classroom. The first section explains how note-taking benefits students in the areas of encoding and externally storing the information from lectures for purposes of review and reflection before assessments. Data from various studies will be used to support these benefits. The literature review then discusses reflective note-taking strategies such as Cornell, graphic organizers, and guided notes for students. The review then describes how to implement note-taking strategies in the classroom. This section includes tips and advice from published educators on what has worked when they have given notes in their classrooms. The last section of the chapter provides a summary and a preview of the upcoming chapter.

Strategies that Affect Student Achievement

Educators are always looking for strategies that will help students achieve. However, many are left with the following question: What strategies can I use that will affect student achievement? Marzano, Pickering and Pollack, (2001) provide a list of nine strategies that affect student achievement. Two of the top strategies on that list were
homework/practice and note taking. These two strategies are commonly used in many high school subject areas, including mathematics, around the country.

According to Cooper, Robinson and Pattell (as cited in Cheena and Sheridan, 2015), the traditional definition of homework is that it is any task that the instructor gives their students to complete after school. However, this definition may not be completely accurate since many students work on homework tasks within the class period. Therefore, homework has now been defined as any activity that should be completed during the time the teacher is not teaching (Benbenutty, as cited in Cheena and Sheridan, 2015). Two common purposes for homework are to prepare students for new material that will be covered and to have them practice on the material that has been introduced (Marzano, Pickering, and Pollack, 2001). Students achieve through the use of homework when they complete their assignments and the teacher provides feedback to them.

Another strategy that greatly affects student achievement is note-taking. Lecturing is still a very common practice in today’s secondary and post-secondary classrooms. In fact, college students spend roughly eighty percent of their weekly time listening to lectures (Armbruster, as cited in Titsworth, 2004). This means that note-taking is then a common method students can use when listening to a lesson.

**Benefits of Note-Taking**

**The Encoding Effect.** Many people believe taking notes provides a written record of the information you want to remember for taking examinations. Note-taking in this role serves the important function of copying the information and displaying it into something usable, either during that class period or afterwards. Students are transferring their memories to an external source such as a paper or piece of technology. DiVesta and
Gray (1972) state that this encoding function of note-taking is the process of coding, integrating, and transforming the important information from the lecture into a meaningful form. Students do this when they translate what is being said into something that makes sense to them. The effects of this function can be seen by looking at recall and academic achievement of the information presented by those learners who took notes, but did not review them, to those who did not take any notes (Wetzals et al 2011). Kiewra (1987) concluded that the amount of note-taking from a single lecture positively correlated with the performance on a test strictly pertaining to that lecture. For this reason, note-taking is effective and beneficial when the learner paraphrases, organizes, and makes sense of the information (Bretzing and Kulhavy 1979). However, to what degree encoding benefits the learner is not the same. Note-taking is not as effective if the student writes the lecture notes verbatim. Studies by (Kiewra 1985; Kobayashi 2005) show that verbatim note-taking has minimum value unless it is used as a platform and later paraphrased and reorganized. When students are trying to record everything that is heard, that recording process takes up a lot of the student’s working memory leaving them without any room to analyze the incoming information (Marzano, Pickering, Pollack, 2001).

The external storage function. Another benefit of taking notes is that it gives the student a written record of what has been discussed during the lecture. DiVesta and Gray (1972) say that note-taking serves as an external storage function by having notes available for review after the lecture and that this is beneficial to the student. This is particularly important because if there is no record of what was talked about during the lecture, then review of what was said will not be possible. Hughes and Suritzsky (1991)
believe note-taking serves as an external storage function because it preserves content and allows for revisions and review. According to Kiewra (1984), note-taking improves student recall of important information. Kiewra (1991) showed that students who took notes and used them for review were able to perform better on a free recall assessments better than those who strictly encoded verbatim and those did not take any notes at all. In this study Kiewra took ninety-six undergraduate students and broke them up into three groups. Twenty-four of those students simply took notes on the material verbatim, twenty-four of the students did not take notes but used someone else’s to review afterwards, and forty-eight students took the notes and reviewed them afterwards. The students were then given a cued recall assessment afterwards. McPherson (2007) defines free recall as remembering information without being given prompts such as writing an essay on the topic and defines cued recall as remembering in response to prompts. The group that performed the best on the cued recall exam were the twenty-four students who took the notes and reviewed them afterwards. Henk and Stahl (1985) similarly conclude that it is the reviewing of the notes that promotes recall rather than the process of taking notes itself. Note-taking enhances learning by getting the note-takers to actively process the material given and relate it to their own existing knowledge (Bretzing and Kulhavy 1979). Peper and Mayer (1978) similarly state that note-taking enhances learning if the learners can actively process the material and relate it to prior knowledge. This process of relating material to prior knowledge is called generative processing. Learners do this when they write summaries, draw graphs, and make conclusions during notes. According to Kiewra (1991), most of this generative processing does not necessarily occur during the lecture since students are continuously and simultaneously trying to listen, copy,
manipulate important ideas, and process what is being said. This further justifies the value of external storage because much of students’ processing of the notes occurs after the lecture is complete.

**Notetaking Strategies**

There are many note-taking strategies that have been used throughout the years. There is no correct strategy of taking notes. Different students might prefer different note-taking strategies (Marzano, Pickering, and Pollack, 2001). The note-taking strategy may depend on type of learner, the subject area, or the topic of the lesson. This review will discuss the Cornell note-taking strategy, graphic organizers, and guided notes.

**Cornell Note-taking.** This system of taking notes was developed by professor Walter Pauk in the 1950’s and was discussed in his book *How to Study in College*. The Cornell method is known for its two-column system with the left column taking up one-third of the page and the right column taking up two-thirds of the page. The right column is the note-taking column and is used to “capture the lecturer’s ideas and facts” (Pauk, 2005, p. 207), where students take notes during the lesson. The left column is called the cue column and is not filled in during the lecture (Pauk, 2005). After the note-taking session, students review their notes and create questions that will create meaning, highlight the main ideas, and develop relationships between the concepts. Writing questions in the cue column, according to (Pauk, 2005), helps students clarify students’ meanings, bring relationships between the ideas to light, and strengthen the students’ memory. This column can also be used to reflect after the lesson. Some examples of this could be: How does this material relate to what I already know?, How could I apply this to other ideas?, and Why is this significant?. This column could also be used as a review
before tests and quizzes (Paulk, 2005). The learning strategies center at Cornell
University recommends that students take at least ten minutes every week to study these
notes. The bottom summary area is used to sum up the main points discussed on that
page in a couple of sentences.

Cornell notes have been shown to be beneficial to students. Faber et al. (2000)
conducted a study on 115 students, sixty-one who were taught how to take Cornell notes.
This study showed that students who were taught this method scored significantly better
on teacher created objective tests than those who were not taught Cornell notes. Students
using the Cornell note-taking system in their ninth and tenth grade science classrooms
scored 10%-12% higher than students the previous semester (Donohoo, 2010). AVID
(Advancement Via Individual Determination), a global organization that is concerned
with closing the achievement gap and preparing students for college, included the Cornell
note-taking method as part of their successful curriculum (AVID, 2012).

**Graphic Organizers**

Graphic organizers are another note-taking strategy teachers use in the classroom.
A graphic organizer is a strategy that organizes information and encourages thinking
about the relationships between concepts (Zollman, 2009). Brackett (2004) defines
graphic organizers as drawings that contain words or numbers. Graphic organizers create
a bridge between the linguistic mode that uses words and phrases with one that uses more
symbols, pictures, and arrows to represent relationships (Marzano, Pickering, and
Pollack, 2001). The graphic organizer shows you about the relationships among things
instead of just telling you (Brackett, 2004).
Graphic organizers can be used a number of ways. They can be used before the lesson to set the foundation for new material (Brackett 2004). Graphic organizers used in this way help the student recall what they already know about the subject and how it connects with the new material. Graphic organizers may also be used during the lesson to organize student thoughts. Zike (2003) states that graphic organizers can replace teacher generated notes or photocopied notes with one that is specifically student created and more visual. Graphic organizers have also been used during vocabulary instruction and have been shown to be effective when teaching technical vocabulary (Moore and Readance, as cited in Monroe 1998). During reading instruction, graphic organizers can help ELL students understand what they are reading in a story by classifying information, analyzing the problems that occur during the story, and summarizing main ideas (Pang, 2013).

There are many types of Graphic Organizers. The graphic organizers that will be discussed are Foldables, the Four Corners and Diamond organizer used in math classes, and Mind Maps.

**Foldables.** Foldables are defined as 3-dimensional graphic organizers that take information and data and make it visual and kinesthetic for the learner (Giles and Parscale, 2017). Not much literature has been found on foldables other than the books by educational consultant Dinah Zike. Sheets of paper are cut, glued, or folded according to the type of topic and the skill that is demanded for that topic (Zike, 2003). For example, a comparison and contrast of parallel and perpendicular lines would require two folds, where as a KWL on a certain topic would require three folds. Foldables can also be created to form a book or half book about the topic or chapter. The main idea of the
lesson is written on the outside tabs and facts and details that go along with that idea are written on the inside under the tabs. Information is chunked this way and students are then encouraged to question what is being taught while the foldable is being created (Giles and Parscale, 2017).

The benefits of foldables are that they quickly organize, display, and arrange information for students (Zike 2003). NCTM’s Curriculum and Evaluation Standards states, “The assessment of students’ ability to communicate mathematics should provide evidence that they can express mathematical ideas by speaking, writing, demonstrating and depicting them visually” (NCTM, 1989, p. 214). Foldables can be created by students to make their own math journals for recording main ideas, for solving problems, for questions that come up during class, and for sharing their personal story that occurs during learning (Zike, 2003). The journals created could be short trifold books that only require three folds or a larger accordion style book that requires multiple folds.

**Four Squares and a Diamond.** A common graphic organizer that is used in many math classrooms is the four corners and a diamond graphic organizer shown in Figure 2.1. This organizer is a slight variant of the four squares and writing graphic organizer described in a book by Gould and Gould (Zollman, 2009). The organizer is broken up to five main areas:

1. What problem are we trying to solve?
2. What information is given?
3. What are some methods that could be used to solve the problem?
4. Try a method and show your work.
5. What did you learn by solving this problem?
Figure 2.1 Four Squares and a Diamond

The four square and diamond graphic organizer is based on George Polya’s four procedure problem solving process (Zollman, 2009). The great thing is that students can start in a non-linear fashion at any particular portion of the organizer and still get to the same end result. The students can work in pairs when using this graphic organizer or they can work alone. Zollman (2009) encourages teachers to model use of the organizer and have the students work in groups at the beginning.

The four square and a diamond graphic organizer was used in an action research study conducted by nine middle school teachers (Zollman, 2009). Students were given a pre-test and a post-test to see the effectiveness of the four squares and a diamond organizer. Students of all nine teachers showed dramatic improvement on open-response questions from the pre-test to the post-test (Zollman, 2009). The nine teachers also found the graphic organizers to be effective for levels of students. Even the low level students were giving partial solutions to problems that they would not even have attempted before (Zollman, 2009). The students now had an efficient method for writing and communicating the mathematics they learned in class.
Mind Maps. The term mind map was popularized by brain psychologist Tony Buzan in the early 1970’s (Brinkman, 2003). A mind map is a diagram where the key topic is displayed at the center of a blank page with picture or drawing. That image is then connected to other ideas and concepts associated in a graphical pattern as shown in Figure 2.2.

![Mind Map Diagram](https://mathspace.co/learn/world-of-maths/algebra/rewriting-expressions-14598/changing-words-into-numbers-803/)

Major ideas and concepts associated with the key topic may be represented by pictures as well as words. Buzan (2005) compares a mind map to a city map where the center of the map or main idea represents the center of the city, and all other important ideas, which are represented by buildings, are connected back to that center. Additional details can then branch off from those important ideas. Each of the main themes is only to the single key topic and not to any other. According to McPherson (2007), this is one of the major differences between mind maps and concept maps.

To construct a mind map, Buzan (2005) outlines a seven step process. First, Buzan states that the individual should start in the center of the page. This makes sense since it gives the individual space to branch freely. The second step, according to Buzan, is to draw that key topic using an image or picture. This image is whatever the person creating the map associates with that topic. Buzan suggests for the third step that the
individual use colors so that the images are more real. The fourth step is to connect the main branches to the central image and the second and third to your first and second levels. Buzan (2005) states that the mind map creator should do this because the brain works by association, and by linking things together it will help in understanding and remembering things. The fifth and sixth steps according to Buzan are to make sure that the line connections between ideas are curved and to use only one key word per line. Finally, the seventh step is to make sure to use additional colors. This relates back to step three and helps the images come to life.

There are many benefits to using mind maps. McPherson (2007) believes mind mapping can help generate ideas during brainstorming. Using mind maps for brainstorming according to Brinkman (2003) can be very beneficial during the problem-solving process. Another benefit to mind maps is that they help the student organize information (Brinkman 2003). The openness of the mind map helps the students see how the main ideas are connected. In many instances, mind maps are used as a memory aid (Brinkman 2003). For example, a student may use a mind maps for a quick review to check that they have all of the main points down before a test. Goldberg (2004) believes one of the reasons memory is improved by mind maps is because the physical process involves kinesthetic learning. Another benefit of mind maps is that they can help in a visual way to connect new information with existing knowledge (Brinkman 2003). For example, new information in a geometry class about different kinds of figures can be added to an older map created in the previous unit. Buzan (1976) believes one of the chief reasons mind maps are so useful is that they connect both the right and the left sides of the brain. The imaginative right side of the brain that is shown with pictures of color
is connected through the map to the logical left side of the brain. Abi – El-Mona and Adb-El-Khalick (2008) conducted a study using sixty-two eighth grade science students to assess the mind map as a learning tool and to see if the maps affected the students’ conceptual understanding. The students were broken up into two groups. One of the groups was taught using mind maps while the other was not. The mind map group scored significantly higher on the multiple choice test given at the end of the unit and showed greater conceptual understanding than the other group. In fact, the groups who used mind maps scored an average of fifteen points higher on both the conceptual understanding and practical reasoning portions of the test (Abi – El-Mona and Adb-El-Khalick (2008).

There are some limitations to using mind maps. McPherson (2007) states that mind maps insistence on images is not for everyone because images are more ambiguous than words. A student’s display of the key topic and its main points may look very different than someone else’s. Another drawback of mind maps is that since they are very personal, they don’t tend to be very easy to share because they are reflections of the individual who created them (McPherson 2007). Brinkman (2003) believes since mind maps connect the key topic to the main points with only one branch, students fail to see relationships between the main points. Brinkman gives the example of solving a pair of simultaneous equations. There is a graphical and then an algebraic piece to this key topic. Without connecting these two main ideas, the students will not see the entire scope. Brinkman and McPherson both feel that in circumstances where the main ideas need to be connected to each other, concept maps would be better.

Guided Notes. Guided Notes are one strategy that has been proven successful in increasing the accuracy of students’ notes (Lazarus, 1991). Heward (1994, as cited in
Konrad et al. (2009) defined guided notes as teacher prepared handouts that ‘guide’ the student through with standard cues and prepared space in which to write the key facts, concepts, and/or relationships” (p. 304). The teacher outlines the lesson for the student before the lesson and creates a handout for the student to fill in missing information during the lesson. An example of this can be seen in Figure 2.3.

![Image](image.png)

**Figure 2.3 - From Hamilton et al. (2000) page 137**

The student can then actively listen to find out what information is important and record it without having to do an excessive amount of writing (Montis, 2007).

There have been numerous studies that have been done to show the effectiveness of guided notes. Hamilton et al. (2000) used guided notes with seven incarcerated adolescent students in a social studies class. Hamilton et al. (2000) measured students’ accuracy of notes and their scores on daily quizzes. The results of this study were that accuracy improved from an average of 35.7% to an average of 84.6%. Students in this study also improved on their quiz performance by an average of three points (Hamilton et al. 2009). A questionnaire given showed that students preferred using guided notes and that their grades improved (Hamilton et al. 2000). Sweeney et al. (1999) also found guided notes improved accuracy and quiz performance when they were given to at-risk students.

**TABLE 1. Sample of Guided Notes**

<table>
<thead>
<tr>
<th>Event</th>
<th>Guided Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>William Still was run by Still.</td>
<td>Of all the stations was run by Still.</td>
</tr>
<tr>
<td>Acting as conductor of the Underground Railroad was</td>
<td>During his life as an official of the society, William Still was run hundreds of times to</td>
</tr>
<tr>
<td>He was originally from</td>
<td>He kept his big house of the fugitives so that might locate them.</td>
</tr>
<tr>
<td>He helped organize and finance a “social, civil, and statistical association” to</td>
<td>For a time these records were kept in a</td>
</tr>
<tr>
<td>He was one of the</td>
<td>By his count:</td>
</tr>
<tr>
<td>He taught himself to</td>
<td>His</td>
</tr>
<tr>
<td>In he left his family’s farm in New Jersey and moved to Philadelphia.</td>
<td>He was elected of the Pennsylvania Abolition Society.</td>
</tr>
<tr>
<td>In he was elected</td>
<td>Acting as conductor of the Underground Railroad was</td>
</tr>
<tr>
<td>Through his efforts an _ was set up in Philadelphia.</td>
<td>He helped organize and finance a “social, civil, and statistical association” to</td>
</tr>
<tr>
<td>He was one of the</td>
<td>He was one of the</td>
</tr>
<tr>
<td>He remained</td>
<td>the for his people in America.</td>
</tr>
</tbody>
</table>

In 1902.
during a summer class. A meta-analytic review of guided notes done by Konrad et al. (2009) examined eight published studies on guided notes and found that guided notes consistently showed positive effects on learning and note-taking accuracy. According to Konrad et al. (2009), outcome performance improved when guided notes were mixed with structured review activities.

Guided notes can be a low-cost and efficient method to help teachers get students actively engaged during their lectures (Konrad et al. 2009). To do this, (Heward 2001, as cited in Konrad et al. 2009) recommends teachers use the following steps when creating guided notes. First, Heward recommends that teachers look at an existing outline of their notes or create one where students are focusing on important content presented during the lecture. For example, a teacher-created outline of a math lesson on parallel and perpendicular lines should have the important information that the teacher wants the students to know about those lines. Heward suggests keeping the number of key points to a minimum in the outline. This outline can be created using multiple presentation formats such PowerPoint, smartboard technologies, etc. (Heward 2001, as cited in Konrad et al. 2009). This type of format according to Heward will make the key facts, definitions, and concepts more visual for the learner and improve the pace of the lesson. Teachers should then create a handout for students where the important information is left out for the students to fill in (Konrad et al. 2009). Heward suggests leaving plenty of space for the students to write their responses but not having the students write too much. This according to Konrad et al. (2009) will increase student engagement in the lecture.

There are many ideas that can get students more interested in taking guided notes. Students may like guided notes because they require less effort (Konrad et al. 2009).
However, according to Konrad, some students may need training on how to use guided notes and others may need additional teacher contingencies in place to promote the note-taking. For example, a teacher may randomly collect the notes at the end of the lesson and assign points. This may keep students questioning whether the teacher will collect their notes. The teacher may give students short quizzes over the previous day’s material where the students can use their notes. Konrad et al. (2009) suggests that students may be also given extra credit points. This may push students to use their notes as more of a reward.

**Implementing Note-taking in the Classroom**

**Before Note-Taking.** At the beginning of the school year one thing teachers must do is have the required materials listed in the syllabus. Eades and Moore (2007) suggest that some required materials students need before taking notes are a three-subject notebook, a writing utensil, and calculator. The syllabus can be used to show parents during open house at the beginning of the year and at conferences during the course of the year.

According to Weishaar and Boyle (1999) the importance of notetaking needs to be stressed early. They suggest that it may be useful to lead a discussion on notetaking and how it will help students succeed. Weishaar and Boyle use the analogy of a carpenter that carries a toolbox to his job. They say that a carpenter would not be successful without a toolbox or not knowing which tool to use for each task. In the same way, students must be also be stressed the importance of note-taking. Videos may be used, TED talks, studies on note-taking, and teacher enthusiasm and personal relation with the subject should be addressed (Fisher and Frey, 2014). For many students, according to Weiman (2011) referring to their notes seems like they are admitting to everyone that they are a failure when others can recall the material immediately. Weiman believes that it is important to
debunk the belief that the students who struggle are the only one who use their notes. Chandler (2016) states that to change students’ perceptions of note-taking, we as educators should help them to understand and experience the process. However, Weiman states that changing student perception of notes takes time. One thing teachers can do is set contingencies for taking notes in place. Some students may need these to reinforce taking notes. Examples of these may include telling students that notes will be part of their formative grade, that notes will be looked at weekly, or that notes can be used as an aid on tests or quizzes.

It is important that the teacher explains what note-taking strategy or strategies they will use (Weishaar and Boyle, 1999). It is important for students to know why and how they will use their notes (Frey and Fisher 2014). Frey and Fisher 2014) suggest that it is important for the teacher to devote time to the subject of note-taking. This can be done continually throughout the year.

Teachers should model through guided instruction when going through the major parts of the note-taking process. Eades and Moore (2007) believe that at first the teacher should slowly go through this process so that the students can get a good representation of the style, order, and content of good note-taking. This can be done on an actual math lesson or a fictional practice lesson created by the teacher to teach note-taking. This may take a day or a week. Weiman (2011) spent a week teaching note-taking to his students. There is no agreed upon optimal amount of time to do this. Students should know how to set up their notebook, state the objectives, and write summaries of a lesson in order to achieve success.
Before the lesson begins the teacher should outline the major components and key ideas of the lesson. This organizes the teacher’s lesson by stressing the key points they want the students to really understand. This organization may in turn benefit students who struggle if they get a set of guided notes from the teacher.

Some students may need a full set of notes as stated in their I.E.P. In this case, it would be wise to have a set of master notes created by the teacher to have in a binder in front of the class. This may also serve students who were absent or students who want to check their notes for additional information to be added.

**During the Note-taking Process.** There are a number things teachers can do during the note-taking process to assist students. Weishaar and Boyle (1999) suggest that students get independent practice using the note-taking technique. This practice can also occur in pairs as well. Rozalski (2008) suggests teachers teach some general strategies that will help students utilize and process the information contained in their notes. Some suggestions that Rozalski gives are Think-Pair-Share which encourages students to think silently about the topic, pair with another student to discuss their answers, and then share the most important ideas with the class. Another suggestion Rozalski gives is having students use K-W-L. Teachers can ask students to share their K-W-L’s with their partners first and then develop additional questions for the group (Rozalski, 2008). This breaks the lesson up and helps focus the attention on the students. This also gives students an additional reason for taking the notes because they now know they will be sharing them with their partner.

The teacher should ask students to listen for specific key points and ideas during the lecture so that the notes are accurate (Weishaar and Boyle, 1999). These points should
be related to the objectives of the lesson. However, students may be tempted to write down more than they need or write down everything that is stated in the lecture. This can cause the student to get too bogged down. In this case, Fisher and Frey (2014) recommends that students paraphrase the material and improve their working memories. The teacher may ask a student to put what another classmate just stated into their own words. Weishaar and Boyle also suggest that students be encouraged to use abbreviations or to create their own notations to improve speed and accuracy. Fisher and Frey agree with the importance of teaching students notations so that they understand the relationships between concepts and ideas. However, it is important not to include too many symbols because it may make the notes more difficult to decipher (Fisher and Frey, 2014).

Teachers may want to key students in on when to write concepts and lists and when to write notes in hierarchical order (Meeks, 1991). For example, students should write down the steps necessary to a certain type of problem (Meeks, 1991). Other examples may include proofs in geometry class.

Use of organizational cues are another way teachers can help students take better notes during class (Titsworth, 2004). Organizational cues are statements given by the teacher to the student that will help them understand the order or relationship of the information given in the lesson (Kierwa, 2002). Some examples of these cues are when the teacher uses “The topic is”, “Today our main objectives are”, “Then”, “In the following order”, “To Review”, and “To Summarize”. In a study conducted by Titsworth and Kierwa in 2004, students who received lesson with organizational cues were able to note more of the lesson’s main points and details than those that were not receiving the cues (Kierwa et al, 2016).
Teachers will also want to highlight and stress the important ideas, definitions, and theorems that students should study (Weishaar and Boyle, 1999). The teacher may do this by using immediacy or emphasis cues. These cues highlight and stress to the student that this is an important point and that this should be in their notes (Titsworth, 2004). These cues can be done verbally by saying, “This is something you need to know”, or “This is key”. Immediacy cues can also be done visually by placing asterisks, boldfacing, or highlighting what the student should key in on.

Providing pauses during the lecture for students is another technique teachers may use. According to Kierwa et al, (2016), pauses during the lesson are effective because they break the lesson into smaller and easier to process chunks. Providing pauses can also catch students who are slow writers up with the fast-paced word speed of the teacher. Providing pauses for students to revise their notes with a partner can also be beneficial (Kierwa et al, 2016). These pauses do not need to be very long, and as Frey and Fisher (2014) suggest, can be between sixty and ninety seconds. Students during this time can check work with a fellow classmate to see what parts they may add to their notes.

**After the lesson.** When the lesson is complete, there are a number of ways teachers can have the students use their notes. First, teachers should have students review their notes. Weishaar and Boyle (1999) suggest that students should be taught to review their lecture notes within ten to twenty minutes after the lesson or to review them after school. This importance of reviewing notes is echoed by Meeks (1991) who believes that students should go over their notes as soon as possible so that they can fill in missing information and check whether they understand what was covered in the lesson. Frey and Fisher (2014) suggest that this review can be created for students the last few minutes at end of class.
Here Frey and Fisher believe students can use their external storage function of their memories to write three sentence summaries either individually or in small groups. Students may also reflect on these summaries and share them with the class as well.

Teachers should be committed to the process and to the success of note-taking (Weishaar and Boyle, 1999). They believe that teachers should continue to train on monitor students while encouraging them. One way to do this is by having examples of student work shown around the room. Eades and Moore (2007) suggest that teachers ask volunteer students to show their notes and include them in the teachers set of master notes.

Assessing students’ notes will also be important to their success. Providing feedback for students on a regular basis will give them crucial information so that they can adjust their note-taking skills (Frey and Fisher, 2014). Teachers can do this weekly with notebook checks to see if students have the required information. To improve note-taking students will need feedback on if their notes are organized, written legibly, or if they are thorough enough (Frey and Fisher, 2014).

**Summary**

This chapter reviewed the literature on note-taking, the benefits of note-taking, different strategies used in the classroom, and ways a teacher can implement note-taking in the classroom. The chapter gave reasons as to why note-taking is important in getting students to learn mathematics. The second part of the chapter discusses the main benefits of note-taking. The third section discussed the variety of note-taking strategies from Cornell notes to the different types of graphic organizers to guided notes. It is important to identify these different strategies as some students are more visual learners and some are more kinesthetic learners. Also, it was important to include a discussion on guided
notes for students who may need or want that additional service. The last section was on how teachers can implement note-taking in the classroom.

Chapter three takes the information from the literature review to make a plan for research. The chapter will begin by looking at the research setting and subjects. It then explains the rational for conducting a study on note-taking in the mathematics classroom and explains how the researcher intends to use note-taking to improve students’ scores on assessments. The research design for this study is the concurrent mixed methods approach. The researcher will collect quantitative and qualitative data. Approval to conduct this research and collect data was given to the researcher. This process has been described in the following chapter.
CHAPTER THREE

Methods

Introduction

My literature review provided research on the various note-taking methods and the effectiveness of those methods. The review also explained why note-taking is important when it comes to lectures in class. In the following section, I will describe my action research methods on implementing two note-taking strategies to my students and how these strategies can affect student achievement. The action research is designed to answer the following question: *How can I implement effective note-taking strategies to improve my student’s performance on assessments?*

Overview

The following chapter will explain the methods used for conducting this action research. The first section describes the research setting and the subjects that will be participating in the study. The following section discusses the two note-taking strategies used and the rationale and relevance of the research plan. This section goes into detail on the importance of the two note-taking strategies and the rationale behind why these strategies might lead to student achievement. The next section talks about the research design and the methods used. This research uses a concurrent mixed methods approach and will collect both quantitative and qualitative data. Approval has been given for this action research by both the college and the high school at which this research is being done. That process is also discussed later this chapter. The last section will provide a summary of chapter three and a brief preview for chapter four.
**Research Setting and Subjects**

The action research took place in a suburban high school in the southeastern section of a large Midwestern metropolitan area with two classes of Algebra 2 with Trigonometry during the months of September through the early part of December. The school consists of students from mainly two towns that form a population of around 1800. Within the school, 75.4% of the students are white and make up the largest portion of the population. The next largest population is Hispanic students at 9%, followed by African-American students at 5.8%, and Asian students at 5.7%. Roughly 25% of the students at the high school qualify for free or reduced lunch. The school’s percentage of learning disabled students is around 16%. The demographics from my two Algebra 2 classes are shown in the table below.

Table 3.1

<table>
<thead>
<tr>
<th>Algebra 2 (Cornell Class)</th>
<th>Algebra 2 (Foldables Class)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31 students</td>
<td>29 students</td>
</tr>
<tr>
<td>18 males and 13 females</td>
<td>16 males and 13 females</td>
</tr>
<tr>
<td>Grade 9: 2 students</td>
<td>Grade 9: 2 students</td>
</tr>
<tr>
<td>Grade 10: 11 students</td>
<td>Grade 10: 11 students</td>
</tr>
<tr>
<td>Grade 11: 15 students</td>
<td>Grade 11: 13 students</td>
</tr>
<tr>
<td>Grade 12: 3 students</td>
<td>Grade 12: 3 students</td>
</tr>
<tr>
<td>Students receiving services: 2</td>
<td>Students receiving services: 2</td>
</tr>
</tbody>
</table>
**Strategies Chosen for Research**

After completion of the literature review, two note-taking strategies were chosen to be implemented within the researcher’s classroom. The first note-taking strategy chosen is Cornell notes. This strategy was chosen because it contains elements that are very visual for the students in the columns as well as very reflective in the summaries written by the students at the end. Summarizing when taking notes is an instructional strategy that has shown to have the greatest effect on student achievement (Marzano, Pickering, and Pollack, 2001). Cornell notes also serve as an effective way to review before tests because students can review the questions they created in their cue column and check to see whether they are correct in the other column (Paulk, 2005). The second note-taking strategy used is the Foldable graphic organizer. Foldables were chosen because they take information presented and make it visual and kinesthetic for the learner (Giles and Parscale, 2017). Foldables also quickly organize, display, and arrange information for students (Zike 2003). When information is organized and chunked this way, students can identify similarities and differences between the different ideas.

**Rationale and Relevance of the Research**

Identifying similarities and differences between ideas is the number one instructional strategy that affects student achievement (Marzano, Pickering, and Pollack, 2001). Another major strategy affects student achievement is in the use of cues and Graphic Organizers (Marzano, Pickering, and Pollack, 2001). Both Cornell notes and Foldables make use of these two instructional ideas. The two note-taking strategies will be implemented separately in two Algebra 2 classes to see how each one affects student achievement.
Research Design and Methods

The research design used a concurrent mixed methods approach. A concurrent mixed methods approach collects both qualitative and quantitative data. The data during the research is collected and analyzed to draw conclusions. A mixed methods approach is stronger than other approaches because of the fact that it uses both types of data (Creswell, 2009). I chose this research approach because it triangulates the data collected. This means that data from three different sources is drawn upon to come to a conclusion instead of just one. I triangulated the data using well known quantitative and qualitative data collection.

Quantitative Data. During the fall of the 2017-2018 school year, students were given three unit exams, one on solving equation and simplifying expressions, the second on graphing and writing linear equations, and the third on graphing and solving linear inequalities. At the end of the term students were given a multiple choice final. Students were also given one a partner review at the end of each unit. Each test and partner review consisted of a mixture of word problems and expressions. Students completed the partner reviews within the unit and were allowed to use their notes. This helped promote note-taking and gave students a big incentive because they could now use them on their partner review. The average scores students achieved on the tests between the two classes were then compared to the student average scores on the same tests given from the year before. This allowed the researcher to get a numerical perspective on how effective the note-taking strategies were.

Vocabulary has been one area my students have struggled with over the past number of years. It is also a school initiative to increase student vocabulary. At the end
of each unit a list of vocabulary words from that unit and from previous units were given. Students had to define these words in their own terms. Average scores on those vocabulary assessments were then used and compared between the two classes and between the other Algebra 2 teachers’ classes to determine the effectiveness of the note-taking strategies on assessment.

**Qualitative Data.** Data was collected through six student interviews. Three students from each class were interviewed at the end of the researcher’s term. These students were chosen based off the their completion of the notes when note-books were collected and the likert score they gave at the end of the trimester. Some students were interviewed during their thirty-minute daily study hall that is attached to their course during that week. Other students were interviewed before or after school. Students were asked about their comfort level while using the note-taking strategy and how they used it. These questions were not given to the students before the interview was conducted. A sampling of students was chosen so that different math abilities, different ethnic groups, and special needs groups were represented. The interviews were conducted in my classroom. These interviews gave me solid information on the student’s ideas note-taking and how useful the note-taking strategy was. Appendix E contains a list of the questions given during the interview process. Students explained what aspects of the note-taking strategy were helpful, which were not helpful, how the strategy benefited them while studying for tests, and if they used the strategy in other classes. This data analyzes patterns in the interview data and checks to see whether these patterns are supported in the quantitative data generated from the unit tests and from the vocabulary assessments given throughout the trimester.
Approval to Conduct Research

I received approval from my school principal and the Hamline School of Education to conduct my research. The requirements of Hamline’s Human Subject Research review were met. Parents or guardians signed letters of consent for children to participate in the research, take surveys, be interviewed, or both and to have results displayed in this capstone. Students and parents were both assured that all results will be anonymous and confidential.

Summary of Chapter Three

Chapter three looks into the action part of the research process. The chapter begins with a description of the school where the research will be conducted as well as the participants who were involved. The next section discusses the note-taking strategies used in this research and what the rationale was for using them. The research used concurrent mixed methods and collected both quantitative and qualitative data. The chapter then explains what qualitative and quantitative data methods were used, how the data was collected, and how the data was analyzed. Finally, the chapter explains how the research was approved by my college, how it was approved by my high school where the research was done, and that approval was given by the participants and the parents of the participants.

Chapter four will look at the results from the action research and describe their relationship to the literature review. The first section will reintroduce the action research plan. The next section will cover the results of the research. The results will be described by strategy on how they affected student achievement. The last section will conclude the chapter and give a brief preview of chapter five.
CHAPTER 4

Results

Introduction

This study looked to answer the following question: *How can I implement effective note-taking strategies to improve my student’s performance on assessments?*

This was a mixed methods study. Students from my two different Algebra 2 courses used a note-taking strategy. First period Algebra 2 used Cornell notes, while third period Algebra 2 used Foldables. Students the first week of school were told that note-taking was going to be stressed throughout the trimester and that they should have a notebook. Parent consent forms were handed out the first day of class to give students the opportunity to participate in the study (Appendix A). Most students turned in the forms within one to two weeks. The forms that were not collected earlier in the term were collected from parents during conferences. At the end the first week students were shown a short video from AVID that stressed the importance on taking good notes. This video also stressed the importance of increasing student use of notes on the understanding of the material. The first of three in-class ways students got repeated use of the notes was through practice problems given near the end of the class. It was stressed that students practiced using their notes when doing these problems. The second in-class method of building repetition when using notes was by having the students go back and underline key words and circle parts of their notes they were still having questions about. This was done during the first two to three minutes of class and colored pencils were provided for the students at the front of the classroom. A third in-class method students used their notes was on was practice partner problem sets at the end of the unit. These were not
graded but checked and then given back to the students to see what parts of the unit they were still having difficulty on.

Multiple pieces of data were collected from students during the course of the trimester. To get a better understanding of student’s previous experience with note-taking, a short pre-survey was given to both Algebra 2 classes the third week of school (Appendix B). Similarly, a post survey was given to students near the end of the trimester to get feedback on how the note-taking strategy worked for them (Appendix C). The trimester consisted of three units of material. Notes were collected and graded based on completion starting the second unit. Three groups of students were created using the total points students received on unit two, unit three, and a likert score students gave on the post-survey. These students were high users, medium users, and low users of the two different note-taking strategies. Aggregate average test scores from each of the two classes on the three units and the final were compared to the aggregate average test scores of six different Algebra 2 classes from last year. Furthermore, aggregate average test scores were compared in each of the three note use subgroups in each class. On each of the three unit exams, conceptual questions were graded and compared between the three different subgroups of users. During the trimester three vocabulary quizzes were given to students. The aggregate average scores on each of these units for each class were compared against the aggregate average score of other Algebra 2 classes from first trimester. These average scores on the vocabulary quizzes were also compared between the three subgroups of users in each class. Near the end of the trimester six interviews were conducted. Students were chosen based off their scores they received on the second unit. These students were chosen this way since the post-survey and the third unit test
was not given yet. Parent consent forms were given to these students before an interview could be given (Appendix D). These students with the exception of one fell into each of the three subgroups. These interviews were short and gave an in depth and personal look into how students used the notes (Appendix E).

**Overview**

The following sections will first take a closer look at the pre-surveys to get a preview on how students react to note-taking. The next sections will look at test data on each of the three units and the final along with the three vocabulary quizzes to see the two note-taking strategies affected student’s knowledge and vocabulary. A separate section will discuss the student notebook checks done after units two and three. The next two sections will discuss the post-surveys and the six interviews conducted near the end of the trimester to get a more in depth student view of how the note-taking strategies worked for them. The last section in this chapter ties the results together and provides a preview for chapter five.

**Pre-Survey Results**

The second week of class both Algebra 2 classes were given a short survey of four questions about their note-taking experiences in the past. Most students used their notes to study for tests and as a reference when doing homework. A chart of the results of how students used their notes can be seen in Appendix F. This told me that students used their notes when they had a direct purpose such as reviewing before a test and using them to complete their homework. Not many students looked back and reviewed them at the end of the day. Only two students in both classes used notes for reflective purposes. A total of nine students took notes and used the encoding function of note-taking.
DiVesta and Gray (1972) state that this encoding function of note-taking is the process of coding, integrating, and transforming the important information from the lecture into a meaningful form. However, this is where these student’s use of notes ended.

In previous classes, students reiterated that they used them for mainly for studying for tests and referencing them on homework assignments. Some students mentioned that they use them if they get sick or for a quick review to refresh their memory on a topic. Some students mentioned that they used foldables, or what our Geometry department calls “flipcharts,” and some mentioned using printed notes.

As an educator, I wanted to know what worked well with students when they took notes. My third question revealed some interesting information of what worked. Roughly three to four students in each class like the Cornell style of notes, while others enjoyed having a choice of what style worked for them. Some students mentioned that they like foldables, while others preferred bulleted lists or fill-in-the-blank notes. One student mentioned that they, “liked using their own layout and not a forced one.” Another common theme that worked well students when taking notes are notes that are in a nice format. Students mentioned that they like going back marking up the notes by highlighting them or underlining key words or definitions. This marking of the notes serves an easy repetition for students. One student even mentioned like to “doodle in their notes.” Both classes mentioned that giving good examples to use for reference was a key to their success.

On the other end of the spectrum, it was important to find out what did not work for students when taking taking notes. A number of students from each class mentioned that “jotting notes randomly” did not work. There was no organization in their notes.
Another important aspect that many students mentioned was not having enough time write everything thing down. According to Kierwa et al, (2016), pauses during the lesson are effective because they break the lesson into smaller and easier to process chunks. Giving kids that additional time to not only digest what has been said but also giving those kids who are slower writers a chance to catch up was confirmed by student responses in the pre-survey. Four students from each class mentioned that they just needed to take them and not lose them was what was holding them back when taking notes. This told me that stressing organization and making sure each student had a notebook was key.

Test Data

Aggregate Average Test Scores. In order to get a better picture of how the two note-taking strategies were affecting student achievement, students average test scores from each class were compared to the aggregate average test scores of six Algebra 2 classes from the previous year. This was done on three unit tests and a final exam. However, it is not sufficient to just compare the average test scores between the two classes. Therefore, each class was broken into three groups of users of each note-taking strategy. Use of the note-taking strategy was based off of two notebook checks after the second unit and third unit along with the numerical score on a scale of 1-5 the student gave on how much they used their notes at the end near the end of the trimester. The three groups of users were high users, medium users, and low users of the notes. My first period Algebra 2 class used Cornell notes, while my third period Algebra 2 class used foldables. Each of the three groups from both Algebra 2 classes scored at 5% above the
aggregate Algebra 2 scores on unit 1 from the previous year. A chart of these scores can be seen below.

Table 4.1

All groups in both classes outperformed the aggregate average from the Algebra 2 classes from the previous year. There was a difference between the high users of each of the note-taking styles and medium and low users, but not much of a difference between the medium and low users themselves. This may be because the first unit was largely a review of material the students had already seen before. As the trimester continued, the material became more algebraic. Below is a chart of the averages between the three groups of users for each note-taking format and the aggregate average of the Algebra 2 classes from last year.
The differences in average test scores between the three types of users in the Algebra 2 Cornell class was even more noticeable during the second unit. This time the low users of Cornell notes scored on average 3.5% below the aggregate Algebra 2 average scores from the previous year. Both the medium and high users of Cornell notes scored above the aggregate Algebra 2 average scores from the previous year. On unit two high users of Foldables did outperform the Algebra 2 groups from the previous year. However, the mid to low users of the Foldables scored slightly below the Algebra 2 groups from last year. On this unit exam the mid-level users of Foldables scored roughly 5.5% below the low level users of Foldables. This may be due to fact that there were two students in the mid-level user group who missed class due to illness.

The last unit exam given during the first trimester was unit 3. The chart of the average scores between the three users of each note-taking strategy and the aggregate average from the Algebra 2 groups from last year is given below.
Table 4.3

Students from the Cornell group performed much better on this unit than the Foldables groups. The difference between the high and low users of each note-taking strategy was greater in this unit than in the other units. Only the high and medium level users from the Cornell note-taking performed better than the previous years’ average amongst Algebra 2 courses.

The final exam was given to students the last two days of the trimester. The results of that exam are shown in the chart below.
All groups with the exception of low users of each note-taking strategy scored better than the previous years’ Algebra 2 groups. The high users of each strategy outperformed the mid and low level users of each strategy. The difference on performance was more noticeable amongst the class that used Cornell notes.

**Conceptual Test Items.** Each of the unit tests had two to four conceptual based questions. The final had six of these types of questions. Student performance of these questions were also tracked over the course of the trimester. The first exam had two questions for a total of six points. The second exam had two questions for a total of ten points. The third exam had four questions for a total of eleven points. The final exam had six questions for a total of six points. The averages between the three groups of users of Cornell notes and Foldables were tracked and are shown in the chart below.
Average scores on the conceptual portion of the first unit between the high, medium, and low use groups within the Cornell and Foldables classes were fairly close to the same. This was expected as unit one was mostly a review of material from the previous year. However, in unit two the three subgroups using each strategy started to separate in conceptual knowledge scores. In the Cornell class, the high users of the notes outperformed the low users by roughly two points and the medium level users by .62 points. The differences in conceptual knowledge was even more noticeable in the Foldables class. The high users of Foldables averaged roughly two to three points more than the medium and low users. The medium users of the Foldables scored slightly higher in conceptual knowledge over the low users by .67. As the trimester progressed, the differences in conceptual knowledge in the Cornell groups grew. The high users of the Cornell notes performed better than the medium and low users by .75 and 2.59 points, respectively. The differences between the three levels of note users in the class that used
Foldables also grew. The high level users of Foldables scored on average two to three points higher than the medium and low level users of those notes. The two classes did not show much of a difference in conceptual knowledge on the final exam. One explanation for that may be due to the nature of the exam itself. The final exam was a multiple choice exam with six conceptual questions worth one point a piece, while the other exams were free-response.

**Vocabulary Quizzes.** Throughout the trimester students in both Algebra 2 classes were given a short vocabulary quiz at the end of each unit. The first unit vocabulary quiz had 10 questions worth one point a piece. The second unit vocabulary quiz had 17 questions for 17 points. The third unit vocabulary quiz had 26 questions for 26 points. Below is a chart that shows the averages between the three subgroups of students in the Cornell and Foldables classes on the first vocabulary quiz.

Table 4.6

<table>
<thead>
<tr>
<th>Unit 1 Average Vocabulary Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cornell High</td>
</tr>
<tr>
<td>Cornell Medium</td>
</tr>
<tr>
<td>Cornell Low</td>
</tr>
<tr>
<td>Foldables High</td>
</tr>
<tr>
<td>Foldables Medium</td>
</tr>
<tr>
<td>Foldables Low</td>
</tr>
<tr>
<td>Aggregate Algebra 2</td>
</tr>
</tbody>
</table>

There was not large difference in scores between the three subgroups of users in each class or between the classes in general. Both classes scored on average 1.5 to 2.25 points higher than the aggregate average of the other Algebra 2 their peers in this same semester.
However, as the trimester unfolded the averages between the three subgroups began to spread out. Shown below are the averages from the second unit.

Table 4.7

<table>
<thead>
<tr>
<th></th>
<th>Cornell High</th>
<th>Cornell Medium</th>
<th>Cornell Low</th>
<th>Foldables High</th>
<th>Foldables Medium</th>
<th>Foldables Low</th>
<th>Aggregate Algebra 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Points</td>
<td>13.75</td>
<td>13.42</td>
<td>10.42</td>
<td>15.08</td>
<td>15</td>
<td>14</td>
<td>12.58</td>
</tr>
</tbody>
</table>

The class that used Foldables performed higher on average than all three groups in the class that used Cornell notes. Even the low-level users of Foldables performed higher than my high users of Cornell notes and outperformed this year’s aggregate average Algebra 2 classes by a little over a point. The Cornell class still performed better amongst the high and medium users than the other Algebra 2 classes from the current semester by slightly over a point. On the unit three vocabulary quiz, the Foldables subgroups performed better than the other Algebra 2 classes from the current semester with the exception of the low users of Foldables. This may be because that group had one student who was an extreme outlier and scored a 4 out of 26 points. Without that student, that group would have averaged 19.4. The Foldables groups did not outperform the Cornell group on this quiz with the exception of the high users. The Cornell subgroups all performed higher than the average amongst the other Algebra 2 classes. The high users of Cornell performed roughly two points higher than the low users of Cornell.
Note Check

During the trimester, notebooks and Foldables were collected after units two and three. Notes were graded based on completion alone. Each section in the Cornell notes needed to have the Essential questions listed at the top, the important vocabulary for that section labeled, and a short summary of what was covered to get full credit. Shown in Appendix G is a student sample that shows the objectives or essential questions and the important vocabulary labeled. The section summary was written by students the following day in class. For the note-book checks, I was looking to see if the student had something written down for that section. Most if not all of the students did not have real experience writing summaries on notes within the math class. Many of the note-books graded had summaries, but in many cases students wanted to reword the essential question. This did not seem out of the ordinary. To assist with writing summaries, I took roughly two to three minutes and as a class we discussed what a well written summary looks like. As the trimester progressed, what I found was that the summaries slowly tended to move away from a simple rephrasing of the essential questions and more into what small parts needed to be pieced together from that lesson. A small student sample of this change is shown in Appendix G.

Notes from the Foldables class were also collected at the end of units two and three. A sample of this of notes are also shown in Appendix G. The Foldable looks like a small pamphlet with tabs that represent the key topics from that unit. Students needed to have information on each tab along with the important vocabulary filled out on the final tab to get full credit. For the most part students did fill out the vocabulary tab. This tab was something I added this year that other teachers in the department did not use in
the past. However, not all students took the time to fill in each tab with what they knew about that topic and thus did not receive higher scores on the checks. There could be a number of reasons for this. One student stated, “I don’t know what to write for that topic.” Therefore, in Unit 3, I made sure each student had an example problem for that topic along with any important formulas needed to solve that problem. That helped in getting some students to write more on each tab.

**Post Survey Data**

At the end of the trimester students were given a short four question survey about their experiences using the note-taking strategy. This survey can be seen in Appendix C. As a teacher, I wanted to know what worked well when using each note-taking strategy. In both classes, the most common answer was to use the notes to study vocabulary. The Cornell class liked underlining the important vocabulary. The Foldables class liked the vocabulary tab at the end of the notes. One student stated, “having all of the vocabulary in one place was very helpful.” Having all of the notes in one spot rather than over several sheets in a note-book is also something many students many worked well for them in the Foldables class. One student mentioned, “foldables are easy to study without being overwhelmed with information.” Making sure the example problems used in the notes were also mentioned as something that worked well.

In both classes, the common places where students used their notes were on were right before the unit test, on team formative partner work before the end of the unit, on the homework as a reference, and as a guide for studying vocabulary. Each class had roughly one-quarter of the students respond that they used the note-taking strategy in
each of those four common places mentioned above. Slightly more students in the Foldables class used their notes to study vocabulary.

The third question of the survey asked on a scale of one to five how much the student used the note-taking strategy throughout the trimester. Both classes roughly had the same average rating out of five with the Foldables class having slightly higher average at 3.38. The difference between the classes was that the most common rating for the Cornell class was a four and the most common rating for the Foldables class was a three. The ratings in the Cornell class ranged from one to five. There were three students who gave a rating of one in that class, where there was only one student in the Foldables class who gave a one.

The last part of the post-survey asked students what parts of the note-taking strategy can be improved. The most response from the class that used Cornell notes was writing summaries. One student mentioned that they would like them done as a class. Where two students struggled to find the purpose of writing the summary. What I found interesting is that five students who mentioned they hated summaries at the beginning of the trimester showed a willingness to improve on writing them. One student mentioned, “I can improve on writing summaries” as part of the note-taking strategy that can be done better. Another student mentioned that “making better summaries” was a part of the strategy that could be improved. There seemed to be a shift in attitude away from a dislike of writing summaries to a “what I do to write better summaries.” Students in the Foldables class mentioned that they did not have enough space to write notes and that they might be able to write more with a little more room. Other students mentioned that they just need to spend more time putting additional information on the charts.
Student Interviews

To get a more in-depth personal perspective on student use of the note-taking strategy, a short interview was conducted with a high user of the notes, the medium level user of the notes, and a low level user of the notes from each class. These interviews were conducted during the course of the school day during study hall, shortly before school, and shortly after school. The questions used for the interview are found in Appendix E.

First, I wanted to know how the note-taking strategy was helpful. In the Cornell class, my high level use student mentioned using notes “every” time they were confused on something on the homework. They also mentioned using the notes every time before taking the vocabulary test to write and rewrite definitions. My medium use student also mentioned using them on homework and to study for unit exams right before the test.

One difference between the responses was that high user student stated they created short quizlets based on their notes and took the time write and rewrite parts of their notes. The low level user of Cornell notes used them but only to refer to an example problem when they were stuck on their homework. In the Foldables class, the high user student used the notes to study for the vocabulary tests. They would cover the definition and then double-check their notes for accuracy. Similarly, the medium level user of Foldables found use for them when studying for vocabulary tests, but used them mostly for assignments. However, they did not use them to study for tests. The low user of Foldables only used them as a “reference” to see how problems were done to complete the assignments.

It was also important to find out what some of the disadvantages of each note-taking strategy were. All three students from the Cornell class had similar responses. The high user student mentioned using summaries was good strategy, but sometimes they
felt forced to write them when they were not needed. This student felt that summaries worked well with longer sets of notes and not as much with shorter sets. The medium level user mentioned they wrote some of the summaries. They felt they were a different type of learner that “could just look at the math to see how the problems were supposed to done.” This told me that they were looking at the notes for clues to solve the problems on the homework instead looking them to understand the concepts. This user stated, “I don’t really need to understand the concepts when I can just look at the problem and get the concepts within a few seconds.” The low level user did not do or when they did do them, did not look at them. This student stated that, “summaries felt like extra work.” One disadvantage the high level mentioned was writing questions on the side of their notes. They felt they got more from highlighting. In the Foldables class, all three students did not have much to say about the disadvantages. The only disadvantage mentioned among the three users was that they felt forced to use Foldables instead of another strategy. Otherwise, the low user of Foldables stated they just needed to take more notes and use them more.

Both Cornell and Foldables have been used by the six students in previous classes. The common classes where Cornell notes were used were in math, science, and English. Cornell notes were mostly used for summarizing after presentations in English and for vocabulary in science class. The medium level user did mention using them in German class for vocabulary translations. The low level user did used Cornell in math and science but still rarely did summaries and only looked at them when completing homework. The only class Foldables were used in previously was geometry class as a resource for vocabulary and reference the different figures.
There were a number of things that worked well when using the Cornell and Foldables. The high user of the Cornell notes really enjoyed going back and highlighting the parts they felt were important from the previous lesson. The medium level user thought Cornell notes were very organized and used the Essential Questions at the beginning of each lesson as posts on what was covered. The low user of Cornell notes mentioned only that they used them as a reference for homework. All three students of the Foldables mentioned that the notes were very organized. One student liked that everything was in one spot, where another like being able to go right to the tab where that topic was being covered. The low user of Foldables stated that he liked not having to “rummage” through many pages of notes in notebook.

What parts of the note-taking strategy that can be changed for the future is also something I wanted to find out as an educator. When I asked what parts could be changed in the future to the Cornell users, the high user of the notes mentioned that they would like more emphasis placed on highlighting and that they wrote the questions on the left side but did not get much out of them. The medium level user said giving just a little more space to write the terms would help. The low level user did not mention any parts that they would change differently other than the fact that they should take better notes and label the sections better. The only aspect of the Foldables that the three students in that class mentioned was giving a little more time in class instead of outside of class to add and transfer additional questions to the chart.

**Data about the Overall Process**

The researcher chose incorporate two note-taking strategies to see if they were effective on improving student performance on assessments. Peper and Mayer (1978)
state that note-taking enhances learning if learners can actively process the material and relate it to prior knowledge. This process of relating material to prior knowledge is called generative processing. Learners do this when they write summaries, draw graphs, and make conclusions during notes. What this told me was that I needed to insert these moments in during the trimester. Many students on their surveys stated that they used notes during homework for reference and to study right before the test. Students were given time at the beginning of each class to underline in colored pencil the key terms from the previous day’s lesson. Student’s confirmed during the pre-survey and post-survey that this process worked well. Writing summaries shortly after the notes was another method where students used generative processing. Some students did not mind writing the summaries while others did not feel they got much out of them. What I found interesting was that students who hated writing summaries at the beginning of the trimester started to realize near the end that summaries might help them. This was confirmed in the post-survey where students mentioned that “I just need to do a better job writing summaries.” This was also confirmed in an interview where a student stated, “I just need to take better notes and make sure they are organized.” Using a quick problem in the Foldables class also gave students more repetition.

The unit exams did show that the Cornell notes were effective on improving student scores. Scores on the unit 1 exam were roughly 10% and 5% higher for my high and medium to low users of these notes than the aggregate average on the same exam from last year. These results continued on the second unit for my high and low users of Cornell notes. However, the low users of the notes fell slightly below the aggregate average from last year’s classes. This trend continued on into unit 3 and the final exam
but to a slightly lesser degree. Donohoo (2010) stated that ninth and tenth grade science classrooms who used the Cornell note-taking system showed a 10%-12% increase in scores over students from the previous trimester. The increase in student performance on tests did not occur to the same degree in the Foldables class. Where the Foldables class did shine was on the vocabulary assessments. All three types of users in the Foldables class outperformed the aggregate average vocabulary scores from other Algebra 2 courses this year. This would have been the case for the third vocabulary quiz but there was an extreme outlier in that group that brought the average slightly below the average of other Algebra 2 classes. Graphic organizers have also been used during vocabulary instruction and have been shown to be effective when teaching technical vocabulary (Moore and Readance, as cited in Monroe 1998). These results confirm that the graphic organizer Foldable is effective. During the post-survey, a majority of the students from the Foldables class specifically stated they used the Foldable to study vocabulary during the unit and before the vocabulary test. During an interview, one student mentioned that they had their brother use the Foldable to quiz them on vocabulary. Students in the Cornell class did score better on average than the algebra 2 groups from this year but not to the same degree with all groups of users. The high and medium users of the Cornell notes scored better on average than the other algebra 2 classes. However, my low users of the Cornell notes did not score as high on the second vocabulary quiz. This may be because the students had to look over several sheets of paper to see each vocabulary word that was underlined. If the students are low users of Cornell notes to begin with, they might not have even underlined the key vocabulary or possibly did not write down the key vocabulary words at all. A student who used
Foldables to a lesser degree stated in an interview that he used Foldables on vocabulary and that he liked not having to rummage through several sheets of paper to get an overview of the notes. According to Zike (2003), one of the benefits of Foldables are that they quickly organize, display, and arrange information for students. Many students in that class stated they liked the layout and the organization of the Foldable tabs.

Conceptual knowledge was also looked at in relation to student note-taking. It was very difficult on some of the units to see the difference in performance of conceptual knowledge between the three types of users of each note-taking strategy. The one unit that did have a few more conceptual knowledge questions on the exam was unit 3. High and medium level users of Cornell notes performed 2-3 points higher out of 11 points than the lower users for those types of questions on the exam. In the Foldables class the medium and low users of the notes both scored roughly two points lower than the high users on the conceptual knowledge piece of unit 3.

**Conclusion**

In an effort to see how I can implement effective note-taking strategies to improve student performance on assessments, students from two Algebra two courses each used a note-taking strategy. Students were given opportunities to underline, use on warmups, to write summaries, and to use on the notes on partner formative practice pieces before each unit exam. Data was collected through a pre-survey, unit exam scores, vocabulary exam scores, a post-survey, a conceptual knowledge piece of each exam, and 6 short interviews.

After analyzing the data, the two note-taking strategies proved to be beneficial on improving student performance on assessments. Use of both Cornell and Foldables did
improve student scores on unit exams. Foldables did this to a lesser degree. This may be
due to the fact that Cornell notes stressed writing summaries which get at the heart of
what concepts were covered during the lesson. Using the Cornell notes and the Foldables
did improve student vocabulary scores. The Foldables did this more so. Over the course
of the trimester using both note-taking strategies did improve student performance on
assessments.

**Preview of Chapter Five**

The next chapter will take a deeper look into the study. The chapter will begin by
discussing the most useful parts of the literature review and how it impacted the study. I
will then look at connections between the data from this research and the information
found in the literature review. The chapter will also discuss the implications and
limitations of the study. The researcher also describes future research to be done off the
results from this study. The last section of the chapter provides a conclusion to the study.
CHAPTER FIVE

Conclusion

Introduction

Throughout the research process, this capstone looked at answering the question, *How can I implement effective note-taking strategies to improve my student’s performance on assessments?* The research done in the literature review and the data collected in this action research within the classroom have allowed me to make the conclusion that implementing the two note-taking strategies did improve performance on vocabulary and unit assessments. These results have many implications on my own classroom and the mathematics department at my school have pushed me to continue using note-taking strategies in my classroom as well as extending them to my math colleagues.

Overview

This chapter has allowed me to look back on the action research project as a whole. The first section will look back at the literature review and discuss its useful parts and its connections to the data from the study. The next section of the chapter looks at the implications of the study and how it will affect my classroom and school. Throughout this research, there were some limitations that may have had an impact on the data. These implications and limitations have caused me to look into further research on the topic of note-taking in the math classroom. The final section of the chapter provides a conclusion to the capstone with a summary of what was learned throughout the process.
The Literature Review

The literature review looked at strategies that affect student achievement, the benefits of note-taking, the different note-taking strategies, and then implementing note-taking in the classroom. There were several portions of the literature review that were important for my research. After looking at my data, I have been able to make new connections and develop deeper understandings with the literature review.

**Useful parts of the literature review.** While the literature review was an important part of the capstone, there were a few sections that were more useful than others. First, the section on note-taking strategies was the most useful. As a teacher, I know how important note-taking is but did not know a lot of the strategies that have been identified and the research data for how they were beneficial to students. The research done on Cornell notes and Foldables narrowed down which strategies might work best to improve student performance on assessments. In particular, I was really drawn to the Foldables strategy in that the notes were more visual and compact for the students to use.

Another section of the literature review that was very helpful was on implementing the note-taking strategy in the classroom. This section not only guided me on how I could get more students interested in note-taking but also gave me ideas on how I could change students perceptions of note-taking. Although these perceptions do not change overnight, this section gave me the idea that setting contingencies in place might be helpful. For example, students were told that the note-books would be a part of their formative grade. Students were also allowed to use their notes on all warm-ups and end of unit partner review sessions. These ideas were used not only to change student perception but also to give students additional repetitions for using their notes.
Connections to the literature review. After analyzing the data, I found several connections to the literature review. Zike (2003) states that the benefits of Foldables are that they quickly organize, display, and arrange information for students. At the beginning of each unit students created the Foldables within a matter of a few minutes. The tabs on the Foldables allowed me as a teacher to chunk the unit better. Students on their post-survey stated the organization of the Foldable as one of its main benefits. The student surveys also confirmed that the layout of the Foldable was easy to follow for review. I could see the connection between how easy it was for students to quickly get information from their notes and their ability to go directly to the source area in the unit that was giving them problems.

Another connection to the literature review was on the after the note-taking process was complete. Providing feedback for students on regular basis will give them crucial information so that they can adjust their note-taking skills (Frey and Fisher, 2014). I did this after the second unit and the third unit of the trimester. To improve note-taking students will need feedback on if their notes are organized, written legibly, or if they are thorough enough (Frey and Fisher, 2014). When students received this feedback on their notes, their summaries in the Cornell class started to improve and their Foldables were labeled correctly.

Data and the literature review. Overall, the data from my capstone agrees with the findings from the literature review. Data from the unit exams showed students who used the Cornell notes scored higher on their exams than the students who did not use them. Also, my Cornell class scored higher on average than the previous years’ Algebra Two classes. These are the same results Donohoo (2010) found in his research on ninth and
tenth grade science classrooms. The same results were also found in Faber et al. (2000) when students who used Cornell notes scored higher on teacher created objective tests.

The data on Foldables used during vocabulary instruction matches the literature review as well. Graphic organizers have been used during vocabulary instruction and have been shown to be effective when teaching technical vocabulary (Moore and Readance, as cited in Moore 1998). Students who used Foldables scored slightly higher on vocabulary exams given throughout the trimester. Even students who only used the Foldable a little scored higher on average than the average amongst the other Algebra 2 students who were not exposed to note-taking strategies.

**Implications**

After reviewing the results of the study, there are a number of implications that can be made. The study brought to light the effectiveness of the note-taking strategies used by high school Algebra Two students. The study also helped me determine areas of need in my classroom and improvements that can be made to promote the learning in all of my students.

The note-taking strategies used in this study, the Cornell notes and the Foldables, were effective in improving student scores on unit and vocabulary assessments. The Cornell notes allowed students to organize their notes, underline key vocabulary, and then reflect on what they learned that day. The written summary forced students to think about what they had learned that day and to make their own connections to the material. Foldables helped students separate out the major ideas learned throughout the chapter and organize those ideas into one compact easy to find place. These Foldables also included
a nice place for students to find important vocabulary so that they could easily study for vocabulary tests.

After looking at this data, I will use both Cornell notes and Foldables in my class. Both strategies improved student performance. Student scores improved on tests when using Cornell notes and vocabulary quiz scores improved under Foldables. Cornell notes will be my main form of notes and the Foldables will serve as a strategy for students to summarize and study for vocabulary. These strategies and my results will also be shared with the mathematics department at my school so that all grade levels can start using them. I believe students will be more likely to use and enjoy these note-taking strategies if they start using them once they start in ninth grade and continue to use them throughout their high school years. Students will develop a comfort level using these note-taking strategies and will become even more successful on assessments when they discover how the strategies work best for them. Students will need more practice doing written summaries in math classes. A number of students struggled with this concept but found it necessary to complete them. Hopefully, my results will encourage my colleagues to begin using these strategies in their own classrooms. I believe we need to get more teachers working on note-taking strategies so students can have even greater success on assessments.

Limitations

There were several limitations in this study. The first limitation was time. There was only time for three unit assessments and a final with my students using the note-taking strategies before the end of the trimester. Changing student’s perceptions of note-taking and their use of the notes takes time. I would have liked to have used these
strategies with the same group of students over the course of a year to see if more students can experience growth on assessments. I plan on continuing to use these note-taking strategies with my classes for the rest of this school year and next year to see if student performance on assessments continues to improve. Another limitation was the nature of the examinations. Each examination had a limited number of conceptual knowledge questions. The only exception was exam three, where I was able to draw results on conceptual knowledge. Adding a few more of these types of questions will allow me and others an even greater chance to see how student use of these strategies can improve student scores on assessments.

**Future Research**

This study also provided some insights about my own classroom and teaching and has caused me to consider areas of future research. First, I would like to repeat this study starting at the beginning of next school year. I would like my students to start using both note-taking strategies at the same time right away so they can become more comfortable using them and possibly enjoy using them even more than the students did in this study. Cornell notes improved test scores and will be used as the main form of notes. However, Foldables are an excellent portable form of notes and will be used mainly as a summary and vocabulary strategy. I am interested to see student data after a year of working with both strategies.

Throughout the study, a number of my students struggled with written reflection. Marzano, Pickering and Pollack, (2001) state that summaries are important because students analyze the information at a deep level to delete, substitute, and keep the key ideas. I also think students need more time to develop writing summaries than was given
in this study. Written reflection is not something that can be changed over the course of one trimester. Students at first wanted to re-state the essential questions given at the beginning of their notes. As the trimester progressed their summaries improved but I think they would have improved even more with more time and practice. This made me realize that I may need to incorporate more opportunities for written summaries and written reflections in my class. To get a better idea of how I can do these things I will ask a number of teachers in our English department as well as our ELL staff for ideas on what works well. I am interested to see how incorporating more written reflections in the math classroom improves student knowledge of the concepts.

**Conclusion**

Throughout the completion of this capstone, I learned a tremendous amount about note-taking in the mathematics classroom and about Cornell notes and Foldables. The literature review found each of these strategies to offer different ways of improving student performance and the results of the study confirmed the information found in the literature review. The findings have given me a new insight for my own classroom and for the math department at my school. The findings will be presented to my math department and I will encourage my colleagues to start using them in their classrooms. I think by having our students start using the strategies earlier in their high school careers will make allow them more opportunities to adjust them in fashion that works best for them. The study helped me realize I may need to create more opportunities and time spent on written summaries. I would like to see the effects of both strategies used at the same time and for an entire year instead of one trimester. A longer time period will give students more of a chance to use each strategy.
The purpose of the study was to show how I can implement note-taking strategies to improve student performance on assessments. The results of the study show these note-taking strategies did improve student performance on assessments. Many students expressed that they liked how the notes were organized. Students who used Foldables really enjoyed having all of the notes in one specific spot. The performance of students using both strategies on vocabulary tests were above the averages in other classes. This was even more noticeable in the Foldables group. This was very exciting to see. The students using Cornell notes for the most part enjoyed using the notes. They did struggle writing summaries but these improved throughout the trimester. These strategies and the knowledge I obtained throughout this capstone will continue to be used in my classroom as way to continue to improve student performance.
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Appendix A

General Consent Letter

August 23, 2017

I am your child’s mathematics teacher and a graduate student working on an advanced degree in education at Hamline University, St. Paul, Minnesota. As part of my graduate work, I plan to conduct research in my classroom from September 5th to December 2, 2017. The purpose of this letter is to ask your permission for your child to take part in my research.

The study is exploring how two different note-taking strategies affect students ability to perform on tests and their comprehension of the mathematics are related vocabulary. I plan to use the note-taking strategies throughout the fall trimester. The intent of this research is to see which of the two strategies most helps students on tests and with their language of mathematics.

There is little to no risk for your child to participate. This work will occur during normal math instruction. All students in the class will benefit from this work. Only the students whose families grant consent will have data included in the capstone results. All results will be confidential and anonymous. I will not record information about individual students, such as their names, nor report identifying information or characteristics in the capstone. Only aggregate average exam scores between classes and aggregate average scores on the vocabulary portions of these exams will be included. Participation is voluntary and you may decide at any time and without negative consequences that information about your child will not be included in the capstone.

I have received approval for my study from the Hamline University’s IRB and from the principal of Park High School. This research is public scholarship; the abstract and final product will be cataloged in Hamline’s Bush Library Digital Commons, a searchable electronic repository and that it may be published or used in other ways. My results might also be included in an article for publication in a professional journal or in a report at a professional conference. In all cases, your child’s identity and participation in this study will be confidential.

If you agree that your child may participate, keep this page. Fill out the duplicate agreement to participate on page two and return to me by mail or copy the form in an email me.

If you have any questions, please email or call me at school.

Sincerely,
Mike Swenson
Informed Consent to Have Your Adolescent’s Data Included in This Study

*I have received your letter about the study you plan to conduct in which you will be analyzing note-taking strategies for success. I understand there is little to no risk involved for my child, that his/her confidentiality will be protected, and that I may withdraw or my child may withdraw from the project at any time.*

______________________________
Student’s Name

______________________________  ________________
Parent/Guardian Signature        Date

Participant copy
Appendix B

Pre-Survey Questions

1) How do you use your notes?
   a. I review notes before taking a test
   b. I reference my notes when doing homework.
   c. I look back on my notes at the end of each day.
   d. I take notes but do not use them very much.

2) How have you used notes in previous classes?

3) What has worked well in the past for you when taking notes?

4) What has not worked well for you in the past when taking notes?
Appendix C

Post-Survey Questions

1) What parts of the note-taking strategy worked for you?

2) What parts of the course did you find your notes helpful?

3) On a scale of 1-5 (5 represents a lot), how much did you use your notes this trimester?

4) What parts of the note-taking strategy can be improved?
Appendix D

Parent Consent form for the Interviews

August 23, 2017

Dear Parent or Guardian,

As you were informed at the beginning of the trimester, I am conducting a study on two note-taking strategies and how they affect student’s ability on assessments and recall of important vocabulary in mathematics. Your adolescent used one of these two strategies in their math class. An important aspect of this study is a set of one-on-one interviews with six students, three from both Algebra 2 math sections, that would provide individual insight how students used the note-taking strategy. This feedback given will provide me important information on note-taking so learning at Park High School can be a great experience.

The interview with your adolescent will occur on school grounds either before, during, or shortly after school hours depending on your adolescent’s preference. The interviews will be audiotaped for purposes of reviewing details. These tapes will only be used for this study alone and will be deleted upon the completion of the study. Strict confidentiality will insure that your adolescent’s name will not be used in the research. Students will only be referred to as student A, B, C, etc. The intent of this research is to see which of the two strategies most helps students on tests and with their language of mathematics.

There is little to no risk for your child to participate. The time of the interview will be conducted in such a manner as to limit any impact on your adolescent’s other school work. Only the students whose families grant consent will have data included in the capstone results. All results will be confidential and anonymous. The interviews will be audiotaped for purposes of details. These tapes will only be used for this study alone and will be deleted upon its completion. Participation is voluntary and you may decide at any time and without negative consequences that information about your child will not be included in the capstone results.

I have received approval for my study from the Hamline University’s IRB and from the principal of Park High School. The capstone will be catalogued in Hamline’s Bush Library Digital Commons, a searchable electronic repository. My results might also be included in an article for publication in a professional journal or in a report at a professional conference. In all cases, your child’s identity and participation in this study will be confidential.

If you agree that your adolescent may participate, keep this page. Fill out the duplicate agreement to participate on page two and return to me by mail or copy the form in an email to me.
If you have any questions, please email or call me at school.

Sincerely,
Mike Swenson
Park Math Teacher

Informed Consent to Participate in One-On-One Interview

Return this signed page to Mr. Swenson. Keep the letter for your records.

I have received your letter about the study you plan to conduct in which you will be analyzing note-taking strategies for success. I understand there is little to no risk involved for my child, that his/her confidentiality will be protected, and that I may withdraw or my child may withdraw from the project at any time.

______________________________
Student’s Name

______________________________
Parent/Guardian Signature

______________________________
Date

Participant copy
Appendix E

Student Interview Questions

1) How was the note-taking strategy we used in class helpful when working on assignments as well as in studying for tests?

2) What were some of the disadvantages of using the note-taking strategy we have used this semester in class?

3) How has the summary writing process during notes been helpful in getting you to remember the information given during the lesson?

4) How have you used the note-taking strategy we in math class in your other classes? Which ones?

5) What parts of the note-taking strategy worked well for you?

6) What parts of the note-taking strategy would you like to change or do differently?
Appendix F

Student Responses to Pre-Survey Question 1

How Students Used Notes in the Past

- Took notes but did not use them much: 3 Period 3, 6 Period 1
- Look back at the end of the Day: 2 Period 3, 0 Period 1
- Reference on Homework: 22 Period 3, 20 Period 1
- Review for Test: 18 Period 3, 14 Period 1

Period 3 Period 1
Appendix G

Student Sample of Cornell Notes

Example: \( x \geq 2 \)
Sample Cornell Summary

If the inequality has $a > or <$, then graph with a dashed line.
If the inequality has $a \leq or \geq$, then graph w/ a solid line.

When graphing an inequality, identify the slope & y-intercept.
Get "y" alone if needed first.
Graph those points w/ a dashed or solid line. Then test the point w/ (0,0). Then you shall have the graph depending on the inequality.
Appendix H

Foldable Sample of Notes

Unit 2: lines + systems

Graphing lines
Writing linear functions
Parallel & perpendicular lines
Classifying systems of equations
Arithmetic sequence
Arithmetic series

Vocab