The Effects of Teaching Cornell Notes on Student Achievement

A Capstone Project
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Abstract

The purpose of this action research project was to determine if Cornell Notes (CN) increased student achievement and note quality in my math classroom. Two classes were taught how to take notes using CN (the intervention group), and two other classes took notes in their own format (the base group). I gathered data using assessments and note checks. Independent *t*-tests were used to compare the results of the assessments and note checks of the groups. The data analysis indicated the intervention group had a higher quality of notes than the base group at the end of the study, while student achievement of the two groups was not significantly different.

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Chapter One

Introduction

During my first five years of teaching, I implemented many forms of note-taking. I gave notes on the board expecting students to copy my notes, used skeleton notes so students only wrote key pieces of information, and gave students copies of completed notes. During summer 2011, I attended a conference on Advancement via Individual Determination (AVID) training in Dallas, Texas, where I learned the Cornell note-taking (CN) method. During the 2011 school year, I showed students the basics of CN. The "ah ha" moments that occurred when students realized why they took notes the way they did made me want to do research for additional information on this note-taking strategy. I wanted to determine whether this format of note-taking could impact student achievement.

Motivation for the Project

For the first time I found a better plan with CN. I returned from Dallas with confidence that CN could encourage effective and increased note-taking. The best aspect of this note-taking format is its transferability. I can teach my students to take notes, not only in my class, but in all their classes. I also believe my administration can implement CN as a school-wide method, because it does not require teachers to change their pedagogical techniques.

Background on the Problem

As a teacher, I ask students to take notes. I have tried different methods for providing notes. I tried a different method for students taking notes each year while looking for positive learning. I still have not found a magical way. The problem each year was I did not teach students to effectively use the new method I introduced.

Studies show an increase in student achievement with the incorporation of guided notes (Boyle, 2011; Faber, Morris, & Lieberman, 2000; Haydon, Mancil, Kroeger, McLeskey, & Lin, 2011). Students believe "taking notes is a necessity that will provide them with a source from which to study at a later time" (Faber et al., 2000, p. 257). If I could increase the number of students who take notes and improve the quality of their notes, then their achievement might increase in my class. Also, students could use the same method in other classes, which might increase their grades in those other courses.

Statement of the Problem

"Note-taking is the most common method used by students to learn information from content lectures" (Boyle, 2011, p. 51). The problem with note-taking is students are rarely taught to take effective notes (Kiewra, 2002). I did not instruct students how to take good notes, nor did their previous teachers. I left it up to students to decide methodology for note-taking, and some students were unsure of themselves. Teaching students CN would give them the guidance they need for note-taking.

Last year, I first "taught" students CN. I used "taught" loosely because I only showed them the basics of CN. I did not solve the problem of truly teaching students a way to take notes successfully. In this study, I wanted to teach students how to take effective notes instead of introducing them to a note-taking strategy like I did in the past.

Statement of Purpose

The purpose of my study was to determine the impact teaching students CN had on their achievement and note-taking quality in my math classroom.

Research Questions

Will teaching my Algebra II students CN improve their mathematics achievement? Subsequent questions included:

- Will students perform higher on tests and quizzes after they were taught CN versus students who were not taught CN?
- Will teaching CN to students increase the quality of notes students take?

Definitions

Cornell Notes—A note-taking format designed by Walter Pauk which involves sectioning paper to record main ideas, supporting details, and summaries (Pauk & Owens, 2011).

Summary

My high school history teacher taught me the basics of note-taking. I further developed my note-taking skills in college. As a high school mathematics teacher, I specialize in teaching mathematical concepts, not note-taking. Therefore, I overlooked teaching the process of note-taking during my first few years of teaching. Teaching students an easy, efficient method for taking notes would not only benefit them in my class, but also in their other classes. In this study, I determined whether teaching CN in my classes positively impacted the achievement of my Algebra II students. The following chapter includes a discussion of note-taking as a whole, the impact teaching note-taking strategies had in different studies, and CN.

Chapter Two

Review of Literature

Note-taking is the process of taking notes from reading, lectures, or class lessons (Sedita, 2010). Students use note-taking to learn or recall material. They are expected to know how to take notes effectively by the time they reach college. "[Students] spend so much of [their] academic life accumulating information, it's unwise to do so haphazardly…The key is to take notes effectively" (Pauk & Owens, 2011, p. 234). Teachers not teaching students how to take notes creates the problem that I researched.

The purpose of my project was to determine the impact teaching Cornell Notes (CN) has on mathematical achievement. This chapter includes a discussion of the following topics: note-taking as a means of recording information; teaching note-taking and its impact on student achievement; and CN.

Note-Taking

Note-taking is a common strategy used by students to gather information from the classroom setting. "You forget almost half of what you hear or read within an hour" (Indiana Career and Postsecondary Advancement Center, 1996, p. 9), which is why students take lecture notes in their secondary and post-secondary careers. The problem is students usually have not been taught how to take complete notes from a lecture. Studies described below show that interventions can improve the quality of notes students take. These interventions are, but not limited to, guided or skeleton notes, completed notes, and CN.

Students use note-taking as a process of encoding and storage. The process requires students to use multiple skills at once, such as, listening, synthesizing, organizing, and writing (Czarnecki & Rosko, 1998; Haydon et al., 2011). Many students find taking notes difficult

because it "requires the integrations of auditory processing skills, visual-motor skills, writing skills, reading or listening comprehension skills, and sustained attention" (Sedita, 2010, p. 69). Even though difficult, note-taking is a popular method students use to record information.

Kenneth A. Kiewra (2002), a professor of educational psychology at the University of Nebraska-Lincoln, paraphrased Palmatier and Bennet, "99% of college students record lecture notes" (p. 72). He also paraphrased Dunkel and Davy's statement that "94% of American students believe that note taking is a valued and important activity" (as cited in Kiewra, 2002, p. 72). Note-taking is a popular method used by and demanded from students. With such popularity, why isn't note-taking taught better?

Students come to college inadequately prepared in note-taking. Students' ability to record main ideas during lectures is below average (Kiewra, 2002; Neef, McCord, & Ferreri, 2006). This inability comes from a lack of teaching note-taking strategies by teachers during the middle and high school years. Dr. Allen Ornstein, a Professor of Education at St. John's University in New York, stated "Many students do not learn these skills, or learn them too late, simply because they were not explicitly taught them" (as cited in Faber et al., 2000, p. 260). Tsai-Fu and Wu (2010) also noticed a lack of note-taking skills in college students. They noted an importance of teaching students note-taking skills and making sure an adequate amount of time is spent doing it.

Backman (1994) suggested using guided instruction to effectively introduce and teach note-taking strategies. Teachers can then scaffold instruction so students take notes independently. Czarnecki and Rosko (1998) stated memorizing the strategy is the next step, followed by controlled practice and feedback, advanced practice and feedback, and then generalization. Kiewra (2002) further discussed how to embed note-taking strategies. Teachers

must first introduce a proven strategy to students, then sell the strategy, generalize the strategy, and perfect it.

Backman (1994) noted some key attributes to note-taking. A consistent format aids students in the note-taking process. Format also helps organization of notes, which benefits students when they use their notes for review. Another key attribute was listing objectives for students each day to copy in their notes. This activity let students know exactly the material to be covered, and they were able to organize by topic when it came to review. Sedita (2010) stated, using a two-column approach similar to CN is a good format for students to use. She also noted re-reading and revising notes is a key to note-taking. Marzano, Pickering, and Pollock (2001) also listed revising as a key attribute. Notes are a work in progress and should be continually read, re-read, and revised. They also stated revision should be worked into classroom time for teacher guidance to aid in the revision process. The last attribute they stated was summarizing. Students should write summaries of their notes to synthesize the information they have written down. Summarizing also helps with retention of material, and provides students with a fast, efficient way to review. Davis and Hult (1997) conducted a study strictly on writing summaries at the college level. They found summary writing paired with note-taking helped students retain information for a longer period of time compared to students who did not write summaries. Marzano et al. (2001) posited summarizing and note-taking as "two of the most powerful skills students can cultivate" (p. 48). Unfortunately, students struggle with summaries the most (Donohoo, 2010; Marzano et al., 2001).

In their book, *How to Study in College*, Pauk and Owens (2011) gave a four-step outline to take notes effectively: be prepared, start with the Cornell System, gather information, and tie things together. These topics are discussed in greater detail in the following paragraphs.

Students should be prepared to take notes from a lecture or textbook before they begin to physically take notes. Pauk and Owens (2011) described ways for students to be prepared for either situation. They suggested students get acquainted with their textbooks. Students can do this by looking through the table of contents and introductions. Also, reading through a few sections gives an idea of how the book reads, which helps preview some topics that will be covered during the year. The advice given for lecture preparation is similar since many lectures are accompanied by suggested readings. They also stated reviewing previous lecture notes will aide in understanding the forthcoming lecture. They suggested this since time "will rarely permit a rehash of ideas that have already been fully explained" (p. 243). This time constraint requires students to revisit previous material, which also increases student understanding of that material.

Since the Cornell System will be discussed in more detail later in this chapter, gathering information is discussed here. Engagement is the key to gathering information, whether it is from a textbook or a lecture. Having an inquisitive mindset is the key to engagement. Pauk and Owens (2011) posited students should formulate questions while they are reading or listening to lectures to stay engaged and process information in a more meaningful way. Asking questions during a lecture clarifies information for the listener, although some students are too timid to ask. Teachers should always remind students of the old adage "the only dumb question is the one that is never asked" (Pauk & Owens, 2011, p. 255). Students taking notes from a textbook can also formulate questions while reading. Writing down questions helps summarize material students have read. Rewording headings in the text to formulate questions is one hint the authors gave for students who struggle with creating questions. Other signs to look for during lectures or textbook readings are changes in intonation. Changes in pace and volume are examples of intonation during lectures. Changes in size, color, and font are examples of intonation in textbooks. The

final piece of gathering information is writing efficiency. Pauk and Owens (2011) suggested developing a system of shorthand writing. Using symbols in place of words allows students to record notes more efficiently. Students who spend less time writing every word are able to concentrate more on the lecture and record more pieces of information.

The final key Pauk and Owens (2011) stated is tie things together. A great opportunity arises at the end of a lecture or end of a reading. Students have the ability to summarize material they received while it is fresh in their minds. This crucial time allows students to rerun the lecture in their minds or skim back through the text to recall any information they may have missed. The authors suggested adding information to the students' notes that they might have missed. It is also a time for students to formulate questions they may still have about the presented material. The studies listed next show, by using these guidelines and key attributes, teachers can increase student achievement.

Note-Taking and Achievement

Working through the strategies listed above produced many positive results on student achievement. A study done on college students showed an improvement on quiz scores with the use of guided notes. Guided notes are teacher-prepared notes that students receive to fill in important pieces of information. The results of the study also showed students preferred the use of guided notes to traditional notes (Neef et al., 2006). Similarly, a study done by Musti-Rao, Kroeger, and Schumacher-Dyke (2008) showed an increase in college students' quiz scores with implementation of guided notes. They also concluded students preferred using guided notes to the traditional form of note-taking.

Studies have also been done at the secondary level. Backman (1994) conducted a study in her math classroom on finding an effective note-taking system for math students. She allowed

students to develop their own sets of notes and then used surveys to find commonalities amongst the notes. Some of the commonalities included "definitions, diagrams, sample problems, rules or steps to do a problem, and a list of items that gave them trouble" (Backman, 1994, p. 77). Some students also used "different color ink, labels, outlines, highlighting and underlining, and special symbols like stars or asterisks" (p. 79). Students then took those commonalities and incorporated them into their own notes. Backman observed an increase in note-taking and also an improvement in students' grades.

Wamsley and Hickman (2006) piloted a study in their math classes to compare the effectiveness of three styles of note-taking: traditional notes, column notes, and mini-textbooks. The findings of the study found column notes were the favored method of students. Column notes contained similar attributes to CN such as listing essential questions and using one column for supporting details. Students also noted they took more notes when using the column style method which made understanding easier. Their results showed students used column notes to improve their understanding of material.

Boyle (2011) conducted a similar study on middle school students, but only showed one strategy of note-taking versus three strategies. Boyle used a strategic note-taking method, which taught students to "link prior knowledge, cluster main ideas, summarizing like ideas, recognize vocabulary, and review main lecture points" (p. 54). The results of the study found students who were taught the method outperformed their counterparts by recording more important lecture cues. These students also outperformed students on compressive tests. Boyle also found students preferred being taught a method to take notes because it improved their note-taking ability and grades.

Faber et al. (2000) conducted a study on the effects of active note-taking. They taught ninth grade students to take notes using CN. They noted a lack of instruction on note-taking, which resulted in lower comprehension by students. Students were not only taught note-taking strategies, but also pre-reading and questioning strategies. The results of their study showed students who were taught CN improved their encoding process. Also, students scored higher on tests than their counterparts. They also showed the teaching of note-taking benefited students of all abilities. Therefore, teaching note-taking strategies facilitates higher comprehension regardless of student ability.

Donohoo (2010) also performed a similar study teaching CN to her students. Her first attempt was unsuccessful. She then followed guidelines, similar to Backman (1994), to introduce CN to her students. She used modeling, guided instruction, collaboration, and independent practice to teach the CN strategy. The results of her study showed an increase in student achievement compared to other classes and also a 10%-12% increase in individual scores from the previous semester. The findings of her study were so compelling; CN became a school-wide strategy the following year.

Tsai-Fu and Wu (2010) performed a study on Taiwanese college students. They investigated the effects of teaching CN and note-taking languages on college students' comprehension. The study focused on teaching CN and the effects it would have during short conversations and long lectures at the college level. Students were also categorized by the language in which they took the notes, either English or Chinese. The findings of the study showed students who were taught CN scored significantly higher on both short conversation and longer lecture recall. They also noted that CN may not have replaced previous note-taking strategies students had, but did show an advantage because CN is a "well-established, practical

way to summarize and highlight important information for later study and review" (p. 127). Another point noted by the authors was intentional, sustained instruction of note-taking strategies is imperative to help students, but is usually absent from most curricula.

Cornell Note-Taking

Cornell Notes got its name from Walter Pauk at Cornell University. Walter Pauk, a director of the reading study center at Cornell University and an author of numerous study skills texts, developed CN in the 1950s. Pauk, influenced greatly by the SQ3R Method, a method for reading and studying that stands for surveying, questioning, reading, reciting, and reviewing, changed his speed reading course during 1953, into a study skills course (Kerstiens, 1998).

Cornell Notes takes students through a systematic approach of recording information. All students have the same outline to follow while recording notes. The students start by dividing their paper into two columns by drawing a vertical line about a third of the way in from the left edge of the paper stopping two inches from the bottom. Students then draw a horizontal line across the paper, two inches from the bottom of the paper. An illustration is given in Figure 1.

Students now begin the note-taking process. They write classroom or textbook notes in the right-hand column they created. The first chance they get, students reduce key ideas from the notes and write them in the left-hand column they created. Covering the right-hand side of the paper, students should use the key terms or questions they wrote to recite the main ideas of the lecture. This will help students retain the knowledge they wrote down.

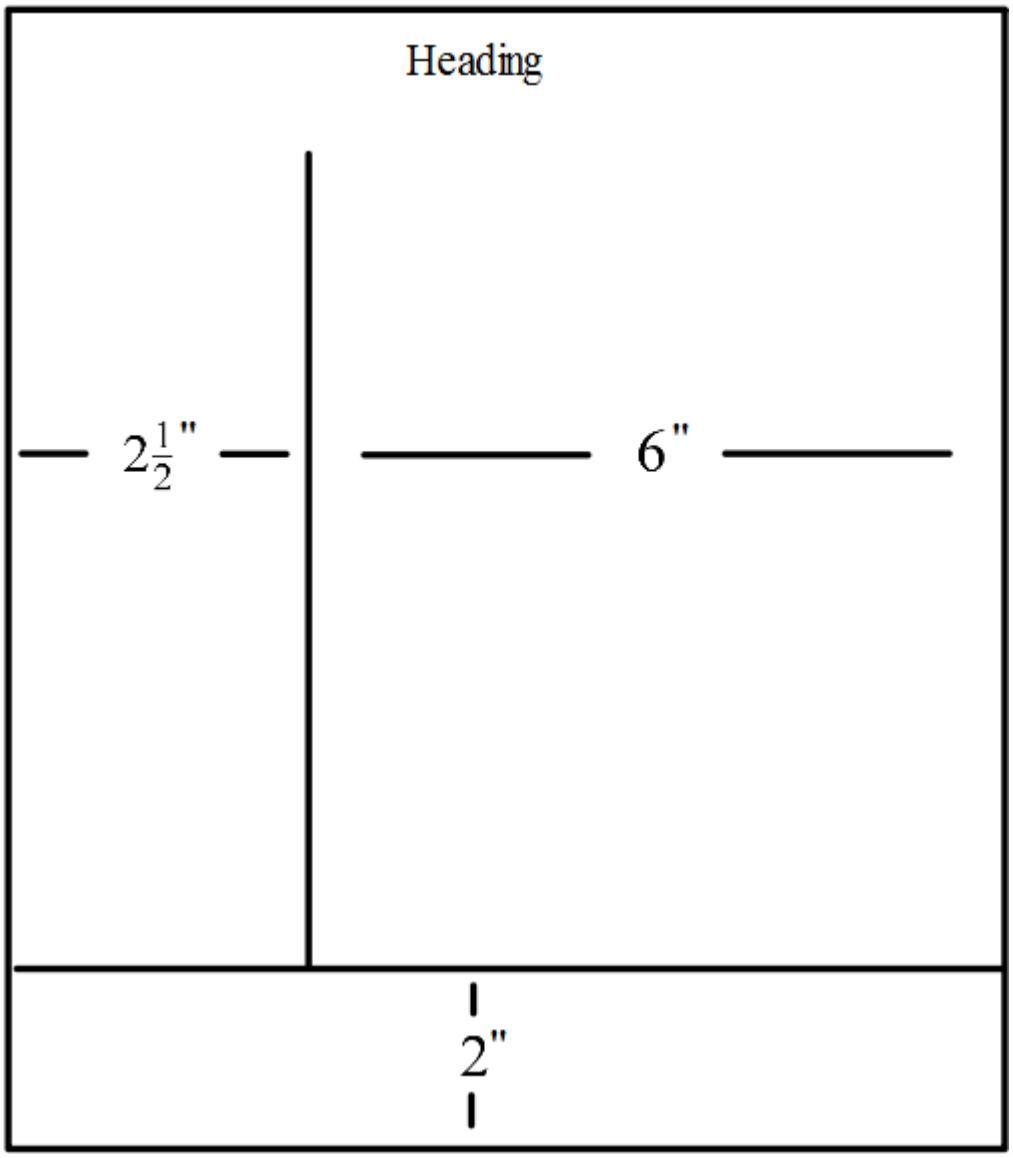

Figure 1. Illustration of Cornell layout for student note-taking.

Think and reflect are the next steps. Students should think about the notes they have taken and why the material they noted is important to them. They can then write summaries about the notes on the bottom of the page in the section they created. This task helps them internalize the information and review the notes they have taken, which is the final step in the note-taking process. Students can re-read the summaries they wrote, ask themselves the

questions they wrote in the left margins, or just re-read all the original notes they took. This process is Cornell Notes.

Summary

Note-taking is a vital skill students need to learn before they reach college. Unfortunately, this skill is often overlooked by middle and high school teachers. The note-taking process encompasses many different skills that require students to perform multiple tasks at once. Some students are not prepared enough to take on such tasks all at one time, which is why teaching the art of note-taking is so crucial to middle and high school students.

Some of the key aspects found in the studies listed above included not only the elements of note-taking, but also how to teach note-taking. Introducing, selling, generalizing, and perfecting are ways to teach a note-taking strategy. This process provides teachers a way to integrate teaching note-taking into their classrooms. Format, revise, and summarize were the key elements for taking notes. Students should develop or be taught to use a certain format, such as CN. They should also revisit their notes frequently to add any details that may have been missed. The final step students take in the process is to summarize. This allows students to review and tie important pieces of information together to improve their overall understanding of the material.

Using these key strategies listed above can result in an increase in student achievement. The studies discussed earlier showed an increase in student achievement when teaching note-taking strategies. When taught a note-taking strategy, students' quiz scores, retention of material, participation in class, recording of key lecture points, and overall grades increased. This shows why teaching students a strategy, such as CN, is so important.

Cornell Notes is a strategy designed to force students to revisit their notes. It involves separating paper into columns for supporting details, main ideas, and summaries. This style of

note-taking was developed by Walter Pauk and embeds many of the key attributes of note-taking stated above. I taught this strategy to my students to determine if it increased their achievement in mathematics and quality of notes.

Chapter Three

Research Design and Method

The intent of this study was to determine if teaching students Cornell Notes (CN) increases their achievement in Algebra II. This chapter includes an outline of the setting of the study, implementation, and the data collection and analysis processes.

Setting

This study occurred during my sixth year as a mathematics teacher and my fifth year at my current school. Working at one of the largest schools in the state, I had approximately 120 Algebra II students. The total enrollment at my high school is just shy of 1600 students, grades 10-12. With many of my Algebra II students having aspirations of going to college, I thought teaching them a style of note-taking would benefit not only their grades, but hopefully they would carry this skill with them to college.

The participants in this study consisted of approximately 120 Algebra II students in grades 10-12. The students took the same class from me throughout different parts of the day. I started the study with 60 females and 58 males, consisting of 28 sophomores, 28 juniors, 4 seniors, and 26 sophomores, 27 juniors, and 5 seniors, respectively.

A circumstance which could have affected the outcomes of this study was students who might have already been taught CN. Running the study with a control group that had students who already had prior knowledge of CN might have affected the results of the study.

Intervention/Innovation

Throughout the course of this study I taught two of my Algebra II classes how to take notes using CN. I taught students the key attributes of CN and how they could use them to help review for assessments. In the other two Algebra II classes I presented the same material, but did

not give them the background of CN. Students in all four Algebra II classes received the same material, delivered the same way, but two classes took notes on the information using CN, and the other two classes took notes in the format of their liking. All classes learned about square root, cubed root, exponential, and logarithmic functions during the study.

Design

The action research project on CN was a quantitative approach. Numerical data were produced from quizzes and tests and also from note checks. Descriptive and inferential analyses were applied to the data collected. The quality of students' notes was graded according to a rubric (see Appendix A), which provided data to compare the quality of notes students took during class.

Description of Methods and Analysis Strategy

Prior to the start of the research project, I gave a consent form to the parents/guardians of the intervention classes and base classes, as well as a student assent form for the intervention classes and base classes (see Appendix B, Appendix C, Appendix D, and Appendix E, respectively) to gain the approval of their children being involved in the data collection process. The school's principal also signed a permission letter (see Appendix F) approving the study. Permission was obtained from Minot State University's Institutional Review Board (see Appendix G). After all necessary criteria were met, I started my study by doing note checks to get a baseline of the quality of notes students were taking by using a rubric to record scores (see Appendix A). I randomly selected 30 students from the intervention classes and 30 students from the base classes over the course of a week to measure and record the quality of their notes according to the rubric. These rubric results also established a reference for comparative data at the end of the third nine-weeks.

At the beginning of the nine-weeks, I used a 95% confidence level and a *t*-test of independent samples (at 0.05 level of significance) to determine if the two classes had comparable note-taking skills. My null hypothesis was no difference in note-taking rubric scores of the intervention and base classes, and my alternative hypothesis was a significant difference in note-taking rubric scores of the intervention and base classes. I also did the same test using semester scores of the students in my intervention and base classes to determine if the intervention classes and base classes had similar levels of math achievement. My null hypothesis was no difference in math achievement levels of the intervention and base classes, and my alternative hypothesis was a significant difference in math achievement levels of the intervention and base classes. If their math achievement levels were significantly different I would have needed to use an ANCOVA, rather than a *t*-test of independent samples, to compare the two classes after the intervention had taken place.

Throughout the nine-weeks I recorded test and quiz scores from the base and intervention classes. A sample quiz and test have been provided (see Appendix H and Appendix I). I took the assessment results from both classes and used them to determine if those taught CN had significantly higher student achievement than those who were not taught CN. At the end of the nine-weeks, I selected the same 30 students from my intervention and base classes and recorded the quality of their notes according to the rubric used at the start of the nine-weeks.

I calculated mean, median, and standard deviation for note check data. When comparing these results, I used a 95% confidence level and a *t*-test of independent samples (at 0.05 level of significance) to determine if the quality of notes students took in the intervention classes compared to the base classes was significantly higher. My null hypothesis was no difference in the quality of notes of the base and intervention classes, and my alternative hypothesis was the

intervention class has higher rubric scores for the quality of their notes. This method of analyzing note quality was appropriate because this is the standard statistical method to determine if there is a significant difference in data of two groups.

I also calculated mean, median, standard deviation, and percentages for all achievement data. After classes were deemed similar, I used a 95% confidence level and a *t*-test of independent samples (at 0.05 level of significance) to determine if student achievement in the intervention classes compared to the base classes was significantly higher. Student achievement was measured using identical quizzes and tests administered to both classes. My null hypothesis was no difference in student achievement of the base and intervention classes, and my alternative hypothesis was the intervention class has higher student achievement. This method of analyzing student achievement was appropriate because this is the standard statistical method to determine if there is a significant difference in data of two groups.

Expected Results

I hypothesized students would perform better on assessments because of the style of note-taking they learned. I also hypothesized that students would become better note takers after learning the Cornell style of note-taking. I believed teaching students a way to take notes would help improve their ability to process and record information. This would also help students perform better on quizzes and tests.

Timeline for the Study

The timeline for the study was seven weeks. I began by teaching the students how to take notes using CN. This took approximately two weeks. I then administered quizzes and tests throughout the remaining five weeks. During the final weeks I did note checks again to compare

the quality of notes students took. I quantified this data through the use of a rubric. The analyses of the data and writing of the results took additional time after the completion of the study.

Summary

Throughout the course of the study, two of my Algebra II classes were provided guidance on how to take notes. The format with which they took the notes was CN. I collected data from quizzes, tests and note checks. I compared the quiz and test data to my other two Algebra II classes, which had not been taught how to take CN. I compared these data to determine if teaching CN increased student achievement in my Algebra II classes. In addition, I compared the pre- and post-note checks of the classes that were taught CN. The results of the study are provided in the next chapter.

Chapter Four

Results and Interpretations

My study investigated whether the teaching of Cornell Notes (CN) would improve student achievement in my Algebra II classes. During the intervention, two Algebra II classes were taught how to take notes using CN, while the other two classes took notes using a format of their choice. Note checks were also performed at the beginning and end of the data collection period to determine if teaching CN increased the quality of notes taken by students. Identical assessments were used for both intervention and base classes during the study. The analysis of these results determined if CN increased student achievement in my Algebra II classes. This chapter includes results of the analysis of assessment and note check data collected throughout the study and the conclusions generated.

Results of Data Analysis

Throughout the study I collected data on notes and assessments students took. I used a five-point scoring rubric at the beginning and end of the study to assess the quality of notes that students took in my class. I also collected quiz and chapter test scores to analyze if CN increased student achievement.

Note-taking rubric. The note-taking rubric (see Appendix A) was used to develop a base line for the quality of notes that students took in my Algebra II classes. It was also used to determine if students took better quality notes after learning CN. The descriptive statistics of the note-taking rubric at the beginning of the study are presented in Table 1.

Table 1

Descriptive Statistics of Note-Taking Rubric Scores

	Intervention Class			Base Class		
Assessment	*n*	*M*	*SD*	*n*	*M*	*SD*
Note-taking Rubric	31	3.430	0.982	31	3.151	1.125

I began the study by comparing the base class to the intervention class using a *t*-test of independent samples to determine if the two classes had comparable note-taking skills. The null hypothesis was no difference in note-taking rubric scores of the intervention and base classes, $\mu_I - \mu_B = 0$, where μ_I represents the mean of the intervention class and μ_B represents the mean of the base class. The alternative hypothesis was a significant difference in note-taking rubric scores of the intervention and base classes, $\mu_I - \mu_B \neq 0$. Analysis of the comparison was done at $\alpha = 0.05$. Table 2 shows the results of the analysis of the note-taking rubric.

Table 2

T-Test Results of Note-Taking Rubric Scores

Assessment	Difference	Difference in Sample Means	*df*	*t*	*p*
Note-taking Rubric	$\mu_I - \mu_B$	0.280	58	1.04	0.302

Note. *df* = degrees of freedom

Since the *p*-value was greater than 0.05, I failed to reject my null hypothesis. Therefore, the note-taking rubric scores of the base and intervention classes were not significantly different at the beginning of the study. This means the classes had comparable note-taking skills at the start of the study.

Similarly, I performed the same analysis on the semester grades of my classes to determine if the classes had similar levels of math achievement. Table 3 includes the descriptive statistics of the semester percentages of the bases and intervention classes. Table 4 shows the

results of the *t*-test analysis comparing the semester percentages of the classes to determine if they had similar math achievement levels. My null hypothesis was no difference in math achievement levels of the intervention and base classes. The alternative hypothesis was a significant difference in the math achievement levels using a 0.05 significance level. Since the *p*-value for the semester percentages was above 0.05, I failed to reject my null hypothesis; hence, the intervention and base classes' levels of math achievement were similar.

Table 3

Descriptive Statistics of Semester Grades

	Intervention Class			Base Class		
Assessment	*N*	*M*	*SD*	*N*	*M*	*SD*
Semester %	52	80.1%	0.100	56	78.3%	1.113

Table 4

T-Test Results of Semester Grades

Assessment	Difference	Difference in Sample Means	*df*	*t*	*p*
Semester %	$\mu_I - \mu_B$	1.95%	105	0.95	0.344

Note. *df* = degrees of freedom

At the conclusion of the study, I performed the note checks again. The descriptive statistics of the note-taking rubric at the end of the study are presented in Table 5. I also performed a *t*-test of independent samples to determine if the intervention classes took better quality notes than the base classes at the end of the study. The null hypothesis was no difference in note-taking rubric scores of the intervention and base classes, and the alternative hypothesis was note-taking rubric scores of the intervention classes would be significantly greater than the scores of the base classes. Analysis of the comparison was done at a 0.05 significance level. Table 6 shows the results of the analysis of the note-taking rubric.

Table 5

Descriptive Statistics of Note-Taking Rubric Scores (End of Study)

	Intervention Class			Base Class		
Assessment	*n*	*M*	*SD*	*n*	*M*	*SD*
Note-taking Rubric	31	4.118	0.917	30	3.667	1.021

Table 6

T-Test Results of Note-Taking Rubric Scores (End of Study)

Assessment	Difference	Difference in Sample Means	*df*	*t*	*p*
Note-taking Rubric	$\mu_I - \mu_B$	0.452	57	1.82	0.037

Note. *df* = degrees of freedom

Since the *p*-value was less than 0.05, I rejected my null hypothesis. Hence, the note-taking scores of the intervention classes were significantly higher than the scores of the base classes. This means the intervention classes scored significantly higher in the quality of notes they took at the end of the study.

Common assessments. I also performed quantitative statistical analyses on common assessments given to both the intervention and base classes. The results of the analyses were used to determine if CN significantly increased achievement for students in my intervention Algebra II classes versus students in the base classes.

I analyzed the results of ten quizzes and three tests for the study. The descriptive statistics for the quizzes for the intervention and base classes are presented in Table 7. I also ran *t*-tests of independent samples to determine if students taught CN had significantly higher achievement than those who were not taught CN. My null hypothesis was no difference in achievement scores, and my alternative hypothesis was the intervention class had significantly higher student

achievement, using a 0.05 significance level. The means of the intervention classes are represented by μ_I, and the means of the base classes are represented by μ_B. Table 8 provides the results of the quiz data.

Table 7

Descriptive Statistics of Quiz Scores

	Intervention Class			Base Class		
Assessment	*N*	*M*	*S D*	*N*	*M*	*SD*
7.1-7.2 Quiz	52	11.423	4.504	56	11.045	5.152
7.3-7.4 Quiz	52	8.702	1.866	56	8.482	2.302
7.5 Quiz	51	8.608	2.401	56	9.152	2.004
8.1-8.2 Quiz	53	10.868	2.807	56	10.652	3.094
8.1-8.3 Quiz	53	6.547	2.707	56	6.696	2.593
8.4 Quiz	53	9.368	2.036	56	8.339	3.149
9.1-9.2 Quiz	53	11.509	4.191	56	9.911	4.518
9.3 Quiz	53	9.538	2.379	56	9.393	2.841
9.4 Quiz	53	5.453	1.391	55	5.082	1.745
9.5 Quiz	52	9.038	2.437	55	7.382	3.167

Table 8

T-Test Results of Quiz Scores

Assessment	Difference	Difference in Sample Means	*df*	*t*	*p*
7.1-7.2 Quiz	$\mu_I - \mu_B$	0.378	105	0.41	0.342
7.3-7.4 Quiz	$\mu_I - \mu_B$	0.220	104	0.55	0.293
7.5 Quiz	$\mu_I - \mu_B$	-0.544	97	-1.27	0.896
8.1-8.2 Quiz	$\mu_I - \mu_B$	0.216	106	0.38	0.351
8.1-8.3 Quiz	$\mu_I - \mu_B$	-0.149	105	-0.29	0.615
8.4 Quiz	$\mu_I - \mu_B$	1.029	94	2.04	0.022
9.1-9.2 Quiz	$\mu_I - \mu_B$	1.599	106	1.92	0.029
9.3 Quiz	$\mu_I - \mu_B$	0.145	105	0.29	0.386
9.4 Quiz	$\mu_I - \mu_B$	0.371	102	1.22	0.112
9.5 Quiz	$\mu_I - \mu_B$	1.657	100	3.04	0.001

Note. *df* = degrees of freedom

Since the *p*-values on most of the quizzes are greater than 0.05, I failed to reject my null hypothesis for most of the quizzes. However, on the 8.4 Quiz, 9.1-9.2 Quiz, and 9.5 Quiz, the *p*-value was less than 0.05, and I was able to reject my null hypothesis for these quizzes. The percent differences on the quizzes were 8.58%, 9.99%, and 23.67%, respectively. This means that students who used CN did not have significantly higher student achievement on seven out of ten quizzes, but did have significantly higher achievement on three out of ten quizzes.

I ran the same data analysis for three tests during the study. The descriptive statistics for the tests for the intervention and base classes are presented in Table 9. I also ran *t*-tests of independent samples to determine if students taught CN had significantly higher achievement than those who were not taught CN. My null hypothesis was no difference in achievement scores, and my alternative hypothesis was the intervention class had significantly higher student achievement, using a 0.05 significance level. The means of the intervention classes are

represented by μ_I, and the means of the base classes are represented by μ_B. Table 10 provides the results of the test data.

Table 9

Descriptive Statistics of Test Scores

	Intervention Class			Base Class		
Assessment	*N*	*M*	*SD*	*N*	*M*	*SD*
Ch. 7 Test	52	44.25	8.64	56	43.99	10.08
Ch. 8 Test	53	67.66	9.94	56	63.72	14.66
Ch. 9 Test	53	54.42	10.57	55	52.47	13.23

Table 10

T-Test Results of Test Scores

Assessment	Difference	Difference in Sample Means	*df*	*t*	*p*
Ch. 7 Test	$\mu_I - \mu_B$	0.26	105	0.14	0.443
Ch. 8 Test	$\mu_I - \mu_B$	3.94	97	1.65	0.051
Ch. 9 Test	$\mu_I - \mu_B$	1.96	102	0.85	0.198

Note. *df* = degrees of freedom

Since the *p*-values of each test are greater than 0.05, I failed to reject my null hypothesis on all of the tests. This means that students who used CN did not have significantly higher student achievement on the three tests given than the base classes. In conclusion, the intervention classes did not outperform the base classes after being taught CN.

Interpretation of Results

In this section I summarized the answers to my research questions: Will teaching my Algebra II students CN improve their mathematics achievement? Will students perform higher on tests and quizzes after they were taught CN versus students who were not taught CN? I hypothesized CN would increase student achievement on both quizzes and tests. *T*-tests of independent samples were used on semester grades before the study to show the classes had

similar achievement levels. The results indicated no significant difference between the classes; meaning, the base and intervention classes had similar achievement levels. Another set of *t*-tests compared quiz and test data during the study. The results indicated the intervention class did not score significantly higher on ten of thirteen assessments; hence, CN did not increase student achievement in my Algebra II classes.

I am slightly surprised that CN did not increase student achievement in my Algebra II classes. I hoped that a structured form of note-taking would provide students a solid method for gathering and reviewing material. This result is only slightly surprising because some students come into Algebra II already knowing how to take notes in a style that is beneficial to their learning. All classes received the same instruction, the same material, and the same assignments. As long as the students where actively engaged in the learning process, it is not so surprising the assessment results varied so little.

My final question was the following: Will teaching CN to students increase the quality of notes students take? I hypothesized teaching students CN would increase the quality of notes students took. Again, *t*-tests of independent samples were used to compare the quality of notes students took. The first set of *t*-tests compared the quality of notes at the beginning of the study to determine if there was a significant difference in the quality of notes. The results indicated no significant difference between the intervention and base classes; meaning, the intervention and base classes had comparable note-taking skills at the beginning of the study. The second set of *t*-tests compared the quality of notes at the end of the study. The results indicated the intervention classes did outperform the base classes on the quality of notes after the intervention; hence, CN did increase the quality of notes students took. This confirmed my hypothesis.

Summary

Chapter Four offered analysis of note-checks, quizzes, and tests comparing the base and intervention classes. The analysis provided me with large amounts of data to answer my research questions; will teaching CN improve achievement on tests and quizzes, and will teaching CN increase note quality? Analysis of the data yielded no significant increase in student achievement on 3 tests and 7 of 10 quizzes between the intervention and base classes. However, the results yielded significantly greater note quality of the intervention classes than that of the base classes. The conclusions of the research, reflections, and recommendations are discussed in Chapter Five.

Chapter Five

Conclusions, Action Plan, Reflections, and Recommendations

The purpose of this study was to determine if Cornell Notes (CN) had an impact on student achievement and note-taking quality in the math classroom. Two classes were taught how to take notes using CN, and two other classes were allowed to take notes in any style. In this chapter the findings of my study, my action plan, and recommendations for others considering using CN are discussed.

Conclusions

At the beginning of the study my intervention classes were taught CN, while the base classes took notes in a format of their choice. After the data were collected and the tests ran, I attained the following conclusions to my research questions. Through analysis of assessment scores, I found no significant difference between the intervention and base classes on achievement. However, through analysis of note quality, I found significantly greater note quality of the intervention classes than that of the base classes. In conclusion, CN did not have an impact on student achievement, but it did have an impact on note-taking quality.

Action Plan

I am a little torn between the results of the action research. I am pleased that the students took better quality notes at the end of the study, but I was hoping for an impact on achievement as well. It was nice to see students begin to take better notes and write down all the steps to the problems. I thought this would have more of an impact on their achievement though. However, I was pleased that CN did not have any adverse effects on student achievement.

I plan to continue to use CN in my classes as a way for students to take notes. During the study, I only checked the notes students were taking at the beginning of the study and then again

at the end. I think providing more frequent checks towards the beginning and working with them on summary writing will be beneficial. I did not stress summary writing to students as much as I think I should have. I also should have asked how frequently students reviewed their summaries. Students not reviewing their notes could be a reason why there was no significant difference in achievement.

I plan to use the results of this study to stress to students the importance of note-taking. I believe the use of CN can improve the quality of notes students take. I also believe that, with better teaching of the note-taking process, a positive impact on achievement can be made.

Reflections and Recommendations for Teachers

This project was a success. Teaching students CN improved their note-taking ability. I expected this to happen and would say the results were predictable. Teaching someone to do something usually increases the quality of the task or performance. However, I hoped for a different outcome with achievement. I thought CN would have a positive impact on achievement, but I was pleased to find no negative drawbacks to CN.

I appreciated the challenge of analyzing all of the data collected. Even though it was tedious to collect the data, it was very invigorating to run all of the statistical tests on the data. Learning the process of how to hypothesize, collect, analyze, and then interpret the results was extremely rewarding to me. I can continue to use this process throughout my teaching career with questions that may arise.

Another aspect of the project I surprisingly enjoyed was the literature review. It is astonishing how much information is available to use. The process of researching topics is something I have used multiple times since the beginning of the project, sometimes on topics completely unrelated to my study.

The last thing I enjoyed about this project was the project itself: starting with a problem I thought could be fixed, researching the problem, hypothesizing how to fix the problem, implementing a strategy to fix the problem, collecting and analyzing data, and finally, drawing conclusions. The whole circular process amazes me, never being satisfied with the status quo, always asking, "Is there something more that can be done?", and then starting back at the beginning. The action research process taught me how to complete this cyclical and reflective process, and how to do it successfully.

My advice to other teachers who want to implement CN into their classrooms is, start slow. Teach students how to write their headings for a week. Show them exactly what they should write at the top of the notes every day. Also, give them feedback on this. Another piece of advice is to set aside class time to practice the summary writing process, one of the most important pieces of CN. Writing a summary forces students to revisit their notes, which makes them review material without even realizing it. My final suggestion would be to check student summaries frequently to insure they are writing them.

Summary

I do not think that CN is the magical answer everyone wants. Students who were taught CN did take better notes than those who were not, but they did not have higher achievement results. I found success using this format of note-taking as a student and believe other students also find CN successful for them. I plan to continue to teach this style of notes to my students, but will not go so far to say it is the only way to take notes.

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Appendices

Appendix A

Note-Taking Rubric

Note Rubric

	1	3	5
Legibility	• Notes are difficult to read. • It is difficult to see different sections. • Indentation or bullet points are not used.	• 1 – 3 words are difficult to read. • Spaces missing between some sections. • Indentation or bullet points are not used.	• Neat and completely legible. • Adequate spacing between sections. • Indentation and bullet points help organize information.
Notes	• Notes are incomplete. • No use of abbreviations.	• Notes may/may not be accurate, information is not always paraphrased. • Uses little abbreviation. • No highlighting or underlining evident.	• Notes are selectively and accurately paraphrased. • Use of logical abbreviations. • Notes have been edited. • Key words have been highlighted or underlined. • Revisions/additions are made in a different color.
Thoroughness	• Students didn't write down examples or steps for problems	• Students copied some examples with some steps for problems copied	• Students copied all of the examples with all steps shown for the problems

Appendix B

Parent/Guardian Consent Form: Intervention Class

Purpose of the Research

I am currently completing work toward my Masters of Arts in Teaching: Mathematics degree through Minot State University. For my final degree requirement, I am conducting an action research project in my Algebra II classrooms during quarter 3, January 14th to March 19th, to determine if teaching Cornell Notes increases student achievement and note-taking quality.

Specific Procedures

In Algebra II, students will be taught how to take notes using the Cornell style of note-taking. I will be present to facilitate this process and help correct any mistakes students might make. The teaching of the note-taking will last approximately two weeks.

At the end of the quarter, student assessment (quizzes and tests) results from my Algebra II classes, including your student's class, will be analyzed to determine whether teaching Cornell Notes increased student achievement in Algebra II. Assessment results will be compared with the other Algebra II classes that were not taught Cornell Notes. In addition, I will analyze data from pre- and post-note checks. My results will be summarized and included in my research paper. No students will be identified in my results. Mr. Clark, principal of West Fargo High School, has approved this research study.

Confidentiality

The researcher (myself) will treat all data confidentially. All data will be kept safe in a locked cabinet or on my password-protected computer. All data will be destroyed once the paper has been defended. The researcher agrees to maintain strict confidentiality; which means your student's name will not be discussed or divulged with anyone.

Voluntary Nature of Participation

I hope you approve of your student being involved in this study because a large sample size improves the accuracy of the results of my study. If you decide to allow your student to participate, you are free to withdraw your consent at any time. If you want to withdraw your consent, write me a short note about why you want to withdraw and sign it. If you do not consent or withdraw your consent, your student's data will not be included in my results, but your student will still participate in the classroom as it is part of the course work.

Human Subject Statement

The Institutional Review Board of Minot State University has given me permission to conduct this research. If you have questions regarding the rights of research subjects please contact the Chairperson of the MSU Institutional Review Board (IRB), Dr. Bryan Schmidt at 701-858-4250 or bryan.schmidt@minotstateu.edu.

Offer to Answer Questions

If you have any questions or concerns now or during the study, feel free to contact me at dbroe@west-fargo.k12.nd.us. Thank you for your consideration.

Consent Statement

You are voluntarily making a decision whether or not to allow your student to participate in this study. With your signature below, you are indicating that upon reading and understanding the above information, you agree to allow your student's assessment results to be used in this study.

_____

Participant (Please Print Student's Name)

_____

Name of Parent or Guardian (Please Print)

_____ _____

Signature of Parent or Guardian Date

_____ _____

Signature of Researcher Date

Appendix C

Parent/Guardian Consent Form: Base Class

Purpose of the Research

I am currently completing work toward my Masters of Arts in Teaching: Mathematics degree through Minot State University. For my final degree requirement, I am conducting an action research project in my Algebra II classrooms during quarter 3, January 14th to March 19th, to determine if teaching Cornell Notes increases student achievement and note-taking quality.

Specific Procedures

In Algebra II, students take notes to help retain material. I will be presenting material to all of my Algebra II classes using the same methods. Students in two of my other Algebra II classes will be taught a specific style of note-taking, Cornell Notes.

At the end of the quarter, student assessment (quizzes and tests) results from my Algebra II classes, including your student's class, will be analyzed to determine whether teaching Cornell Notes increased student achievement in Algebra II. Assessment results will be compared with the other Algebra II classes that were taught Cornell Notes. In addition, I will analyze data from pre- and post-note checks. My results will be summarized and included in my research paper. No students will be identified in my results. Mr. Clark, principal of West Fargo High School, has approved this research study.

Confidentiality

The researcher (myself) will treat all data confidentially. All data will be kept safe in a locked cabinet or on my password-protected computer. All data will be destroyed once the paper has been defended. The researcher agrees to maintain strict confidentiality; which means your student's name will not be discussed or divulged with anyone.

Voluntary Nature of Participation

I hope you approve of your student being involved in this study because a large sample size improves the accuracy of the results of my study. If you decide to allow your student to participate, you are free to withdraw your consent at any time. If you want to withdraw your consent, write me a short note about why you want to withdraw and sign it. If you do not consent or withdraw your consent, your student's data will not be included in my results, but your student will still participate in the classroom as it is part of the course work.

Human Subject Statement

The Institutional Review Board of Minot State University has given me permission to conduct this research. If you have questions regarding the rights of research subjects please contact the Chairperson of the MSU Institutional Review Board (IRB), Dr. Bryan Schmidt at 701-858-4250 or bryan.schmidt@minotstateu.edu.

Offer to Answer Questions

If you have any questions or concerns now or during the study, feel free to contact me at dbroe@west-fargo.k12.nd.us. Thank you for your consideration.

Consent Statement

You are voluntarily making a decision whether or not to allow your student to participate in this study. With your signature below, you are indicating that upon reading and understanding the above information, you agree to allow your student's assessment results to be used in this study.

_____

Participant (Please Print Student's Name)

_____

Name of Parent or Guardian (Please Print)

_____ _____

Signature of Parent or Guardian Date

_____ _____

Signature of Researcher Date

Appendix D

Student Assent Form: Intervention Class

Purpose of the Research

I am currently completing work toward my Masters of Arts in Teaching: Mathematics degree through Minot State University. For my final degree requirement, I am conducting an action research project in my Algebra II classrooms during quarter 3, January 14th to March 19th, to determine if teaching Cornell Notes increases student achievement and note-taking quality.

Specific Procedures

In Algebra II, you will be taught how to take notes using the Cornell style of note-taking. I will be present to facilitate this process and help correct any mistakes you might make. The teaching of the note-taking will last approximately two weeks.

At the end of the quarter, assessment (quizzes and tests) results from my Algebra II classes, including yours, will be analyzed to determine whether teaching Cornell Notes increased your achievement in Algebra II. Assessment results will be compared with the other Algebra II classes who were not taught Cornell Notes. In addition, I will analyze data from your pre- and post-note checks. My results will be summarized and included in my research paper. None of your names will be identified in my results. Mr. Clark, principal of West Fargo High School, has approved this research study.

Confidentiality

The researcher (myself) will treat all data confidentially. All data will be kept safe in a locked cabinet or on my password-protected computer. All data will be destroyed once the paper has been defended. The researcher agrees to maintain strict confidentiality; which means your name will not be discussed or divulged with anyone.

Voluntary Nature of Participation

I hope you approve being involved in this study because a large sample size improves the accuracy of the results of my study. If you decide to participate, you are free to withdraw your consent at any time. If you want to withdraw your consent, write me a short note about why you want to withdraw and sign it. If you do not consent or withdraw your consent, your data will not be included in my results, but you will still participate in the classroom as it is part of the course work.

Human Subject Statement

The Institutional Review Board of Minot State University has given me permission to conduct this research. If you have questions regarding the right of research subjects please contact the Chairperson of the MSU Institutional Review Board (IRB), Dr. Bryan Schmidt at 701-858-4250 or bryan.schmidt@minotstateu.edu.

Offer to Answer Questions

If you have any questions or concerns now or during the study, feel free to contact me at dbroe@west-fargo.k12.nd.us. Thank you for your consideration.

Consent Statement

You are voluntarily making a decision whether or not to participate in this study. With your signature below, you are indicating that upon reading and understanding the above information, you agree to allow your assessment results to be used in this study.

_____

Participant (Please Print Name)

_____ _____

Signature of Participant Date

_____ _____

Signature of Researcher Date

Appendix E

Student Assent Form: Base Class

Purpose of the Research

I am currently completing work toward my Masters of Arts in Teaching: Mathematics degree through Minot State University. For my final degree requirement, I am conducting an action research project in my Algebra II classrooms during quarter 3, January 14th to March 19th, to determine if teaching Cornell Notes increases student achievement and note-taking quality.

Specific Procedures

In Algebra II, you take notes to help retain material. I will be presenting material to all of my Algebra II classes the same. Students in two of my other Algebra II classes will be taught a specific style of note-taking, Cornell Notes.

At the end of the quarter, assessment (quizzes and tests) results from my Algebra II classes, including yours, will be analyzed to determine whether teaching Cornell Notes increased achievement in Algebra II. Assessment results will be compared with the other Algebra II classes that I taught Cornell Notes. In addition, I will analyze data from your pre- and post-note checks. My results will be summarized and included in my research paper. None of your names will be identified in my results. Mr. Clark, principal of West Fargo High School, has approved this research study.

Confidentiality

The researcher (myself) will treat all data confidentially. All data will be kept safe in a locked cabinet or on my password-protected computer. All data will be destroyed once the paper has been defended. The researcher agrees to maintain strict confidentiality; which means your name will not be discussed or divulged with anyone.

Voluntary Nature of Participation

I hope you approve being involved in this study because a large sample size improves the accuracy of the results of my study. If you decide to participate, you are free to withdraw your consent at any time. If you want to withdraw your consent, write me a short note about why you want to withdraw and sign it. If you do not consent or withdraw your consent, your data will not be included in my results, but you will still participate in the classroom as it is part of the course work.

Human Subject Statement

The Institutional Review Board of Minot State University has given me permission to conduct this research. If you have questions regarding the rights of research subjects please contact the Chairperson of the MSU Institutional Review Board (IRB), Dr. Bryan Schmidt at 701-858-4250 or bryan.schmidt@minotstateu.edu.

Offer to Answer Questions

If you have any questions or concerns now or during the study, feel free to contact me at dbroe@west-fargo.k12.nd.us. Thank you for your consideration.

Consent Statement

You are voluntarily making a decision whether or not to participate in this study. With your signature below, you are indicating that upon reading and understanding the above information, you agree to allow your assessment results to be used in this study.

_____

Participant (Please Print Name)

_____ _____

Signature of Participant Date

_____ _____

Signature of Researcher Date

Appendix F

School Principal Consent Form

Dear Mr. Clark:

I am completing work toward the Master of Arts in Teaching: Mathematics degree through Minot State University. As a degree requirement, I must conduct a research project in my classroom during the third quarter this year. I am planning to teach students how to take notes the Cornell way to determine if teaching note-taking strategies increases student achievement in my Algebra II classes. To accomplish this, I would like to work with the students in my Algebra II classes.

During this time, students will be taught how to take notes using the Cornell style of taking notes in two of my Algebra II classes. The other two Algebra II classes will be taught the same material, but not shown how to take notes the Cornell way. All classes will be given the same assessments. The data from those assessments will be used for data analysis.

At the completion of the study, I will analyze the data from the assessments. Classroom and student confidentiality will be observed regarding all data collected and no individual will be identified by name.

Before the study begins, I will send home consent forms for parents/guardians to notify them of this project and request their permission allowing their student to participate in the research study. A copy of this letter is attached for your inspection. Students will complete a similar assent form.

I am requesting your permission to carry out this research in my classroom. Please contact me if you have any questions. Thank you for your consideration.

_____ I grant permission for Duane Broe to conduct the above mentioned research in his classroom.

_____ I do not grant permission for Duane Broe to conduct the above mentioned research in his classroom.

_____

Signature of Mr. Gary Clark, Principal at West Fargo High School

_____

Date

Appendix G

IRB Approval Letter

Minot State UNIVERSITY

Institutional Review Board

Notice of IRB Approval

Name of Principal Investigator: Duane Broe

University Address: Mathematics and Computer Science

Title of Project: The Effects of Teaching Cornell Notes on Student Achievement

Protocol Number: 1276

November 26, 2012

The above project has been reviewed and approved by the IRB under the provisions of Federal Regulations 45 CFR 46.

This approval is based on the following conditions:

1. The materials you submitted to the IRB provide a complete and accurate account of how human subjects are involved in your project.
2. You will carry on your research strictly according to the procedures as described in materials presented to the IRB.
3. You will report to the chair of the Institutional Review Board any changes in procedures that may have a bearing on this approval and require another IRB review.
4. If any changes are made, you will submit the modified project for IRB review.
5. You will immediately report to the IRB Chair any problems that you encounter while using human subjects in your research.

Dr. Bryan Schmidt

Chair, Minot State University's IRB

500 University Ave W, Minot, ND 58707 701-858-3594 1-800-777-0750 FAX 701-858-4260

Appendix H

Sample Quiz

Algebra II **Name:_____**
Quiz 7.1-7.2 **Per. _____**

Evaluate the expression without using a calculator.

1. $16^{\frac{3}{4}}$ **2.** $25^{\frac{-3}{2}}$ **3.** $-32^{\frac{4}{5}}$ **4.** $(-8)^{\frac{2}{3}}$

Solve the equation without using a calculator.

5. $(x+2)^3 = -125$ **6.** $\frac{1}{3}x^4 = 27$

Write the expression in simplified radical form.

7. $\sqrt[3]{\frac{8}{3}}$ **8.** $\sqrt[3]{81x^5y^3}$ **9.** $\sqrt[3]{4} \cdot \sqrt[3]{16}$ **10.** $\frac{\sqrt{36x^2}}{\sqrt{y^4}}$

Write the expression in simplified rational exponent form.

11. $\sqrt[3]{x^2} \cdot \sqrt[4]{x}$ **12.** $8^{1/5} + 2\left(8^{1/5}\right)$ **13.** $\frac{xy^{1/2}}{x^{3/4}y^{-1/3}}$ **14.** $\left(x^{1/5}\right)^{5/2}$

Appendix I

Sample Test

Algebra II **Name_____**
Chapter 7.1-7.6 TEST Part 2 **Period_____**

CALCULATORS ALLOWED!!! Show all work.
Perform the given operations. Simplify your answers. Give the domain for 1, 4, 5, and 6.

$e(x) = x^2 + 1$ $f(x) = x^2 + 5x - 6$ $g(x) = x - 1$ $h(x) = \sqrt{x+3}$

1. $f(x) + g(x)$ 2. $f(x) \cdot g(x)$ 3. $g(x) - f(x)$ 4. $\frac{f(x)}{g(x)}$

D: ***D:***

5. $h(e(x))$ 6. $e(e(x))$ 7. $e(h(x))$

D: ***D:***

Find an equation for the inverse of the relation.

8. $f(x) = 2x - 4$ 9. $f(x) = 2x^4$

Verify that *f* and *g* are inverse functions. Show all work!!!

10. $f(x) = -3x + 6 \qquad g(x) = -\frac{1}{3}x + 2$

Solve. Check for extraneous solutions. Circle your answer.

11. $\sqrt[3]{2x} = 4$

12. $\sqrt{3x} - \sqrt{x+6} = 0$

13. $\sqrt{2x} = x - 4$

14. $\sqrt{x^2 + x - 3} = 3$

15. $5 = -\sqrt{7y - 3}$

16. $2(x+1)^{\frac{3}{2}} - 4 = 50$

Solve. Check for extraneous solutions. Circle your answer.

17. $\sqrt[3]{3x+1} + 5 = 3$

Bonus- (Only attempt after you have completed your test.):

1. $(\sqrt{x})^{\sqrt{y}} \cdot (\sqrt{x})^{-\sqrt{y}}$

2. Find all zeros of the polynomial function:

$$f(x) = x^3 - x^2 + 25x - 25$$