

THE IMPACT OF NOTE TAKING STRATEGIES
IN A NINTH GRADE EARTH SCIENCE COURSE

by

Rachel Mae White

A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2012

STATEMENT OF PERMISSION TO USE

In presenting this professional paper in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the MSSE program shall make it available to borrowers under the rules of the program.

Rachel Mae White

July 2012

TABLE OF CONTENTS

INTRODUCTION AND BACKGROUND	1
CONCPETUAL FRAMEWORK	4
METHODOLOGY	11
DATA AND ANALYSIS	17
INTERPRETATION AND CONCLUSION	39
VALUE	43
REFERENCES	46
APPENDICES	47
APPENDIX A: Guided Notes Symbols.....	48
APPENDIX B: Treatment Plan Schedule.....	50
APPENDIX C: Data Triangulation Matrix.....	52
APPENDIX D: Teacher Journal Template	54
APPENDIX E: Quick Quiz Examples.....	56
APPENDIX F: Initial Survey.....	59
APPENDIX G: Initial Survey Results: Likert	61
APPENDIX H: Initial Survey Results: Open-ended	63
APPENDIX I: Final Survey	65
APPENDIX J: IRB Exemption Letter	67
APPENDIX K: Student Notes (Artifacts) Examples.....	69

LIST OF TABLES

1. Matrix of Data Collection Instruments	15
2. T-test: Cycle A Compared to Cycle B	18
3. Quick Quiz Mean Scores by Style of Note Taking.....	19
4. T-test: Treatment and Nontreatment Comparison	22
5. Selected Items from Surveys	27
6. Initial and Final Survey Comparison	27
7. Final Survey, Item 10 Results.....	30
8. Student Artifact Completion.....	35
9. Time Spent Preparing for Lecture/Notes	37

LIST OF FIGURES

1. Quick Quiz Score Frequency	20
2. Highest Scoring Strategy for Each Student	23

ABSTRACT

Note taking is part of life and learning, inside and outside of the classroom. Note taking, in some form, will be required of students beyond high school if they pursue higher education. High school students sometimes have difficulty taking notes during a lecture and are not always engaged. In an ideal situation, an instructor would provide an inquiry approach to all new concepts to allow students to build their own model of thinking. Unfortunately, the reality is that time and resources are limited and thus some material must be delivered through lecture to cover all concepts dictated by state standards. Delivering some short lectures are necessary in order to cover all the required material, but students are not always actively learning during lectures whether or not they are taking notes. Would more formal note taking strategies and instruction on note taking skills benefit students? This question led me to my action research topic and research questions. The main research question asks what impact different note taking strategies have on conceptual understanding. Three different note taking strategies were implemented: self-generated, partial (empty-outline), and guided. Formative assessments, summative assessments, surveys, interviews, and a teacher journal were used collectively to gather data. Not only did most students prefer guided notes, but most performed best on formative assessments when guided notes were in place. While guided notes were not a perfect solution, this strategy keeps more students engaged during lecture and their formative quiz scores were positively affected.

INTRODUCTION AND BACKGROUND

Project Background

Note taking is part of life and learning, inside and outside of the classroom. Note taking, in some form, will be required of students beyond high school if they pursue higher education. High school students sometimes have difficulty taking notes during a lecture and are not engaged. Short lectures are necessary in order to cover all the required material, but students are not always actively learning during lectures whether or not they are taking notes. This observation led me to my action research topic and research questions.

Given the current trends in science education of student-centered learning and increasing emphasis on learning through inquiry, focusing on note taking strategies in the classroom may seem hollow. However, I have spent the first four years of my teaching career attempting to cover required concepts through inquiry and other student-centered means, but at the cost of omitting some other concepts. In an ideal situation, an instructor would provide an inquiry approach to all new concepts to allow students to build their own model of thinking. Unfortunately, the reality is that time and resources are limited and thus some material must be delivered through lecture to cover all concepts dictated by state standards. Since I deliver one to two short lectures a week, I have always wondered if I am doing my students any favors by telling them what to write down (if anything at all). Should more formal note taking strategies be implemented and students receive instruction on note taking skills? Traditional note taking can be boring and does not necessarily engage the learner. There must be a better way to implement note taking

and lectures that is more engaging and student centered. Thus the purpose of this action research (AR) project is to measure the impact of different note taking strategies on engagement, understanding and retention.

The intention of this project was to hone my skills at presenting material in a fun and interesting way as well as actively engaging students even when taking notes. I wanted to know how different strategies worked in my classroom with my teaching style. More to the point, I hoped to collect evidence of the effect of different strategies and finally have an answer to my question “are notes a waste of classroom instruction time?” This has high personal value in my pursuit of becoming a great teacher, because I do not want to be teaching the same material in the same way five, ten, or twenty years from now if it is not best practice.

The results of this AR will directly impact student learning in several ways. By design, the treatment cycle allowed students to consider their quiz scores from the perspective of which style of notes were used with the unit. They were also able to make judgments on how attentive they are during class and how much they learn while in class. Self-awareness of learning and attention levels may have increased as a result of discussing the different strategies as they were implemented. It was anticipated that student confidence in note taking ability increased as a result of this awareness. Also, students may develop skills that will aid them in other classroom settings. For example, by becoming familiar with note taking models in science, they could potentially become better at deciphering a lecture and taking notes from other teachers.

Many of my colleagues (and myself) have attempted different lecture and note

taking strategies, but there is no consensus or clear direction for what is best. In short, note taking is a necessity for students in many of their classes, but students are not taught how to take good notes. I will be able to share documentation of how each strategy impacts students with my colleagues. This could potentially lead them to developing a better approach in their own classroom. In the long term, there is a potential benefit for teachers to work together and develop a short list of homogeneous guidelines across curriculum areas to better create a framework for the high school. Such a framework (when built around empirical evidence) could positively impact students in all academic arenas. While I am not suggesting all teachers should teach the same way or give up their personal teaching style, such a framework for lectures/notes could provide younger (ninth and tenth grade) students more consistent opportunities to build their note taking skills. This framework could also be passed on to beginning teachers who typically struggle with setting up a routine that is successful. In the end, I anticipate that I will gain insight into my students, and also myself, and will pass the results on to other teachers in my district.

Research Questions

First and foremost, I wanted to know how note taking affects learning in the classroom environment. Consequently my main research question addressed learning the material through different lecture/note-taking approaches. Three different strategies were implemented: self generated, partial (empty-outlines), and guided. The first two sub questions were a result of this learning in order to uncover any correlation between academic successes and how interesting each strategy is to the student. The final sub

question is personal and addresses the issue of time; will implementing these significantly change the way I teach and how much time is spent in preparation for class each week?

Main Question:

What is the impact of implementing different note taking strategies on conceptual understanding in a ninth grade earth science course?

Sub-questions:

What is the impact of these strategies on student quiz performance, and concept retention?

What is the level of student engagement and perceived value of notes with these strategies?

What is the impact of these strategies on the teacher?

CONCEPTUAL FRAMEWORK

While interviewing some of my students on taking notes, all of them reported that notes were important, but they did not like to write everything down. In the same interviews, it was evident that most of them prefer notes provided by the teacher in some form. This feedback led to more questions regarding why students have these preferences and if it has any value in the academic world of neuroscience and formal research. Does the act of writing “some” things down really promote learning, the development of working memory, and attention to the lecture all at the same time? This

led me to search for more formal research and published articles on note taking, instructor provided notes, and learning through lecture. There is a multitude of formal research and published articles on this topic dating back to the 1920's. As a result, ample source material relevant to my research topic was discovered and two themes have developed from it: the rationale of note taking regarding learning/cognition, and the benefits of instructor provided notes. Articles that pertained to instructor provided notes influenced the overall purpose and research design for my action research project, while others helped to validate my research project in general. My review of the literature first examines the articles that relate to theoretical evidence of note taking and then leads into the discussion of the benefits of instructor provided notes.

Several articles outline the basis of the rationale and demands of note taking regarding learning and cognition. In one article, Baddely (2007) states that working memory is a critical part of note taking. In order for note taking to be successful, the brain uses working memory to coordinate multiple processes (comprehension, writing etc.) in rapid succession (Baddely, 2007). Piolat, Olive, and Kellog (2005) also explain the "what and why of note taking" in terms of working memory: "When listening, more operations are concurrently engaged and, thus, taking notes from a lecture places more demands on working memory resources" (p. 298). Taking notes means there is understanding of what is presented in a lecture and is written down (Piolat et al., 2005). When taking notes, we need a short-term memory buffer (interpreted as working memory) in order to process the incoming information, and to update the already stored information (Piolat et al., 2005). It is important to give students enough time to write within the lecture since their working memory can only hold so much at a time. This

seems fairly straightforward, but according to Piolat et al., not all forms of note taking are created equal. Some techniques are better suited than others for the way the brain processes and stores information.

By implementing different techniques, I collected data based on note taking strategies, but, by default, also on the different ways the brain deals with information in a lecture setting. How much is learned will depend on cognitive function and the note taking strategy used. To show that some note taking techniques may be better than others, a study by Makany, Kemp, and Dror (2009) with adult learners compared cognitive performance with traditional note taking against a nontraditional technique. The results showed that linear (traditional) note takers did not learn as much as the nontraditional note takers (such as concept mapping). Using cognitively compatible note taking techniques is important for deeper understanding (Makany et al., 2009). This evidence shows that a note taking strategy that works *with* the way the brain manages knowledge should be used. “Non-linear note taking is cognitively less demanding and allows the note-taker to focus on learning the material instead of how to organize notes” (Makany et al., 2009, p. 633). Reduction in cognitive load during a lecture can enhance academic performance (Titsworth, 2004). Building in cues for lectures notes and using non-linear/non-traditional note taking formats creates a visual structure that allows for a reduction in cognitive load and can ultimately make the note taking process more effective (Titsworth, 2004). One way to encourage this nonlinear note taking as well as integrate lecture cues is to use instructor provided notes.

Instructor provided notes have shown to have many benefits to student learning and they exist in many forms. When considering all these forms there have been many

studies that have implemented this type of note taking and measured the impact. In a study based on college students by Cornelius and Owen-Deschryver (2008), students were given two types of instructor generated notes (partial versus full notes) over the course of a semester. Partial notes in this study were essentially an outline where students insert information as they listen and full notes are handouts with all the information provided. Exam scores (four), including a cumulative final, were analyzed to look for evidence of impact of both strategies. Ultimately it was found that partial notes somewhat positively impact scores on exams and therefore the results supported the use of partial notes over full notes. The authors discussed possible reasons why partial notes are beneficial (i.e. higher exam scores of students receiving partial notes) based on the amount of participation required in both scenarios. “Providing incomplete notes encourages students to elaborate on and encode material during lectures...and through the process of taking notes, students gain some mastery of the material” (Cornelius & Owen-Deschryver, 2008, pp. 10-11). In short, taking notes impacts student performance. The conclusion and discussion sections of the study supplied me with useful key terms for further research led me to a review conducted by Konrad, Joseph, and Eveleigh (2009) on guided notes.

Guided note taking is not a new idea, but the terminology was new to me. Guided notes are a type of partial notes, but by looking into this specific type, it led to more specific (and conclusive) studies. Konrad et al. (2009) defined guided notes as instructor provided and nonlinear in order to select relevant studies to include in their review. The review was conducted in order to summarize the results of eight studies on the effectiveness of guided notes and then provided recommendations for use in everyday

classrooms. The eight studies selected all fit within pre-determined criteria. Five of the studies used school-aged participants and the other three studies used college students. Three of the studies were deemed inconclusive, but nonetheless, the other studies found that students prefer guided notes and they possibly reduce frustration of students when taking notes. Guided notes are an efficient way to help teachers promote active participation during their lectures and provide students with thorough and accurate reference for exam preparation (Konrad et al.). Another benefit is that this type of note taking encourages higher order thinking. The instructor can build in stopping points within the notes/lecture for students to “pause and think critically, ask questions, connect with personal experience, relate prior knowledge, and generate new ideas” (Konrad et al, 2009, p. 138).

In addition to the findings, the recommendations at the end of the review for teachers were very influential in designing guided notes and other elements of this action research project. For example, Konrad et al. (2009) suggest including a prompting question at the beginning of the instructor provided notes in order to link students to their prior knowledge. Activating prior knowledge prepares the mind for new information and strengthens connections, which is essentially constructivism. Organizing the new information into what is already there is fundamentally how learning is done.

In addition to providing summaries and recommendations, the summary highlighted studies relevant to my research have been useful to review and model. One such study was conducted by Neef, McCord, and Ferreri (2006). In this study, 46 graduate students were subjects involved in an eight-week study that examined the effect

of guided lecture notes versus completed lecture notes on quiz scores. Although, it was ultimately inconclusive since differences in scores could be attributed to the teaching styles of the different instructors, elements of the data collection methods are useful to my research since I am the only instructor. PowerPoint® was used and each presentation followed the same basic format. For example, in this study, the first slide stated objectives, the second slide had an opening question, the next slides presented the new material, and so on (Neef et al., 2006) I also use slides when delivering a lecture, so this brought to light a potential source of variation that I have been able to avoid during my data collection. A standard format has been followed whenever slides are used. Also, the complete notes were identical to the slides used during the lecture and guided notes were in the same format, but with key parts deleted. Quizzes on the previous class' material were administered during the first 15 minutes of each class. If a student missed a lecture, their quiz score was not counted in the data analysis (Neef et al., 2006). The basic design of this study has been modeled (such as post quizzes) in my research design.

The basic experimental design involved alternating guided notes and completed notes each week. The quiz score each week would potentially reflect the note taking strategy used the previous class. My interpretation of why the study was designed this way is that motivation of students can change over the course of the semester and by alternating styles, you would not have one half skewed toward a certain result. Along with quiz scores, this study also reported that student preference was collected. Although Neef et al. (2006) did not describe how the data was collected; they reported that students had a clear preference for instructor provided notes over personal note taking. Also, the majority favored guided notes over completed (full) notes. Another study (Cornelius &

Owen-Deschryver, 2008) examined partial versus full notes as well and came to similar conclusions. The results showed that students who received partial notes performed better on exams. The authors offered the interpretation and possible reasons for this result which correlates with the concepts of working memory and benefits of instructor provided notes: “Partial notes...may provide a nice balance in terms of providing students with some notes, which they report as helpful, and still require encoding and higher level processing of information, which will ultimately improve learning and performance” (Cornelius & Owen-Deschryver, 2008, p. 11). Using these studies as a guide, and the previous works of Joseph Konrad, I knew that I wanted to implement guided notes, but was still unclear about how to implement them in my classroom. These questions led to the most influential article to my research project design: “Using Guided Notes to Enhance Instruction for All Students” (Konrad, Joseph, & Itoi, 2011). Methods from this article became the basis of my treatments, particularly the treatment phases using guided notes.

It is an article that was written to provide specific suggestions for creating and using guided notes, and to promote higher order thinking skills. Konrad et al. (2011) suggest using visual cues and embedded organizers within the notes. More specifically, a table of symbols in the article offers ideas for cues and symbols to use for them. For example, a * means “pay special attention to this part” or an ear means “put your pencil down and listen” (Konrad et al., 2011). Not only do the embedded organizers and visual cues promote learning since they are non-linear, but these cues provide consistency and engagement opportunities beyond simple writing. Notes designed with embedded organizers and visual cues increase active student response.

Guided notes are a way to enhance instruction and add value to note taking, thus impacting student performance. Based on the reviewed literature, evidence supports the idea that notes are a way to learn and provided the backbone to my treatments. By understanding the cognitive process of note taking on this basic level, I am now more informed and this has affected the analysis of data collected. Differences in achievement could possibly be linked to working memory function and the note taking strategy being used (not just student proficiency with the subject matter).

METHODOLOGY

Treatment

The first phase of treatment was a traditional way of taking notes where students decide what (and how) to record as I moved through the lecture. The other two treatments involved instructor provided notes that allowed for less information to be held in working memory and more time for students to process what they were writing and hearing.

The first treatment phase applied was simply student-generated notes. This baseline phase is a product of the status quo. Since no special instructions to students or change in routine were introduced, it is more appropriate to refer to this phase a nontreatment. It simply is doing what is typically done in my classroom in regards to lectures and note taking. During a lecture, students take notes using blank pages and will be left to their own devices to write down what is important. Students were encouraged to write down main ideas and anything else that was important, but were not told directly

what to record.

During the second phase, partial notes were introduced. Here, students were given empty-outline style handouts that supplement the lecture. Students are not told when/what to write down, but to follow along with the presentation slides and the handout to fill in what is missing or they feel is important. Diagrams and difficult words are provided on these partial notes, creating opportunity for students to listen and engage with the material as opposed to just trying to “get it all down” on paper.

The third strategy implemented was modeled after descriptions in the article titled “Using Guided Notes to Enhance Instruction for All Students” (Konrad, Joseph, & Itoi, 2011). It is an article that was written to provide specific suggestions for creating and using guided notes, and promote higher order thinking skills. Guided notes are an extension of partial notes, but it was anticipated that engagement level would increase with this strategy. While the lead author is undoubtedly an authority on note taking (decades of published studies and articles), the article delivers mere suggestions. These suggestions were tailored to my classroom and teaching style. Cues were built into the lecture and symbols on the handout will let students know how to interact during the lecture. For example, a * means “pay special attention to this part” or an ear means “put your pencil down and listen” (Konrad et al., 2011). The cues (symbols) are placed on the presentation and correspond to the same cue imbedded within the handout given to the student. For a full list and the meaning of all visual cues used for guided notes see appendix A.

Six total phases of data collection were used (two cycles of the three phases). The

first phase was student-generated notes (nontreatment), followed by partial notes and then guided notes. Then this three-phase cycle was repeated. Each of the six treatment phases included all data collection methods described in the subsequent section. Each treatment was one “unit” of instruction. Each unit is one to two chapters in the textbook, depending on subject matter, and approximately two weeks in duration. To allow for unforeseen changes in scheduling and holidays, collection began in late October 2011 to be followed by 18 weeks of collection ending in early February 2012. Appendix B outlines the timeframe for each of the three types of note taking strategies that took place. During each treatment phase the note taking strategy was utilized during two to three short lectures.

For each lecture in class students took notes using one of three strategies: self-generated, partial, and guided. Notes were collected and returned the next day after the quick quiz was collected. A formative quiz (I coined the phrase “quick quiz”) was administered the day immediately following a lecture. These quick quizzes consisted of five questions that were directly related to the notes from the lecture as recommended by Konrad et al. (2011). Appendix E contains samples of quick quizzes administered for the first cycle of treatments. The difficulty level of the quizzes was considered and every effort was made to ensure each quiz had roughly the same type and difficulty of questions. Students were given the quick quiz at the beginning of class and were allowed as much time as they needed to complete the five questions. Once I collected all quick quizzes, I addressed the class and read through each question and asked for volunteers to share answers. These created an instant feedback situation for students (regarding their answers) as well as served to activate their prior knowledge before beginning the rest of

the class.

A summative quiz on each “unit” was then administered and re-taken two weeks later as a way to measure retention. An initial survey (Appendix F) was administered before the treatment cycle began and a final survey was given after the treatments were complete. The initial survey items were designed to uncover student perceptions about note taking. Item one of the survey asked if students have been taught how to take good notes. Given responses were strongly agree, agree, disagree, and strongly disagree for items 1-7. These responses were then assigned values for the data analysis portion: strongly agree = 4, agree = 3, disagree = 2, and strongly disagree = 1. Item 8 responses and values assigned are 0 = 0, 1 = 1, 2 = 2, 3 = 3, 4+ = 4. Item 9 responses and values assigned are none = 1, very little confidence = 2, somewhat confident = 3, very confident = 4. Item 10 responses and values assigned are never = 1, sometimes = 2, most of the time = 3, every time = 4. The final survey was analyzed in the same way and results have been compared in the analysis section of this paper.

Instrumentation

Table 1 summarizes what types of instruments were used to collect data. Each research question has three or more data sources in order to attempt to triangulate results to answer each question. Quizzes (as described in the following paragraphs) were the primary instrument.

Table 1
Matrix of Data Collection Instruments

Research Questions	Data Collection Techniques						
	formative quizzes	student surveys	interviews	summative/post unit quizzes	planning log	teacher observation journal	student note samples
What is the impact of implementing different note-taking strategies on conceptual understanding in a ninth grade Earth Science course?	x		x	x		x	x
What is the impact of these strategies on student quiz performance, and retention?	x	x		x			
What is the level of student engagement and perceived value of notes with these strategies?	x	x	x				x
What is the impact of these strategies on the teacher?			x		x	x	

Student work samples (artifacts, appendix K) were collected and evaluated with a rubric in order to compare student participation and completion of the notes. A journal (see template in Appendix D) was created and used daily to record observations of both classes involved in data collection. The journal was designed to streamline analysis. Each box addressed specific points and all responses were related to note taking. Part of the journal included a planning log where time spent preparing the lecture and its notes were recorded. Surveys and interviews were also utilized to gain insight into student perception of the strategies.

Each instrument was designed to ensure that each was targeted at what the

instrument was intended to measure (validity). For example, each lecture was presented in the same manner to the same students, with the same pacing and level of difficulty. The second cycle was identical to the first cycle. No instruction was given for the nontreatment phase of self generated notes. Observations were recorded as accurately as possible in the journal, and results were accurately recorded. The initial research design was submitted to my graduate advisor, committee members, and other colleagues for input.

Students were given numbers and all data was put into Excel spreadsheets. The number assignments ensured that I objectively analyzed numbers without names of students. Triangulation was used (three or more sources to answer each research question) and in an attempt to remove any bias and ensure reliability of the data. The formative and summative quizzes were designed to exclude any ambiguous questions, and target concepts directly covered in the lectures. I am confident similar results would be produced consistently (over time), if the same instruments were used because of multiple data collection techniques.

Demographics

Belgrade High School (BHS) is located in southwest Montana in the city of Belgrade. The overall student population of BHS is approximately 885 students. Twenty-five percent of the students are on free and reduced lunch and the drop out rate is typically 5%. Population ethnicity is 96.5% White, 2% Hispanic or Latino, 1% Native American and the remaining 0.5% from other races. The students in this study are in two sections of Earth Science for a total of 41 individuals (22 males, 19 females). There are

22 students in sixth period and 19 students in seventh period. It is a freshman class, so most of the students are ninth graders; however there are two students that are re-taking the class, so one of the 41 is a sophomore and one is a junior. Three students have Individual Education Plans (IEP) and there are no students with 504 plans or any other official accommodations. These two sections were chosen since they are demographically similar, scheduled at the end of the day, and are first year high school students that have otherwise had very little note taking experience and instruction. Since earth science is the prerequisite for Biology I, students must pass earth science before moving on. Typically students take earth science as a freshman and move on to Biology I as a sophomore. All students were assigned a number in order to track their progress, but their names have not been included here to maintain confidentiality. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (see Appendix J).

DATA AND ANALYSIS

In order to determine if there was an impact from the treatments a number of analyses were performed, which are summarized in this section. A few trends emerged and several findings of significance were revealed. Data was collected in two cycles, which resulted in two sets of information. Each cycle was the implementation of all three note taking strategies (self generated, partial, and guided) including the data collection instruments used. The results of the first cycle (cycle A) were compared to cycle B to look for any inconsistencies or significant differences between the two collections of results. If a difference had been found, the data would be analyzed in two sets.

Qualitatively, there are only slight differences that could have occurred simply because of normal changes in student effort and performance. Also, a two-sample (paired) t-test was performed for each note taking strategy using all 18 sets of the quick quiz scores. Guided notes scores from cycle A were paired with guided notes from cycle B etc. All three t-test values resulted in p-values greater than 0.05 (see Table 2).

Table 2
T-test: Cycle A Compared to Cycle B

Style	t-test value	p-value
Self	1.41	0.17
Partial	1.32	0.19
Guided	0.94	0.35

Note. df = 40.

These results indicate that each pair (Cycle A and Cycle B) of note taking styles had similar results since the p-values are greater than 0.05. There is no statistical evidence of a difference in results between the two cycles. This outcome has generated the inference that there is no reason for the cycles to be kept separate and thus the data from the two cycles has been analyzed as one set (rather than two sets). Since it was apparent that the two cycles could be analyzed as one set of data, the main data collection instrument (Quick Quizzes) were analyzed first to look for evidence of the treatments impacting scores.

Quick quizzes are short, formative assessments used to measure the impact of note taking styles. For each note taking strategy, three short lectures and a corresponding quick quiz were administered the following day (for a total of nine quizzes for each treatment cycle). Each quiz was scored out of five points, and then the three scores for the given note taking strategy were averaged. The mean value of each set of quiz scores

indicates that students performed better on the quick quizzes when guided notes were used the previous day (see Table 3).

Table 3
Quick Quiz Mean Scores by Style of Note taking

Style	Mean	SD
Self	3.31	0.68
Partial	3.05	0.71
Guided	3.96	0.72

Note. SD = standard deviation, ($N = 41$).

Average scores were placed into groups (high, medium, and low) to look for patterns.

Again, students performed better on quizzes after guided notes. Figure 1 summarizes the results of these quizzes when they are grouped (high, medium, low). Frequency indicates the number of students in that category. The high range is a score of 4 or better (out of five), which is an 80% and considered proficient in most education settings. The mid range is scores of 3 to 3.9 where students would be “passing.” The low range is where all students that would not be passing have been placed.

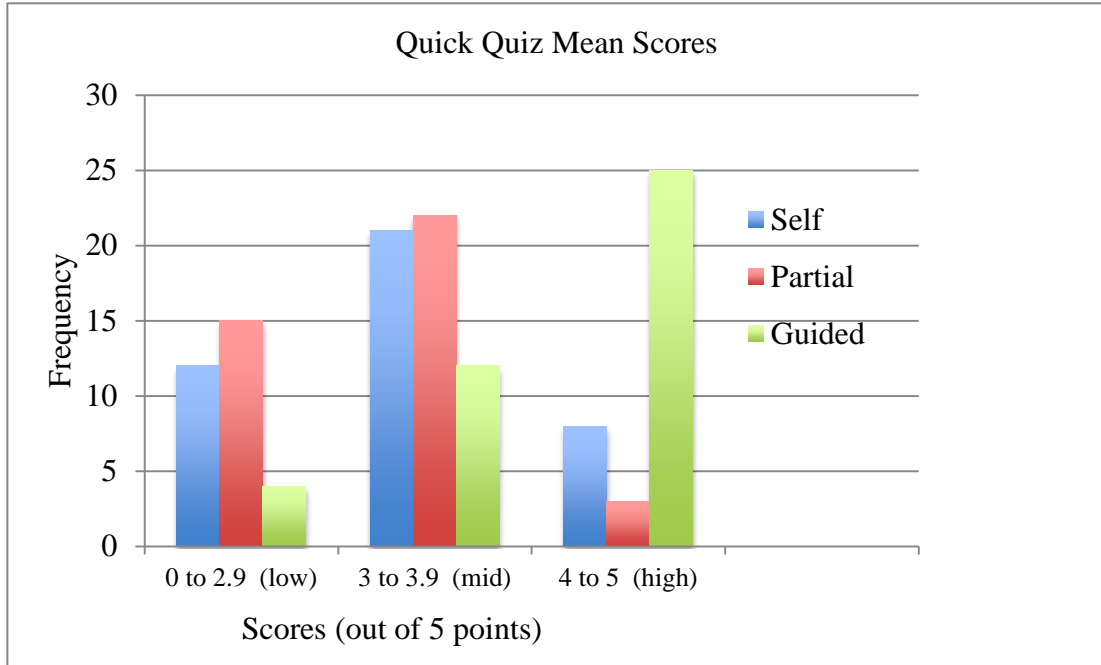


Figure 1. Quick Quiz Score Frequencies, ($N = 41$).

For self-generated notes, eight students scored in the high range and for partial notes, only 3 students scored in the high range. However, for guided notes, 25 students scored in the high range. In fact, 90% of the students were in the mid and high categories (see Figure 1) for guided notes. Also, guided notes had the fewest number of students in the low range. This large portion of the students above the low ranges could be a result of the interactive nature of guided notes since students write, discuss, draw, and diagram during the lecture.

Ten students had an average guided notes score at or above one standard deviation above the mean and 19 students scores 85% or higher (mean score of 4.2+). Not only does the overall mean value indicate better performance with guided notes, but these mean values also indicate that students did the worst when partial notes were in

place. Only four students performed one standard deviation above the mean for partial notes, with only one of those scoring 85% or higher. For the non-treatment (self generated), seven students scored one standard deviation above the mean and four students scored 85% or higher. Since the largest group of students scoring in the proficiency range is from the guided note quizzes, this substantiates the trend of the higher mean values. This is encouraging from a teaching standpoint since the positive impact of guided notes means that they will continue to be a part of the classroom routine in some way or another. Perhaps these formative assessment scores for guided notes are a result of a reduced load on working memory and higher engagement with the material during class. Even though not all students prefer this type of note taking, it also is a starting point for further (although informal) data collection for the coming school year. With more data collection, and a new set of students, the extent of the benefits (or limitations) of guided notes can be fully understood.

While the quick quiz mean scores indicate that guided notes are effective, not all students fit this trend. For example, student 28 scored the same in self and guided notes, and lowest for partial notes. Student 28 is an average student who has varying degrees of motivation. This observation comes from day to day variances in work ethic and also the stark differences in quarter grades (73% and 87%). Another example that is somewhat of an outlier is student 36. This student scored highest for self notes (3.75, but below the mean), a 2.6 for partial, and 3.0 for guided. Student 36 is consistently a “B” student and even prefers guided notes (survey results), so perhaps this student was more engaged in the material covered during self-generated note taking. Student 5 is also an outlier in that their highest quick quiz scores came from partial notes. This student’s scores were

similar (3.8, 4.0 3.8) and so without a significant difference in scores it is difficult to pinpoint the reason. Student 5 prefers guided notes and does well on most assessments (typically around 85%), so while note taking may make this student an outlier; he is not struggling to learn new concepts in any scenario. At this point, raw scores have been looked at with the “naked eye” and student mean scores were tallied to create groups where trends emerged. However, to further analyze these results, paired t-tests were utilized again to compare the results of the quick quizzes from self-generated notes to the results of partial notes and guided notes (see Table 4).

Table 4
T-test: Treatment and Non-Treatment Comparison

Style	t-test value	p-value
Self to Partial	0.91	0.37
Self to Guided	2.4	0.017
Partial to Guided	2.9	0.004

Note. df = 40.

Again, the value of 0.05 was used to compare the resulting p-values to determine if there was a change in scores. There is no significant change in scores when comparing self-generated to partial. The resulting p-value when comparing self to guided is less than 0.05, which indicates a difference or change in scores that is significant. However, using the same procedure to compare self-generated notes scores to guided notes scores, a very different p-value was revealed (0.004). The low p-values of 0.004 and 0.017 are considered statistically significant and thus result in a failure to reject the impact of the treatment (guided notes). In short, the t-test results provide evidence toward the positive impact of guided notes on quick quiz scores. Based on the mean values of quick quizzes

and t-test results, students appear to perform better on these short formative assessments when the treatment of guided notes was in place.

The mean values of the quick quizzes coincide with the resulting p-values from the t-tests. This is because the mean value for guided notes was the highest (of the three) and the lowest p-value was from comparing the two treatments to each other (partial vs. guided). The mean for partial notes was lowest (lower than the non-treatment) and thus producing the greatest difference of scores when the t-test was performed. In order to triangulate the findings thus far (mean values, and t-tests) a third comparison was made. For each student, the mean of the three styles were compared to themselves. For example, student four scored mean values of 3.8, 3.7, and 5.0 for quick quizzes (self, partial, and guided, respectively). A total of thirty-three of the 41 students had the highest quick quiz mean value when guided notes were used (see Figure 2).

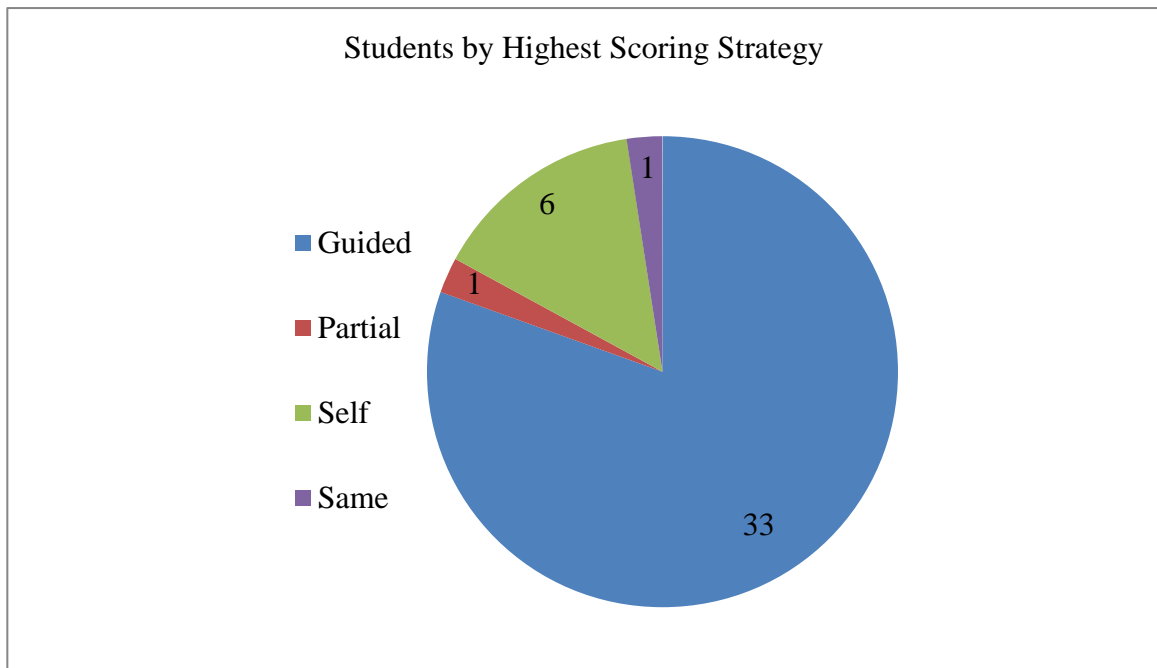


Figure 2. Highest Scoring Strategy for each Student, ($N = 41$).

Six of the 41 saw their highest score on quick quizzes when self-generated notes were in place, and one student has the highest mean for partial notes. It is important to mention that one student did not have a discernible change in scores when comparing note taking strategies (3.5, 3.6, and 3.6). This student did poorly for quarter grades and thus failed the semester, so there is no correlation academically. However, when looking closer into why the semester grade was an F, it is obvious that it is a result of missing work. So, while this student has not performed better for any note taking strategy, as an individual, her guided notes scores were higher the second cycle. She may be an indicator of a type of student that needs more practice with something new before it benefits them. For the six that did best on self-generated notes, four of them reported preferring guided notes and the remaining two preferred self-generated notes. There are no apparent patterns as to why these six are in this group except perhaps it suits their learning style best to write out what is being discussed in a lecture. Two of the six are twins, but they were not in agreement on what style they prefer. As mentioned earlier, student five is the single student that did best on partial notes, thus is considered an outlier. Even with the eight students not performing best with the treatment of guided notes, there is a convincing trend toward the treatment. Overall, 80.5% of the students performed best (highest mean score) as a result of guided notes. Since the analysis of the quick quizzes uncovered a trend toward the positive impact of guided notes, the summative quizzes were analyzed next in order to correlate with the quick quiz scores. However, the summative quizzes were not as revealing.

In an attempt to measure retention, at the end of each set of note-taking implementation series, a summative quiz was given that included concepts from the last

style of note taking used in class. Two weeks later, the quiz was taken again. This resulted in six sets of summative quiz scores. Initial analysis was promising, but upon further analysis the results were somewhat inconclusive. The initial quizzes for guided and partial notes produced very similar mean values of 83% and 82%, respectively. For self-generated notes, the mean was 79%. T-tests produced p-values greater than 0.05 when all comparisons were made, thus no real difference in the initial summative quiz scores was revealed. Historically, these initial averages resemble scores for similar quizzes on the same material in previous years, but since those scores were not part of formal data collection it cannot be truly compared. However, the self-generated notes post-quiz mean value dropped to 69%, and the partial notes mean value dropped to 70%. The guided notes mean dropped to 74%, which is the smallest change in score of the three styles. This is the only piece of the summative quizzes data that could possibly correlate with the quick quiz results. However, there are some students that did significantly better on the summative quizzes for material covered with guided notes. Student 14 is an interesting example (a student with an IEP) since she only dropped by one point on the post-quiz (for guided notes material). Student 14 dropped 18 points for self-generated quizzes, which from a percentage standpoint is very significant (62% to 23%). So for this individual student, there appears to be a significant change in retention for the treatment of guided notes, and she also scored highest on the quick quizzes for guided notes. Also, seven students scored the same on the guided notes initial and post-summative quizzes. These seven (students 8, 9, 14, 17, 27, 28, and 41) dropped in scores from the initial to post-quiz for self-generated and partial notes, but did not drop for the guided notes quizzes. This group is only 17% of the students, however, for this small

group, it could be interpreted that they truly learned the concepts (long term memory) and were able to score the same as the initial quiz. Four of these seven had the highest mean score for guided notes quick quizzes. There does not seem to be any defining commonality with this group other than their scores. They are a cross section of the student population as a whole from an academic achievement perspective. While the data on summative quizzes is somewhat inconclusive, students performed slightly better on formative quizzes while utilizing guided notes and could have a higher retention rate as a result. Since the scores for the summative quizzes had the smallest drop on the post-quiz for guided notes, there is some evidence that guided notes impact retention. It is this teacher's opinion that this result is definitive or at least supported by some evidence. Perhaps the summative quizzes, being longer than the formative quizzes, covered too much material to accurately measure learning. Also, it is worth mentioning that none of the quizzes were modified for students with IEP's. Surveys and interviews were then examined for trends, which could possibly connect with these findings.

The initial survey was designed to provide a baseline of student perception and to help guide the rest of the data collection. Appendix G summarizes the results of all ten of the initial survey items (without the open response portion). In order to track any changes in student opinion of notes in general the final survey (Appendix I) was compared to the initial survey (Appendix F). In particular, survey items 1, 3,4, and 8 (see Table 5) were compared and a paired t-test was performed to look for quantitative changes in addition to qualitative differences since these items were the most pertinent in answering the research questions.

Table 5
Selected Items from Surveys

Survey Item/Question
1. I have been taught how to take good notes.
3. Taking good notes is easy.
4. Taking notes helps me pay attention in class.
8. How would you rate your overall confidence at note taking (in any class)?

Again, as described in the methodology section, these were Likert style survey questions with an additional open response portion for many of the questions. Given responses were strongly agree, agree, disagree, and strongly disagree for items 1-7. These responses were then assigned values for data analysis: strongly agree = 4, agree = 3, disagree = 2, and strongly disagree = 1. Item 9 (initial) and 8 (final) were the same on both surveys but simply were numbered differently. For this question (9/8) responses and values assigned are none (no confidence) = 1, very little confidence = 2, somewhat confident = 3, very confident = 4. Table 6 shows the mean values for the responses of each survey as well as the resulting p-values of the t-tests comparing the data sets of the two surveys.

Table 6
Initial and Final Survey Comparison (N=41)

Survey Item	Initial Survey		Final Survey		t-test value	p-value
	Mean	SD	Mean	SD		
1	2.59	0.67	2.88	0.75	1.87	0.066
3	2.54	0.59	2.61	0.74	0.49	0.628
4	2.71	0.85	3.10	0.66	2.30	0.022
8	2.88	0.64	3.17	0.67	2.03	0.046

Note. SD = Standard Deviation.

Item 1 of both surveys stated “I have been taught to take good notes, ” and students had the standard Likert response choices available (see above). On the initial survey, the mean value was 2.59, which falls between agree and disagree. Eighteen of the 41 marked disagree or strongly disagree. However, on the final survey for the same item, the mean value is higher (2.88) which still falls between disagree and agree. Student perception only changed slightly and the p-value of 0.066 is greater than 0.05, so there is no statistically significant difference between the initial results and the final results. Similarly, item 3 on the surveys showed an increase in the perception of “taking good notes is easy.” The mean value increased slightly, but a p-value of 0.66 shows that this change could be a result of chance and the action research methods did not change how students felt about taking good notes. However, comparing the results for item four produced a p-value of 0.022, which is below 0.05, and therefore the differences in the responses for “taking notes helps me pay attention in class” are statistically significant. This increase (from initial to final survey), in student agreement of item four, aids in answering the question of engagement during a lecture. The frequency of the responses that were agree or strongly agree (that notes help them pay attention) was 38 (out of 41). This large portion of the students that have a positive opinion of taking notes and engagement is gratifying and correlates with the t-test results as well. Item nine on the initial survey and item 8 on the final survey asked the same question; how would you rate your overall confidence at note taking? Once again, there was an increase in the mean value and the p-value of 0.046 (just below 0.05) verify that this change is not due to chance and the treatments helped students to increase their confidence in their note taking abilities. While 37 of the 41 students are somewhat confident or very confident in their

note taking ability, the four remaining still marked very little or no whatsoever. On a positive note, there were nine students who felt this way on the initial survey, but five of them increased their rating of their confidence on the final survey. Of the 12 students that indicated they were “very confident” in their ability to take notes, only two had a mean score less than one standard deviation above the mean for guided notes quick quizzes. While those two were lower than the others they were still above the mean. Also, four of the 12 scored in the high range for self-generated notes. This could mean these students have a false sense of their note taking ability. What is pertinent to mention is that two of the 12 performed the best on self-generated notes (the other 10 had the highest in guided). The two students both have high confidence as well as performed best on the nontreatment portion. These two students may feel that they take better notes on their own and do not interact as much as they could during guided lectures. It could also mean that these two students process information more efficiently when they encode and write their own notes.

Appendix H summarizes the responses from the open-ended questions in the initial survey. Three to five themes were identified and responses that did not fit a theme were placed in the “other” category. Overall, more than half of the students have a positive correlation with note taking and their success in classes. As with most things in the world of education there is no “one size fits all” solution that works in a class of many different individuals. Each student is a unique individual and learns in a variety of ways. While the results show most students find some value in note taking, they do not all like taking notes the same way. However, after analyzing the results of the final survey and

specifically honing in on question 10 (Which style of note taking do you prefer and why?), clear trends emerged (see Table 7).

Table 7
Final Survey, Item 10 Results

Style Preferred	Frequency	%
Self	7	17.1
Partial	10	24.4
Guided	24	58.5

Note. $N = 41$. Item 10 = Which style of note taking do you prefer?

Most students (58.5%) preferred the guided notes to the other two methods. For the open-response portion of this question, 13 of the 24 mentioned that they liked guided notes because they were easier. For example, student 13 wrote, “It’s easier and I get a better understanding.” Student 9 commented on the improvement of their note taking: “I used to write down the wrong things, it’s easier to get it right (with guided notes).” Student 35 (one of the students with an IEP) stated, “You actually know what to take notes on.” During an interview, another student with an IEP (student 3) commented that they struggled keeping up with the lecture unless a “note sheet” with the “codes” was handed out. This also correlates with entries in the teacher journal. Students were happy to get a handout rather than being told to just take notes. “Thank you’s” were mentioned on several occasions when the notes sheets were being distributed. Student 15 scored a 2.8 for both partial and self-generated, but a perfect 5 for guided notes. She also preferred guided notes on the final survey and in her interview stating, “It’s more fun than the other notes.” Ten students preferred partial notes (empty outlines), and the distribution of low, middle, and high achievers for this group was relatively even. Three of these students gave no response to the open-ended part of the survey question, but

three of the students who did, mentioned that they like partial notes because it did not make them draw. Two students said they liked this style because it was the easiest.

These two sets of comments seem to be related since they come from the perspective of the least amount of work of the student. Student 6 was blunt in mentioning there was “less writing” than the other types of notes. While these students give the impression that they are minimalists, the other group that prefers to write their own notes (non-treatment) gave a very different impression. The act of writing in their own words or the processing done cognitively may be a better match for their personality. Quantitatively this group fit together with their quick scores and all being “A” or “B” students.

Without question, all students that preferred self-generated notes were high achievers. These "high achievers" are all at least one standard deviation above the mean for quiz scores ($N=7$). In response to why they preferred that method of note-taking each mentioned that they like to write everything or like to put information down in their own way so that it is clear to them. Five of the seven in this group mentioned that they like to write, and two even mentioned that do not like to draw or do extraneous things that are required during the guided notes. For example, one of these students stated, “I like to write as much as I can, and I don't like discussions and drawing.” This student does well in my class as well as all his other classes, he is a typical “A” student. Student four performed best when guided notes were used. This student's mean score for guided note quick quizzes was a perfect 5.0, yet on the final survey and her interview she stated she preferred self-generated notes. When pressed for more of an explanation as to why, the student stated that writing things down in a more personal way was preferable and “I like to write.” However, this student does not prefer what seems to work best for their

learning style. Student 27 was a similar story. This student preferred self-generated notes and performed best on guided quick quizzes. Students like this may not be realistic or in touch with their own learning style. As a teacher, I would want to investigate this further and involve the student to help them become more self-aware of their learning style and how it impacts them on assessments.

Another interesting outlier of the final survey results is one of the IEP students, student 35. This student preferred guided notes, stating, “You actually know what to take notes on.” I also wrote this student’s name in the teacher journal since his notes were completed when guided were used. Notes were collected and marked off as none, incomplete, or complete. Student 35 only had complete marks for guided notes. However, the scores for this student are not revealing (2.2, 1.6, 2.0 for self, partial, and guided respectively). While this student seemed to gain confidence and prefer guided notes, his performance was not improved by the treatments. However, 24 of the 41 students preferred guided notes, and 34 of the 41 performed best on guided notes. This finding validates my research topic, confirms that guided notes can be beneficial, and supports the continuation of this note taking style in some form. Since there was such a positive reaction to the partial and guided notes in general (based on surveys and interviews), any guidance from the instructor with students in this age group has some benefits. A gradual progress or even a rotation of note taking strategies throughout the year could possibly keep students from getting bored with taking notes in general.

Another major finding through the interviews and teacher journal was that many students liked the process of the formative quizzes. The first quick quiz given was a pilot and did not come into the data analysis, but it helped to establish buy-in with the students.

These quizzes were introduced with some apprehension that students would not “do their best” and would not complete it since it did not give them any points toward their grade. However, not only did these quizzes become part of the classroom routine without complaint, but students asked about them. Student 1 (has an IEP) even asked if “we get to keep taking those quick quizzes?” “I think those little quizzes help me,” Student 36. In hindsight, it would have been a good interview or survey question to find out more about the quick quizzes as a learning tool. However, that was not the purpose of this research project, but it does bring to light the importance of formative assessments helping the students as well as the instructor.

As a result of the general enthusiasm for the quizzes, an informal poll was taken by show of hands and recorded in the teacher journal. Although peer pressure may have skewed the results for a few students, 100% of the students were in favor of the quizzes. I asked student 1 to stay after class briefly to tell me more about her opinion of the quick quizzes. She reiterated that she likes knowing how she did right away and if she learned anything from the day before. Student 29 “likes them because they don’t hurt your grade” (interview response). Immediately after the collection of the quizzes, I would go over the answers verbally and students showed enthusiasm when they knew they had written a correct answer. The willingness of the students to participate, enthusiasm for a perfect score, and general intrinsic value that students had toward these short little formative assessments showed me that not everything needs to go in the grade book for it to be valuable to learning and student confidence. Formative assessments were a part of my lesson planning, but making that element a little more formal with a small piece of paper that they hand to the teachers has revealed much about the audience of these

assessments. This unanticipated outcome influenced my teaching style and will continue to impact how I view and implement formative assessment in my classroom.

Student engagement was difficult to assess without hidden cameras or another adult monitoring my class every day, and as a result, much of the data is qualitative. The teacher journal, surveys, and interviews served as the primary sources. Items on the survey asked about how often students take notes in this class. Through analysis of the journal there seems to be a trend in engagement as well. Student names and their behavior were recorded, along with any other relevant comments, during note taking sessions. Trends became evident once the names and comments in the journal were compared to the completion (or not) of their notes. During the first three lectures where self-generated notes were used; students were not on task or appeared not to be fully attentive (three consistently wrote nothing at all). One of these students was student 29. This student did not write any self-generated notes down, but when the change was made to instructor provided notes his notes were complete. In an interview I asked what were his favorite type of notes and he explained he does “not like to write a bunch down that I don’t need.” “Copying from the screen is boring” (student 29). This student is very capable and could easily be in the “high achiever” category, but motivation is a factor. I asked why, then, when the instructor provided notes were used, he typically wrote (or drew) in all the right things in the right places, but not when he just had to use his own notebook paper. “I think it’s because I don’t get bored.” Also, this student marked on his final survey that he preferred partial notes, but performed best with guided. This could be because his engagement level was highest during guided lectures since he pointed out

that copying and self-generated notes were boring. The teacher journal and student artifacts were also looked at in order to make a judgment on engagement.

The student artifacts were each collected after the lecture and then rated as none (student did not take notes), incomplete (more than one important idea was missing), and complete (one or no important ideas missing). Originally, the partial notes were rated and tallied separately from the other strategies, but showed no difference in completion rate than guided notes, but this was not true when compared to self-generated notes. So, the artifacts were tallied by self-generated versus instructor provided (partial and guided). Overall percentages of completion varied slightly, but no great differences were revealed when looking at the entire group. However, when looking at the data one student at a time, a pattern emerged (see Table 8). Six students consistently did not take notes (4-6 out of 6 lectures) when self-generated notes were suggested. This table combines the qualitative approach to the student artifact analysis with a quantitative output.

Table 8
Student Artifact Completion

Rating	Self-generated	Instructor Provided
None	6	0
Incomplete	20	2
Complete	15	39

Note. $N = 41$.

The most obvious difference is that when students were given a handout, they completed at least some of the notes. When self-generated notes were in place six students did not take any notes whatsoever. However, when you compare this to instructor provided notes, every single student had at least some of the notes completed. A very large portion

of the students (39/41) had fully completed instructor notes. The same six students (who did not take any notes when they had to create them) at least attempted to take notes with a handout and four of them were totally complete. This appears to be relevant when viewed from the perspective of engagement. It is possible for students to be engaged when they are not writing, that is certain. However, considering the six students that did not turn in notes, I do not think this was the scenario. Five of these six students names appeared in the teacher journal on at least one occasion for being off task and/or not participating. Only two students turned in incomplete guided notes throughout the treatment cycles, compared to the 20 students with incomplete self-generated notes. Since the majority of students turned in complete notes for instructor provided strategies, and this was not the case for self-generated notes, this could be interpreted in several ways. Students do not know what is important and miss concepts, they cannot keep up with the pace of the lecture, or they are simply not participating in the lecture at all. Based on student feedback from surveys and interviews, I would argue that it is the latter. Also, from a qualitative standpoint, I also made a note in the teacher journal whenever I had students turn in notes with “doodles” on them. There was only one student that “doodled” on guided notes, and three students that “doodled” on partial notes. Eight students at one point or another “doodled” on the self-generated notes that they handed in and three of these received a rating of incomplete. This qualitative observation could mean that for some students, taking notes when they had to generate them did not keep them interested in the material compared to the other strategies.

Student comments were positive toward the instructor provided notes, so a substantial effort was made to observe and record in the journal for the second cycle to

look for more evidence of differences. After all, 38 out of 41 students reported that they agree that notes help them pay attention in class (Survey Item 4). On the final survey, of the 24 that prefer guided notes, five specifically mentioned that it helps them pay attention. Interestingly enough, when the second treatment cycle began and students were asked to go back to self-generated notes and there were some “outcries” of negativity, and I was able to record a few. “I like it better when you give us a handout.” This type of student may feel more comfortable when it is made clear what is important from the lecture, and what they can expect to be on a quiz or an exam.

Also, providing some type of handout seems to drastically reduce the amount of time needed on a lecture. Without having to wait for some students to write down every detail I have more control over the pace of the lecture and can keep it shorter. Since ninth grade students easily become bored, shorter lectures are better, which leaves more time for labs and other activities. There is less precious classroom time wasted and more learning accomplished. Self-generated notes use more class time and the teacher journal revealed another impact on the teacher in regards to preparation.

In the teacher journal, a planning log was one of the sections filled in. For each lecture/note preparation the time spent was recorded. The time was averaged for each note taking strategy (see Table 9). More time was spent preparing the guided notes.

Table 9
Time Spent Preparing for Lecture/Notes

Strategy	Average Prep Time Per Lecture
Self	19 minutes
Partial	26 minutes
Guided	50 minutes

While there is much more time required of the teacher to prepare guided notes, it is time well spent since 80.5% of students perform better on formative assessments for this strategy (and also the highest mean value overall). It is also time well spent from the student perspective since 58.5% prefer guided notes. Since teachers often teach the same class in consecutive years, the first time is where the investment is made and after that small edits are all that is required. Another observation was that the time spent scoring quick quizzes and other data collection instruments seemed minimal. Thus, carrying on the practice of checking notes and getting feedback to students regarding their quick quizzes was easily integrated into the regular classroom routine. While there were slight setbacks and scheduling adjustments, this action research project produced some pertinent findings regarding the impact of the treatment of guided note taking.

The quick quiz data revealed that most students (80.5%) performed better after using the guided notes strategy than the other two strategies. Also, the overall mean values for guided notes quick quizzes was the highest of the three (3.96). Guided notes quick quizzes had the highest number of students in the high range (proficient, 85% score or higher) of the three strategies. Consequently, and perhaps more important, guided notes quizzes had the lowest number of students in the low range of scores. T-tests revealed that there was not a statistically significant difference of the non-treatment (self) compared to partial notes. However, when self and partial were compared to guided notes, both t-tests resulted in p-values less than 0.05 and thus enough of a difference to confirm the impact of the treatment of guided notes. While the summative quiz scores were not statistically significant, the highest mean value of the summative assessment (and lowest drop for post quizzes) was achieved from material covered after the guided

notes phases. The surveys showed that most students (95%) agree that notes are important to their success at school. Comparing initial and final survey results showed that students gained confidence in their note taking abilities and an increase in the perception that note taking helps them to pay attention in class. The final survey also revealed that 58.5% of the students prefer guided note taking to the other strategies. All students interviewed (and recordings in the teacher journal) revealed that students were enthusiastic about the formative assessment of the quick quizzes, which was an unintentional discovery of this project. Students had the highest completion rate for guided notes, and another unanticipated outcome was that less class time was taken up when guided lectures were in place. Teacher preparation time was higher for guided notes, but can be viewed as an investment for the next course. In the following section, these results are interpreted in an attempt to explain how these findings answer (or fail to) the research questions.

INTERPRETATION AND CONCLUSION

The purpose of this action research project was to discover how implementing different note taking strategies affects student learning, engagement, and retention. The data collection instruments were also implemented to find out what (if any) value students place on taking notes in relation to their academic success. Finally, the teacher journal and time log served as an avenue to determine how the treatments impacted me as the teacher.

The impact of the different strategies on quiz scores and cognition was fairly straightforward. Overall, there was a positive impact when the treatment of guided notes

was in place on quiz scores (most students, 80.5%, performed better after using the guided notes strategy than the other two strategies). The positive impact of the treatment of guided notes could be a result (or combination) of many factors. First, students are not required to copy too much information, which reduces the load on working memory. This reduced load allows time and processing for the new information. To contrast the positive impact of guided notes, overall, students did the worst in the partial notes treatment phase. This treatment did not require students to interact and they did not have to write very much. This treatment may have failed to activate any prior knowledge and also may have failed to keep students interested in the lecture. Similarly, self-generated notes (the non-treatment) failed to produce a positive impact on scores and student perception. Self-generated notes can be overwhelming (student interviews) to students and some take the “all or nothing” approach (6 students consistently did not complete any self-generated notes). So, with guided notes, compared to the self and partial notes, students become aware of what is important and may become a quiz or test question later. Lastly, students that are engaged in the material are more likely to learn since the concepts have at least been moved into working memory and processing has begun to take place. The data showed that there is evidence (quiz scores, surveys, and interviews) of a positive impact on learning when guided notes are in place.

Another perspective to consider since some students (7 out of 41) prefer self-generated notes is that students have had the most exposure to this type of note taking. Self-generated notes are the norm for many teachers and students. This could be why some students preferred them when surveyed. While seven may prefer self-generated, only two performed best on self-generated notes. The other five who preferred self-

generated performed best with guided notes. Ten students preferred partial notes (10 out of 41). Three of these students mentioned that they like partial notes because it did not make them draw. Two students said they liked this style because it was the easiest. These two sets of comments seem to be related since they come from the perspective of the least amount of work of the student. What may be the easiest strategy for the student may not be the best. As students advance in school and pursue higher education, self-generated notes may be a necessity for them to succeed in a class. A school-wide adoption of note taking techniques with some type of scaffolding to build on skills each year could prepare students to be excellent note takers on their own. A gradual progress or even a rotation of note taking strategies throughout the year could possibly keep students from getting bored with taking notes in general.

While the summative quiz scores were not statistically significant, the highest mean value of the summative assessment (and lowest drop for post quizzes) was achieved from material covered after the guided notes phases. Even though guided notes had the highest mean value overall, for some students it was significantly higher (such as student 14 who had a much higher initial score, and a much higher post score). The similarity in these summative quiz scores could be a result in the light of note taking in general. Perhaps students taking notes, no matter the strategy, will have similar success of summative and post assessments. Since the t-tests forced me to reject the impact of the treatments on retention, there may have been a flaw in the writing of these summative assessments such as differences in difficulty level undetected by me or student retention may be tied to something else. The age of the learner and cognitive development may be more influential in determining retention than note taking strategies. The research

question aimed at retention has no statistically definitive answer, yet there was not a negative impact on retention as a result of the treatments. This lack of impact produces more questions about retention than it answers, but it is conservative to say that the treatments in this study did not help or hinder retention rates.

Qualitatively, student engagement was highest for guided notes as shown in the journal, examination of student artifacts, and survey results. For example, the teacher journal indicated more attentiveness and interaction of the students (for guided notes). Also, most students (58.5%) preferred the guided notes to the other two methods. These results are consistent with formal research such as the study done by Neef et al. (2006). It was reported that students had a clear preference for instructor provided notes over personal note taking, and the majority favored guided notes over completed (full) notes (Neef et al., 2006). This is likely to be attributed to the interaction that is required during guided notes lectures. Students must answer questions, talk to their neighbor, draw etc. to complete them and also students feel more connected to the lecture. Since they are not a passive observer for this strategy they are engaged and more likely to move information from working memory into short term (and possibly long term). This engagement could also be responsible for the higher completion rate of instructor provided notes (39 out of 41, compared to 20). The surveys also revealed that students feel that the act of taking notes helps them pay attention (38 out of 41). When taking guided notes students may not “check out” for short periods of time and miss information. Another benefit of instructor provided notes is that when students are absent, they know exactly what was covered and can simply use a classmate’s notes or have the teacher set up the presentation for them to go through on their own to complete the notes

Implementing different note taking strategies had an effect on lecture delivery in class and teacher preparation before class. Teacher preparation time was higher for guided notes (an average of 50 minutes per lecture compared to 19 and 26), but can be viewed as an investment for the next course as well as an investment in student engagement and learning. Another positive impact of the treatments compared to the non-treatment of self-generated notes was that less class time was used to complete the lecture. The journal reveals that “extra time” was created on 5 occasions for guided notes. While this research project was not looking at the impact of formative assessments, all students interviewed (and recordings in the teacher journal) revealed that students were enthusiastic about the formative assessment of the quick quizzes. Since the students liked (and even asked for after the treatments were over) the routine and implementation of the quick quizzes, these have continued to be a part of the classroom routine and this project serves as a central reminder of the importance of formative assessments.

VALUE

Any teacher could see benefits from a more structured way of taking notes since it reduces the cognitive load (on working memory) for their students. Hopefully, my results will be useful to teachers from all subjects. I also intend to combine guided notes with other effective teaching strategies: response cards, guided reading on their own, adding graphic organizers, study cards on back (of note sheets), and possibly student led lectures where they design the guided notes. Since teaching through inquiry is important to me, I want to integrate questioning within the notes that promotes this type of learning. By building in more of an inquiry approach to the guided notes through the use of

questions, mini activities, hypothetical scenarios etcetera, I hope to integrate guided note taking with guided inquiry.

The classes involved in this study were shown the summarized results. They were interested to know that most of them did better on guided notes and most of the students preferred them, but not as many. I discussed why their perception of what they liked best (or did the best on) might be different than how they actually performed. I mentioned that what they may prefer might not be the best. For example, “I prefer not to study for exams, but do I perform better if I do study?” One student commented, “I’m just lazy, Mrs. White.” This generated laughter but I am sure there was some truth to it. Not every student will excel, and not every student will complete a college education, but as the teacher I will attempt to provide them with strategies and skills to move on from high school. There is no “one size fits all” solution that works in a class of many different individuals. Each student is unique and learns in a variety of ways. While the results show most students find some value in note taking, they do not all like taking notes the same way. The discussion helped bring closure to the research project and also led to reflection and ideas to follow up with.

Some new questions have developed as a result of this Action Research project: Does providing notes improve student ability to take their own notes later in the year? Does providing full notes have the same positive impact on formative assessments as guided notes? These questions were not within the scope of this project, but my own research next year will help answer these questions and aid in developing my skills as a teacher-researcher. I would also like to further investigate the quality of the notes taken and how that impacts conceptual understanding.

Once students have mastered the use of instructor provided notes that I have used in this project, I will begin teaching them how to take notes on their own. Especially in science, it is difficult to write everything from a lecture. I will be teaching chemistry to juniors and seniors next year. I will continue to use guided notes and further develop this strategy with my chemistry students.

My research questions have been answered and new questions emerged. Often in education we use what we think is working without really knowing. Action research has allowed me to put note taking to the test and collect data that helps answer the ultimate question I have been having for years: do different note taking strategies impact students? A great deal research on this topic exists but it is out of context because it was not my classes, and not my teaching style. I finally have something to look at that is in the context of my teaching style and how I run my classroom. Taking notes can be interactive and valuable, and adapted to different students. So, in short, while the data indicates that guided notes help most students achieve higher quiz scores (which correlates with formal research findings discussed in the literature review), this project and its findings have high intrinsic value and I am excited to pursue my remaining questions next year with a different set of students.

REFERENCES CITED

- Baddeley, A. D. (2007). *Working memory, thought and action*. Oxford: Oxford University Press.
- Cornelius, T. L., & Owen-DeSchryver, J. (2008). Differential effects of full and partial notes on learning outcomes and attendance. *Teaching of Psychology, 35*(1), 6-12. doi: 10.1080/00986280701818466
- Konrad, M., Joseph, L. M., & Eveleigh, E. (2009). A meta-analytic review of guided notes. *Education and Treatment of Children, 32*(3), 421-444. doi: 10.1353/etc.0.0066
- Konrad, M., Joseph, L. M., & Itoi, M. (2011). Using guided notes to enhance instruction for all students. *Intervention in School and Clinic, 46*(3), 131-140. doi: 10.1177/1053451210378163
- Makany, T., Kemp, J., & Dror, I. E. (2009). Optimising the use of note-taking as an external cognitive aid for increasing learning. *British Journal of Educational Technology, 40*(4), 619-635. doi:10.1111/j.1467-8535.2008.00906.x
- Neef, N. A., McCord, B. E., & Ferreri, S. J. (2006). Effects of guided notes versus completed notes during lectures on college students' quiz performance. *Journal of Applied Behavior Analysis, 39*(1), 123-130. doi: 10.1901/jaba.2006.94-04
- Piolat, A., Olive, T., Kellogg, R.T., (2005). Cognitive effort during note taking. *Applied Cognitive Psychology, 9*(3), 291-312. doi: 10.1002/acp.1086
- Titsworth, B. S., (2004). Students' notetaking: The effects of teacher immediacy and clarity. *Communication Education, 53*, 305-320. doi: 10.10/0363452032000305922
- Titsworth, B. S., & Kiewra, K. (2004). Organizational lecture cues and notetaking facilitate student information processing. *Contemporary Educational Psychology, 29*, 447-461. doi:10.1016/j.cedpsych.2003.12.001








APPENDICES

APPENDIX A

GUIDED NOTES SYMBOLS

Appendix A

Guided Notes Symbols

-  = pencils down, listen
-  = fill in the blank, definition, or idea
-  = talk it out with your neighbor
-  = draw and/or color
-  = answer the question
-  = key idea
-  = get up and move

APPENDIX B

TREATMENT PLAN SCHEDULE

Appendix B

Treatment Plan Schedule

Cycle 1			Cycle 2			Semester End Inter- views, POST Unit Quiz 3 and final survey Jan
Treatment 1a	Treatment 2a	Treatment 3a	Treatment 1b	Treatment 2b	Treatment 3b	
Student Generated	Partial Notes	Guided Notes	Student Generated	Partial Notes 2b	Guided Notes	
1a Quizzes and initial survey	2a Quizzes and Unit Quiz 1	Quiz 3a, and POST Quiz 1	1b Quizzes and Unit Quiz 2	Quizzes and POST Quiz 2	3b Quizzes and Unit Quiz 3	
Oct	Oct/Nov	Nov	Nov/Dec	Dec	Dec/Jan	Jan

APPENDIX C

DATA TRIANGULATION MATRIX

Appendix C

Data Triangulation Matrix

Data Collection Techniques

Research Questions	formative quizzes	student surveys	interviews	summative/post unit quizzes	planning log	teacher observation journal	student note samples
What is the impact of implementing different note-taking strategies on conceptual understanding in a ninth grade Earth Science course?	x		x	x		x	x
What is the impact of these strategies on student quiz performance, and retention?	x	x		x			
What is the level of student engagement and perceived value of notes with these strategies?	x	x	x				x
What is the impact of these strategies on the teacher?			x		x	x	

APPENDIX D

TEACHER JOURNAL/TIME LOG TEMPLATE

APPENDIX E

QUICK QUIZ EXAMPLES

Appendix E

Quick Quiz Examples

Quiz 1a.1

1. Rank the following from smallest to largest: solar system, earth, moon, sun, galaxy
2. How much of the solar system's mass does the sun make up?
3. The inner most layer of the sun is called the:
4. Which of the following is the layer just outside the core:
convective zone, chromosphere, photosphere, radiative, corona
5. T or F ; the sun is the brightest star in the universe.

Quiz 1a.2

1. True or False: A parsec is a unit of time.
2. True or False: A parsec is 3.26 light years.
3. How bright a star appears from Earth is called _____ Magnitude.
4. How bright a star actually is (or 10 pc away) called _____
Magnitude.
5. True or False: A star's "retirement" depends on its _____. (size, mass, color, temperature)

Quiz 1a.3

1. Our galaxy is called the _____.
2. T or F Our galaxy is about 100,000 ly across.
3. T or F Our sun is in the middle of the galaxy.
4. Why don't we have a "real" picture of our galaxy?
5. Sketch a picture of what our galaxy looks like from the side:

Quiz 2a.1

1. Galaxies are the major building blocks of the _____.
2. **T or F** Astronomers estimate that the universe contains hundreds of billions of galaxies.
3. Galaxies are classified by shape into _____ main types.
4. A _____ **galaxy** has a nucleus of bright stars and flattened arms that spiral around the nucleus.
5. _____ **galaxies** have various shapes and are extremely bright in the center and do not have spiral arms. Pure bulge– no disk component

Quiz 2a.2

1. The collapsing of an _____ cloud theoretically explains the formation of the (2) _____.
3. T or F All planets orbit the sun in the same direction.

4. Kepler's first Law of planetary motion explains that the shape of planetary orbits is in the shape of an _____.
5. Earth's average distance from the Sun is used as a unit of measurement called an _____.

Quiz 2a.3

1. _____ reveals the chemical composition of the planets.
2. T or F Mars is the closest planet to the Sun.
3. There are _____ inner planets.
4. T or F The inner planets are relatively small.
5. The inner planets are sometimes referred as "earthlike" or _____ (means land)

Quiz 3a.1

1. The outer planets are also called _____ planets.
2. _____ is the largest planet in the solar system.
3. The outer planets are composed of (mostly) _____.
4. **T or F** Saturn is the only planet with rings.
5. **T or F** Neptune is blue AND the outer most planet in our solar system.

Quiz 3a.2

1. What is the *relative* sizes of Earth and Mars when compared to each other?
2. **T or F** Mars is a desert landscape.
3. **T or F** Mars is a very cold compared to Earth.
4. The atmosphere of Mars is composed mostly of _____.
5. Name one feature or other evidence that Mars had/has water?

Quiz 3a.3

1. Mars has two moons that are probably captured _____.
2. **T or F** Mars has liquid water.
3. The Phoenix lander directly sampled _____ in shallow Martian soil on July 31, 2008
4. MSL stands for _____
5. Curiosity will reach Mars in about _____ days.

APPENDIX F

INITIAL SURVEY

APPENDIX G

INITIAL SURVEY RESULTS: LIKERT QUESTIONS

Appendix G

Initial Survey Results: Likert

Survey ITEM	1	2	3	4	5	6	7	8	9	10
Response Value	2.55	3.10	2.55	2.71	2.88	3.15	2.68	3.12	2.88	2.71
AVERAGE Standard Deviation	0.71	0.76	0.59	0.84	0.73	0.74	0.75	0.89	0.63	0.77
Frequency of response value: 1	3	2	1	3	0	0	3	2	1	1
%	7.14	4.76	2.44	7.32	0.00	0.00	7.32	4.76	2.38	2.38
Frequency of response value: 2	15	4	17	13	13	8	10	8	8	17
%	35.71	9.52	41.46	31.71	30.95	20.00	24.39	19.05	19.05	40.48
Frequency of response value: 3	22	24	22	18	20	18	24	15	28	17
%	52.38	57.14	53.66	43.90	47.62	45.00	58.54	35.71	66.67	40.48
Frequency of response value: 4	2	12	1	7	9	14	4	17	5	7
%	4.76	28.57	2.44	17.07	21.43	35.00	9.76	40.48	11.90	16.67

Items 1-7: strongly disagree = 1, disagree = 2, agree = 3, strongly agree = 4

Item 8: 0 = 0, 1 = 1, 2 = 2, 3 = 3, 4+ = 4

Item 9: none = 1, very little confidence = 2, somewhat confident = 3, very confident = 4

Item 10: never = 1, sometimes = 2, most of the time = 3, every time = 4

APPENDIX H

INITIAL SURVEY RESULTS: OPEN-ENDED QUESTIONS

Appendix H

Initial Survey Results: Open-ended

N = 41

Item 1 Open Ended Question: When were you taught (to take notes) and by whom?		
<i>Theme</i>	<i>Frequency</i>	<i>Percentage</i>
Refers to teachers who have taught them	22	52.4%
Blank (no response)	9	21.4%
Explicitly details they were not taught	6	14.3%
Other	5	11.9%
Item 2 Open Ended Question: (Taking notes is important to my success at school) Why?		
<i>Theme</i>	<i>Frequency</i>	<i>Percentage</i>
Refer to notes for later study	27	64.3%
Act of note taking aids in memory	8	19.0%
Blank (no response)	4	9.5%
Other	3	7.1%
Item 4 Open Ended Question: (Taking notes helps me pay attention in class) Why?		
<i>Theme</i>	<i>Frequency</i>	<i>Percentage</i>
Mentions staying focused or awake	28	66.7%
Taking notes it boring	5	11.9%
Its difficult to listen and write	4	9.5%
Other	3	7.1%
Blank (no response)	2	4.8%
Item 8 Open Ended Question: Do you take notes in some classes but not others? Why?		
<i>Theme</i>	<i>Frequency</i>	<i>Percentage</i>
Some classes are more difficult	18	42.9%
Teacher direction differs (some encourage, some don't)	9	21.4%
Don't take notes/Other	8	19.0%
Take notes in every class regardless	3	7.1%
Some teachers allow notes on tests/quizzes	2	4.8%
Some teachers give out handouts so you don't take notes	2	4.8%

APPENDIX I

FINAL SURVEY

Appendix I

Final Survey

Final Survey questions:

1. I have been taught how to take good notes.
 strongly agree agree disagree strongly disagree
 When were you taught and by whom?
2. Taking notes is important to my success at school.
 strongly agree agree disagree strongly disagree
 Why?
3. Taking good notes is easy.
 strongly agree agree disagree strongly disagree
4. Taking notes helps me pay attention in class.
 strongly agree agree disagree strongly disagree
 Why?
5. Taking notes helps me understand the material better than if I don't take notes.
 strongly agree agree disagree strongly disagree
6. Studying my notes helps me learn and be prepared for quizzes and tests.
 strongly agree agree disagree strongly disagree
7. I use my notes to study for quizzes and tests in THIS class.
 strongly agree agree disagree strongly disagree
8. How would you rate your overall confidence at note taking (in any class)?
 very confident somewhat confident very little confidence none
9. How often do you taken notes in THIS class when Mrs. White lectures?
 every time most of the time sometimes never

APPENDIX J

IRB EXEMPTION LETTER

Appendix J

IRB Exemption Letter



INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 0000165

960 Technology Blvd. Room 127
 Immunology & Infectious Diseases
 Montana State University
 Bozeman, MT 59716
 Telephone: 406-994-6783
 FAX: 406-994-4503
 E-mail: cheryl@montana.edu

Chair: Mark Quinn
 406-994-4707
 mquinn@montana.edu
Administrator:
 Cheryl Johnson
 406-994-4706 or 6783
 cherylj@montana.edu

MEMORANDUM

TO: Rachel White
FROM: Mark Quinn, Ph.D. Chair *Mark Quinn CJ*
 Institutional Review Board for the Protection of Human Subjects
DATE: October 31, 2011
SUBJECT: "Impact of Note Taking Strategies on Student Comprehension" [RW103111-EX]

The above research, described in your submission of October 31, 2011, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal Regulations, Part 46, section 101. The specific paragraph which applies to your research is:

- (b)(1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
- (b)(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.
- (b)(3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
- (b)(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.
- (b)(5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.
- (b)(6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX K

STUDENT NOTES (ARTIFACT) EXAMPLES

Appendix K

Student Notes (Artifacts) Examples

Galaxies Notes name ~~XXXXXXXXXX~~ p 6th

Galaxy: A collection of stars, dust and gas bound together by gravity.

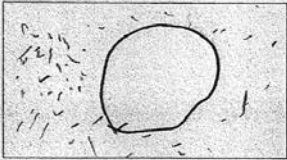
- Galaxies are the major building blocks of the universe. Astronomers estimate that the universe contains hundreds of billions of galaxies.
- A typical galaxy, such as the Milky Way, has a diameter of 100,000 light years and may contain more than 200 billion stars.
- Galaxies are the "ecosystem" of the universe.
 - are cosmic engines that turn gas into stars and stars into gas
 - between them no star formation occurs; "nothing happens" in intergalactic space
 - are a recent discovery (by Edwin Hubble in late 1920's)
 - can be classified by morphology (shapes or sizes)

Types of Galaxies

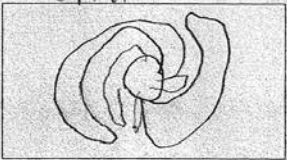
- Galaxies are classified by shape into 3 main types.
 - A spiral galaxy has a nucleus of bright stars and flattened arms that spiral around the nucleus. Disks vary from mostly bulge with barely detectable disks to those totally dominated by their disks
 - Elliptical galaxies have various shapes and are extremely Bright in the center and do not have spiral arms. Pure Bulge - no disk component
 - An irregular galaxy is... well. Odd. Has no particular shape, and is fairly rich in dust and gas.

Sketches of the 3 types of Galaxies (label!!)

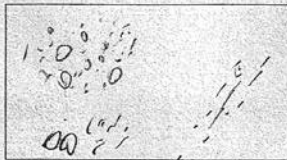
Elliptical



Spiral



Irregular



~~XXXXXXXXXX~~

more notes
on back

Small or System Bodies

- basically anything left over, taking
out planets and dwarf planets...

Asteroid

Rocky bodies that revolve ^{around} the sun
with a rocky or metallic surface.

1st major orbit between Mars & J

"Belt" between Mars & J
and J & P

Some have been collected by

Earth's atmosphere in the form

of Meteoroids

Asteroid

As a meteoroid passes through
atmosphere it's heated by friction
and forms a streak of light that we call
a meteor

If the material doesn't totally burn up
on Earth's atmosphere it's called
meteorite

Outer Planets: Notesname [scribble]

1. First...fill out the meaning of each symbol

👂 = listen

? = question

✍ = fill in

🔑 = key idea

🗣 = talk to neighbor

🚚 = get up + move

🎨 = draw

Review:

? List the four inner planets (without "looking"):

Mars

Mercury Venus Earth

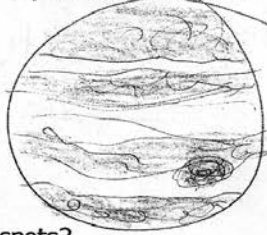
🔑 ✍ **OUTER, GAS GIANT, Jovian PLANETS!**The 4 outer "gassy planets"....-Relatively large masses- low average densities (composed mostly of hydrogen and helium)- many moons and rings

☞ Jupiter

- Jovian ^{largest} Planet
- Orbit: 12 years
- Radiates more energy into space than it receives from the Sun!!!
- At least 63 satellites orbiting outside of its rings, 4 large "main" moons (I,E,G,C)



Sketch and color a pic. of Jupiter (3 minutes)



what are these spots?

Storms of gases

- What we see of Jupiter is just the outer shell of its thick atmosphere (hydrogen and helium and also has traces of water, carbon dioxide, and methane)

The great red spot: storm the size of 2 earth diameters!

☞ Saturn

- * 2nd largest Planet
- * Orbit: 29 years
- * Radiates more energy into space than it receives from the Sun
- * 47+ moons, biggest is Titan (size of Mercury)



what are the rings of Saturn made of?

Ice, gas, and dust

Galaxies Notes

name Amman Ibrahim p. 3

Galaxy:

a collection of stars, dust and gas bound together

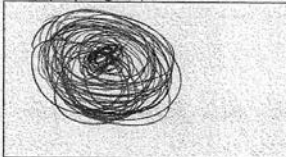
- Galaxies are the major building blocks of the universe. Astronomers estimate that the universe contains hundreds of billions of galaxies.
- A typical galaxy, such as the Milky Way, has a diameter of 100,000 ly and may contain more than 200 billion stars.
- Galaxies are the "Ecosystems" of the universe.
 - are cosmic engines that turn gas into stars and stars into gas
 - between them no star formation occurs; "nothing happens" in intergalactic space
 - are a recent discovery (by Edwin Hubble in late 1920's)
 - can be classified by morphology (sizes and shapes)

Types of Galaxies

- Galaxies are classified by shape into three main types.
 - A spiral galaxy **galaxy** has a nucleus of bright stars and flattened arms that spiral around the nucleus. Disks vary *from mostly bulge with barely detectable disks to those totally dominated by their disks*
 - Elliptical **galaxies** have various shapes and are extremely _____ in the center and do not have spiral arms. Pure _____ - no disk component
 - An irregular **galaxy** is... well. *Odd*. Has no particular shape, and is fairly rich in dust and gas.

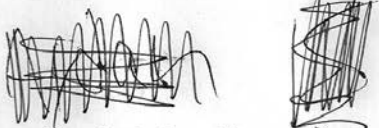
Sketches of the three types of Galaxies (label!)

Elliptical



Spiral





Small Solar System Bodies

~~asteroids~~ asteroids

- Rocky bodies that vary in diameter and have a pitted irregular surface
- ~~thousands~~ thousands orbiting the sun
- some times they collide and break up

~~as a meteor~~

ast or meteoroid passes it burns up and becomes a meteor

if the meteoroid does not burn up and hits the surface its called a meteorite

~~the~~

Kuiper belt

- mostly rock and ice
- 30-40 AU from the sun

Galaxies Notes

name Dominique Gaudy p 6

Galaxy:

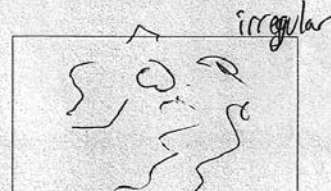
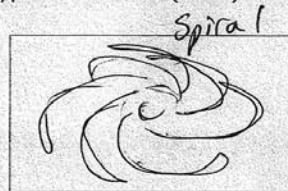
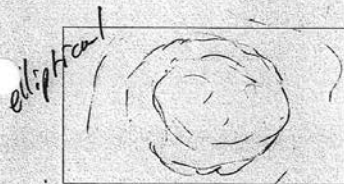
a collection of stars, dust, & gas bound together by Gravity

- Galaxies are the major building blocks of the universe. Astronomers estimate that the universe contains hundreds of billions of galaxies.
- A typical galaxy, such as the Milky Way, has a diameter of 100,000 ly. and may contain more than 200 billion stars.
- Galaxies are the "ecosystems" of the universe.
 - are cosmic engines that turn gas into stars and stars into gas.
 - between them no star formation occurs; "nothing happens" in intergalactic space
 - are a recent discovery (by Edwin Hubble in late 1920's)
 - can be classified by morphology (shapes and sizes)

Types of Galaxies

- Galaxies are classified by shape into 3 main types.
 - A spiral **galaxy** has a nucleus of bright stars and flattened arms that spiral around the nucleus. Disks vary from mostly bulge with barely detectable disks to those totally dominated by their disks
 - Elliptical **galaxies** have various shapes and are extremely bright in the center and do not have spiral arms. Pure bulge - no disk component
 - An irregular **galaxy** is... well. Odd. Has no particular shape, and is fairly rich in dust and gas.

Sketches of the 3 types of Galaxies (label!)



Small Solar Body

anything left after planets / dwarf planets are gone

Asteroid: Rocky bodies that vary in diameter & have pitted irregular surface

- Thousands orbiting sun in the "belt" between Mars & Jupiter
- Sometimes they collide & break up
 - If anything like this enters the Earth's atmosphere we call it a meteoroid

METEOR

- As a meteoroid passes through the atmosphere it's heated by friction & causes a streak of light that we call a ~~meteor~~ meteor
- If the meteoroid does not totally burn up and hits the earth's surface, it's called a meteorite

Kuiper Belt - 30-40 AU from the Sun (outside) of Neptune)








- Mostly rock and ice

COMETS small icy bodies that have highly eccentric orbit (really squashed circle)


1-10 km in diameter
Most outside Kuiper Belt

Outer Planets: Notesname Kayla p 6

1. First...fill out the meaning of each symbol

 = pencils down, listen = answer the ? = fill in blank / definition / idea = key idea = talk it out w/ neighbors = get up & move = draw / color**Review:****? List the four inner planets (without "looking"):**

Mercury Venus Earth Mars

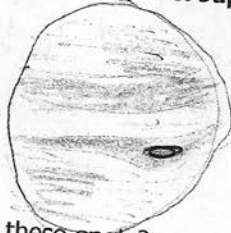
 ~~8~~ OUTER, GAS GIANT, JOVIAN PLANETS!The 4 outer "gassy planets"....-Relatively large masses- Low average densities (composed mostly of hydrogen and helium)- Many moon and rings

Jupiter

- largest Planet
- Orbit: almost 12 years
- Radiates more energy into space than it receives from the Sun!!!
- At least 63 satellites orbiting outside of its rings, 4 large "main" moons (I,E,G,C)



Sketch and color a pic. of Jupiter (3 minutes)



what are these spots?

eddies

- What we see of Jupiter is just the outer shell of its thick atmosphere (hydrogen and helium and also has traces of water, carbon dioxide, and methane)

The great red spot: storm the size of 2 Earth diameters!

Saturn

- * 2nd largest Planet
- * Orbit: 29 years
- * Radiates more energy into space than it receives from the Sun
- * 47+ moons, biggest is Titan (size of Mercury)



what are the rings of Saturn made of?

Smith
 Lineup, matte black
 Tactic, black lace

POC
 helmets/armour
 WAS Sunglasses

Sydney
 stick in heart