

AN INVESTIGATION IN NOTE-TAKING STRATEGIES
FOR HIGH SCHOOL BIOLOGY STUDENTS

by

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ABSTRACT

High school students often struggle to find the value in writing down content information, known more commonly as note-taking. To many, note-taking is a requirement that involves filling notebook pages with content on which they will eventually be assessed. In a day and age where science educators are shifting their instruction from lecture to more inquiry or problem-based learning, note-taking remains an important skill and instructional tool in the science classroom. The focus of this action research project was to determine how various note-taking methods influenced students in a high school freshman biology classroom. My research questions focused on student learning and achievement, student friendliness within the classroom, and student friendliness outside the classroom. Students were assigned one of four different methods to use during lecture for one content unit while data was collected through surveys, assessments, observations, and student interviews. Results showed that while the method of note-taking had little to no impact on student learning, digital and digital, outlined notes were the least student-friendly in and out of the classroom.

INTRODUCTION AND BACKGROUND

High school students often struggle to find the value in writing down content information, known more commonly as note-taking. To many, note-taking is a requirement that involves filling notebook pages with content on which they will eventually be assessed. In a day and age where science educators are shifting their instruction from lecture to more inquiry or problem-based learning, note-taking remains an important skill and instructional tool in the science classroom.

I have recently completed my fifth year of teaching life sciences at Washington High School in Sioux Falls, South Dakota. Regular education biology has been my primary instructional course, although I have had some experience in English Language Learner (ELL) education as well. Washington High School is a relatively diverse Title I school by South Dakota standards, consisting of approximately 2,000 9-12th grade students. According to the 2015-2016 data profile, 39.3% of these students are classified as non-white minorities and 230 students are enrolled in the ELL or Migrant Student Education programs.

Our school is currently in its fourth year of a 1-1 Chromebook™ initiative for students. Upon receiving their Chromebooks, many students in my classroom transitioned from handwriting to typing their notes. Since then, the vast majority of my students have returned to the handwritten form. I have not been a supporter of typed notes for two reasons. First, I felt that students were more likely to commit information to memory if they were physically forming the letters and words of their notes. Second, I felt that the students creating notes on Chromebooks could be easily distracted. I experienced that

first-hand since I knew that some of my students were bouncing back and forth between note-taking and live updates on their March Madness brackets. Some fellow teachers in my building encourage their students to take electronic notes, believing that this method is faster, more accessible outside of class, and easier when it comes to inserting diagrams versus drawing diagrams. Each teacher in the science department holds individual beliefs about the efficacy of note-taking, and we have our preferred method, but none of us have substantial evidence to back our claims beyond personal preference and experiences.

By means of a classroom research project based upon the action research model, I planned to investigate what methods of note-taking proved to be the most effective in student learning as well as the most student-friendly in and out of instructional time. My overarching research question was “What method of note-taking most positively impacts student learning in the science classroom?” My secondary questions were as follows: “What method of note-taking is most effective in student review and retention?” and “What method of note-taking is the most student-friendly?” While only sampling a small population, the purpose of this investigation was to provide answers in the context of a typical high school freshman student in the life science classroom.

CONCEPTUAL FRAMEWORK

Despite reform of educational practices, lecture note-taking remains a primary component of the high school and college classroom. Kiewra (1987) writes that while very few are given formal instruction on note-taking strategies, students are found to be higher achieving when they take adequate notes. He goes on to explain that note-taking is valuable in both its “process and product functions” (p. 234). The process portion refers

to how note-taking contributes to students' attentiveness during the receiving of information. The product function refers to how notes provide students with a resource for future referral and review (Kiewra, 1987).

Challenges Faced in Note-taking

The value of note-taking and its purpose is not a new or under-studied topic in the education realm. Ladas (1980) published an *Educational Psychology* article in which various models of memory and information-processing are used to quantify the values of lecture note-taking. An educator must consider student limitations on processing information, writing speed, student distraction, and prior knowledge when making decisions regarding lecture format (Ladas, 1980).

“Wait, go back. I wasn’t finished!” “My hand hurts.” “Do you want us to write that down?” These are perhaps some of the more commonly heard phrases in the classroom during lecture note-taking. Bui, Myerson, and Hale (2013) describe the unseen demands note-taking requires of students:

Despite its benefits, lecture note-taking is a complex and cognitively demanding skill that requires comprehending what the instructor is saying, holding that information in memory, organizing and paraphrasing it, and then writing it down before it is forgotten, all while attending to the ongoing lecture (p. 299).

This description conjures up mental images of students frantically scribbling information down as a professor rants on in a removed and monotone manner. A study was conducted in which the same lecture video was shown to various groups of undergraduate students. The only variable that was changed between each group was the way in which the information was presented. Results showed that students performed

significantly better on assessments and recalled more information from the lecture version in which the instructor used more clarity and organizational cues throughout the presentation. For example, rather than lecturing without pause, the speaker used transitions such as “My second point to make is...” The speaker also included more gestures, voice variation, and eye contact in the second version of the lecture (Titsworth, 2004).

The level of the student and their skills will also greatly impact their ability to learn and take notes during a lecture. One study conducted on undergraduate college students compared note-taking differences between genders. Results showed that females outperformed males in a handful of categories such as handwriting speed and language comprehension. The most glaring differences showed that females were significantly more adept in the categories of notes quality and working memory (Reddington, Peverly & Block, 2015). Another study compared two groups of high school students who did and did not have a diagnosis of Attention Deficit Hyperactivity Disorder. Results showed that students with the diagnoses took significantly lower quality of notes and performed well below their peers on a multiple-choice test based upon the notes (Gleason, 2012).

Student motivation can also impact the quality of note-taking and the strategies used by students. A study was conducted in which a group of college students was split into two groups: one group that was told that they should expect a multiple-choice test over the coming information, and a second group that was told that their test would be essay-based. When comparing notes between the two groups, researchers found that those expecting an essay-based test had a greater quality of notes and higher recall on

elements rated as having high structural importance to the passage compared to their peers who were anticipating a multiple-choice test (Rickards, Friedman 1978).

Methods of Note-taking

Upon examination of articles and research, there is clearly no shortage of opinions regarding the various methods of note-taking. One's views can presumably be influenced by personal preference, the academic level of students, and the overarching goal of the note-taking process. For example, one action research study showed that ninth grade earth science students performed higher on formative assessments after taking a detailed form of guided notes. These notes were designed chronologically and contained visual images to cue students as to when they should be writing, listening, or performing a task during the lesson (White, 2012). While this may be a great tool in some classrooms, it may not be the strategy of choice in a college-preparatory chemistry class in which the teacher is looking to instill students with note-taking skills that require them to self-regulate and sift for essential information.

One study showed that students performed higher on assessments after reviewing a skeletal outline of notes instead of a full transcript of the lecture that was provided for them (Kiewra, DuBois, Christian & McShane, 1988). Another study confirmed this and added that an outlined version of student notes along with the availability of the lecturer's notes after the session was most effective for student learning (Potts, 1993). However, other studies show that outlined notes do not match the benefits of notes that are organized into matrices and diagrams (Saunders, Wise, & Golden, 1995). In fact, one showed that notes which are too general or skeletal can actually lower student

achievement (Kiewra, 1987). The SOAR method posed by Jairam and Kiewra (2010) suggests that notes should not be taken in a linear fashion because “These linear structures obscure relationships among ideas and especially mask comparison” (p. 602). Instead, the SOAR method requires that students *Select*, *Organize*, *Associate*, and *Regulate* during note-taking exercises. *Select* challenges students to differentiate between important and secondary information. *Organize* requires students to think about their notes in a logical manner which leads them to *Associate* new information in connection to previous knowledge. Finally, *Regulate* includes the summarization and application of ideas (Jairam and Kiewra, 2010).

A recent study comparing handwritten versus typed notes showed that not only did students take a larger quantity of notes using a computer, but they also scored higher on recall and test assessments after taking typed notes (Bui, Myerson & Hale, 2013). These results may not hold true beyond live lecture note-taking. If students are taking notes on a computer-based resource, they have the option to directly copy and paste these notes into a second document. While this information is similarly accessible to them, a study conducted on college students found that their performance on cued-recall, multiple choice, and essay assessments were all higher when their ability to copy and paste notes was restricted (Igo, McCrudden & Bruning, 2005). It is important to mention that typed and handwritten notes are not the only forms of note-taking available to students and educators. A study conducted in fifth grade classrooms found that students, particularly those with disabilities, had significant learning gains with the use of voice-recorded notes (Horney et al. 2009).

Note-taking cannot be assessed solely upon the layout and method used to record notes. Some may argue that the ways in which notes are reviewed can have an equal impact on student achievement. A recent study split nearly two hundred sixth-grade students into three groups. After viewing a pre-recorded lecture in five-minute segments, partners were required to share their notes electronically through Google Docs™. The partners in the first group simply read their notes in review. The partners in the second group formed and answered questions in review of their notes, and finally the participants in the third group wrote summaries of their notes. While student surveys showed no preference towards one form of review over another, collected data suggested that both note quality and student test scores were significantly increased when the review practices of questioning or summarizing were implemented (Chiu, Wu, & Cheng, 2013).

Conclusion

Inarguably, there are many factors that influence student learning through note-taking. While some of these variables, such as learning disabilities, are uncontrollable, most can be kept within a manageable range and instruction can be adapted to meet the needs of the students. Many different methods of note-taking have been scrutinized and studied with mixed results. Goals of note-taking may also vary between detailed memory storage and general connection of ideas. Nonetheless, it is important for educators and students to be aware of existing note-taking strategies and seek the most effective method for the specific time, topic, and individual.

METHODOLOGY

The purpose of this investigation was to determine what media and methods used in note-taking most positively impacts student learning in the ninth-grade biology classroom. Some of the initial questions that I had were “Does analog note-taking promote retention over digital note-taking?” and “What forms of note-taking are most student-friendly in and out of the classroom?”

Participants

Participants in this study were 63 high school freshman biology students split into three different fifty-minute class periods throughout the day. Three of these students were on an individualized education plan and thirteen of them were receiving supplementary reading help through a literacy intervention curriculum. Students who were omitted from the data collection and/or analyses were those who either missed one or more days of note-taking during the unit, did not follow the assigned method for the duration of the unit, or whose individualized education plans may have been compromised with a change in note-taking methods. The methods used to conduct this research project received an exemption from Montana State University’s Institutional Review Board for the use of human subjects in academic research (Appendix A).

Biology is a one-credit, yearlong course that fulfills the state of South Dakota’s high school life science graduation requirement. Traditionally a sophomore-level course in the Sioux Falls School District, it has recently shifted down to the freshman level during a curriculum overhaul and following a review of the Next Generation Science Standards. The curriculum is divided into four, quarter-long units including ecology,

cells, genetics, and evolution. The genetics unit was chosen for this classroom research project primarily for its significance in the course curriculum and the objectivity of which its content can be assessed.

Intervention

In order to answer my research questions, student note-taking methods were altered for a classroom unit on Mendelian genetics. This unit contains a substantial amount of information about genetic heredity of which the students have little to no previous knowledge. It contains many unfamiliar vocabulary terms such as *homozygous*, *incomplete dominance*, and *recessive*. The unit also requires simple math calculations with ratios and percentages when predicting genetic probability using Punnett squares.

To begin the data collection phase, all students completed a pretest assessment based upon the content of the upcoming unit (Appendix B). During the unit, which can also be referred to as the treatment phase, students were randomly assigned one of four note-taking methods to implement for the duration of the unit. The methods were as follows: analog notes in which the student wrote down content information in their notebook, analog outlined notes in which the student received an incomplete outline of the notes and wrote in the missing information, digital typed notes in which the student typed his or her notes electronically into a Google Doc on their school-issued Chromebook, and digital outlined notes in which the student received an electronic, incomplete outline of the notes through Google Classroom and typed in the missing information (Appendix C). Students were asked to use the assigned method of note-taking for the entirety of the unit and use it as their primary source of information for

referral when completing assignments or studying for assessments. Because all of the students had been taking notes using the analog method prior to this investigation, the group of students assigned this method during the treatment phase was used as the control, or comparison treatment group.

Data Collection

Several different methods of data collection were implemented to measure the impacts of the aforementioned note-taking strategies. Students were first asked to complete an initial survey regarding their current practices and attitude towards note-taking (Appendix B). All of the students had been taking notes entirely in the analog notebook method prior to this study, so this survey provided a baseline to which the final student survey could be compared.

Students completed a pre-test assessment before the beginning of the unit to establish a starting data point for prior knowledge (Appendix B). As the unit progressed, students used their assigned method of note-taking to record content information, which was then available to be used as a reference for completion of daily assignments and review for summative assessments. A final summative assessment was given at the end of the unit that was identical to the pre-test so that normalized gain could be calculated to measure student learning (Appendix B). Three formative assessments were also given during the treatment unit following note-taking sessions to gauge short-term retention and immediate impact on student learning.

After the final summative assessment, students were asked to complete a final survey that was nearly identical to the initial survey taken before treatment (Appendix B).

The initial and final surveys aided in measuring the student friendliness of each note-taking method. Items on the survey included statements such as “This method of note-taking helped me stay organized” and “This method of note-taking was helpful when I studied for my tests and quizzes.” A Likert scale model was used in the creation of this survey so that quantitative data could be collected and used in analyses and comparisons between the four note-taking methods. Likert answer options were “strongly agree,” “agree,” “disagree,” and “strongly disagree.” Statistical analyses were then run to compare the four note-taking methods and find significant differences in student responses. As mentioned before, the analog notebook method was used as the control group.

I recorded my own observations during the unit by keeping a running log and journal in which I recorded notes and observations pertaining to each method of note-taking. I especially noted student distractions and attention to task, student speed of note-taking, and external student attitudes toward their assigned method of note-taking. I also made notes on teacher time and preparation that was required to facilitate each method of note-taking.

Finally, face-to-face student interviews were conducted at the conclusion of the unit to collect additional data on students’ attitudes towards note-taking and the varying note-taking methods. Two students from each method were interviewed: one student who was considered high-achieving and one who was considered low-achieving during the unit of treatment. A summative unit test score of an eighty-five percent or above identified the high achieving student and a summative unit test score of a seventy percent

or below identified the low achieving student. Students were asked to provide open-ended feedback regarding their method of note-taking in response to five questions: What did you think of this method of note-taking? Did you feel that this type of note-taking helped you learn? Did other students' method of note-taking distract you during class at all? Would you like to continue this method of note-taking? Is there another type of note-taking you think you would like better?

Multiple forms of data were collected and used to discover emerging trends in how altered note-taking methods impacted students. Each of the research questions had three different sources of evidence of which to analyze. Table 1 shows the data sources used to answer each of the research questions.

Table 1
Data Triangulation Matrix

Focus Question	Data Source 1	Data Source 2	Data Source 3
<i>Primary Question:</i> 1. How do various methods of note-taking impact student learning?	Pre-treatment test scores on pretest assessment	Post-treatment test scores on summative assessment	Three formative assessment quizzes
<i>Subquestions:</i> 2. What method(s) of note-taking are the most student-friendly in the classroom?	Post-treatment students surveys	Post-treatment student interviews	Recorded teacher observations
3. What method(s) of note-taking are the most student-friendly outside the classroom?	Post-treatment student surveys	Post-treatment student interviews	Pre-treatment and post-treatment test scores

DATA AND ANALYSIS

As mentioned in the above section, the treatment phase of this research was conducted throughout the Mendelian genetics unit, which lasted for two-and-a-half weeks of instruction. Students in three different class sections were randomly assigned one of the four note-taking methods and asked to use this method throughout the entirety of the unit. Multiple forms of data were collected and analyzed including pre- and post-test data, student surveys, interviews, and instructor observations (Appendix B).

Initial survey responses were analyzed to determine student conceptions about the current analog written note-taking method. Question #1 on the survey asked students, “Why do you take notes in this class?” (Appendix B). Over half of the students responded that the notes were for studying and reviewing information outside of the classroom. This response likely stems from a classroom expectation that has been established. Students know that I am reluctant to help them with assignments if their notes are incomplete, lost, or nonexistent. Table 2 summarizes student responses to the first open-ended survey item.

Table 2
Initial Survey Open-ended Results for Item 1

Why do you take notes in this class?	Number of responses
Reference to understanding and learning	15
Reference to paying attention in class	2
Reference to study and review	38
Reference to being told and expected to	6
Reference to helping them remember information	9

Note. Item 1 read, “Why do you take notes in this class?” Blank responses are not shown in the table. Some responses referenced multiple reasons for note-taking and were included in the count for both areas.

Impact on Student Learning

Results of the study showed that altering the note-taking methods of students likely did not have an impact on summative student learning. Pre-test assessment scores showed that students had minimal experience and prior knowledge with the unit content. Each group scored a mean of 40-45% on the pre-test ($N=60$). Post-test scores showed that each treatment group improved in their learning with the analog outlined group scoring an average of 45.3% higher ($N=17$), the analog written group scoring an average of 45.3% higher ($N=15$), the digital outlined group scoring an average of 45% higher ($N=15$), and the digital typed group scoring an average of 37.7% higher ($N=13$) (see Table 3).

Table 3
Pre-test and Post-test Scores

Treatment Group	Mean on Pretest	Standard Deviation on Pretest	Mean on Post-test	Standard Deviation on Post-test	Percent gain mean	Sample Size (N)
Analog	8.27	3.28	17.33	2.47	45.33	15
Analog, outlined	8.59	3.59	17.65	1.66	45.29	17
Digital	8.69	3.17	16.23	4.25	37.7	13
Digital, Outlined	8.33	3.27	17.33	2.85	45.0	15

Note. Pre-test and post-test means are given out of 20 possible correct answers.

Formative test scores also showed that the note-taking method had no immediate impact on student learning. The calculated median on three formative assessments for analog outlined was 92.28% ($N=17$), for the analog written it was 82.3% ($N=18$), digital outlined was 90.5% ($N=15$), and for the digital typed group it was 83.4% ($N=13$) (see Table 4). Overall, the analog and digital groups scored the lowest on all three formative

assessments but with higher standard deviation values compared to the other note-taking groups. These differences can be attributed to the fact that these groups contained a higher occurrence of low-achieving students who served as statistical outliers.

Table 4
Formative Assessment Data

Treatment Group	Mean for Assessment #1	SD for Assessment #1	Mean for Assessment #2	SD on Assessment #2	Mean for Assessment #3	SD on Assessment #3	Mean Percent on Assessments	Sample Size (N)
Analog	6.75	1.57	11.72	2.72	7.89	2.03	82.33	18
Analog, outlined	7.18	1.33	12.94	1.59	9.47	.54	92.28	17
Digital	6.77	1.69	11.52	2.97	8.35	1.82	83.44	13
Digital, outlined	7.4	.83	12.33	1.69	9.1	1.11	90.53	15

Note. Formative assessment #1 was out of 8 possible points, #2 was out of 14 possible points, and #3 was out of 10 possible points.

Student Friendliness within the Classroom

To gauge the student-friendliness of each note-taking method within the classroom, Likert-scale student surveys were given using a quantitative value for each response (Appendix A). “strongly agree” was documented as a value of four and “agree” was a three. These responses were recorded as showing an affirmative answer to the survey item. Likewise, “disagree” and “strongly disagree” were given values of two and one respectively and were recorded as a negative response to the posed survey item. Frequencies of positive and negative responses for each survey item were recorded and analyzed for each of the four note-taking method groups, starting with items relating to student-friendliness within the classroom (see Table 5 and Table 6).

Table 5
Survey Items Relating to Student-friendliness in the Classroom

Post-test Survey Item
3. While using my assigned method, I didn't mind taking notes in class.
4. While using my assigned method, taking notes helped me pay attention in this class.
5. While using this method, taking notes was stressful for me.
10. While using my assigned method, I felt that I was good at taking notes.
11. If I had a choice, I would continue to take notes in class using my assigned method.

Results of the post-treatment final survey showed that while there was no definite method that was the best for students to use during instructional time, digital outlined was clearly the least student-friendly. Only 57% of students reported that this note-taking method helped them pay attention in class ($N=14$) by marking either “agree” or “strongly agree” on the post-treatment survey item number four (see Table 6). Likewise, only 57% of students who were assigned the digital outlined method marked that they would like to continue note-taking in this manner. In contrast, 73.3% of students using analog outline ($N=15$), 87.5% of those using analog written ($N=16$), and 78.6% of those using digital typed ($N=14$) marked that they would like to continue using their assigned method. Compared to peers using other methods, students using the digital outlined method also marked much more frequently that their assigned method of note-taking was stressful (see Table 6).

Table 6
Mean Percent of Positive Responses to Survey Items Related to Student-Friendliness in the Classroom

Survey Item	Analog Mean Percent	Analog, Outlined Mean Percent	Digital Mean Percent	Digital, Outlined Mean Percent
3	94.44	93.75	100	78.57
4	88.89	100	93.33	57.14
5	5.56	0	0	21.43
10	87.5	100	100	71.43
11	87.5	73.33	78.57	57.14

Note. Positive responses are identified as those in which students marked “agree” or “strongly agree” on their final survey.

Teacher observations during the treatment phase both supported and opposed the results of student surveys in regard to student-friendliness within the classroom. For example, Student 32 was assigned the digital typed note-taking method. His response on the final survey was that this type of note-taking helped him to pay attention during class. However, it was observed that this student was playing a Tetris computer game during a note-taking session. In addition, while eight out of eight students reported in post-treatment surveys that other students’ note-taking methods did not distract them during instruction, two students sitting behind the student playing the Tetris game were watching the game play out.

As I made further teacher observations of my own, it appeared that the digital outline note-taking method was not only the most disliked, but also the most challenging for students. Student 70 was a clear example. A high-achieving student, she struggled to switch her note-taking routine from analog to digital. Some of her challenges were

directly related to the limitations of her equipment. For example, her Chromebook had non-functional keys, forcing her to borrow a spare laptop for every note-taking session. She also openly displayed her frustration when slow internet connections delayed the loading of her note documents. This student was not alone in her struggles. On seven different occasions students had to borrow spare school Chromebooks due to their Chromebook's malfunction, forgetting to bring their Chromebook to class, or having misplaced its charger. Student interviews were conducted after treatment showed that both high- and low-achieving students all had positive feelings about their assigned method of note-taking. However, when asked if they would prefer a specific type of note-taking over another, two of the eight students mentioned that they would not like the digital or the digital outlined form of notes. On the contrary, question ten on the final survey showed that a higher occurrence of students felt they were better at taking notes with the outlined form compared to the initial survey regarding the analog written method (Figure 1). This is likely due to reduced stress and workload required to fill in matrices versus writing or typing every element of the notes.

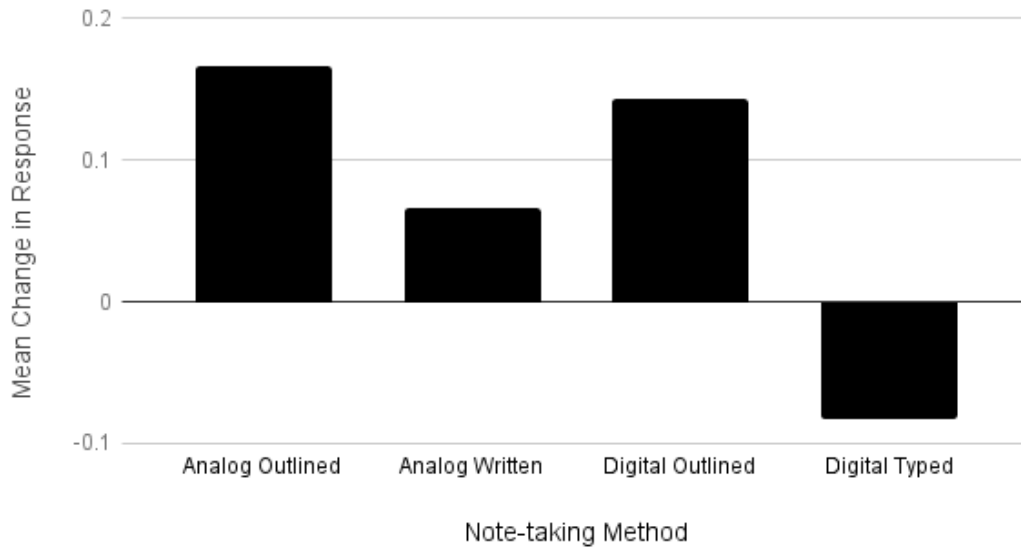


Figure 1. Mean change in response for survey question 10, ($N=63$).

Formatting also became a struggle in digital note-taking. During the genetics unit, students were completing sample Punnett square crosses in their notes. When many students were unable to insert a table correctly, or the autocorrect on their Chromebooks would capitalize an allele that needed to be lowercase, class progression was delayed. This type of note-taking may prove even more challenging in courses such as chemistry, where there is a high use of many different symbols and formatting such as superscript and subscript characters. I initially expected the digital note-takers would be much faster than the analog writers, but the challenges mentioned above kept them recording at relatively the same pace.

Student Friendliness Beyond Instructional Time

Further survey items were analyzed to gauge the student-friendliness of each note-taking style beyond the classroom (see Table 7). The goal was to determine what

style of note-taking most impacted student learning outside of the instructional time in which the notes were actually recorded. Likert-scale survey items were analyzed according to the frequency of positive and negative responses as mentioned above with the exception of survey item number 1. This item asked students how often they took notes during lecture, with 4= “every time,” 3= “most of the time,” 2= “sometimes,” and 1= “never” (Appendix B).

Table 7

Survey Items Relating to Student-friendliness Beyond the Classroom

Post-Survey Test Item

-
1. How often did you take notes during this unit when Mrs. Smith lectured?
 6. While using my assigned method, taking notes helped me remember information, even if I didn’t study the notes.
 7. While using my assigned method, taking notes helped me understand information better than if I didn’t take notes.
 8. While using my assigned method, notes that I took helped me review and study for tests/quizzes.
 9. While using my assigned method, I used my notes to review and study for tests/quizzes.
-

Results of the survey showed that those students who were in the analog and digital outlined groups were much less likely to use and find the value in their notes when it came to reviewing and studying for assessments (see Table 8). Many of these students responded to the open-ended survey item explaining that they used other materials such as a study guide, worksheets, or Quizlet™ vocabulary review instead, but did not indicate why the notes were not used. In my observations, some students in the digital outlined

group struggled to find different files in which their notes were located, as I had shared with them a different outline document for each note-taking session.

Table 8

Mean Percent of Positive Responses to Survey Items Related to Student Learning Outside the Classroom

Survey Item	Analog Mean Percent	Analog, Outlined Mean Percent	Digital Mean Percent	Digital, Outlined Mean Percent
1	100	83.33	100	92.86
6	77.78	87.5	73.33	71.43
7	94.44	93.75	100	85.71
8	77.78	100	93.33	64.29
9	56.25	93.33	85.71	50

Note. Positive responses are identified as those in which students marked “agree” or “strongly agree” on their final survey. Survey item 1 was an exception in which a positive response correlated with the answers “every time” and “most of the time.”

INTERPRETATION AND CONCLUSION

The goal of this classroom research project was to determine which methods of note-taking most positively impacted students. Analysis of data was made to determine student learning as well as student-friendliness within and outside of instructional time.

In reference to student learning, analog and digital note-taking groups were the lowest achieving on the formative assessments and the digital typed note-taking group had the smallest percent gain between their pretest and post-test scores. This information is contradictory to that found in a recent study in which students who typed notes scored higher on assessments than peers who took handwritten notes (Bui, Myerson & Hale, 2013).

Student friendliness was gauged using student surveys, interviews, and teacher observations made during the treatment phase. All three of these data collection tools indicated that digital notes, specifically digital outlined notes as the least student-friendly method during and outside of instructional time. Student engagement was observed to be lower for students with this method and students were also less likely to use these notes for study and review. This can be remedied with intentional, structured time that is allotted for students to interact with their notes such as using the *SOAR* method or peer collaboration (Jairam and Kiewra, 2010) (Chiu, Wu, & Cheng, 2013).

The small sample size of groups in this study makes it difficult to point out any significant differences in data to answer the initial research questions. While trends emerged, it is important to recognize the many variables that come into play with student performance including engagement, attendance, and transparency throughout the treatment phase. Several students were dropped from the research due to lack of attendance that resulted in them missing critical checkpoints including pre-test administering or note-taking sessions. Students' biases, caused by their knowledge of the research project, may also have impacted results. As one student turned in his final survey, he proudly proclaimed, "I put all good things down for you so that you get an 'A' on your paper." While this student had sweet intentions, this sort of action is likely to skew the research data on qualitative items such as student surveys and interviews. There can also be emergent inconsistencies within individual responses. For example, one high-achieving student who was assigned the digital outlined method was interviewed after the treatment phase. During the interview, the student had all positive things to say about his

assigned method: “I liked it. It was easy because I knew what I was looking for,” and, “I liked it a bit more than the normal kind because I was looking for something specific and not just listening.” The student also gave all high marks for this method on his final survey, with the surprising exception of item number five which stated, “While using this method, taking notes was stressful for me.” The student marked strongly agree for this item, which is glaringly inconsistent with his written answers on his survey and the oral answers given during his post-treatment interview. Whether the student misread the question or truly does feel this way is left in question and the data is taken at face value.

Another interesting example of conflicting data is student number three. This student can be classified as low-achieving academically, but simply lacks the motivation to be successful in his classes. This student was assigned the analog written method of note-taking, meaning that there was no change for him during the treatment phase and the data collected for this group could be considered somewhat of a control set. On his initial survey, student 3 gave the typical method of note-taking very low marks, however he gave much higher marks for the same type of note-taking on his final survey. Where he marked “strongly disagree” for the statement “I don’t mind taking notes in class” on his initial survey, he marked “strongly agree” on his final survey. Likewise, he marked “agree” for note-taking as a stressful task on his initial survey but marked “disagree” on his final survey. The conflicting answers continued when he marked “disagree” on his initial survey for items pertaining to note-taking helping him understand content material and whether or not he thought that he was good at note-taking, but for both items he marked “strongly agree” on his post-survey. Both his final survey and student interview

indicated that he wished to continue this method of note-taking. The fact that this student's view on the same type of note-taking changed so drastically from pre- to post-treatment raises questions about the validity of his survey results. Could it have been that the student had a particularly poor attitude toward this class or note-taking in general on the day that he took the initial survey? Did he better understand and engage the content that was assessed during the treatment phase than previous course units? Perhaps this student was comparing his method to what he was seeing and hearing from other students who were assigned an alternative form of note-taking and had a new-found appreciation for the traditional method.

VALUE

The process of this action research has allowed me to reflect on my current teaching practices and expectations for my students within the classroom. As mentioned in the introduction, this topic stems from a curiosity I have regarding varying teaching styles within my building and observations about student preferences evolving over time. Some teachers in my building within the life science content area have mandated that students take digital notes with their Chromebooks, other teachers only allow analog notes, and still others allow students to go by their individual preference.

The note-taking methods that a teacher allows or requires within their classroom must reflect what the teacher is trying to accomplish through this time of instruction. In my own classroom, lecture is a time in which I present information to my students in a way of explaining difficult concepts and introducing new vocabulary. The expectation is that students take notes that allow them to easily access this information in the future

without me having to recreate the instructional time, and more importantly, not requiring them to search for information on the internet that may be incorrect or too advanced for their level of understanding.

I have admittedly spent a limited amount of time teaching my students note-taking strategies. My class presentations are designed in a way to streamline note-taking so that students have no question as to what I feel is important for them to record. For example, I often color-code the presentations so that students can differentiate between what I expect them to know and document versus what I have included as supplementary information or as a cue for my own train of thought.

Perhaps as the school year progresses, I should wean my students from this form of note-taking, which could really be classified as a guided or outlined form of notes. The ultimate goal would be for students to take self-regulated notes that can be just as thorough and useful as the teacher-designed format and outline. This would require a significant amount of time and intentional use of exercises in which the teacher modeled and the students practiced this method. A cost-benefit analysis would need to be weighed by each teacher in knowing that having students self-regulate their notes, you may be sacrificing the effectiveness of the notes as well as introducing a new element of stress to the students as they struggle to pay attention, learn, discern important information, and transcribe this information in a condensed, but understandable form. The sacrifices made to teach note-taking skills may have long-term benefits for those students who are destined for advanced classes and higher education. However, lower-level students need and benefit from a very guided and concrete form of note-taking. I currently teach a

foundational level of biology for students who are considered special education and benefit from an individualized education plan. I did not include these students in my action research study since deviating from the analog, outlined method of note-taking they currently utilize would put them under undue stress. I would also expect that their quality of notes would plummet if making decisions about primary versus supplementary information was left to them.

It is interesting to note that following the treatment phase, the vast majority of students in the study returned to the analog written form of notes. Several students, however, continued to take digitally typed notes using their Chromebook. All of these students had been assigned this method for the treatment phase and naturally decided to continue this method since many of their semester notes were already in an electronic form. In terms of digital note-taking, I now know I would not allow students to use this method again without the implementation of classroom management software, such as LanSchool, with which the instructor can view, blank, and freeze screens on student devices. This tool would then allow me to monitor student note-taking and ensure that they are staying on task during instruction.

This classroom research project has answered my research questions and revealed additional questions that I hope to answer in the future. For instance, I would like to know more about strategies for improving student-generated note-taking skills as well as better understanding the scientific correlation between writing and remembering information. My hope is that the data generated from this study will be helpful to other

educators in molding their classrooms and making instructional decisions that best meet student needs.

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APPENDICES

APPENDIX A

MSU IRB EXEMPTION LETTER



INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects

FWA 00000165

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MEMORANDUM

TO: Allison Smith and Eric Brunzell
FROM: Mark Quinn *Mark Quinn*
DATE: December 12, 2016
SUBJECT: "An Investigation in Note-taking Strategies for High School Students" [AS121216-EX]

The above research, described in your submission of December 12, 2016, 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 B
DATA COLLECTION TOOLS

Action Research Initial Survey

Name _____

Pd _____

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. How often do you take notes in THIS class in your notebook when Mrs. Smith lectures?

Every time

Most of the time

Sometimes

Never

Why do you take notes in this class?

2. Taking notes is important for my success in this class.

Strongly agree

Agree

Disagree

Strongly disagree

3. I don't mind taking notes in class.

Strongly agree

Agree

Disagree

Strongly disagree

4. Taking notes helps me pay attention in this class.

Strongly agree

Agree

Disagree

Strongly disagree

5. Taking notes during this class is stressful for me.

Strongly agree

Agree

Disagree

Strongly disagree

6. Taking notes in this class helps me remember information, even if I don't study the notes.

Strongly agree

Agree

Disagree

Strongly disagree

7. Taking notes in this class helps me understand information better than if I don't take notes.

Strongly agree

Agree

Disagree

Strongly disagree

8. Notes that I take in this class help me review and study for tests/quizzes.

Strongly agree

Agree

Disagree

Strongly disagree

9. I use my notes to review and study for tests/quizzes in this class.

Strongly agree

Agree

Disagree

Strongly disagree

What other materials do you use to study for tests and quizzes?

10. I feel that I am good at taking notes in this class.

Strongly agree

Agree

Disagree

Strongly disagree

Mendelian Genetics

Biology Test

1. Which of these would NOT be studied by a geneticist?
 - a. Probability of inheriting allergies
 - b. Whether or not the trait for double-jointedness recessive
 - c. Training programs for gaining muscle mass
 - d. How much variety there is in a herd of sheep

2. If an individual possesses two recessive alleles for the same trait, the individual is said to have a _____.
 - a. homozygous genotype
 - b. heterozygous genotype
 - c. homozygous phenotype
 - d. heterozygous phenotype

3. A cross between an individual heterozygous for a trait and an individual homozygous recessive for the trait will be able to produce offspring with _____.
 - a. all the same genotype.
 - b. three different genotypes.
 - c. two different genotypes.
 - d. all the same phenotype.

4. The genotype of an organism
 - a. reflects all the traits that are actually expressed.
 - b. represents its genetic composition.
 - c. occurs only in dominant pure organisms.
 - d. can be observed without a microscope.

****Questions 5 and 6 refer to a plant for which “R” represents a dominant red flower allele and “r” represents a recessive white flower allele.****

5. What color would a flower with the genotype Rr be?
 - a. white
 - b. a mix of white and red
 - c. red
 - d. a lighter shade of red

6. What color would a flower with the genotype rr be?
 - a. white
 - b. a mix of white and red
 - c. red
 - d. a lighter shade of red

7. A cross between a homozygous red flower and a homozygous white flower that produces all pink flowers is an example of _____.
 - a. polygenic inheritance
 - b. multiple alleles.
 - c. incomplete dominance.
 - d. codominance

8. A red horse that mates with a white horse produces offspring with red and white hair patches, called roan. This is an example of _____.

- a. polygenic inheritance
 - b. multiple alleles.
 - c. incomplete dominance
 - d. codominance
9. "The alleles for a trait separate when gametes are formed." This is a restatement of Mendel's law of _____.
- a. independent assortment.
 - b. mutation.
 - c. segregation.
 - d. crossing over.
10. Humans can have blood phenotypes of A, AB, B, or O. The four blood types result from _____.
- a. codominance.
 - b. multiple alleles.
 - c. regular dominant/recessive
 - d. all of the above
11. Trait Z is influenced by the inheritance of many genes. Which of these must be true for trait Z?
- a. There are probably two possible genotypes for trait Z.
 - b. Trait Z is probably someone's blood type.
 - c. There are probably many different phenotypes for trait Z.
 - d. Trait Z is mostly inherited through codominance.
12. Since the allele for colorblindness is located on the X chromosome, colorblindness
- a. cannot be inherited by females.
 - b. is sex linked.
 - c. occurs only in males.
 - d. occurs only in females.
13. A genotype of AaBBCCddEe indicates that this trait is inherited by _____.
- a. incomplete dominance
 - b. polygenic inheritance
 - c. codominance
 - d. sex-linkage
14. The children of the F₁ generation are called the _____ generation.
- a. P
 - b. Ch
 - c. F₂
 - d. Mendel

Use the key regarding penguin traits below to answer the succeeding questions.

Chinstrap (C) is dominant over a bare chin (c)
Large beak (B) is dominant over a short beak (b); Hybrid has medium beak.
Orange feet (O) is dominant over black feet (o)

What is the genotype for the following phenotypes?

15. Medium beak, homozygous chinstrap
a. BBcc b. BbCc c. bbCc d. BbCC

16. Black feet, large beak

- a. OoBb b. OoBB c. Oobb d. ooBB

17. Bare chin, black feet

- a. CcOo b. ccOo c. ccoo d. CCoo

What is the phenotype for the following genotypes?

18. bbCc

- a. medium beak, bare chin c. medium beak, chinstrap
b. short beak, chinstrap d. large beak, bare chin

19. ooBB

- a. black feet, medium beak c. orange feet, large beak
b. orange feet, large beak d. black feet, large beak

20. CcOo

- a. chinstrap, orange feet c. bare chin, orange feet
b. chinstrap, black feet d. bare chin, black feet

GENETICS NOTES DAY 1

Name _____ Pd _____

• If a base is a letter (G)

• Then a codon is a 3-letter _____ (CAT)

• And a gene is a _____ of 3-letter words (THE CAT ATE THE BAT.)

• A chromosome would be a _____ (Chromosome 15)

• A genome is the whole _____

Gregor Mendel:

- Austrian Monk 1822-1884
- Studied the inheritance of traits in _____
- Developed _____
- Nickname: _____

Word	Definition	Examples
	Any characteristic of an organism	
Heredity		
		You go to a geneticist to see what you inherited and what you could pass on to you kids
		R, s, E, f, P, b
Dominant Allele		
Recessive Allele		

You receive _____ alleles for each gene... one from _____ and one from _____.

These are given to you through the _____.

Genotype		
Phenotype		

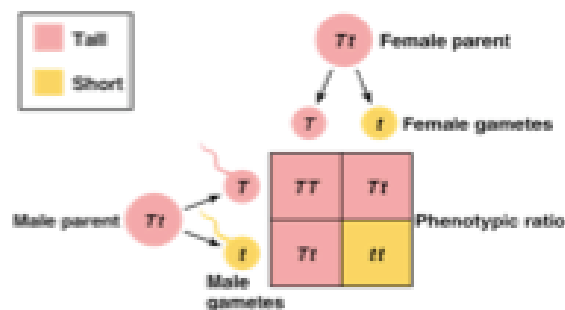
Two types of genotypes:

	gene combination involving 2 dominant or 2 recessive alleles; also called <u>purebred</u> or <u>true-breeding</u>	
Heterozygous		

Law of _____: Each parent has _____ alleles for each gene (one on each chromosome); During the process of _____, they separate (or segregate) into different _____.

Thus, you have a _____ % chance of inheriting each allele.

This can be shown using a _____. Used to show probabilities of passing on traits.



In cats, long hair (L) is dominant over short hair (l). Cross a LL cat with a ll. Show genotypic and phenotypic ratios.

Genotypic ratio: _____

Phenotypic ratio: _____

Action Research Final Survey

Name _____

Pd _____

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Please circle what method of note-taking you were assigned (treatment):

Handwritten Outline, handwritten Typed Outline, typed

Please answer the following items with your note-taking treatment in mind.

1. How often did you take notes during this unit when Mrs. Smith lectured?

Every time Most of the time Sometimes Never

2. How often did you use your assigned method of note-taking during the unit when Mrs. Smith lectured?

Every time Most of the time Sometimes Never

Why did you ever *not* use your assigned method?

3. While using my assigned method, I didn't mind taking notes in class.

Strongly agree Agree Disagree Strongly disagree

4. While using my assigned method, taking notes helped me pay attention in this class.

Strongly agree Agree Disagree Strongly disagree

5. While using this method, taking notes was stressful for me.

Strongly agree Agree Disagree Strongly disagree

6. While using my assigned method, taking notes helped me remember information, even if I didn't study the notes.

Strongly agree Agree Disagree Strongly disagree

7. While using my assigned method, taking notes helped me understand information better than if I didn't take notes.

Strongly agree Agree Disagree Strongly disagree

8. While using my assigned method, notes that I took helped me review and study for tests/quizzes.

Strongly agree Agree Disagree Strongly disagree

9. While using my assigned method, I used my notes to review and study for tests/quizzes.

Strongly agree Agree Disagree Strongly disagree

What other materials did you use to study for this unit's tests and quizzes?

10. While using my assigned method, I felt that I was good at taking notes.

Strongly agree Agree Disagree Strongly disagree

11. If I had a choice, I would continue to take notes in class using my assigned method.

Strongly agree Agree Disagree Strongly disagree

Thank you for helping me with my research!

Teacher Classroom Observations Template

[illegible]

APPENDIX C
STUDENT ARTIFACTS

Mendelian Genetics

2/14/17

Gregor Mendel

- Studied the inheritance of traits in pea plants
- Developed the laws of inheritance
- Called the "Father of Genetics"

*Trait-any characteristic of an organism(i.e. Shape of nose)

*Heredity-passing of traits from parent to offspring

*Genetics-study of heredity

*Alleles-forms of a gene

*Dominant allele-stronger allele; shown by a capital letter (R, T, H)

*Recessive-weaker allele; shown as a lowercase letter (r, t, h)

- You receive two alleles for each trait. One from mom, the other from dad; given through the gametes.

*Genotype-gene combination for a trait (e.g. RR, Rr, rr)

*Phenotype-the physical feature resulting from genotype (e.g. red, white)

*Homozygous-2 dominant or 2 recessive alleles (e.g. RR or rr); also called purebred or true breeding

*Heterozygous-one dominant & one recessive allele (e.g. Rr); also called hybrid

- Law of Segregation

*Each parent has 2 alleles for each trait; During the process of meiosis, they separate into different gametes

*Thus, you have a 50% chance of inheriting each allele

- Punnett Squares

*Used to show probabilities of passing on traits to offspring

Mendelian Genetics Notes

- If a base is a letter (G)
- Then a codon is a 3-letter **Word** (CAT)
- And a gene is a **Sentence** of 3-letter words (THE CAT ATE THE BAT.)
- A chromosome would be a **Chapter** (Chromosome 15)
- A genome is the whole **Book**

Gregor Mendel:

Austrian Monk 1822-1884

Studied the inheritance of traits in **Pea Plants**

Developed; **Laws of inheritance**

Nickname: **Father of genetics**

Word	Definition	Examples
Trait	Any characteristic of an organism	Shape of nose, skin color, etc.
Heredity	Passing of traits from parent to offspring	Getting your parents eye color
Genetics	Study of heredity	You go to a geneticist to see what you inherited and what you could pass on to your kids
Alleles	Forms of a gene	R, s, E, f, P, b
Dominant Allele	Stronger allele	R T H
Recessive Allele	Weaker allele	r t h

You receive **two** alleles for each gene... one from **mom** and one from **dad**

These are given to you through the **gametes**.

MENDELIAN GENETICS NOTES

Name _____

- If a base is a letter (G)
- Then a codon is a 3-letter word (CAT)
- And a gene is a sentence of 3-letter words (THE CAT ATE THE BAT.)
- A chromosome would be a chapter (Chromosome 15)
- A genome is the whole book

Gregor Mendel:

- Austrian Monk 1822-1884
- Studied the inheritance of traits in pea plants
- Developed the laws of inheritance
- Nickname: father of genetics

Word	Definition	Examples
Trait	Any characteristic of an organism	shape of nose
Heredity	Passing of traits from parents to offspring	blood disorder
genetics	Study of heredity	You go to a geneticist to see what you inherited and what you could pass on to your kids
alleles	forms of a gene	R, s, E, f, P, b
Dominant Allele	stronger alle shown by a capital letter	R, T, H
Recessive Allele	weaker alle shown by a lower case letter	r, t, h

You receive 2 alleles for each gene... one from mom and one from dad.

These are given to you through the gametes.

Genetics Notes

VA

Gregor Mendel

Studied the inheritance of traits
Pea plants.

Developed the laws of inheritance
Trait - any characteristic of an
(shape or height)

Process

Heredity - passing of traits from
to offspring

Genetics - study of heredity

Alleles - forms of a gene

until

Dominant allele - stronger allele; shown
a capital letter.

Recessive - weaker allele; shown
a lowercase letter

You receive two alleles for each t.
from mom, one from Dad; given
the gametes.

CA +

A+

Genotype - gene combination for a
phenotype - the physical feature re
genotype.

Homozygous - 2 dominant or 2 re
alleles. Pure bred or true bred