COMPARING THE EFFECTS OF TRADITIONAL LEARNING (LECTURE) VS INDEPENDENT ONLINE LEARNING ON STUDENT UNDERSTANDING IN WEATHER AND GEOLOGY

by

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DEDICATION

This paper is dedicated to my father and “critical buddy”. My father has been a tremendous help to me throughout this program and my first years of teaching. I cannot imagine what I would have done without his support, encouragement, advice, and the countless hours he spent proofreading my papers for this program. I am very thankful for all of the time he spent helping me earn this degree and could not have done it without him.

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ABSTRACT

Poor student performance on summative assessments has been a common problem throughout my teaching career. This has caused me to consider alternative methods of delivering new material to my students. The purpose of this study was to investigate the effects of online learning vs. lecture on student understanding. During unit one of my treatment I delivered notes entirely by lecturing. Following each lecture, my students completed guided note questions within small groups. We discussed their answers as a class and the students then took an individual note quiz over the new material. The second unit was studied by online learning in which students logged on to our class website, read the notes individually, and answered guided note questions within small groups. We discussed their answers as a class and students completed an individual note quiz as we had done following a period of lecture. For the remainder of my treatment, I allowed my students to choose which method of note-taking they preferred and divided my students into two groups according to their responses. Students followed the same procedure as they had during the first two units. Through the analysis of data collected I was able to determine that male students learned better following units of online learning while female students learned better through lecture. I also learned that the lower level students experienced the greatest impact when changing between lecture and online learning. Despite the success many male students had with online learning, analysis of student survey data and interview responses showed that the majority of students preferred lecture to online learning and felt better prepared and more confident following units in which that strategy was implemented. Observations and journal entries suggest that I experienced fewer behavioral problems and a greater percentage of students asking and correctly answering questions following periods in which a mixture of lecture and online learning were implemented. As a result, I have concluded that combining both strategies and allowing students to choose their preferred method of note-taking will continue to have a positive effect on both my students and my future teaching.

INTRODUCTION AND BACKGROUND

Project Background

Teaching Experience and Classroom Environment

For the past three years I have been teaching freshman level Physical Science and junior-senior Weather and Geology at Naperville Central High School (NCHS) in Naperville, Illinois. Naperville Central High School is one of two high schools in Illinois School District 203 and offers twenty two different science courses for grades 9-12. The majority of incoming freshman take Dynamic Earth Systems, the freshman Physical Science class that I teach. Many of the lower level juniors and seniors take Weather and Geology in order to fulfill their second or third year of science requirement for graduation. As someone who majored in Geology when completing my Bachelor's degree, I was extremely excited to have the opportunity to teach Earth Science to freshman, juniors, and seniors. I have thoroughly enjoyed my time teaching at NCHS and am very proud to be a part of our science department.

School Demographics

Naperville Central High School is a suburban school that ranks in the top three percent of the nation according to US News and World Report. There are 3086 students enrolled in the school, of which 82% are Caucasian, 12.3% are Asian/Pacific Islander, 3.6% are African American, 2% are Hispanic, and 0.1% are Native American. The school has a culture of achievement and the students are academically successful. The graduation rate is 96.8% and the average ACT composite score is a 24.9. About 85% of

the Class of 2008 enrolled in a four-year college, 13% attended two year college and 2% entered the military or vocational workforce (About Our School, 2010).

According to the State Report Card for Naperville Central High School, 7.4 % of the students who attended NCHS in the 2010 academic year were from low-income families. NCHS does offer a free and reduced lunch program for students who qualify (Naperville Central High School, 2011). Throughout the past three years I have had two students benefit from this program. While there are students of low-income families who attend NCHS, the vast majority of students come from families of an above average socioeconomic status. The median household income in Naperville is $106,525 compared to the Illinois average of $58,823 and the national average of $54,595. The income per capita in Naperville is 57.8% greater than the Illinois average and 61% greater than the national average. The poverty level in Naperville is 2.2% compared to the Illinois average of 8.5% (Naperville Employment, Unemployment & Median Household Income, 2010). It has always been clear to me that the vast majority of NCHS parents are very supportive and generous when it comes to their children's education, teachers, and the school itself. Based on my experience teaching at NCHS, this school also has a very positive environment with a high involvement of students and staff in extracurricular activities.

Focus Question

Throughout my time teaching Weather & Geology at Naperville Central High School, I have noticed a common trend amongst many of my students: poor performance on summative assessments. I have been continuously trying to find ways to improve my students understanding of course content in order to enable them to be more successful on

both major and minor assessments. While I have tried to incorporate numerous review activities throughout each unit such as “Challenge of the Day” questions, review games, concept mapping, and so forth, I have still been experiencing the same general level of achievement from my students. This caused me to reflect on the manner in which I teach new material and deliver notes to my students.

Several teachers I work with have been substituting online, independent note-taking for lecture for the past few years. There are numerous reasons for this approach, including: online note taking allows students to work at their own pace, that many students are not auditory learners, and that online note-taking forces students to read through the material and think about what they have learned rather than sitting back while someone explains the content to them. The teachers believed that online note-taking forced students to take a more active role in learning course material. I have always been interested in studying the effects of this type of note-taking on student understanding because, quite honestly, I could see positives and negatives to both online learning and lecture.

When thinking about the many underachieving students in my Weather and Geology class, I began to think that they could benefit from being able to work through the notes at their own pace. One of the main reasons I started to consider online learning as opposed to lecture was that many off the students who did not do well on summative exams struggled with paying attention and staying focused during lecture. I did not believe this was the only reason they were struggling on summative assessments as these students also had many missing assignments and did not always participate fully in labs. However, I did believe that the methods I used to deliver new content to my students was

not as effective as it could be and, therefore, a significant factor in terms of their exam scores. I began to consider the fact that they may need an alternative method for learning new material such as online learning.

The purpose of my action research was to determine the effects of traditional learning (lecture) vs. online learning on student understanding in my junior/senior Weather & Geology electives. In other words, I hoped to learn more about the different outcomes each instructional strategy has on student learning and how each method of teaching impacts individual students in my classroom. In order to do this, I have collected qualitative and quantitative data in order to answer the following questions:

Primary Question: How do the effects of traditional learning (lecture) compare to the effects of independent online learning on student understanding in Weather & Geology?

Sub-question 1: What impact does lecture compared to online learning have on student performance on assessments?

Sub-question 2: How does the level of student confidence and preparedness on assessments during units of lecture compare to units of online learning?

Sub-question 3: What impact does lecture compared to online learning have on my future teaching?

As I learned from my literature review, the use of online learning is going to become more widespread as time goes on. The use of technology in the classroom is definitely increasing and becoming an important part of teaching. Every year NCHS requires that all of its teachers learn a new form of technology. Throughout the past three years I have learned how to incorporate SmartBoard, Senteo, PASCO probes, ClassConnect, and Graphical Analysis into my teaching. The more research that can be

done to determine the effects of technology on student learning, the better prepared we will be to incorporate this new technology in the classroom as effectively as possible.

CONCEPTUAL FRAMEWORK

Prior to the beginning of my treatment I researched the findings of others who have investigated the impacts of online learning and lecture on student learning. The most important theme I learned from my reading was that there are benefits to both lecture and online learning and that students learn best when they experience a combination of both strategies. Despite all the new technology out there, my students still need a teacher who is a real human being in order to be successful.

Bate and Pool (2010) explained that learning is really a social process which requires strong communication between the teacher and the students. The social process of learning cannot successfully be replaced by technology; however, technology definitely helps to facilitate learning. I think this article supports my action research project because it shows that adding a technology component has the potential to improve the way students learn, but at the same time, it cannot be the only means for learning new material. According to this article, teachers and computers do not need to compete for students' attention; I can share my teaching time effectively with computers as long as I implement a variety of instructional methods such as a mixture of online learning and teacher-centered learning.

Kolowich (2009) explained that teachers who use a mixture of online learning and lecture see an improvement in the quality of their lectures because the online learning takes care of the basics, such as vocabulary, leaving more time during lecture for

reinforcing the more difficult concepts and points of confusion. This conclusion was based on study in which researchers tested the effects of "Open Learning" software on Carnegie Mellon students to ensure that this software did not have negative effects on student learning. What researchers discovered was that, over a two-semester trial period, students in a traditional classroom introductory statistics course scored no better than similar students who used the open-learning program and skipped the three weekly lectures and lab period. Kolowich further explained that Carnegie Mellon was not considering replacing all its professors with computer programs but rather exploring how the open-learning software could be used in conjunction with classroom education to speed up the teaching and learning process. Researchers found that, by combining the open-learning software with two weekly 50-minute class sessions in an introductory statistics course, students were able to learn the same amount of material in half the time. Candace Thille, director of the Open Learning Initiative at Carnegie Mellon, stated that "If they're all getting that baseline information, [faculty] can spend that class time going deeper and doing something much more interesting, so they can really leverage that you're an expert," says, "because right now, oftentimes the faculty expertise is wasted" (Kolowich, 2009, p.1).

Another important theme which was evident in the majority of articles I read is that active learning is vital to the learning process and that cooperative learning in groups is very beneficial to students. Chickering and Gamson (1987) explain that students do not learn as well when they are simply sitting, listening to their teachers. They need to be engaged and have the opportunity to talk and write about what they have learned. They further explained that learning is increased when it is collaborative rather than isolated.

When students have the opportunity to share their ideas and listen to their peer's responses, they will have a deeper understanding of the material. Chickering and Gamson came to these conclusions after evaluating four online courses in a professional school at a large Midwestern University. They were able to gain an understanding of student experiences and perceptions based on student comments and posts on an online discussion forum. This particular article reinforced my idea that there may not be one perfect method for delivering new material but rather a mixture of lecture and online learning which would provide students the opportunity to work in small groups on summary note questions and share their ideas.

While my research was focused on the impacts of online learning compared to the impacts of lecture on student understanding, another important theme was embedded in each of the articles I read. Prompt feedback is vital to student learning and the longer the gap between an assessment and teacher feedback, the less beneficial that feedback is to the student. I feel that this theme was relevant to my treatment as I implemented note quizzes immediately following a period of note taking as a means for assessing student learning. Chickering and Gamson (1987) explained that students benefit from being shown what information and content they have mastered and what content they need to continue to work on. By integrating one or more quick note quizzes, even as simple as a five-question quick quiz at the end of a period of note taking, I was able to give my students prompt, timely feedback they could use to better focus their study time and questions. I also believed that by allowing students to practice assessment questions in the form of note quizzes throughout a unit would feel more confident and prepared going into a unit test.

In addition to prompt feedback, Davis (1999) explained a multitude of instructional strategies teachers can use to improve the overall motivation of their students. One of the first strategies she describes deals with providing students frequent, early, and positive feedback which support's students' beliefs that they are capable of succeeding. This belief supported the research of Chickering and Gamson (1987) and supported my reasoning for administering short note quizzes immediately following a period of note-taking. What I found most interesting from Davis's article was her statement that teachers need to make students active participants in learning to increase their level of motivation. Davis emphasized the importance of posing questions to students rather them simply telling them information. This made me consider a possible benefit to online learning; during online learning students are responsible for reading the notes and thinking for themselves to answer the summary note questions. During lecture, however, students are basically told the information that they need to know. Through online learning students are forced to become active participants in their learning while during lecture their role tends to be more passive. Because the majority of my students typically have low motivation, I was curious to learn if actively participating in their learning would influence their motivation level and/or their ability to stay focused during note-taking.

A final theme from my readings is that, even though online notes and simulations are often oversimplified and imperfect, they can teach key concepts well when lecture by itself is not sufficient. Winn (2005) wrote about a study involving two introductory college-level oceanography classes consisting of 25 students per class. Both classes took part in this study for three sessions. The first and third sessions were identical consisting

of the same content taught by the same instructor using the same activities. The only difference was that one class performed exercises on a field trip while the other class performed similar exercises using a three-dimensional computer simulation of the same environment. The results of this study showed that these students learned oceanography concepts better through a computer simulation than through observations in the field. This proved that students can learn effectively in an online learning environment. However, because the professor played a significant role in his students' learning, it also means that computer based simulations and activities do not, on their own, teach general principles. This supports the idea that online learning should never replace the teacher but rather be a tool to facilitate learning.

These main ideas caused me to reflect on my own curriculum. I teach earthquakes, volcanoes, and storms in my Weather & Geology class in Illinois. Pictures or even videos alone really do not do these topics justice, and the baking soda/vinegar volcano, tornado in a bottle, or tiny wave tanks I use, for me, almost takes away from the magnitude of these natural disasters. On the other hand, I have found that creating online notes which incorporate computer simulations where students can build virtual volcanoes, change the size and speed of a tornado's vortex, or watch news footage of a real tsunami has been much more engaging than simply lecturing.

Before considering ways to change the way I teach, I thought it was important to gain a better understanding of how students learn. Because my Action Research project was about comparing two methods of teaching new material, lecture only vs. computer-based notes, I wanted to see if I could find articles that addressed both the nature of learning in general and some strategies for integrating technology to support that

learning. The article, “The Nature of Learning,” supported my theoretical framework as it explained the difference between what we know about teaching and how we actually teach (Bates, 2010). Before discussing the link between how students learn and how to design technology-based teaching, the authors reviewed three key categories of learning theory: behaviorism, cognitivism, and the social construction of knowledge. They then examined the role of media and technology in teaching and learning, and the planning, design, and delivery of technology-based courses. While I found the review of the categories of learning theory to be very dry, I did find this article to be helpful for my action research. What I found was how they linked each theory to a modern-day, technology-based application.

For example, after outlining behaviorism, the authors wrote that the behaviorist theory resulted in teachers implementing measurable learning objectives, computer-based instruction, and multiple choice tests (Bates, 2010). There was also a tendency, until recently, to see technology, particularly computers, as being closely associated with behaviorist approaches to learning. This was interesting to me as I use learning objectives, computer-based instruction, and multiple-choice testing on a weekly basis within my classroom. After summarizing cognitivism the author explained that cognitive approaches to learning seem to fit much better in higher education even though attempts have even been made to provide electronic and physical representations of mental processes. Finally, after describing the social construction of knowledge it was explained that learning can be seen as essentially a social process, requiring communication among learner, teacher, and others. This was important to me as it shows the importance of the teacher’s involvement in learning as well as the need for students to collaborate with each

other. I feel this article supports my theoretical framework as it shows that even when applying the classic models of learning theory, adding a technology component can improve the way students learn but it cannot replace the teacher entirely. According to this article, teachers and computers do not need to compete for students' attention; I can share my teaching time effectively with computers as long as I design my online lessons to meet the needs of multiple types of learners (Bates, 2010).

While I was not able to find any resources which outlined a specific classroom strategy for implementing online learning compared to lecture, I was able to modify the strategy I originally planned to fit to the main themes of my literature review. Originally I had planned on having all students answer the guided note questions on their own without the help of partners in order to see what each individual had learned. After completing my literature review I could see that collaboration and the opportunity to discuss and share ideas is vital to learning. Because of this I incorporated small group work into both lecture and online learning. Following a session of note taking through both lecture and online learning, I instructed my students to work with two to three other students to complete the guided note questions. In doing this students were able to share their answers and hear what their peers thought. Also, research shows that contact between the students and teacher is important which motivated me to circulate the room during this small group work and discuss questions with each group of students as well as to discuss answers as a class at the end of the period. Without completing this literature review I may have missed an excellent opportunity to promote collaborative learning in my treatment.

Prior to completing my literature review, I believed that online learning on its own would be the most beneficial teaching strategy for my students. My reasoning was that my students would be more engaged in their learning, work at their own pace, and be more responsible for self-assessing what they had learned. After completing my literature review I now know I have underestimated the importance and value of lecture and teacher involvement in learning. Time and again my sources stressed the importance of a combination or "hybrid" method of teaching in which the teacher is the facilitator and encourages contact between teacher and student. With this in mind, my goals for my research were not to replace direct instruction with online notes, but rather to find a way to help students with different skill sets and levels of interest to succeed in my class by comparing a more teacher-centered approach to teaching with more student-centered learning. The following section describes how specifically I implemented my treatment within my classroom.

METHODOLOGY

I compared two different teaching strategies, lecture and online learning, in order to determine the effects of each on student understanding. For the first unit I taught on oceans currents and climate patterns, I lectured to my students as a means for delivering the new course material. This unit lasted for seven days and I lectured for about 15 minutes on three different days. Following each lecture, my students completed guided note questions which covered the main ideas of the content within small groups comprised of two to three students. Sometimes, I collected these questions while at other times I did not. As a class we discussed their answers and each student took an

individual note quiz over the content they learned. This note quiz typically contained 10-15 multiple choice questions which summarized the notes covered during the previous class period.

During the second unit I taught covering Earth's seasons and heat transfer, I had my students log on to their ClassConnect accounts and open the class notes for the unit. ClassConnect is an online software program designed by a former student of NCHS. He created ClassConnect as a way for students and teachers to collaborate and share materials in a secure and efficient online environment. I have been using ClassConnect for two years now and have enjoyed how easily my students can access classroom materials and stay up to date after extended illnesses. Because this program is very student-friendly, I decided to incorporate ClassConnect into my action research.

Using ClassConnect, my students read and completed their notes individually. I made myself available to students who had questions, but the majority of my students were able to complete their notes independently. Once they read through and filled in their notes, each student completed their guided note questions within small groups of two to three as they did during unit one. As a class, we discussed their answers and, as in the previous unit, they were responsible for taking a note quiz of the same format.

After completing the second unit of my treatment, which had lasted for eight days, I administered a student survey asking students to evaluate the benefits and drawbacks of both lecture and online learning (Appendix C). In this survey, I provided my students the choice of learning through lecture or through online learning for the following unit. Based on these survey results, I divided my students into two groups for the upcoming unit: those who preferred lecture and those who preferred online learning.

During this unit students learned about energy transfer within the Earth's atmosphere and how the unequal heating of the Earth's surface relates to changes in air pressure and winds. Once my students made a decision in terms of which method worked best for them for the unit, which lasted for 13 days, I implemented both techniques as a means for differentiating instruction.

For those students who chose lecture, I displayed my notes on the SmartBoard and lectured as I normally do. During this time, the students who chose online learning had access to computers in the back of the room. They read through their notes and completed their guided note questions with a partner. Students that chose lecture also had the opportunity to work with a partner to complete their guided note questions. I checked that all students from both groups completed the guided note questions and we then discussed their answers as a class. All of my students took a note quiz the following class period over the new material that they had learned.

I required that once a student decided in which group they preferred to be a part, they were not allowed to switch groups until the start of the next unit. Students were given the choice of lecture or online learning for Units 5/6, 7, and 8. Even though these groups turned out to be uneven in numbers for Units 5/6, 7, and 8, I was able to compare student performance to the baseline data collected during the first two units of my treatment. Once a unit was finished, such as Unit 5/6, students were allowed to switch groups if they wanted to. I modified my groups to accommodate these changes for Units 5/6, 7, and 8 (Table 1).

Table 1
Treatment & Data Collection Schedule

Length of Unit	Unit Topics	Method of Note Taking	Data Collected
October 12th through Oct. 20th	Unit 3: Oceans & Climate	Lecture	Note Quiz, Summative Assessment, Teacher Observations, Teacher Journal
October 25th through Nov. 4th	Unit 4: Seasons & Heat	Online Learning	Formative Assessment, Note Quiz, Summative Assessment, Teacher Observations, Journal, & Student Surveys (at the end of Unit 4)
November 5th through Nov. 23rd	Unit 5/6: Atmosphere & Air Pressure	Student Choice	Formative Assessment, Note Quiz, Summative Assessment, Teacher Observations, & Teacher Journal
November 29th through Dec. 9th	Unit 7: Moisture & Clouds	Student Choice	Formative Assessment, Note Quiz, Summative Assessment, Teacher Observations, Individual Interviews (at the end of Unit 7), and Teacher Journal
December 10th through Dec. 17th	Unit 8: Severe Weather	Student Choice	Formative Assessment, Note Quiz, Summative Assessment, Teacher Observations, & Teacher Journal

During my treatment I did not compare groups of students but rather individual students as the groups changed from unit to unit. For instance, I compared how a student did during one treatment to how well he/she performed during the other treatment. In this way, I was able to track changes in individual student progress on note quizzes, formative assessments, and summative assessments based on the method in which they learned the new content. I also collected data to determine if students who do the best in a specific treatment select that treatment as well as if there are any general characteristics of students who select each treatment. In order to track my students' progress, I used both

quantitative and qualitative data instruments. Each data instrument correlated with at least one of my research questions which can be seen in Table 2.

Table 2
Data Triangulation Matrix

Focus Questions	Data Source 1	Data Source 2	Data Source 3
Primary Question: 1. How do the effects of traditional learning (lecture) compare to the effects of independent online learning on student understanding in Weather & Geology?	Note Quizzes	Summative Assessments	Observation Rubrics
Secondary Questions: 2. What impact does lecture compared to online learning have on student performance on assessments?	Note Quizzes	Summative Assessments	
3. How does the level of student confidence and preparedness on assessments during units of lecture compare to the levels during units of online learning?	Individual Interviews	Student Surveys	
4. What impact does lecture compared to online learning have on my future teaching?	Teacher Observations	Teacher Journal	

In order to gather the information I needed to answer each of the above research questions, I chose my 3rd period Weather and Geology class as the group from which to collect data and conduct my research. Within this class I had seven students with IEPs and/or 504 plans. At the start of the school year, all students indicated that they were comfortable using the internet, Microsoft PowerPoint, and Microsoft Word. Even though

all of my students stated that they were comfortable using these programs, only three of the 25 students had experience with online-learning at some point in their lives. These three students explained that they had completed online-notes and guiding questions within their Chemistry classes. Their teacher, Linda Bennett, had exposed them to this kind of learning and also was one of the members of my support team throughout my research. The remaining 22 students had no background knowledge or experience with this mode of instruction. The fact that so many students were comfortable and accustomed to lecture as opposed to online learning was an important factor which will be discussed later in my analysis.

In total, I had 25 students in this class, 11 females and 14 males. Weather and Geology is typically a lower level science course designed for juniors and seniors who have struggled with science in the past. Many of the students in my 3rd period Weather and Geology class were involved in the extracurricular activities such as football, wrestling, choir, Theatre Central, soccer, band, etc. These activities occupied much of their after school time. This made finding time to complete homework and study for exams even more of a challenge. While I did have nine students who were highly motivated and strong students academically, the remaining 16 students struggled academically and had a very low level of motivation. I can honestly say that I did the best I could to motivate these students; however, as the semester neared to an end this class became increasingly more difficult to motivate.

At the start of my research, I selected 12 individual students, six female and six male, from whom to collect quantitative data. I recorded these 12 students' note quiz scores, formative assessment scores, and summative assessment scores. In order to

account for students of all levels, I implemented a technique known as stratified random sampling. In using this technique I chose two high, two medium, and two low achieving male students. I did the same for the female students. In addition to tracking these 12 students, I also sampled my entire third hour class of 25 students when conducting student surveys. I also interviewed six of the 12 students from above. My goal throughout my research was to obtain as much data as possible from as many different students as possible. Prior to the beginning of my treatment, each student within my Weather and Geology class took a learning style survey in which they were able to determine how they learn best in the classroom (Appendix H). 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.

I decided to use the following data collection methods throughout my treatment: formative assessments, note quiz scores, summative assessment scores, student surveys and interviews, teacher observations, and a teacher journal. The formative assessments used included student generated test questions, the muddiest point, and exit slip quizzes. The summative assessment scores were based on student performance on a major unit exam given at the end of each unit. Formative assessments, note quizzes, and summative assessments made up the quantitative portion of my data collection (Appendix A and B).

I also collected qualitative data through the use of student surveys which I described earlier as individual interviews, observations, and journaling. I selected six students, three male and three female, to interview on an individual basis. Of the six students selected, two were high achievers, two did moderately well in my class, and two

were low achievers. I tape recorded these interviews in addition to taking hand-written notes during the interview itself (Appendix D). I also took observational notes of my students during times of lecture and times of online learning (Appendix F). This data was critical in addressing the impact both methods have on me as the teacher and on my students' level of engagement. Finally, for one to two days a week I recorded my own personal reflections in my teacher journal during both units of lecture and online note taking. The act of journaling was been extremely beneficial in helping me clarify my thoughts and contemplate future improvements. While I used a very simple format (Appendix E), this technique worked well for me during my research.

In order to ensure the validity and reliability of my data, I implemented a wide variety of data instruments so that I could compare the results of each source to determine what trends exist. If I had only used data from interviews for instance, I would not have been able draw reliable conclusions because I would not have any other source to compare it to. If I compared data from interviews to my observations, student surveys, and teacher journal and saw a common result that would suggest that my data was reliable and valid. Also, the use of consistent data instruments, such as the same observation rubric, note quiz format, and journal format, has increased the reliability of my data. If I had changed the format of my note quizzes making one short answer and one multiple-choice than that difference in format could have compromised the reliability of the data collected. Overall, I was pleased with the validity and reliability of the data I collected. My analysis of the trends and outliers identified throughout my research can be found in the following section.

DATA AND ANALYSIS

The first set of data I analyzed was summative assessment scores (Appendix A). Students are color coded by their level of achievement in Weather and Geology. Students whose names are in red were typically high achievers, students whose names are in blue performed moderately well in class, and those students whose names are in green represent students who struggled from the beginning of the semester in understanding and with completion of assignments.

In order to identify trends within this data, I have created a bar graph of summative assessments for both male and female students. For both graphs, the bars which represent lecture illustrate unit exam scores from Unit 3: Oceans and Climate, the bars labeled “Online Learning” represent scores from Unit 4: Seasons and Heat, and the bars labeled “Student Choice” represent scores from Unit 5/6: Atmosphere and Air Pressure, Unit 7: Moisture and Clouds, and Unit 8: Severe Weather. It is important to know which method of instruction these 12 students selected for Units 5/6, 7 and 8. Table 3 and 4 illustrate which methods were chosen based on student survey results.

Table 3
Male Student's Preferred Method of Instruction for Units 5/6, 7, and 8

Males	Preferred Method of Instruction for Unit 5/6	Preferred Method of Instruction for Unit 7	Preferred Method of Instruction for Unit 8
Student A	Lecture	Lecture	Lecture
Student B	Lecture	Lecture	Online Learning
Student C	Online Learning	Lecture	Lecture
Student D	Lecture	Online Learning	Lecture
Student E	Lecture	Online Learning	Online Learning
Student F	Online Learning	Lecture	Online Learning

As you can see from studying Table 3, Male Student A was the only student to remain in the same group throughout this portion of my treatment. Male Student A strongly preferred lessons designed for auditory learners and was a focused individual. Because of this, I feel he was the most comfortable in a lecture environment. Male Students B, C, D, E, and F switched groups one to two times throughout these units. My female students showed a similar trend in that three of the six female students tracked throughout my treatment switched groups one or two times through these units. As you can see from Table 4, Female Students A, B, and C remained in the same group while Students D, E, and F changed groups.

Table 4
Female Student's Preferred Method of Instruction for Units 5/6, 7, and 8

Females	Preferred Method of Instruction for Unit 5/6	Preferred Method of Instruction for Unit 7	Preferred Method of Instruction for Unit 8
Student A	Lecture	Lecture	Lecture
Student B	Lecture	Lecture	Lecture
Student C	Lecture	Lecture	Lecture
Student D	Lecture	Online Learning	Online Learning
Student E	Lecture	Lecture	Online Learning
Student F	Lecture	Online Learning	Lecture

Prior to beginning my research, I had encouraged my students to select the method of note-taking that would benefit them the most and to avoid joining a group because their friends may have joined that same group. I also encouraged them to try both techniques because there were significant positive and negatives to both types of learning. Based on Table 3 and 4, the majority of my students were open to trying both techniques and working, at least for one unit, out of their initial comfort zone. I am glad many of my students did this because switching groups helped them to realize some of their own strengths and weakness as a learner. With this is mind, I began to analyze the data represented in the following graphs for summative assessment scores.

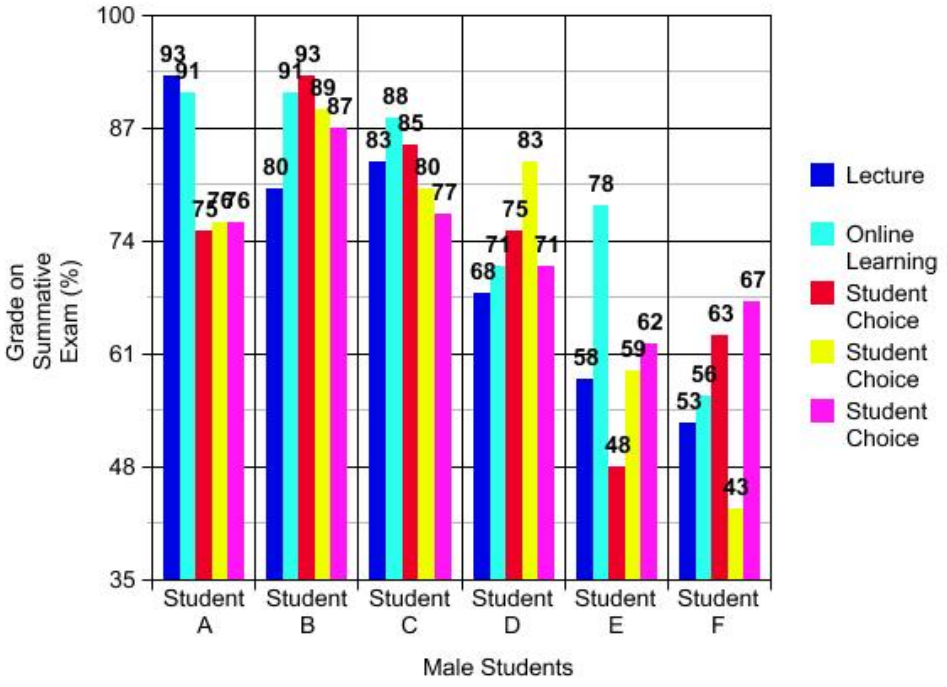

Figure 1. Summative Exam Scores for Units of Lecture Compared to Online Learning, *(N*= 6).

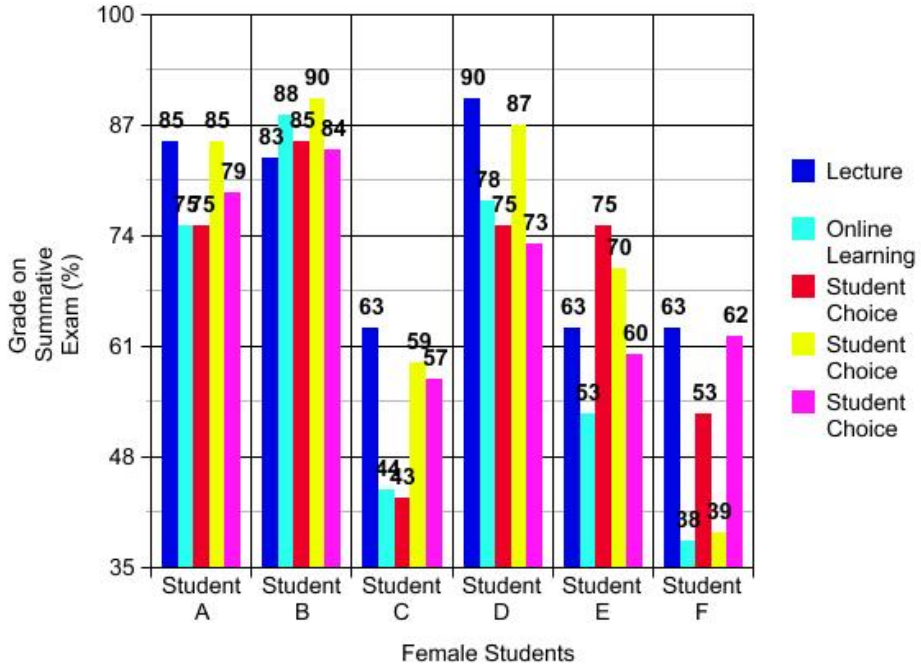

Figure 2. Summative Exam Scores for Units of Lecture Compared to Online Learning, *(N*= 6).

After graphing all of the summative assessment scores collected throughout my treatment and comparing them to the Tables 3 and 4 for both my male and female students, I was able to see a number of surprising trends within my data. When analyzing the baseline data I collected from the first two units of my treatment, I was able to see that all male students, with the exception of Student A, showed improvement on unit exams when experiencing online learning. This initial baseline data suggests that five of the six male students I tracked benefited from working independently at their own pace rather than listening to me explain the notes to the class. The one outlier I found within this data was Student A; he experienced a dramatic 16% decrease in his summative exam scores following unit two of my treatment. When I discussed this with him he explained that he was falling behind in all of his classes as a result of an extended absence from school due to multiple leg surgeries and that, despite what his test scores show, he really did learn best from lecture. What I found interesting was that, even though the five out of six male student test scores increased dramatically during the first unit of online learning, all male students, with the exception of Student C and F, selected lecture when given the choice for the upcoming unit on the atmosphere and air pressure. During a survey which followed the first unit of online learning, male students explained that, despite performing better during the unit of online learning, they still preferred lecture because they felt they paid more attention during lecture and that they preferred having their teacher explain the new information to them rather than reading about it on their own.

After analyzing this initial baseline data, I was curious to see if this initial trend would continue throughout my research. I was very surprised to see that after comparing

the type of note-taking a male student selected during the last three units of my treatment with his summative exam scores for each unit, four of the six male students continued to perform better on summative exams following units of online learning when compared to units of lecture. Five of the six male students tracked chose online learning over lecture at least once throughout the last three units. My lower level male students selected online learning for two out of three times when given the choice. My middle and high achieving students selected online learning only once with the exception of Student A who choose lecture for all three units.

When examining the summative exam scores for all five units of my treatment, it is clear that my middle to lower level students were affected the most by the change from lecture to online learning. For example, the only time Student D earned a B on an exam was following a unit in which he chose online learning. During the last three units in which students were given the choice, Student E initially selected lecture and earned a 48% on the exam that followed. He then decided to go back to online learning and earned a 59% and 62% for the remaining two units of my treatment. Student F, who had failed the first two unit exams, earned a 63% on an exam after selecting online learning over lecture. He then decided to try lecture and experienced a 20% decrease in exam score. For the last unit he decided to go back to online learning and brought his exam score up to a 67%. A possible reason for this trend could be that many of my male students struggled with staying focused and concentrating in class while many of my female students were more auditory learners, capable of staying focused for longer periods of time.

Contrary to the trends seen when studying summative exam scores for male students, Figure 2 shows that the opposite occurred for my female students. When studying the initial baseline data collected during the first two units of my treatment, I learned that all but one female student, Student B, performed better during units of lecture than online learning. This initial trend from my baseline data proved to be true throughout my entire treatment. Summative exam scores showed that all female students performed better on unit exams following units of lecture compared to units of online learning. Even Student B, who experienced an increase in exam score during the first unit of online learning, earned her highest test score of the semester during a unit in which she chose lecture. Student B selected lecture for all three units in which students were able to choose their preferred method of note-taking. While two of the three test scores were lower than the first unit of online learning, all of her scores throughout the semester were within 7% of each other. Because Student B earned her only A on a unit exam followed by a unit of lecture, I believe that she benefited the most from this method of note-taking.

Similarly to my low achieving male students, the switch from lecture to online learning had the greatest impact on my medium to low achieving female students. For instance, Student C saw a 19% decrease in her exam score when switching from lecture to online learning. She performed very poorly on her first unit after selecting lecture; however, she was able to bring her test scores up by 14-16% for the remaining two units in which she selected lecture. Student F saw the most significant difference in her exam scores through changing between lecture and online learning. Her exam score dropped from 63% to a 38% when going from lecture to online learning. She selected lecture for

her first unit of student choice and saw another significant shift from a 38% up to a 53%. She then decided to go back to online learning for the second unit of student choice. As a result, her exam score dropped back down to a 39%. Fortunately, she decided to rejoin the lecture group and her exam score rose to a 62%. I believe that, similarly to my male students, my middle to low level female students were the most affected because lower level students do not typically have the same set of skills and strengths as my higher achieving students. Students who are stronger academically are more capable of learning in a variety of situations whereas students who struggle under normal circumstances are often more affected by changes to their normal routine.

While my ultimate goal in my research was to learn the effects online learning compared to lecture have on students' summative exam scores, I was also interested in learning the effects of lecture compared to online learning on note quizzes as well as formative assessments. I was unable to identify any significant trends or outliers within the data collected from formative assessment scores, however, the data collected from note quizzes yielded interesting results (Appendix B). Figure 3 illustrates data collected from male students while Figure 4 depicts data collected from female students.

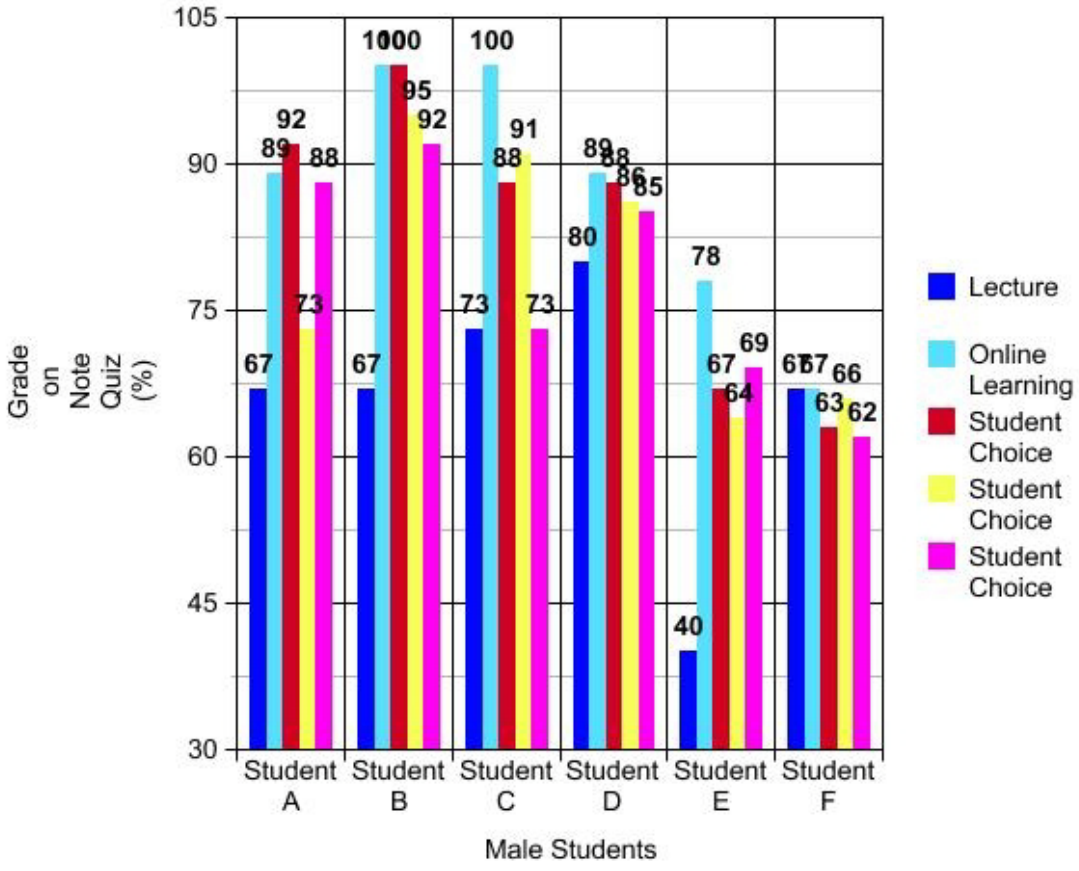

Figure 3. Note Quiz Scores for Units of Lecture Compared to Online Learning, *(N*= 6).

The first trend was that all male students performed better on note quizzes during the first unit of online learning when compared to the first unit of lecture. This was true for all groups of students: high, middle, and low achieving. While this was true during the first two baseline units, this trend changed slightly during the last three units of my treatment in which students were able to choose their preferred method of note-taking. Students A and B scored better on note quizzes during units of lecture while Students C and E experienced their highest note quiz scores during units of online learning. Students D and F performed consistently on note quizzes regardless if they experienced online learning or lecture. Student D, for example, had a consistent B average of all of the note quizzes he took while Student F had a consistent D average for each of his note quizzes.

Male note quiz scores were consistent with male summative assessment scores in that both forms of data show the majority of male students benefited from online learning when compared to lecture during the first two units of the treatment. The note quiz scores showed that as the treatment continued, there was not as significant a difference between lecture and online learning for male students as there was on summative assessment scores. I believe this is because there was very little time in between a period of note taking and the note quiz while there were multiple days between a period of note taking and a summative exam. Regardless of the method of note taking, the content was fairly fresh in the minds of my students and easier to recall than during a summative exam days later. I was interested to see if the trends shown by female summative assessment scores were also consistent with female note quiz scores.

After studying Figure 4, I was surprised to see a noticeable trend which was very different from the trends I had seen from female summative assessment scores. While female summative assessment scores had decreased significantly following the first unit of online learning, note quiz scores indicate that five of the six individual students tracked performed better on a note quiz following a unit of online learning compared to the first unit of lecture. One possible explanation for this may be that the first time these students took a note quiz following the first unit of the treatment they did not really know what to expect. It is possible that, following the second unit of the treatment, these students now knew what to expect and how to best prepare for note quizzes.

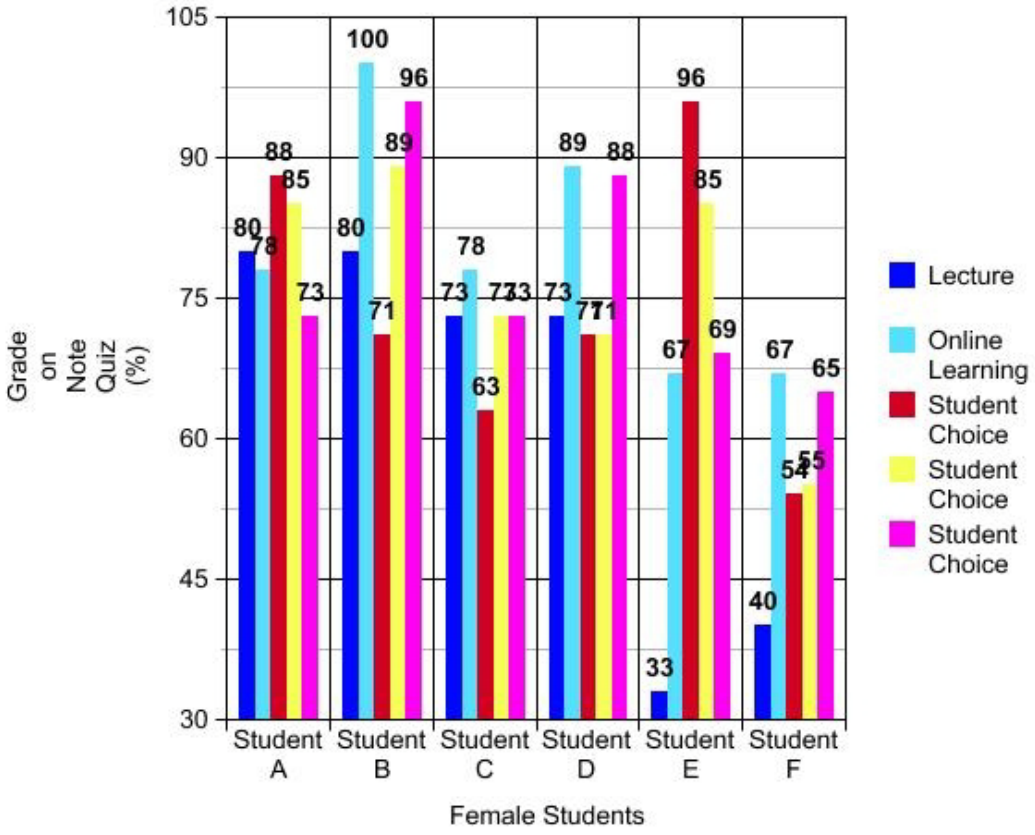

Figure 4. Note Quiz Scores for Units of Lecture Compared to Online Learning, *(N*= 6).

While this initial trend was definitely the opposite of what was expected based on female summative exam scores, the second trend I was able to identify from studying note quiz scores was much more consistent with summative assessment data. The second trend that could be seen from note quiz scores was that four of the six female students tracked throughout this treatment performed better on note quizzes during units of lecture compared with units of online learning for the remaining three units of the treatment. This supports the conclusion that female students learned best from lecture when compared to online learning while the majority of male students experienced the opposite effects of online learning. I believe that collecting both note quiz scores and summative

assessment scores has helped to attain a more complete picture of how these two types of note taking impact student learning.

In addition to comparing student summative exam and note quiz scores to assess student understanding, I also analyzed qualitative data in the form of observation rubrics during periods of both online learning and lecture. In total I completed 10 observation rubrics: two per unit of my treatment. Through observing and recording the level of questions asked during a period of note-taking I was able to gain further insight into the level of students' understanding during units of lecture compared to those of online learning. I also observed and recorded information regarding students' ability to answer questions during both types of note-taking. A noticeable trend I identified after analyzing these observation rubrics was that students were more capable of answering questions during units of lecture than during units of online learning. When comparing the observation rubrics from the first two baseline units of my treatment, I saw a dramatic decrease in terms of students' abilities to answer questions during online learning. This was an indication to me that students did not understand the information as well as they had during the first unit of lecture. This may have been because my students really learned better from lecture when compared to online learning or it could also be due to the fact that the second unit was more challenging to my students. Another possible explanation could be that the questions I asked during units of lecture and online learning were verbal and so was the lecture. Had I provided written questions for my students, they may have been more successful at answering them correctly during times of online learning.

Another trend I noticed was that during my first unit of lecture as well as during Units 5/6, 7, and 8, where the majority of students chose to learn through lecture, students asked more questions which were of a higher level than they did during the second unit of online learning. According to my observation rubrics, during the second unit of online learning, only one question was asked and in the comments margin of my observation rubric I noted that the question was "Where do I find the answer? I don't get it." During units that were mostly taught via lecture, students not only asked more questions but were better able to state and clarify their question. For example, in one of my observation rubrics I wrote the comment, "Students are asking better questions during lecture. One student said "I know that heat is released during condensation so why do clouds continue to form?" I thought this was a huge improvement from the comment "I don't get it." The data collected from observation rubrics suggests that students had a better understanding during units of lecture compared to units of online learning. This could be seen from their increased ability to answer questions and ask higher level questions.

While completing observation rubrics was very informative, I also wanted to learn more about my students' thoughts and perceptions of how they learn during lecture and online learning. On November 5th I administered a survey to my 3rd period Weather and Geology class. After analyzing summative exam scores and note quiz scores, I wanted to see if there were any correlations between quantitative data and student survey results. I was also interested in seeing if the type of learning students preferred correlated to the unit in which they performed their best. After organizing and studying my students' feedback on the student survey, I was surprised to see that the majority of my students surveyed, 76%, (N=21) preferred lecture to online learning and 24% (N= 21) of students

preferred online learning to lecture. What I found interesting was that 64% of male students and 90% of female students preferred lecture to online learning. This means that 36% of male students and 10% of female students who participated in the survey preferred online learning to lecture. Because I asked students to put their names on their surveys, I was able to determine if the 12 individual students I had been tracking in regards to quantitative data preferred the method of learning that summative assessment that data suggested worked the best for them.

When comparing summative assessment scores to the method of instruction preferred by these 12 students, I noticed a surprising trend. Even though five of the six male students I have complete data for improved their unit exam scores following a unit of online learning, four of these six students preferred lecture as the method of instruction during the first unit in which they were given the choice of lecture or online learning. Student A did experience a slight 2% decrease in his assessment score during online learning and provided a great deal of insight into why he learned best from lecture. I was surprised to see that the other students who saw drastic improvements still feel that lecture is a better way for them to learn. I will discuss possible reasons for this later in this paper.

I noticed a much less surprising trend when comparing the change in summative assessment scores for the six females students I have been tracking to the mode of instruction they feel helped them learn the most. All six of the female students I have been tracking selected lecture to online learning. This did not come as a shock to me as all female students, with the exception of Student B, saw a decrease in their summative assessment scores during the first unit of online learning. Although Student B performed

better after a unit of online learning, she also performed well with lecture and explained that she prefers hearing the teacher explain the information and provide additional explanations.

The student survey I created asked students to describe three aspects of lecture they liked and disliked along with three aspects of online learning they liked and disliked (Table 5). The data in this table provides insight as to why some of my male students, who performed better during online learning, still chose lecture as their preferred method of instruction.

Table 5
Student Written Responses from Student Survey

Lecture	**Online Learning**
PROS:	*PROS:*
"I like having a teacher explain everything and it's simpler to ask questions"	"Can be done outside of school"
"I listen better than I read."	"Easy to understand and read"
"I pay more attention during lecture because I have to."	"Allows me to work at my own pace"
"I remember what the teacher said better during lecture."	"No distractions, can go over notes as much as I want"
CONS:	*CONS:*
"Too much info to take in during a short time of lecture"	"Can get off track easier"
"Boring"	"Can't go through it as a class and ask questions"
"Lose focus easily"	"Can be confusing…I feel like I am just going through the motions."

Based on the responses from my students Table 5, I was able to identify a number of common themes within that data. The first is that many of my students believed that they focus better and that it is easier for them to ask questions during lecture as opposed

to online learning. A possible explanation for this may be that they have not had much experience, if any, with online learning. One student mentioned that "I like having a teacher explain everything and it's simpler to ask questions". A con of online learning seemed to be that students did not feel they could ask the questions they would normally ask if I had been lecturing. One male student explained that he "Can't go through it as a class and ask questions". This struck me as odd because I had been constantly walking around the room asking if anyone had questions and received very few questions from students. It may be that they are more comfortable asking questions in a more formal setting, like lecture; however, it may also be that lecture is easier for many of my students. Online learning requires more work and effort on their part to master the material which may be why many students prefer lecture. Another common theme I noticed was that many students found it difficult to stay on task and focus during both lecture and online learning. I would agree that many of my students are very easily distracted during most classroom activities. This is an area I have been trying to improve upon within the classroom.

In order to analyze the remainder of this survey, I have created two graphs which illustrate the level of student preparedness and confidence during units of lecture and online learning. These graphs were designed to help me answer sub question three of my research questions: "How does the level of student confidence and preparedness on assessments during units of lecture compare to the levels during units of online learning?" These graphs provided me a clear picture of student confidence and level of preparedness during the first two units of my treatment.

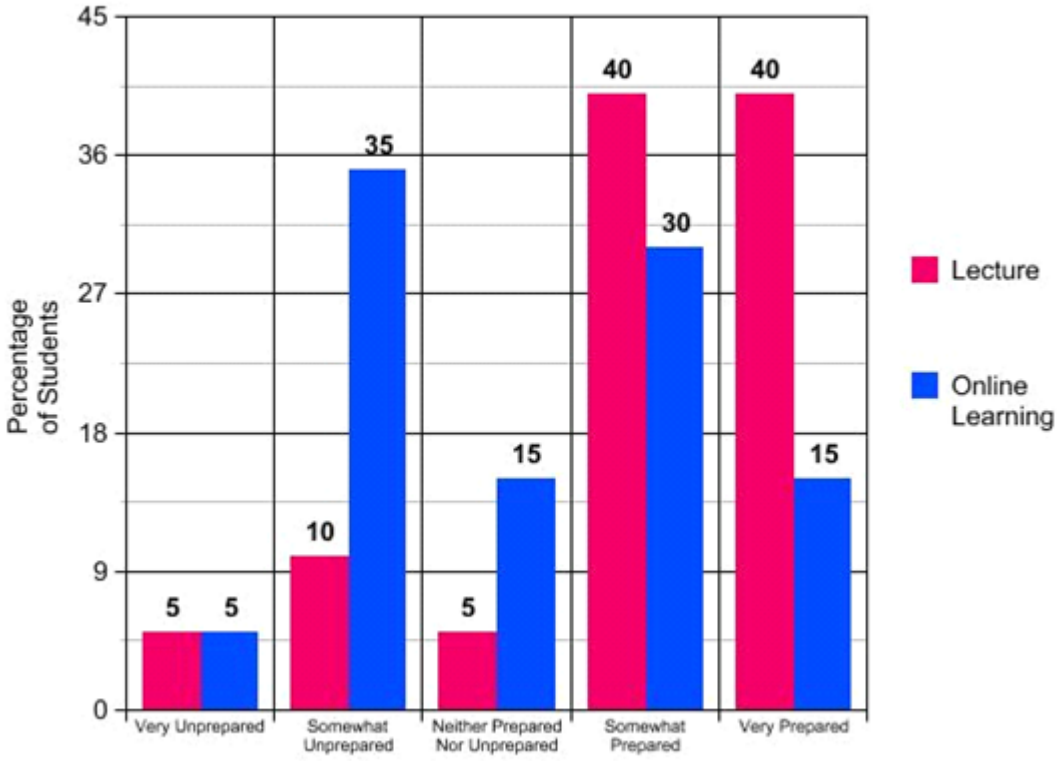

Figure 5. Level of Student Preparedness during Units of Lecture Compared to Units of Online Learning, *(N*=21 students).

Based on Figure 5, it can be seen that there is a significant difference between the level of preparedness and confidence during units of lecture and units of online learning. 80% of students felt somewhat-very prepared after a unit of lecture whereas 45% of students felt somewhat to very prepared following a unit of online learning. This data does confirm what my students explained on the student survey and the fact that 76% of students prefer lecture to online learning. Based on this data, the vast majority of students felt more prepared after having experienced lecture. This may have been because all of my students had much more past experience learning through lecture than from online learning. It could also be that many of my students are auditory learners and prefer having information explained to them. One student explained that "I feel better

when you explain the information because I know what parts you think are more important." Students may feel more prepared from lecture because their teacher puts particular emphasis on the key concepts so they know what topics to focus on more when studying.

I believe that the level of student preparedness and student confidence are directly related in that the better prepared a student is for an exam, the more confident they felt going into that exam. During this survey students were asked to rank their level of confidence during units of lecture and during units of online learning. Figure 4 illustrates the results of these survey questions.

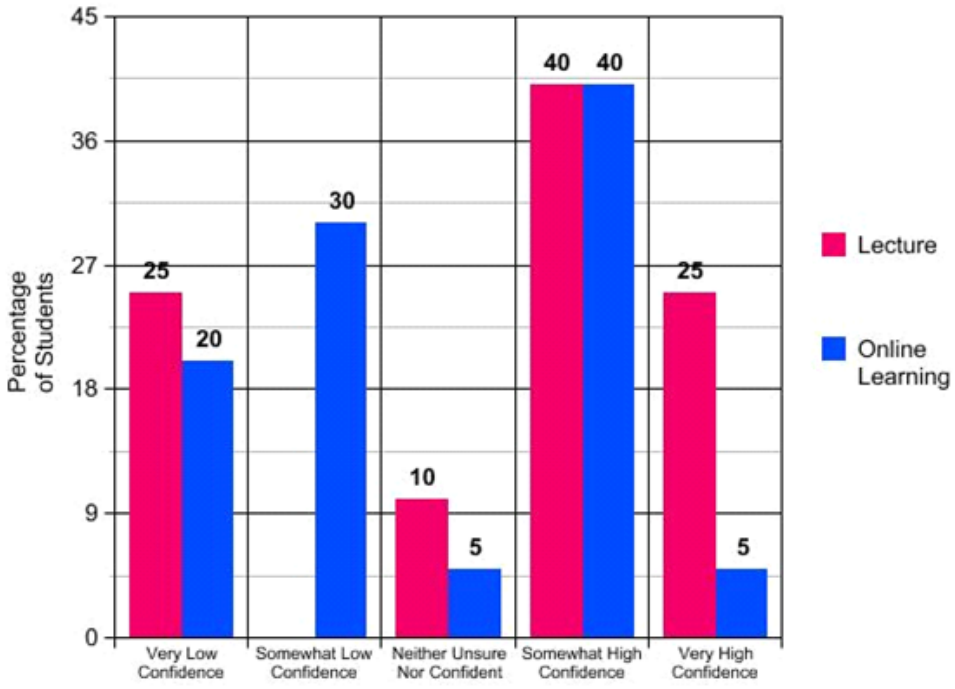

Figure 6. Level of Student Confidence during Units of Lecture Compared to Units of Online Learning, *(N*=21 students).

Based on Figure 6, it can be seen that the majority of students, 65%, felt somewhat to very highly confident following units of lecture compared to 40% of students who felt somewhat highly confident. Following a unit of online learning only 5% of students felt very confident while 25% of students felt very confident following a unit of lecture. This data is in sync with Figure 5 which shows student preparedness. It can be seen that many students felt more prepared following units of lecture which in turn caused them to be more confident on the summative assessment for that particular unit. A noticeable outlier from Figure 6 is that, even though the majority of students felt more confident following a unit of lecture than a unit of online learning, there was still a significant percentage of students, 40%, who felt somewhat highly confident following a unit of online learning. I feel that this shows that, even though most students preferred lecture, a significant portion of students were also able to see the benefits of online learning. I believe that, with more exposure to online learning, my students would feel more confident and prepared for an upcoming assessment following units of this type of note taking. Because this survey was given early in my treatment, I also wanted to interview students closer to the end of the treatment to see if their feelings had changed with more experience in both lecture and online learning. I thought this was important because interviews allow students to go into more depth than surveys, and interviews allow students more opportunity to explain their answers thoroughly.

I decided to interview six of the 12 male and female students I had been tracking. Of the six students selected for interviews, I chose one high achieving male and female, one average achieving male and female, and one low level male and female. In doing this I was able to learn more from the opinions of students of all levels and abilities.

Each interview lasted about 10-15 minutes and took place before or after school in my classroom. The purpose of these interviews was to gain more knowledge regarding my second sub-question, "How does the level of student confidence and preparedness on assessments during units of lecture compare to the levels during units of online learning?" through analyzing each interview I was able to determine a number of interesting trends within each set of data.

The most obvious theme that came out of my interviews is very similar to the trends learned from studying my student surveys: all six of the students interviewed preferred lecture to online learning. Even though four of the six students interviewed admitted that, at times, lecture can be boring, all six students felt very strongly that it was a better method of learning new material when compared to online learning. I thought this was interesting because five of the six male students tracked throughout my treatment performed better on summative assessments following units of online learning than lecture. I brought this point up to both the male and female students I interviewed. One female student offered her opinion in saying "I think the guys do not want to do the extra work and online learning is more work than lecture. Even if it's good for them, they don't want to do it." One high achieving male student explained to me that "Yeah I know I did better with online learning, but I still like listening to you explain the notes. It goes faster and takes less time. Then we have more time for labs and group stuff." Overall, I was able to determine that, even though male students are more successful from online learning, they do not prefer to put in the extra time and effort, even if it means they are more successful in learning the material.

When explaining their reasons for each interview question, most of my students offered similar explanations. All six of the students interviewed explained that they preferred listening to their teachers explain the material because they needed the extra elaboration and insight their teacher provides them during lecture. For example, one of my high achieving female students explained that "I like it when you tell us ways to remember things. You always have a funny story or something that helps me remember it better." One of my low level male students further explained that "I like lecture even though it's not always fun because you help us understand. When I'm doing online learning, I'm just scanning for the answers. I just go through the motions without getting it." All six students interviewed agreed that lecture, when teachers offer their own ideas, stories, and ways of remembering the information, is more meaningful than reading their notes individually.

Despite the unanimous opinion that lectures are more beneficial than online learning, all six of the students interviewed did express some positive aspects of online learning. One high achieving male student stated that "Online learning is good when you want to work at your own pace and get your stuff done without waiting for the whole class to catch up." A low level female student agreed by saying that "it is nice to be able to go back over stuff without feeling like everyone's waiting for you." The ability to work at your own pace was a definite benefit of online learning. Two female students also explained that online learning "…is a great resource for kids who are absent." They further stated that "If you are home sick or run out of time in class, it is nice to review the notes at home." Although there were positives aspects of online learning, the consensus among all six students was that online learning is not nearly as effective as lecture. A

moderately successful male student explained why he felt this way by saying “I don’t absorb anything during online learning. I just keep going through the motions and nothing sinks in. There is no one to offer me deeper reasons for things.”

In terms of feeling better prepared for an upcoming test or quiz, all six students agreed that lecture helped them to prepare more because “the teacher lets us know which topics to study and how important each topic is.” I reminded my male students that, while they may have felt better prepared from lecture they performed better during units of online learning. I explained to them that, while the extra work and time required during online learning may not have been fun, they really seemed to benefit from it. Unfortunately, the three male students interviewed seemed reluctant to admit that online learning was the best technique for them. One low-level male student explained that “I just don’t like having to read all of that stuff by myself. I don’t think it sinks in.” Despite what he said, I truly believe more knowledge sunk in when completing notes through online learning than through listening to me lecture. I truly think many of my male students were looking for the method which required the least amount of thought and effort, even though they were capable of doing better through online learning.

In addition to lecture, four of the six students interviewed explained that the guided readings I assigned for every unit really helped them prepare for an upcoming test. For every unit I assign a fairly long guided reading worksheet which goes along with a chapter. Students have about a week to read the chapter and complete the guided reading before having to turn it in for a grade. A low level female student explained that “I think the guided readings are good because I would never read the chapter otherwise.” This is the first year I have assigned a guided reading for every unit and I am glad

students find them beneficial. Another theme that emerged from these interviews came from three of the six students interviewed who mentioned that they wished I would incorporate more activities for visual learners in my classroom. One student stated that "Even if you just gave us blank diagrams to color in and label, that would be helpful. You could have us create our own coloring book of groundwater features. It sounds a little kid-ish but it would help us remember the words." I thought this was a good idea and definitely something I will try to incorporate in future units.

As always, I found each interview to be extremely beneficial to me as a teacher. My students always offer great advice and opinions on how I can improve my teaching for future students. I was not surprised to hear that all six students preferred lecture to online learning, especially the female students, however, I wondered if this was because these students have had so much more experience with lecture. Because only one of the six students interviewed had past experiences with online learning prior to my treatment, I believe that a huge part of the reason they feel so confident and prepared following a unit of lecture compared to online learning is because during online learning they are forced to work out of their comfort zone. Also, as one of my low level male students explained, "Online learning is a lot harder than lecture. It takes more time and you have to read a lot." This comment has caused me to think that some students may prefer lecture to online learning because it is easier to listen to someone explain information rather than to read and think on one's own. While I think many of my students prefer lecture because they truly need more detailed, in-depth explanations from their teacher, I think others may prefer to do as little reading and thinking as possible.

My final research question, “What impact does lecture compared to online learning have on my future teaching?” was answered through the analysis of my teacher journal as well as my observation notes taken throughout my treatment. My teacher journal and classroom observations were extremely beneficial to my research as they provided me the opportunity to reflect on my personal reactions to my student’s behavior during both lecture and online learning and the affect each method had on my teaching throughout the day. Throughout my treatment I wrote a total of 17 journal entries and filled out 10 observation rubrics. While my goal was to journal three to four times a week, I fell into a pattern of journaling twice a week: just once on Wednesday night and once on Saturday morning. I used a very simple format when journaling which involved answering two questions each time: “What went well?” and “What did not go well?” (Appendix E). I also completed the observation rubric during times of lecture and/or online learning in order to track student behavior and questions asked (Appendix F). Because these two forms of data are so closely related to my final research question, I have decided to analyze them side by side.

I began looking for trends in terms of what went well during lecture and what went well during days of online learning. After studying my journal entries and observation rubrics from the first two units of my treatments in which all students learned through lecture and all students learned through online learning, I was able to identify an important trend. I had fewer classroom management problems during my first unit of lecture when compared to my second unit of online learning. In my journal I discussed that during my first unit of lecture the majority of my students were respectful and attentive. The observation rubrics completed for this unit supported the same conclusion.

The first rubric completed during my unit of lecture showed that, initially, most students were quiet during note-taking. After making a few changes to my seating chart, the second rubric for lecture showed that all of my students were attentive and focused during note taking. This was most likely because of the change in seats for a few easily distracted students and also because this was a shorter period of lecture than the first day.

According to both my journal and observation rubrics, during the second unit of my treatment, I experienced an overall decrease in students' level of focus and attention. During this same unit, I experienced a general increase in the volume of students talking and a decrease in the number of students raising their hands to ask questions. Students reverted back to shouting out their questions without raising their hand to get my attention first. This became very frustrating very quickly. After re-explaining my rules and expectations for online learning, I did see an improvement in student behavior. However, both my journal and observation rubrics show that student behavior and the number of questions asked during note taking was better during lecture than during online learning. I noted in my observation rubrics that during the first unit of lecture students asked two to three questions during note-taking. During my first unit of online learning, I recorded that only one question was asked during note-taking. This suggests that my students are more comfortable and/or motivated to ask questions in a lecture setting than when they are working individually during online learning. This finding is supported by the comment a student made on his student survey when he explained that during online learning he "can't go through it as a class and ask questions". The data collected from observation rubrics as well as student surveys suggests that students are not as likely to ask questions during online learning as they are during lecture. Again,

this could be the result of students having more experience with lecture throughout their high school career than with online learning. Students may feel more comfortable asking questions during lecture because they are in their comfort zone.

Another major trend I discovered through analyzing my teaching journal and observation rubrics was that I saw a very significant improvement in terms of my students' behavior during note-taking as well as an increase in the number and quality of questions asked during note-taking after allowing my students to choose which group, lecture or online learning, they wanted to join for the remaining three units of the semester. For the remaining three units, the number of questions asked increased from one to three during the first two units of my treatment and four to seven during the last three units of my treatment. According to my observation rubrics, most of my students were very attentive and focused during note-taking. The only classroom management issues I experienced were a few students talking quietly while they completed their notes online in the back of the room. In my journal I explained that "this did not concern me too much because I could hear that they were talking about the notes". In my journal I discussed how I believed that, through giving students a choice of how they like to learn, they are more likely to pay attention and try harder in class. On November 16th, I wrote that "the students who chose lecture seemed to truly appreciate having me explain the content to them in my own words while the students who chose online learning seemed to enjoy the opportunity to work independently of the rest of the class."

According to both my observation rubrics and teacher journal, I did see an overall decrease in student attentiveness and behavior during "Unit 8: Weather Patterns and Severe Storms" despite giving students the choice of lecture or online learning. In my

journal I explained that I was surprised to see this decrease in interest and motivation during one of the most interesting units of the semester, however, I soon realized that it was also the last week of the semester before final exams. I wrote in my journal that "it is really common for my students to lose focus and motivation this time of year. They tend to check out the last few weeks of school regardless of what I do." I think this explains why there was such a decrease in the number of questions asked during note-taking. Despite seeing a decrease in attentiveness, students still asked four questions during note-taking during the first day of notes for Unit 8 and five questions during the second day of Unit 8. This was still an improvement from the number of questions asked during the first two units of my treatment in which students were not given a choice as to which group they preferred to join.

After rereading and analyzing my journal entries and observation rubrics, I was happy to see that, even though I saw a general decrease in student behavior, I was able to identify a level of improvement with each new unit when compared to their behavior at beginning of my treatment. In the past, I may have viewed this last unit of my class on a negative note, but because I was able to reflect on the progress my students made throughout the semester, I was able to see that they still performed better during Unit 8 than they did during the first two units of my treatment. After taking a step back and looking at the full picture, I was able to see this ending as a huge accomplishment. Even though my research has ended, I plan to continue journaling and recording observation rubrics when trying a new strategy or activity with my students. I have learned that this is an incredibly beneficial process as it helps you to take a step back and really see the big picture in terms of the gradual changes which occur in the classroom.

INTERPRETATION AND CONCLUSION

At the start of my research I had hoped to learn more about the effects that online learning and lecture have on student understanding in a junior/senior Weather and Geology class. For years I have been trying to improve my students' performance on summative assessments in Weather and Geology. Through completing this research, I hoped to gain an understanding of the effects both lecture and online learning have on student understanding so that I could implement the most effective teaching strategies when introducing new material and providing notes to my students. My hope was that, through implementing a more effective means of note taking, my students would develop a stronger understanding of the material and feel better prepared and more confident on upcoming assessments. In order to achieve this goal, I implemented one unit of lecture and one unit of online learning for the first two units of my treatment. For the remaining three units of my treatment I allowed my students to choose the method of note-taking that best suited their learning styles and preferences. During these five units I collected a wide variety of quantitative and qualitative data in order to answer each of my four research questions. Throughout the process of collecting and analyzing this data, I feel I have a much better understanding of my research questions:

Primary Question: How do the effects of traditional learning (lecture) compare to the effects of independent online learning on student understanding in Weather & Geology?

Sub-question 1: What impact does lecture compared to online learning have on student performance on assessments?

Sub-question 2: How does the level of student confidence and preparedness on

assessments during units of lecture compare to units of online learning?

Sub-question 3: What impact does lecture compared to online learning have on my future teaching?

In order to answer my primary question and sub-question 1, I collected and analyzed summative exam scores, note quiz scores, and my observation rubric. In the beginning of my research I had thought I would discover a clear-cut, definitive answer to this question. I now know that the answer to this question varies depending on the following characteristics of the individual student: his or her ability level in Weather and Geology, gender, ability to focus in class, and previous experience with lecture and/or online learning in a classroom setting. One of the most noticeable answers to my primary research question was that my low to medium level students felt the greatest impact by the switch between lecture and online learning when compared to my higher level students. An example of this is Male Student F, who had failed the first two unit exams, earned a 63% on an exam after selecting online learning, experienced a 20% decrease in exam score after switching back to lecture, and who brought his exam score up to a 67% when switching back to online learning for the final unit of my treatment. This theme was consistent among both male and female students throughout my treatment. Students who struggled in Weather and Geology felt the greatest effects on their grade when changing between units of lecture and units of online learning.

A possible explanation for this is that students, who are already successful in Weather and Geology and school in general, already have figured out how they learn best and have created a system for themselves in which they complete their work, study for exams, and pay attention in class. Higher level students typically can learn in a variety of

settings because they have learned how to be successful in school. Changes in the way they learn may have some effect on their grade, but changing the method in which they take notes is not going to dramatically affect their scores on tests. They still know how to study from their notes and typically ask a lot of questions regardless of the manner in which they take notes. Students who struggle typically do not have a strong system in which they study and prepare for exams. In my Weather and Geology class, most students who struggled on assessments also struggled with turning in assignments and completing their work. I believe the reason my low-medium level students were so strongly impacted by the switch in note-taking methods was because they are not as solid and consistent in how they prepare and learn material as are the higher level students. Therefore, small changes in the way the low-medium level students take notes may have a more dramatic effect since all of the other pieces of the puzzle are not always in place as they are for my higher level students.

Additionally, a second answer to my first two research questions was that, surprisingly, gender played a significant role in determining the effects of online learning compared to lecture on student understanding. According to my data, female students performed better on both summative assessments and note quizzes during units of lecture while the five of the six individual male students I tracked performed better on these same assessments during units of online learning. While I was initially very surprised to see that this trend remained for every unit of my treatment, it began to make sense when I thought about the students in my class. I had very mature and respectful female students in my 3rd hour who were always very attentive in class. The female students in my 3rd hour Weather and Geology class generally had fewer behavioral problems and had an

easier time staying focused and listening in class than many of my male students. I even went back and reread a "Get to Know You" learning style survey my students completed on the first day of school and was not at all surprised to read that all of my female students indicated that they learn best from listening either to lecture, their classmates presenting projects, or guest speakers. The female students in my class were truly auditory learners who will most likely love lecture hall style classes when they continue their education in college.

In my 3rd hour class, many of my male students were quite the opposite. They were easily distracted and had a very difficult time staying focused and attentive. This was true from the beginning of the semester. For example, I quickly learned within the first week of class to create seating charts in which I alternated male and female students. I did this so that my male students were surrounded by the more focused female students in this class. I also went back and reread many of my male students' "Get to Know You" learning style surveys from the first day of school and was not surprised to recall that many of my male students indicating that they learned best from visual and hands on (kinesthetic) activities. When asked to think about their favorite teacher growing up and to reflect on why he or she was such a great teacher, one male student said that "He didn't just talk to us, he did more than lecture. We played games and did a lot of group projects." I believe that the reason many of my male students were so much more successful with online learning is simply because they are not strong auditory learners and that they have difficulty focusing in that kind of environment.

After studying this data, I believe it is evident that a student's ability to listen to others and focus definitely plays a role when it comes to which method of learning they

benefit from the most. Despite performing better during a unit of online learning compared to the first unit of lecture, many of my male students indicated on a student survey conducted on November 5th that they preferred lecture to online learning. My goal in conducting this survey was to determine if there was any correlation between the quantitative data and the thoughts and opinions of my students. Within this survey, Male Student B explained that while he liked online learning because it "Allows me to work at my own pace" he also said that he "Can't go through it as a class and ask questions". A possible interpretation of why the individual male students I tracked performed better after online learning even though they preferred lecture could be that online learning forced them to be more independent and find the answers to their questions on their own. It may be possible that, because all of their questions were not answered during lecture, they put more effort into learning the material for themselves through completing the online notes and other assignments. Sometimes I believe that not having all of your questions answered immediately is a positive. It forces students think through the problem and find other ways to answer their questions.

An example of this can be seen from studying my lowest level male student, Student E, who experienced the greatest increase on his unit exam score following a unit of online learning. Interestingly, he indicated that he does prefer lecture to online learning on his student survey. I do believe that this particular student benefited more from online learning than lecture but preferred lecture because it required less work and effort for the student. He indicated on this survey that he did not like online learning because "it is hard and takes more time." This particular student struggled terribly with staying focused during lecture; however, it requires little work to fill in notes and an

occasional answer to a question. I believe that this student performed significantly better on his last unit exam because, during online learning, he was forced to read the notes and answer the summary note questions on his own. Even though he doesn't prefer to do this, I do think it helped him better learn the material.

While many of my male students still preferred lecture to online learning, I don't believe it was because they honestly thought they were more prepared following lecture, I think it was because lecture may be easier and requires less work and time than does online learning. My data proved that my male students were more successful during online learning and that they truly benefited from the extra work and commitment online learning required (Following the first two units of my treatment, all male students, with the exception of Student A, showed improvement on unit exams when experiencing online learning.) Online learning does require focus and concentration like lecture, however, students are able to work through at their own pace and use the computer in front of them. I do think it is more difficult for students who are easily distracted, such as my male students, to sit through lecture than it is for them to complete their notes through online learning. With this in mind, I don't believe my male students learned as much from lecture as they did from online learning, even though they believed lecture was easier and more beneficial. I have learned that there is a big difference between what students prefer to do and what actually will help them learn and that, unfortunately, students do not always make the best choice in terms of what is actually best for them.

The use of observation rubrics also provided some interesting data used to answer my primary research question on overall student understanding. My observation rubrics showed that students were more capable of answering questions during units of lecture

than during units of online learning (During the first unit of lecture, my observation rubrics showed that most students were able to answer questions when called on. During the first unit of online learning, my observation rubrics showed that the majority of students were unable to provide correct answers to questions when called on.) According to my data, when comparing observation rubrics during the first two units of my treatment, there was a dramatic decrease in my students' abilities to answer questions during online learning. Initially, I believed that this meant my students had an overall better understanding of the content during units of lecture than during units of online learning. Then I began to think that there may be other reasons for this trend. One possible explanation could be that the second unit may have been more difficult for students to understand. It may have also been possible that my students were simply more comfortable answering questions during lecture than during online learning because that is what they were used to doing. While this data did support the fact that my students were better able to answer questions and explain what they had learned during units of lecture, I can't help but feel that if they had experienced equal amounts of lecture and online learning throughout their education, this trend may have been less significant.

My observation rubrics did offer another answer in terms of determining the effects of online learning and lecture on student understanding. Through analyzing my observation rubrics, I was able to determine that the level of questions asked by my students during lecture compared to online learning was significantly higher. This data showed that my students had a greater understanding of the material during lecture by the fact that they were better able to explain what they knew and what they were having difficulty with. During a unit of online learning, one student simply asked "Where do I

find the answer? I don't get it" while during a unit of lecture one student asked "I know that heat is released during condensation so why do clouds continue to form?" This data supports the conclusion that many of my students either learned better from lecture or simply felt more comfortable and confident asking questions during units of lecture.

The third research question I hoped to answer through analyzing student surveys and student interviews was "How does the level of student confidence and preparedness on assessments during units of lecture compare to the levels during units of online learning?" As I explained before, on November 5th, following the first two units of my treatment, I administered a student survey to my 3rd period class. Because I also wanted to gauge my students' thoughts and opinions towards the end of my treatment, I decided to interview six of the 12 male and female students I had been studying the week of December the 9th. The results from both the student surveys and interviews were extremely similar which showed that my students' opinions did not change drastically as my treatment continued. One significant result from this survey showed that 76% (*N*=21) of my 3rd period students who participated in this survey wrote that they preferred lecture to online learning while 24% wrote that they preferred online learning. In terms of male and female students, 64% of male students and 90% females preferred lecture. After interviewing six of my students individually, I learned that all six students strongly preferred lecture to online learning as well. Based on these results as well as my own interpretations, I believe there are multiple reasons for this. One reason, as indicated by many students on their surveys is that some students feel more comfortable and/or are more motivated to ask questions during lecture than online learning. This could be because all of my students have had more past experiences with lecture while very few

have had many past experiences with online learning. Whether or not they realized it, I think they were likely to gravitate to the type of learning they are the most used to. One student said "I like having a teacher explain everything and it's simpler to ask questions." I think this is because, during online learning, I am usually moving around the room assisting other students. It may not be as easy to get my attention as during lecture when I am basically up in the front of the room, available to all students at the same time.

Another student stated that "I pay more attention during lecture because I have to." This student was not the only one to say that they paid more attention during lecture; however, he was the only one to admit that it is because they "have to." I think during lecture students know they have to pay attention or there will be a consequence as opposed to online learning when there is more freedom and possibly more opportunity to get off track. Students struggling to focus during both lecture and online learning were common themes when reading each student survey. One student stated that during online learning he "can get off track easier" than during lecture. I think that some students prefer lecture because it is more structured and it does not allow them as many opportunities to get distracted and lose focus. During online learning, students need to monitor themselves and their actions more so than during lecture.

Furthermore, the results taken from each survey showed that 80% of students felt somewhat to very prepared after a unit of lecture whereas only 45% of students felt somewhat to very prepared following a unit of online learning. Similarly to the survey, all of my students interviewed explained that they felt better prepared for an upcoming exam after experiencing lectures. Because many students felt more comfortable asking questions during lecture and also preferred to have their teacher explain the information

to them, as indicated by student surveys, I can see why this type of learning helped students feel more prepared to take an upcoming exam. According to my data, there is a direct relationship between feeling prepared for a summative assessment and feeling confident that they will be successful. 65% of students felt somewhat to very highly confident following units of lecture as compared to 45% of students who felt somewhat to very highly confident following units of online learning. These percentages confirmed that the majority of students do feel that they are better prepared after experiencing lecture and therefore feel more confident going into a summative assessment. The level of preparedness and confidence following lecture may be because that is how students are used to learning and lecture is within their comfort zone or it could be because many of them truly learn better from lecture than from online learning. I believe that this depends on the individual student and their level of success in the class, their learning style, and their ability to focus. I do believe that, with more exposure and experience with online learning, my students could feel the same level of confidence and preparedness from online learning as they did from lecture if I were to continue my research over the course of a year.

The final research question I hoped to answer focused on the impact both lecture and online learning had on my future teaching. While improving student understanding and confidence was my main objective throughout my treatment, it was also important to determine the effect each method of note-taking had on me as a teacher. I had hoped to determine which strategy worked best in terms of reducing minor classroom management issues such as students talking at inappropriate times and being disruptive. In order to best answer this question, I recorded observations of each class period in which both

types of learning took place as well as my personal thoughts and opinions in an electronic teacher journal.

Even though there were both positive and negative aspects of both types of note-taking, I initially learned through journaling and observations that, during lecture, my students were much better behaved than during online learning during the first two units of my treatment. According to my observation rubrics during my first unit of online learning, I saw a significant change in my students' behavior. My students were definitely more talkative than they had been during lecture and showed a significant decrease in their level of focus. On October 27th, I wrote that "Today was a pretty challenging day. Now that we have started using online learning it was like my students forgot the basic rules. Instead of raising their hands to answer questions, they just shouted out their answers. They were so much more talkative than they were during the first unit. I think because I'm not standing up in the front of the room they think it is ok to good around." My observation rubrics showed that, not only were my students failing to meet my basic classroom expectations during online learning, they were also not asking as many questions as they had been during lecture. This bothered me because I knew that they had questions but were simply not asking them. There are a few possible reasons for this. I believe that, because online learning allows for a less formal teaching environment, my students felt that there was more opportunity for them to become lackadaisical in terms of following class policies. I also believe that my students did not really know how to act during online learning because they had never really experienced this type of note-taking before. Because they were out of their comfort zone, they may not have been as focused as much on the material and on asking questions.

Following the first two units of my treatment I firmly believed that lecture had the most positive effect on me as a teacher. I felt more confident in my student's level of focus and understanding following units of lecture and felt that my students were more engaged and focused in their learning. What I did not expect to learn was that my students would benefit the most from a combination of online learning and lecture in which they were able to choose the method of learning they preferred. I was very pleased to see a dramatic improvement in terms of student behavior and the number of questions asked during note taking after allowing my students to choose the method of learning they preferred for the remaining three units of my treatment. The number of questions my students asked during these units increased from one to three questions during the first two units to four to seven questions during the remaining three units.

This had a very strong impact on me as a teacher because I could see firsthand the benefit of utilizing different teaching strategies to meet the needs of all of my students. In my journal I wrote that "It was a good day. The kids who like lecture got to experience lecture without being distracted by the kids who are bored with lecture and want to work at their own pace. I felt like everyone was happy." I strongly believe that by allowing students to choose the method by which they learn whenever possible gives them ownership over what they are doing and motivates them to do well. I will definitely be utilizing this strategy again in the future in terms of note-taking and other classroom activities such as the type of project they turn in (i.e. poster, PowerPoint, book, movie, etc.). I feel that my data supports the fact that any time students are given a choice, they will be more motivated to do well and follow your expectations, which, in turn, has a positive impact on the teacher.

After rereading my journal entries and studying my observation rubrics, I was able to see that my treatment as a whole had a very positive effect on my future teaching. It helped me to realize that there will never be a perfect method of delivering new material to my students and that there will always be positives and negatives to any method of teaching. While there are challenges to both methods of teaching, I did find that I was more calm and content with a class period following a mixture of both lecture and online learning. I explained in my journal that this was because I really do enjoy explaining and discussing the content to my students, but I also enjoy seeing my students work at their own pace and becoming more independent learners. I love Weather and Geology and enjoy talking about it. I have had many excellent experiences, mostly through taking on-campus courses through Montana State University, which I enjoy sharing with my students. Because of this, I definitely believe combining both strategies and allowing students to choose which method of learning they prefer will continue to have a positive impact on my future teaching.

VALUE

There are many implications of my research for myself, my teaching, and my students. The first implication is that it is incredibly important to have a good mix of teacher-centered and student-centered activities in any classroom. Based on the readings from my literature review as well as my research so far, providing students the opportunity to share ideas is a necessity for enhanced student learning. Also, as a teacher, it is vital that I promote a positive learning environment in which students feel comfortable enough to ask questions and interested enough to listen to a lecture.

Literature and information collected through surveys and interviews has shown me that students do need teachers to offer their expertise by explaining information at key times and to provide additional comments and information. Another implication of my research is that oftentimes students choose the easiest option which may not necessarily be the best option for them to learn. For instance, many students explained that lecture is less work and hence, they prefer lecture. Survey results showed that some students believe online learning is more work and hence, they do not prefer to learn that way. It is important to not look only at student preferences but the reasoning behind those preferences. Because of this, I plan on implementing a mixture of lecture with online learning in the future and will also work to improve my own ability in terms of my questioning and discussion skills.

One implication of this study, learned through interviews and surveys, is that students will have to think more about how they learn best and the steps that need to be taken to improve their own learning. Many of my students indicated on the most recent student survey that they have a difficult time staying on task and focusing during both lecture and online learning. A large number of students admitted that they talk too much during note taking and "zone out" a lot during notes. Being aware of these kinds of problems is the first step in changing behavior. With this in mind, in the future, when I notice students are having a difficult time, I can use this information as a reminder of the changes that need to be made to change student behavior.

My study does have important implications for my colleagues at NCHS as well. Many of my colleagues were excited to learn more about the conclusions drawn from this research. One of my critical friends, Linda, has been debating the pros and cons of

lecture vs. computer based learning for quite some time. She is anxious to learn from my results. Linda has been discussing the use of online learning modules, or lessons, for students who need extra assistance or who experience frequent absences from school. She has also been working to basically turn her classroom into an online learning environment in which she is simply there as the facilitator for learning and discussions. Linda is especially excited to hear my results as this may provide additional evidence that supports her belief that online learning in going to be the wave of the future. As Linda explained, "If we are going to expect students to be independent and self-directed learners, we must provide them opportunities to learn through online learning and more student-centered instruction." Many of my other colleagues who would prefer not to lecture would be excited to hear that they could replace lecture with online learning. I now definitely believe that this is not the case. I am sure my friend as well as other colleagues will not necessarily be happy with the results of my study because I have shown that students really do feel more prepared following units of lecture and, at least my students, seem to need that additional support and explanation from me, their teacher. This may, however, be good news for other classroom teachers who prefer to lecture.

While my friends and colleagues may not be very enthusiastic about my findings, I do believe that my study has value to other classroom teachers and researchers. As I learned from my literature review, the use of online learning is going to become more widespread as time goes by. The use of technology in the classroom is definitely increasing and becoming an important part of teaching. More and more teachers are going to be turning towards technology and online learning in the future. The more research that can be done to determine its impacts on learning, the better prepared we will

be to incorporate this new technology as effectively as possible. Because this is such a new idea, it is important to study the effects of online learning in as many contexts as possible.

From my experience, I know that the use of technology in the classroom is increasing in all of the schools in Naperville and the surrounding area. Every year we have "Technology Day" where we select different forms of technology in which we want to learn more about and take a required full-day class on a particular software and hardware. For teachers who are fresh out of college, the use of technology is exciting and makes teaching fun; however, many veteran teachers are reluctant to learn new ways of incorporating unfamiliar technology into their classroom. My research outlines a very simple model for including online notes and visual simulations into the classroom which does not require significant training for the teacher, but does allow for students to work collaboratively. Also, because I am comparing two methods of delivering new material which are not unique to the science classroom, I feel my results can be easily generalized to other teachers in other content areas. I feel my plan and results will demonstrate to other teachers the impact of both lecture and online learning so that they will be better informed and can select the method or methods which best suits their students needs.

When I first began reading about the action research process, I remember learning that action research is truly an ongoing process. Mills (2007) described the process of action research as identifying a problem, collecting and analyzing data, and then "some form of 'action' that invariably 'spirals' the research back into the process repeatedly." This comment has stayed with me throughout my research. Mills helped me to see the work I have done so far as part of a cycle rather than a problem I must solve and be done

with. Thinking of action research as an ongoing process had caused me to think of future questions to continue reflect on in terms of learning the effects different methods of note-taking have on my current and future students. For instance, one possible question I may work to answer in the future is "How do the effects of traditional learning (lecture) compare to the effects of independent online learning on female students compared to male students in "Weather & Geology?" Another future research question may be "How do the effects of traditional learning (lecture) compare to the effects of independent online learning on students with who have difficulty focusing in class compared to those who focus easily?"

While these questions pertain to the research I have done so far, there are other areas and future action research projects I plan to carry out throughout my teaching career. Based on the student interviews I conducted for my current research, I learned that my students felt they would benefit from the inclusion of more activities aimed at visual learners. In the future, I may develop an action research plan to study the effects of these kinds of activities on student understanding. Other areas I would like to improve upon within my classroom are reducing the number of missing or incomplete assignments and increasing student interest through the use of current events as a means of making Weather and Geology more relevant to my students. I believe that a successful teacher is never done trying to improve the way they teach and interact with their students. Because of this, I am sure I will conduct many more action research projects in the future as I found this to be an incredibly worthwhile and beneficial process. I am thankful for the opportunity to have completed my first action research project through Montana State

University and will definitely be carrying the skills and knowledge I have acquired with me throughout my teaching career.

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APPENDICES

APPENDIX A

INDIVIDUAL SUMMATIVE EXAM SCORES

Appendix A

Individual Summative Exam Scores

Summative Assessments					
Male Students	Unit 3 Exam	Unit 4 Exam	Unit 5/6 Exam	Unit 7 Exam	Unit 8 Exam
Student A	93%	91%	75%	76%	76%
Student B	80%	91%	93%	89%	87%
Student C	83%	88%	85%	80%	77%
Student D	68%	71%	75%	83%	71%
Student E	58%	78%	48%	59%	62%
Student F	53%	56%	63%	43%	67%
Female Students					
Student A	85%	75%	75%	85%	79%
Student B	83%	88%	85%	90%	84%
Student C	63%	44%	43%	59%	57%
Student D	90%	78%	75%	87%	73%
Student E	63%	53%	75%	70%	60%
Student F	63%	38%	53%	39%	62%

APPENDIX B

INDIVIDUAL NOTE QUIZ SCORES

Appendix B

Individual Note Quiz Scores

Note Quizzes					
Male Students	Unit 3 Note Quiz	Unit 4 Note Quiz	Unit 5/6 Note Quiz	Unit 7 Note Quiz	Unit 8 Note Quiz
Student A	67%	89%	92%	73%	88%
Student B	67%	100%	100%	95%	92%
Student C	73%	100%	88%	91%	73%
Student D	80%	89%	88%	86%	85%
Student E	40%	78%	67%	64%	69%
Student F	67%	67%	63%	66%	62%
Female Students					
Student A	80%	78%	88%	85%	73%
Student B	80%	100%	71%	89%	96%
Student C	73%	78%	63%	73%	73%
Student D	73%	89%	71%	71%	88%
Student E	33%	67%	96%	85%	69%
Student F	40%	67%	54%	55%	65%

APPENDIX C

STUDENT SURVEY

Appendix C
Student Survey

Directions: Please respond honestly and constructively to the questions below by circling the responses you most agree with and writing brief comments.

1.) When taking notes, which method do you prefer: (LECTURE or ONLINE LEARNING)

2.) Please explain your reasoning for number 1.

3.) List three things you like and three things you dislike about lecture.

Likes	Dislikes
1. 2. 3.	1. 2. 3.

4.) Name three things you like and three things you dislike about online learning.

Likes	Dislikes
1. 2. 3.	1. 2. 3.

5.) Please rate how prepared you feel for an upcoming note quiz and/or unit exam after taking notes through lecture.

1 Very Unprepared	2 Somewhat Unprepared	3 Neither Prepared Nor Unprepared	4 Somewhat Prepared	5 Very Prepared

6.) What could you have done to be even more prepared?

7.) Please rate how prepared you feel for an upcoming note quiz and/or unit exam after taking notes through online learning.

1 Very Unprepared	2 Somewhat Unprepared	3 Neither Prepared Nor Unprepared	4 Somewhat Prepared	5 Very Prepared

8.) What could you have done to be even more prepared?

9.) Please rate your overall confidence level going into a note quiz and/or unit exam after taking notes through lecture.

1 Very Low Confidence	2 Somewhat Low Confidence	3 Neither Unsure Not Confident	4 Somewhat High Confidence	5 Very High Confidence

10.) What could be done to improve this?

11.) Please rate your overall confidence level going into a note quiz and/or unit exam after taking notes through online learning.

1 Very Low Confidence	2 Somewhat Low Confidence	3 Neither Unsure Not Confident	4 Somewhat High Confidence	5 Very High Confidence

12.) What could be done to improve this?

For the following unit, the Atmosphere, you need to decide if you want to learn through lecture or through online learning. Once you have made your choice, you will not be able to switch groups until the start of the next unit. Choose which method of learning works best for you and you alone. Please circle your choice in the space provided:

13.) What were some of your thoughts as to why you selected what you did?

14.) Anything else you wish to tell me regarding your thoughts on lecture as compared to online learning?

APPENDIX D

INTERVIEW QUESTIONS

Appendix D
Interview Questions

1.) Can you tell me about your interests in school, what subjects you might do well in, how you like to learn, and how you prefer classes are conducted?

Why do you like your classes that way? Is it because you get a good grade? Why do you like some classes, and not others?

2.) How do you study for an upcoming test? Do you start the night before? What do you do to prepare yourself? Do you think this is the best way, and why?

3.) Do you feel the way you study and prepare yourself works well for you or do you think that there are improvements that you could make? Why don't you make the improvements? What types of things hold you back?

4.) How confident do you feel going into a test or quiz? Have you felt this way all through school? Are some subjects different than others and what can you tell me about those particularly hard subjects? Do you ever experience test anxiety?

5.) What would help you feel more confident and less anxious about taking tests and quizzes?

6.) What do you like about lecture? Can you name three things? What do you not like lecture? Can you name three things?

Are there some classes that lecture seems better in? Which ones and why do you say that?

7.) Do you feel lecture helps to prepare you for an upcoming exam? Why or why not?

8.) Can you tell me some of your experiences with on line learning?

9.) What do you like about online learning? What do you not like about online learning?

10.) Do you feel online learning helps to prepare you for an upcoming exam? Why or why not?

11.) What would you say is the number one thing a teacher could do to help you with learning new material?

12.) What other comments might you have that might help me improve the way I teach new material in Weather and Geology?

13.) Any other comments about on line learning, tests or school in general?

APPENDIX E

REFLECTIVE JOURNAL TEMPLATE

Appendix E
Reflective Journal Template

Date:
What went well?
What did not go well?
Date:
What went well?
What did not go well?
Date:
What went well?
What did not go well?
Date:
What went well?
What did not go well?

APPENDIX F

OBERVATION RUBRIC TEMPLATE

Appendix F
Observation Rubric Template

OBSERVATION RUBRIC				
Date:	Unit:	_____# of Students in Lecture Group	_____# of Students in Online Learning Group	Total Number of Students: _____
Observation		**Always**	**Sometimes**	**Never**
Students engagement & focus while taking notes		All students were quiet in their seats and actively listening or reading their notes.	Some students were quiet in their seats and reading or listening to their notes while some were talking, not in their correct seats, and not fully listening or reading their notes.	Most students were talking, not in their assigned seats, and were not listening or reading their notes.
Comments & Student Quotes:				
Students' respect of teacher and fellow classmates		All students were quiet, raising their hand when they had questions, and followed all classroom expectations.	Some students were quiet while others were talking to classmates, most students raised their hand when needed, and most students were following all classroom expectations.	Most students were talking to classmates, shouting out answers or questions without being called upon, and were not following class expectations.
Comments:				
The volume of the classroom conducive to learning		There was no talking during note-taking unless a question was asked.	The majority of time there was no talking during note-taking. I had to remind a few students to stay quiet.	Several students were talking during note-taking preventing other students from being able to listen or read.
Comments:				

Student demonstration of an average level of understanding when discussing note questions	When called upon, all students were able to provide a correct answer to all guided note questions.	When called upon, most students were able to provide correct answers to all guided note questions.	When called upon, the majority of students were unable to provide correct answers to all guided note questions.
Comments:			
Number of questions asked during note taking and class discussion of guided note questions	1 2 3 4 5 6 7 8 9 10		
Comments:			
Level of questions asked during note taking	High: All students were able to explain points of confusion and clearly explain what they believed the correct answer was and why.	Medium: Some students were able to explain what they were confused about and also what they believed the correct answer was.	Low: Most students asked where to find information and said that they "Don't get it!" without being able to explain what they were confused about.
Comments:			
Overall impression of the class	This was an enjoyable class. I feel that my students learned what I intended for them to learn. I was able to focus on teaching rather than classroom management.	For the most part this was an enjoyable class. The majority of my students learned what I intended for them to learn. I only had a few classroom management issues to attend to.	This was not a very enjoyable class. Most of my students did not learn what I intended for them to learn. I spent the majority of the class period dealing with classroom management issues.
Challenges & Possible Changes:			

APPENDIX G

IRB CONSENT FORM

Appendix G
IRB Consent Form

Exemption Regarding Informed Consent

I, *William Wiesbrook*, Principal of *Naperville Central High School*, verify that the classroom research conducted by *Megan Hopkins* is in accordance with established or commonly accepted educational settings involving normal educational practices. To maintain the established culture of our school and not cause disruption to our school climate, I have granted an exemption to *Megan Hopkins* regarding informed consent.

_____
(Signed Name)

_____
(Printed Name)

_____
(Date)

APPENDIX H

LEARNING STYLE SURVEY

Appendix H
Learning Style Survey

What type of learner are you?

Directions: Place a check in the appropriate box for each question. This survey will help me to understand how you learn best. Please be honest and take your time.

Question	Often	Sometimes	Rarely
1) I can remember best about a subject by listening to a lecture that includes information, explanations and discussions.			
2) I prefer to see information written on a chalkboard and supplemented by visual aids and reading assignments.			
3) I like to write things down or to take notes for review later.			
4) I prefer to use posters, models, or actual practice and other activities in class.			
5) I require explanations of diagrams, graphs or visual directions.			
6) I enjoy working with my hands and making things.			
7) I am skillful with and enjoy developing and making graphs and charts.			
8) I can tell if sounds match when presented with pairs of sounds.			
9) I can remember best by writing things down several times.			
10) I can easily understand and follow directions on a map.			
11) I do best in academic subjects by listening to lectures and tapes.			
12) I play with coins or keys in my pocket.			
13) I learn to spell better by repeating words out loud than by writing the words on paper.			
14) I can understand a news article better by reading about it in the newspaper than by listening to a report about it on the radio.			
15) I chew gum or snack while studying.			
16) I think the best way to remember something is to picture it in your head.			

17) I often count by using my fingers.			
18) I would rather listen to a good lecture or speech than read about the same material in a textbook.			
19) I am good at working and solving jigsaw puzzles.			
20) I grip objects in my hands when I'm learning.			
21) I prefer listening to the news on the radio rather than reading about it in the newspaper.			
22) I prefer obtaining information about an interesting subject by reading about it.			
23) I feel very comfortable giving others handshakes and hugs, etc.			
24) I follow oral directions better than written ones.			

Final Directions: You are almost finished! Fill out the following table using the scoring system below. For example, if you marked "Often" for question #1, then you enter 5 points in the box labeled #1. If you answered "Rarely" for question #2, fill in 2 points in the box labeled #2 below.

Once you have completed the entire table, find the total number of points for each row. Record this number in the box labeled "T:"

Often = 5 pts Sometimes = 3 pts Rarely = 1 pt

VLS	#2:	#3:	#7:	#10:	#14:	#16:	#19:	#22:	T:
ALS	#1:	#5:	#8:	#11:	#13:	#18:	#21:	#24:	T:
T/KLS	#4:	#6:	#9:	#12:	#15:	#17:	#20:	#23:	T:

VSL= Visual Learning Style
ALS= Auditory Learning Style
T/KLS= Tactile/Kinesthetic Learning Style