# Note Taking Skills Using the LiveScribe© Pen:

## Implications for College Students Diagnosed with Learning Disabilities

by

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The purpose of this study was to examine whether the use of strategic note-taking with the LiveScribe© pen increased the quantity of idea units, quality of notes written down, and retention of information provided for college students diagnosed with specific learning disabilities during a lecture. A multiple baselines approach was utilized in which two different groups were taught strategic note taking at different weekly intervals to assess the effect of this strategy. There were five participants previously diagnosed with specific learning disabilities. Stimuli included three 10-minute sections of the same video-recorded lecture. After each lecture was presented, the participants' notes were collected in two different conditions: immediately following the lecture presentation and after a seven day time period from the original lecture presentation to analyze the quantity and quality of notes taken. After a seven-day time period following lecture presentation, a quiz was given to assess the participants' information retention. Generally, results indicated that students diagnosed with specific learning disabilities wrote down few information units and scored in the failing range on information retention measures. However, three of the five participants benefitted from the use of a LiveScribe© pen with strategic note taking to add information units.

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### *Introduction*

Students diagnosed with learning disabilities may experience difficulties taking notes in an undergraduate college class that can impact college experience as well as academic success. In the last ten years, the number of college freshman entering a full-time, four year undergraduate institution diagnosed with disabilities has been found to be six percent of the entire freshman class (Allsopp, Minskoff & Bolt, 2005). Of this group of students, 40% have reported a diagnosis of a specific learning disability (Henderson, 2001). Horn and Bobbitt (1999) reviewed four surveys by the National Center for Education Statistics, and concluded that in 1994, 28% of students diagnosed with learning disabilities entered a four-year institution, as compared to 61% of students without learning disabilities. The increasing number of students diagnosed with learning disabilities enrolling in a post-secondary institution is partially due to the increase in secondary school graduation rates for students with learning disabilities (Allsopp, Minskoff & Bolt, 2005). However, these students have been more likely to attend a two year institution instead of a four year, full-time undergraduate institution (Allsopp, Minskoff & Bolt, 2005). According to the 23rd Annual Report to the Congress on Implementation of the Individuals with Disabilities Education Act – IDEA (2001), the graduation rates for students with learning disabilities rose to 63% for a standard diploma in high school in 1999. Thus, students with learning disabilities are increasingly graduating from high school poised to access post-secondary education.

The success or challenges of a student with a learning disability in college can be influenced by a variety of factors. Learning disabilities are considered life-long challenges that

impact performance in traditional education settings and can extend to the college environment. Moreover, after reviewing 26 articles addressing post-secondary education for students diagnosed with learning disabilities, Mull, Sitlington, and Alper (2001) asserted that "students with learning disabilities come to postsecondary education with low academic skills and lack of preparation for the academic work required" (p.102). Additionally, once in the postsecondary setting, service delivery is governed by entirely different federal legislation than students are accustomed to in the public school system. The main emphasis for students diagnosed with learning disabilities in a postsecondary institution relates to the provision of appropriate and reasonable accommodations (Brinkerhoff, McGuire & Shaw, 2002). Almost every university in the United States has a disability services offices that facilitates appropriate accommodations for enrolled students and works with students, lecturers, and professors to design the appropriate services. These disability services have arisen from requirements in Section "504-E" of the Rehabilitation Act of 1973 (Rath & Royer, 2002). This Act made post-secondary education accessible to students diagnosed with disabilities, but has a different mission from IDEA. Students with learning disabilities must adjust to these differences as well as changes in the educational setting related to culture and academic practices; a difficult transition for some students. College level expectations related to following instructor lectures and taking effective and efficient notes is one such transition that students with learning disabilities may find challenging.

Secondary teachers in a content area classroom spend almost half of each class period lecturing, and college professors spend almost the entire class period lecturing (Putnam, Deshler, & Shumaker, 1992). This presents a challenge for those students who are diagnosed with learning disabilities and who have difficulty taking notes during these traditional classroom

sessions. Various theories have been proposed to explain why students diagnosed with learning disabilities demonstrate such difficulties with note taking during lectures. These theories include: the students selectively choose what information they write down in their notes, the students are unable to identify the important information in the lecture as decided by the professor, and that the students are unable to keep up with the lecture. According to Kiewra, Benton, and Lewis (1987), students are selective about what information that they choose to write down in their notes. These researchers found that their participants wrote approximately 90% of the main ideas, but only 11% of the information that they recorded was key supporting information (1987). Early research conducted by Locke (1977) demonstrated that typical first year undergraduate students only took notes on an average of 11% of the information the professor designated as important in the lecture. Others have asserted that some students with learning disabilities are unable to identify the most important information to note, are unable to write sufficiently quickly to be able to keep up with the professor or lecturer, or are unable to take complete notes (Bretzing & Kulhavy, 1981; Hughes & Suritsky, 1994; Kiewra & Benton, 1988). Further and more recent research needs to be conducted in this area from a psycholinguistic and speech language pathology perspective due to known relationships between language pathology and its relationship to learning disability, in addition to the prevalence of language learning disabilities and implications for behavioral aspects of learning.

Due to emerging technologies, additional resources are available to assist students who experience difficulties with leaving a post-secondary classroom lecture with notes that contain the quality and quantity of material that will be needed to review for understanding and prepare for upcoming tests. For example, the increase in online course delivery has opened an entirely new educational environment for college students where lectures may be recorded and can be

replayed or paused. Text-to-speech software is now more commonly available to assist students with writing disabilities when drafting papers or participating in online course chat room discussions. Speech-to-text software is becoming more and more accessible and affordable, and can assist students who benefit from hearing text materials read aloud. In the traditional college classroom setting however, students still need to retain the ability to listen to a classroom lecture, interact with the instructor, and leave with high quality notes.

Subpar note-taking skills can put a student diagnosed with a learning disability at a disadvantage during the undergraduate college years. This causes challenges for a student at least twice during the learning process: first, when learning information being presented during the lecture, and second, when studying for an upcoming test with the inaccurate or unfinished notes (Suritsky & Hughes, 1996).

If students leave a classroom with a minimal amount of information recorded in their notes "once the lecture is over, if not captured through electronic means (i.e., audio recording), lecture information will be lost forever, leaving students to rely on their memory to recall the information" (Boyle, 2012, p. 91). Numerous studies have confirmed that students will remember more accurate information provided in class if the students have recorded it within their notes (Bligh, 2000). In 1972, Peters conducted a study in which he found that an appropriate speed of delivery of the spoken information for typical college students is 135 words per minute to best aid students in taking notes in a college classroom. However, even this would be much too quick-paced for some students with learning disabilities. Because college lectures are often delivered more quickly than a learning disabled college student composes notes, emerging technologies can be beneficial to these students. If students with learning disabilities have a way to record lecture material to ensure that all of the information is captured for future

use, then the potential for success in the class increases. The lecture and key information can be processed at a later time and notes can be taken on any information that was missed previously during the lecture.

The literature review for the present study will initially focus on the definition of a learning disability and relationship to language based learning disabilities, the research that describes the note-taking process by undergraduate college students during post-secondary lectures, the psycholinguistic skills underlying the note-taking process, and the benefits of specific assistive technology (i.e. LiveScribe© pen) in taking notes for undergraduate college students who are diagnosed with a learning disability. This section will be followed by an overview of a specific university program that is comprised of undergraduate students diagnosed with learning disorders, and a description of an assistive technology that this university cohort uses in order to facilitate active learning. At the end of this literature review, the rationale, plan, and experimental questions will be provided.

***Learning Disability***

During the elementary school, middle school, and high school years, approximately 6% of students are recognized as having one or more handicapping conditions that affect their education (Allsopp, Minskoff, & Bolt, 2005). These students are provided with services that fall into one of the fourteen federally described categories of disability. These categories include: Autism, Deaf-Blindness, Deafness, Developmental Delay, Emotional Disturbance, Hearing Impairment, Intellectual Disability, Multiple Disabilities, Orthopedic Impairment, Other Health Impairment, Specific Learning Disability, Speech-Language Impairment, Traumatic Brain Injury, or Visual Impairment (The DSM-V, 2013). A learning disability is the classification label given to an individual who demonstrates significant learning problems in an academic

content area. It is neither a medical diagnosis, nor a medical condition; although there can be a high comorbidity with medical conditions. It is also not a psychiatric disorder, even though it is a topic listed in the diagnostic manuals for psychiatric disorders (American, 1994).

> The diagnostic criteria that must be present to diagnose a student with a learning disability is as follows: "difficulties learning and using academic skills, as indicated by (1) the presence of at least one of the following symptoms that have persisted for at least six months, despite the provision of interventions that target those difficulties: (a) inaccurate or slow and effortful word reading (e.g., reads single words aloud incorrectly or slowly and hesitantly, frequently guesses words, has difficulty sounding out words), (b) difficulty understanding the meaning of what is read (e.g., may read text accurately but not understand the sequence, relationships, inferences, or deeper meanings of what is read), (c) difficulties with spelling (e.g., may add, omit, or substitute vowels or consonants), (d) difficulties with written expression (e.g., makes multiple grammatical or punctuation errors within sentences; employs poor paragraph organization; written expression of ideas lacks clarity); (2) difficulties mastering number sense, number facts, or calculation (e.g., has poor understanding of numbers, their magnitude, and relationships; counts on fingers to add single-digit numbers instead of recalling the math fact as peers do; gets lost in the midst of arithmetic computation and may switch procedures); and (3) difficulties with mathematical reasoning (e.g., has severe difficulty applying mathematical concepts, facts, or procedures to solve quantitative problems). The affected academic skills are substantially and quantifiably below those expected for the individual's chronological age, and cause significant interference with academic or occupational performance, or with activities of daily living, as confirmed by individually

> administered standardized achievement measures and comprehensive clinical assessment. The learning difficulties begin during school-age years but may not become fully manifest until the demands for those affected academic skills exceed the individual's limited capacities (e.g., as in timed tests, reading or writing lengthy complex reports for a tight deadline, excessively heavy academic loads)." (Specific Learning Disorder, 2000)

There can be many causes for learning disabilities including: traumatic brain injury, developmental disorders, acquired disorders, environmental factors, chemical factors, other medical condition, birth complications, and genetics. Some learning disabilities are not associated with another etiology, and only affect one facet of a person's life. Subcategories of learning disabilities, referred to as "specific learning disabilities" include language learning disability, math disability, or a mixed language and math disability. Specific learning disabilities are considered specific in that they affect a small area of academic performance.

A common diagnosis in the general category of a "learning disability" is a primary reading disorder. There are several theories that describe how one reads or "decodes." One of the most commonly ascribed to theory is called the dual route model. This model details only one part of the entire reading process- the decoding stage, or the word-recognition stage (Coltheart et al., 1993). There are two components- the direct route, which is also referred to as the lexical or orthographic route, as well as the indirect route, which is also referred to as the nonlexical or phonological route. The phonological route of reading is considered an "indirect" route of reading and is also referred to as the "nonlexical route" of reading (Coltheart et al., 1993, p. 591). The phonological route is used when reading words aloud, especially when reading a non-word (a word that is made up) or when reading a novel word. A novel word is a word that has sound-symbol correspondence. When using this route of reading, the individual recognizes that a letter

makes a distinctive sound, and essentially sounds out the words. If this method of reading was to be used with an irregular word, or a word without direct sound-symbol correspondence, then the individual would mispronounce the word, as he or she would be attempting to sound it out the way it is spelled (Coltheart et al., 1993).

The second component of this theory is the direct route of reading, the lexical route of reading. In this reading route, the individual is required to utilize his or her "mental dictionary," or lexicon (Coltheart et al., 1993, p. 589). When learning to read, an individual learns orthographic forms of various words and then stores them in his or her lexicon. When the individual is reading and sees the same word again, the individual has to search through his or her lexicon in order to use the visual form and the phonological form to recognize the word. Because a mental lexicon cannot be used to retrieve a non-word, this method cannot be used with non-words (Coltheart et al., 1993). However, this component is ideal to use to read a regular or irregular word, as the individual is simply recognizing grapheme patterns that are not necessarily in a sound-letter correspondence. For example, the word "champagne" if read aloud using the phonological route, would sound incorrect because the individual would read each individual sound in the word, instead of looking at the word holistically and recognizing grapheme patterns.

A primary reading impairment is often referred to as dyslexia. In the dyslexia classification system proposed by Elena Boder (1973), there are three distinct subtypes of dyslexia. The three subtypes are: dysphonetic, dyseidetic, and a mixed dysphonetic/dyseidetic classification. Dysphonetic dyslexia is an impairment or disruption in the phonological route of reading. This means that the individual has difficulties with grapheme to phoneme conversion in decoding or word recognition tasks. A prominent characteristic of dysphonetic dyslexia is that the individual cannot read nonwords or novel (unknown) words as they sound (Boder, 1973).

The strength of an individual diagnosed with dysphonetic dyslexia is that he or she can read unknown words holistically. Dyseidetic dyslexia is a deficit where the individual cannot read a word a whole. According to Boder (1973), these individuals have a preserved grapheme to phoneme conversion skill, but will have mispronunciations of irregular words. An individual diagnosed with dyseidetic dyslexia will have a strength of sounding out unknown words. A mixed dysphonetic/dyseidetic dyslexia is a primary reading disorder in which there are disruptions in both the direct and indirect routes of reading, and is the most severe of the three forms of reading disorders.

If an individual is diagnosed with dyslexia, not only will his reading be impacted, but also his spelling, which will affect overall written language. Reading and spelling go hand-in-hand, especially in the dual route model, proposed by Boder (1973). If an individual has a reading and written language disorder and will be taking notes in a classroom setting, the individual could have difficulties with this note-taking. If given a visual presentation (i.e.: PowerPoint slides or definitions), then the individual could have difficulty reading the visual information in order to process it, before even writing it down in his or her class notes. If a student is diagnosed with a learning disability, specifically a primary reading disorder, then the student's note-taking skills may be subpar as compared to other members of his or her classroom.

An important distinction for a specific learning disability is that it is not a result of another condition such as a behavioral disorder, sensory deficit, or lack of educational opportunities. However, it should be mentioned that specific language disabilities can co-occur with these other conditions. Some of these co-occurring conditions can include conditions from the other disability categories. A common comorbid condition with learning disability is

Attention Deficit Hyperactivity Disorder (ADHD). According to the DSM-IV definition, "the essential feature of attention-deficit/hyperactivity disorder (ADHD) is a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development. Inattention manifests behaviorally in ADHD as wandering off task, lacking persistence, having difficulty sustaining focus, and being disorganized and is not due to defiance or lack of comprehension. Hyperactivity refers to excessive motor activity (such as a child running about) when it is not appropriate, or excessive fidgeting, tapping, or talkativeness." (Attention Deficit Hyperactivity Disorder, 2000). To be diagnosed with this disorder, symptoms must be present prior to the child turning twelve years old, and the symptoms must persist in more than one setting. Students with learning disabilities who have been diagnosed with co-occurring ADHD often experience difficulties in the educational setting. For instance, these students often exhibit difficulties attending to a lecture, may experience difficulties with retaining information presented in a lecture, or may have difficulties focusing on information provided during the lecture Hughes and Suritsky (1994).

It is difficult to track down a set percentage of the United States population with learning disabilities due to the large heterogeneity and differing classifications of the group of learning disabilities. The prevalence of learning disabilities has been found to be between 5% and 15% among children (Altarac & Saroha 2007). Prevalence in adults is unknown but is reported to be approximately 4%, secondary to the differing classifications and heterogeneous group of disabilities (Specific Learning Disorder, 2000). Demographic studies of learning disability have shown that a majority of learning disabilities are seen in males (Gillberg, 1995). The genetics of learning disability is becoming better understood but "no specific linkage between gene loci and intelligence has yet been identified" (Simonoff, Bolton & Rutter, 1996).

The diagnosis of a learning disability typically occurs during the elementary school years when students are learning literacy and math skills. There are precursors that can increase the likelihood that a student will be diagnosed with a learning disability, such as the diagnosis of a language delay. Language is a very important component in a learning disability, and often learning disabled students exhibit difficulties with language-related tasks, such as letter recognition, breaking words into syllables, sound/symbol correspondence, word decoding, math problems, spelling, reading comprehension, reading irregularly spelled words, written expression, written organization, and making inferences or conclusions (Specific Learning Disorder, 2000).

Students with learning disabilities experience difficulties with these tasks through their lifetime. Hence, it is important to understand the implication of the diagnosis of a learning disability on a student's academic success in a post-secondary institution. One pivotal component of a student's academic success in a post-secondary institution is the ability to take notes on the information provided during a lecture. This is an area in which students diagnosed with learning disabilities often have difficulties in college.

### *Underlying Psycholinguistic Skills in Note Taking*

Researchers have been conducting studies for many decades specific to the note taking process and the underlying skills necessary to be able to successfully take notes. A large majority of these studies have been conducted from an educational based perspective, rather than psycholinguistic or language based perspectives. Taking notes during a lecture and from textbooks is a critical skill necessary for the undergraduate college student to succeed. To successfully take notes, a student needs to have well-developed working memory skills to be able to take notes while simultaneously listening to incoming information and remembering what

was said. A model that is widely known to explain the process of working memory in the task of taking notes is the three pronged model that Baddeley proposed in 1974. After additional research, he then added a fourth component after additional research (Baddeley, 2000).

### *Baddeley's Model of Working Memory*

In the model proposed by Baddeley and Hitch in 1974, working memory consists of three separate components. The development of this model was to provide a "framework for conceptualizing the role of temporary information storage in the performance of a wide range of complex cognitive tasks" (Baddeley, 2000, p. 417). In the original model concerning working memory, the phonological loop was the highest developed portion. Since, 1974, a new element was added to this model- the episodic buffer.

It is presumed that the phonological loop contains a transient store of phonological information in which the remnants of auditory memory decay after several seconds, unless there is articulatory rehearsal to prevent the decay (Baddeley, 2000). An inherent assumption to the idea of the phonological loop is that the processes of storage and of rehearsal are individual (Baddeley, 2000). The purpose of this phonological loop is to retain incoming ordered information, and is especially important with digit span ordered information (Baddeley, 2000). One of the important considerations that has been researched is how information from different inputs (such as auditorily presented information and visually presented information) is combined, especially if an individual's long term memory intercedes to break the information into smaller chunks to aid with memory (Baddeley, 2000).

One method of investigating where incoming information is stored is to have an individual demonstrate immediate recall of a paragraph, comprised of roughly 15-20 idea units. In this type of study, the individual is asked to immediately recall written information from the

paragraph and again after a set time period of a twenty minute delay (Baddeley, 2000). If the individual must recall information from a written prose paragraph, then the phonological loop has too small a size to be able to adequately contain all of the information that the individual needs to remember. And not only that, but the incoming information will be written over the original information in the phonological loop (Baddeley, 2000). This can be related to note-taking during a lecture even though the individual may not be having to remember written prose. The student still must remember incoming auditory information, while still remembering the previously heard information and writing down or transcribing what was heard. So in essence, the student is essentially perceptually behind in processing and recalling the information from the first minute or two of the lecture.

Based upon this model, working memory has been suggested as the process by which the different information inputs are integrated. According to Baddeley, "There is a clear need, therefore, to assume a process or mechanism for synergistically combining information from various subsystems into a form of temporary representation" (2000). Baddeley maintains that this process is working memory with central executive processing. He maintains that the central executive processing center does not have the capability to be able to hold the store of incoming information such as the phonological loop does and that the central executive processing section of the model aids in information integration (Baddeley, 2000).

The episodic buffer is the fourth added element to the original model. With this extra component, Baddeley proposes that this episodic buffer is the "limited capacity temporary storage system that is capable of integrating information from a variety of sources" (Baddeley, 2000, p. 421). He presumes that this fourth element of the model is regulated by the central executive processing center. The central executive processing portion gathers information from

the storage in the form of cognizant awareness, thinks about that information, changes the information, or even manipulates it if needed (Baddeley, 2000). This fourth component has the word "episodic" in its title because incoming material is manipulated and even carried over a period of time (Baddeley, 2000). Baddeley proposes that this episodic buffer not only integrates information over a period of time, but also can be responsible for creating new mental depictions, which could then assist with problem solving and reasoning tasks (2000).

Taking notes during a lecture requires an integration of many processes, especially incoming information presented verbally and visually. The individual has to be able to remember what was already said, listen to what the lecturer is currently saying, process both, extract the important information, relate the new information to the individual's current knowledge, formulate the information into his own words to facilitate his own comprehension later, physically write the notes, and concentrate. This working memory model (Baddeley, 2000) depicts the different elements of working memory as applied to the psycholinguistic components needed for successful note taking skills.

### *Benefits of Note Taking*

Research has shown how note-taking can help students diagnosed with learning disabilities to succeed in the undergraduate college classroom. It is important that undergraduate college students who have been diagnosed with learning disabilities learn how to effectively take their own notes in their classes. Note taking promotes active learning and active engagement in the class during a lecture (Divesta & Gray, 1972; Peper & Mayer, 1986). Note taking encourages the clarification of information that is unclear to a student (Ruhl & Suritsky, 1995). Note taking aids the process of coding the information presented auditorily into long term memory to allow for better storage (Ruhl & Suritsky, 1995). A positive correlation has been

shown between the amount of notes taken during a lecture in a college classroom and test scores obtained on the information presented (Peper & Mayer, 1986). It has been shown that if students take notes during a lecture, and then do not review them prior to a test or quiz, that they will score lower on the assessment than someone who has reviewed their notes from class (Kiewra et al., 1991).

### *Other Psycholinguistic Skills*

While a student takes notes during a lecture, he or she must use a combination of skills at once time. These skills include: listening comprehension, discrimination between relevant and irrelevant information to the topic of the lecture, information processing, personalizing information, organizing information, and recording notes legibly and fluently (LeBauer, 1984; Peck & Hannafin, 1983; Smith & Tompkins, 1988). University students diagnosed with learning disabilities often have difficulty with these skills in the complex process involved with taking notes. For example, post-secondary students diagnosed with learning disabilities often have difficulties with handwriting (Bireley, Landers, Vernooy, & Schlaerth, 1986; Hughes & Smith, 1990; Moran, 1981); spelling (Gajar, 1986; Hughes & Smith, 1990; Vogel, 1986); listening comprehension (Blalock, 1981, 1987; Torgesen, 1977); and identifying information that the lecturer thinks is important (Hughes, 1991; Suritsky, 1992). Research has illustrated that students diagnosed with learning disabilities write down fewer notes and score lower on recall measures as compared to college students without disabilities (Boyle, 2012). On surveys sent to post-secondary undergraduate students diagnosed with learning disabilities resulted in responses indicated difficulties with being able to keep up with a lecture and write quickly enough (Bireley et al., 1986; Cowen, 1988; and Suritsky, 1992). Suritsky's research (1992) found that these

college students diagnosed with learning disabilities did not know which information was important, and also experienced difficulties when trying to decipher their own notes after class.

Suritsky and Hughes (1994) also found that students who have been diagnosed with learning disabilities do not write as quickly as undergraduate students without learning disabilities. To research how quickly learning disabled students take notes during a classroom lecture, 30 students with learning disabilities and 30 students without learning disabilities listened to a lecture and took notes. Participant selection criteria included the being sophomores or juniors in a northeastern state university. Those participants diagnosed with learning disabilities were included based upon: (1) their response to a letter sent out to 75 students who had been a member of Penn State's Program for Students with Learning Disabilities; and (2) a diagnosis of a learning disability on the bases of a discrepancy between achievement and ability (a minimum of a 40 point differential) in at least of the areas of reading, math, foreign language, written language, or general knowledge. Those participants who did not have learning disabilities were Elementary Education majors, Communication Sciences and Disorders majors, or members of an Introduction to Special Education course.

The study consisted of a measure of note-taking speed based upon a lecture. In this study, the students had to listen to an unfamiliar 20 minute lecture with information from a graduate psychology class. The lecture was delivered at a rate of 108 words per minute on average. The average range of presentation used in previous note taking studies was between 95-120 words per minute (DiVesta & Gray, 1972 and Bretzing et al., 1987). The students were given lined paper and asked to write their names as many times as possible in a one minute time period to assess how quickly the students could write when no extra thought processing was required. The

students were then told to watch the recorded lecture and record notes as they would during a college lecture.

The test results revealed that the rate of letters written per minute were lower in the learning disabled group as compared to their peers. The authors suggested that based upon the results of this investigation, the students could be taught abbreviations to help them to keep up in the classroom while taking notes during a lecture.

There are many formats in which students can take notes. These note taking formats are designed to help students identify the most important parts of the information provided so that they do not have to write down the lecture word for word. If the study described above is accurate, doing so would severely impact their speed of note taking which could, in turn, impact the student's academic performance.

***Note Taking Formats***

Note taking skills and formats fall into two separate and very broad classifications; that is, teacher-directed and student-directed. Teacher directed techniques are those that students can use to improve their knowledge of the material covered during the lecture. The use of these techniques however, is dictated by the instructor (Weishaar & Boyle, 2010). For example, if the professor stops lecturing for a few moments, the students could work together in pairs to clarify any confusing information presented during the lecture (Weishaar & Boyle, 2010).

Student-directed techniques are those techniques that can be used by students prior to, during, and after the note taking. These techniques are very much under the students' control. Of student-directed techniques, the ones that have been more widely researched and found to be the most effective for students diagnosed with learning disabilities include strategic note-taking, guided notes, and columnar format.

### *Strategic Note Taking*

Strategic note taking was developed based upon the idea that students diagnosed with learning disabilities are passive learners, especially during note-taking (Divesta & Gray, 1972; Peper & Mayer, 1986). In this strategy, the professor can give the students special note-taking paper that contains written cues to help the students use metacognitive skills during a lecture. Examples of written cues could include: "what is today's topic?" or "what do you already know about this topic?" (Weishaar & Boyle, 2010). Some of these meta-cognitive skills include: organizing incoming aurally presented information and combining the new information presented with prior knowledge (Weishaar & Boyle, 2010). By becoming more involved in the note-taking, and using these metacognitive skills, students are not only becoming more actively engaged in the learning process, but also are increasing their comprehension of the information presented during the lecture (Weishaar & Boyle, 2010). The first part of the strategic note-taking form asks students to quickly identify the lecture topic and relate their own knowledge with the topic being discussed. By relating what they know with the lecture topic that is being discussed, the information that will be presented becomes more meaningful to the student (Weishaar & Boyle, 2010). The student clusters together three to seven main points with details from the lecture as they are being presented. By clustering ideas together, the student can more easily remember the information presented (Weishaar & Boyle, 2010). At the bottom of each page, students summarize information presented during the lecture to assist with the long-term memory storage of the material (Weishaar & Boyle, 2010). Steps two and three are repeated until the end of the lecture (Weishaar & Boyle, 2010). The very last step calls for the student to write five main points that summarize the overall lecture and describe each point. The purpose of this step

is to serve as a quick review of the lecture, and occurs after the lecture has ended (Weishaar & Boyle, 2010).

The results from studies (Boyle, 1996; Boyle & Weishaar, 1997) that used this technique indicated that the strategic note-taking technique for students diagnosed with mild learning disabilities was more effective that conventional note-taking. The students recorded more of the information presented in their notes and improved their overall comprehension of the material (Boyle, 1996; Boyle & Weishaar, 1997).

***Guided Notes***

Guided notes can be described as a "skeleton outline that lists main points of a verbal presentation and provides designated spaces for students to complete as the speaker elaborates on each main idea" (Lazarus, 1991, p. 33). To construct this outline, a teacher selects the main ideas from his or her lecture notes and places them on prepared note paper with spaces inserted for the students to fill in details during the lecture. Students are given the notes prior to the lecture and are asked to complete the outline during the lecture. One advantage of this technique is that students are given an outline that lists and structures the main ideas prior to learning (Weishaar & Boyle, 2010).

The research on guided notes has indicated that once students are trained to use this technique, they can demonstrate "greater gains on tests" than when using conventional note-taking technique (Lazarus, 1991). Greater gains have also been noted when students use guided notes in conjunction with a review period (Lazarus, 1991).

In a study conducted by Lazarus (1991), six high school students ages 16-17 who were diagnosed with learning disabilities utilized a guided notes technique to take notes during lectures presented during their science class. The six students were eligible to be participants

because they were diagnosed as learning disabled by a 1.75 achievement score standard deviation discrepancy from the mean. In this study, a baseline measure of note taking ability was first collected by the teacher. The teacher asked the students to take notes while he lectured, and did not give any additional instructions. After the baseline data were collected, the teacher then used his own lecture notes to design a guided notes handout for each student. The teacher gave instruction on using the strategy of guided notes, and gave the students examples of guided notes. Following this period of instruction, the students were told to take notes using the guided notes technique. The students used the instructor's guided notes handout to take their notes during the lecture, and then were given ten minutes following the lecture to silently review their notes taken. They were given a quiz based upon the information provided during the lecture.

Following the investigation, the students were given a questionnaire to evaluate their opinion of the effectiveness of the strategy of guided notes. Based upon the results of the quizzes administered, the students scored higher than at baseline testing. The researchers were unable to determine if the increase was solely due to the use of the guided notes strategy or the ten minute time period in which the students were given to read through their notes helped to increase the students' grades.

### *Columnar format*

In this note-taking format, information is visually organized according to the type of information to be written. This format uses two to four columns to assist in note taking. At the top of the page is a line for the topic sentence. The teacher might write in the topic sentence for the student or have it written on the board for the student to copy onto his paper. If the paper is divided into three columns, the first column on the left side is about five inches long and is titled "Basic Ideas." During the lecture, the students fill out this column and write down any important

facts that will be needed for future study. The middle column is two inches long and is called "Background Information." This column is filled out after the lecture, and the student notes anything of interest or an area in which the student has any prior knowledge. The purpose of the column is to help the students facilitate connections between the information presented in the lecture and their prior knowledge, which in turn, can increase comprehension (Weishaar & Boyle, 2010). The right column is one inch long and is labeled "Questions." The students fill in this column both during and after the lecture with any questions or information that is not clear. Saski, Swicegood, & Carter (1983) have suggested that this format can be used to improve the note-taking skills of students diagnosed with learning disabilities during class lectures.

***Academic Note Analysis***

While measuring the quantity of student notes is a fairly straightforward process, assessing the quality of student notes is more difficult and subjective. Two examples of methods for analyzing student notes are note completeness and use of abbreviations. Note completeness is comprised of three different measures: percentage of cued information units recorded, percentage of non-cued information units recorded, and percentage of total information units recorded (Hughes & Suritsky, 1994). Total information units recorded includes the cued plus non-cued information units (Hughes & Suritsky, 1994).

Information units are information chunks or complete ideas that have not previously been presented in a lecture (Bretzing, Kulhavy, & Caterino, 1987). These blocks of information include: sentences, sentence clauses, or phrases (Bretzing, Kulhavy, & Caterino, 1987). Cued information units are information units presented that were verbally cued by the lecturer as being important. They are defined as "informational units verbally highlighted by the lecturer as being important and included organizational cues and emphasis cues" (Hughes & Suritsky, 1994, p.

21). An example of an organizational cue would be: "there are three organizational parts of a paper- the introduction, the body, and the conclusion." An example of an emphasis cue would be: "it is important to recognize that…" These clues serve to draw a student's attention to the important information presented during a lecture, and also may be used to highlight the organizational structure of the lecture (Ladas, 1980).

In order to study the relationship between the information units and overall notes taken from a lecture, Hughes and Suritsky (1994) conducted a study with 30 students with learning disabilities and 30 students without learning disabilities. Selection criteria required participants to be sophomores or juniors in a northeastern state university. Those participants diagnosed with learning disabilities were included based upon: (1) their response to a letter sent out to 75 students that had been a member of Penn State's Program for Students with Learning Disabilities; and (2) a diagnosis of a learning disability on the bases of a discrepancy between achievement and ability (a minimum of a 40 point differential) in at least one of the areas of reading, math, foreign language, written language, or general knowledge. Those participants who did not have learning disabilities were Elementary Education majors, Communication Sciences and Disorders majors, or members of an Introduction to Special Education course.

The study consisted of a measure of note-taking speed and an analysis of the notes taken by the participants. In this study, the students listened to an unfamiliar 20 minute lecture from a graduate psychology class. The students were given lined paper and asked to write their names as many times as possible in a one minute time period to assess how quickly the students could write when no extra thought processing was required. The students were then told to watch the recorded lecture and take notes as they would during a college lecture, with no additional instruction regarding note-taking style.

The test results revealed that the notes taken by the group of students diagnosed with learning disabilities were not as complete as that of the other group. The largest differential between the two experimental groups was that of the number of cued information units recorded. Those without learning disabilities recorded 77% of these information units, while those diagnosed with learning disabilities recorded only 46%. The authors concluded that since writing notes is the "creation of a permanent product from which to study," then notes that are not complete could impact overall impact of performance in college level courses (p. 22).

In an overview of the literature regarding note-taking skills of secondary students diagnosed with learning disabilities, Joseph Boyle (2010) proposes that teachers use a "diagnostic assessment" chart to assess a student's notes taken during a lecture (p. 93). Using this chart as a framework, teachers compare the notes taken by students who they feel experience challenges with note taking to other students in a classroom who do not have problems taking notes. In this way, he proposes that the teacher can determine individual areas of difficulty in note taking for each student, information that can be used to guide remediation. The teacher compares the notes of the students with and without note taking difficulties in each individual measure in this chart. Examples of these measures include: total lecture points, important lecture points, organized lecture points, labeled diagrams/illustrations, and vocabulary words with definitions. The lecture points that he discusses in this chart are equivalent to the "information units" mentioned in the Hughes and Suritsky (1994) article. In addition to these main components of note taking, Boyle also adds additional components found in students notes including: legibility, use of abbreviations, organization, spelling, and indications that the student was confused on any information provided. With these additional components, Boyle created a

multidimensional scoring system to rate the students notes with (0) being not evident; (1) being somewhat evident; and (2) found in almost all of the notes.

### *Abbreviations in Note Taking*

The way to measure abbreviations is to calculate the number of abbreviations as well as the total number of words abbreviated (Hughes & Suritsky, 1994). The way that the word abbreviation was defined was "any group of letters or symbols used to represent a word or phrase" (p.21). Student note takers who have been characterized as "effective" note-takers based upon note completeness and test performance, typically record significantly more word abbreviations than note takers characterized as "ineffective" (Hughes & Suritsky, 1994, p. 21). To calculate the total number of abbreviations, the researcher simply tallies each occurrence of an abbreviation. To calculate the total number of words abbreviated, the researcher would record each instance of abbreviations throughout the student's notes and then tallied only the number of different words abbreviated, not each individual abbreviation. The rationale for choosing this measurement was that if a student who is taking notes uses more abbreviations, then the amount of information that can be taken in the notes presumably will increase.

Due to the importance of taking notes in a post-secondary institution, note taking skills should be addressed at the college level, especially for students diagnosed with learning disabilities. An example of a post-secondary program that addresses academic skills at the college level is Project STEPP through East Carolina University in North Carolina.

## *Project STEPP*

Project STEPP (Supporting Transition and Education through Planning and Partnerships) is an example of a program that assists undergraduate college students who have been diagnosed with learning disabilities. Project STEPP is a program through East Carolina University that

offers “comprehensive academic, social, and life-skills support to a select number of students with identified Specific Learning Disabilities who have shown the potential to succeed” (Project STEPP, 2013). Students can apply to Project STEPP during their junior year of high school, and if accepted, the program will work closely with the student during his or her senior year to facilitate a smooth transition to East Carolina University. Students enter the program in cohorts of ten students. Participants also take a parallel series of courses placed at key transition points in the undergraduate experience. Some of these courses include instruction in note-taking, study skills, and time management to ensure that they get all of their work done on time.

***The LiveScribe© Pen***

The LiveScribe© pen is an example of an assistive technology device that students in Project STEPP use to become more effective note takers. With this pen, the students are able to record a lecture so that they will be able to go back and listen to it again in case they missed pieces of information. Also, the audio from the lecture recording syncs with the handwritten notes so that the student can listen to selected sections of the audio efficiently. This can decrease the amount of time that the students would need to go back and listen to the lectures because they can easily select the portion of the lecture that they want to listen to.

In short, the LiveScribe© pen is a ballpoint pen and voice recorder combination that preserves digital copies of your notes and recordings, which can be replayed, saved to your computer, and shared with others ("LiveScribe© apa-00007 echo," 2013). [Note: Weight- 1.27 oz. without the cap, Length- 6.2”, Computer supported- Mac and PC, and Memory- 8 GB ("LiveScribe© apa-00007 echo," 2013).] Some of the drawbacks to using this pen include: the cost of the pen, pens and caps can be lost, digitizing notes requires special paper, ink cartridges are smaller than standard ink cartridges, and they can get broken.

With the assistance of this LiveScribe© pen, students diagnosed with learning disabilities can become more effective note takers in the post-secondary setting. If they are more effective note takers, it will be easier for the students to retain information provided during lectures and their grades will improve.

***Summary and Rationale***

Note taking has been widely researched in students diagnosed with learning disabilities from an educational perspective. Presently, it is accepted that these students exhibit difficulties with the act of taking notes during a lecture, especially in an undergraduate level course. In effect, these difficulties with note taking may ultimately affect their comprehension and retention of information heard in a lecture.

As discussed in the literature review, results of a study conducted by Hughes and Suritsky (1994) notes taken during a lecture were compared between students with learning disabilities and students without learning disabilities revealed that students with learning disabilities do not take notes as completely as their non-disabled counterparts. However, in this new age of technology used in the classroom, it is not known if college students diagnosed with learning disabilities still demonstrate the same difficulties found in this study. Technology resources such as laptop computers, computers, recording devices, and the LiveScribe© pen, enable these students with learning disabilities to acquire any information that may have been missed while sitting in class and taking notes. This allows the student to listen to the information again, as well as to utilize the technology programs to assist with information retention. Whether such technology has a positive effect on students with learning disability has yet to be explored.

### *Plan of the Study*

This study investigated whether using a specific note taking strategy accompanied by a lecture recorded with the LiveScribe© pen aided college students diagnosed with learning disabilities in note-taking skills during and following a lecture. The participants were taught strategic note-taking to reorganize and rewrite their notes following a lecture. This experimental study involved measurement of the quantity and the quality of the information units present in the participants' notes taken from a ten minute sample of a recorded undergraduate lecture with information that was previously viewed by the students using a LiveScribe© pen and compared to a baseline obtained without use of the LiveScribe© pen.

The quantity and quality of the students' notes were measured in two different conditions: immediately following a lecture and seven days following the lecture. The quantity of the students' notes was measured by the total number of information units present in the notes, total number of abbreviations present in the notes, total number of words abbreviated in the notes, the number of acronyms present in the notes, and the number of vocabulary words with definitions present in the notes during both conditions. The quality of the students' notes was measured by the structure of the notes taken (abbreviations, sentences, phrases, acronyms, or listing), if the student changed the format of the notes between the two conditions, if information units were added in the second condition, and how the student reformatted his notes between conditions. In addition to measuring the effectiveness of a note-taking strategy and reorganization of notes, a quiz was administered to measure information retention following a seven day period from the lecture presentation. The quiz results were measured by the overall percentage accuracy on an eight question quiz comprised of four inferential questions and four factual questions in a random order, the percentage accuracy on the four inferential questions,

and the percentage accuracy on the four factual questions. The following were the experimental questions for this experiment:

1. Did using strategic note-taking with the LiveScribe© pen increase the quantity of idea units (the number of accurate information units, the number of inaccurate information units, and the number of vocabulary words with definitions) written down immediately following a ten minute sample of a lecture and seven days following the lecture within an individual diagnosed with a learning disability and in a group of undergraduate students diagnosed with learning disabilities?
2. Did using strategic note-taking with the LiveScribe© pen increase the quality of idea units (the structure of the notes taken, if the student changed the format of the notes between the two conditions, if information units were added in the second condition, and how the student reformatted his notes between conditions) from immediately following a ten minute sample of a lecture to seven days following the lecture within an individual diagnosed with a learning disability and in a group of undergraduate students diagnosed with learning disabilities?
3. Did using strategic note-taking with the LiveScribe© pen aid lecture comprehension and information retention following a seven day period from presentation of the lecture as measured by the overall percentage accuracy on an eight question quiz comprised of four inferential questions and four factual questions in a random order, the percentage accuracy on the four inferential questions, and the percentage accuracy on the four factual questions within an individual diagnosed with a learning disability and in a group of undergraduate students diagnosed with learning disabilities?

# Chapter II

## Methods

### *Participants*

This study consisted of a total of five participants who were previously diagnosed with a learning disability through psychological testing as having specific learning disabilities. However, the pre-experimental testing allowed the researcher to determine the specific type of primary reading disorder (if present), as well as the episodic memory skills of each participant.

*Participant #1* exhibited a learning disability characterized by a primary reading impairment, specifically dyseidetic dyslexia. This participant exhibited below average sight word identification skills, but average word attack, or phonological decoding skills. As previously mentioned, this participant had preserved grapheme to phoneme conversion skills, but impaired holistic reading skills, which negatively affects his reading fluency and rate. Although he exhibited dyseidetic dyslexia, his overall reading comprehension was average. His visual memory was average; however, his auditory memory was below average, which in turn, impacted his delayed recall for information presented verbally with an intervening distractor task. *Participant #2* presented with a reading comprehension impairment, while decoding skills were intact, for both sight word and phonological decoding skills. This participant had average visual memory skills, but well-below average auditory memory for information presented verbally with an intervening distractor task. This impacted his delayed recall, or recall of information presented previously. *Participant #3* presented with dyseidetic dyslexia, as the sight word identification skills were below average, while her word attack skills were low average range. The reading comprehension of this participant was in the low average range. This participant exhibited slightly below average auditory memory skills, while her visual memory

was in the low average range. Her delayed recall, oral and written fluency scores were below average, which underscores difficulty in decoding fluency. *Participant #4* did not present with any reading difficulties. Her profile revealed intact decoding and reading comprehension abilities. Visual and auditory memory skills, delayed recall, and oral and written fluency skills were all found to be within normal limits. *Participant #5* exhibited a mixed dysphonetic/dyseidetic dyslexia. This participant exhibited below average word attack and sight word identification skills. However, while this student exhibited poor decoding, his reading comprehension was average (for this cloze format), which may indicate that the participant may have been using strategies and contextual cues in completing a reading comprehension task where a word is missing. Visual and auditory memory skills were in the average range.

Four of these participants were males and one was a female. The participants ranged in age from 18 years and 4 months old to 19 years old. These students were drawn from an East Carolina University Project STEPP cohort. All participants were American Caucasians and native English speakers. An informed consent form was signed by each participant, after hearing an overview of the purpose and the procedures of the study.

***Pre-experimental Testing***

All participants passed the hearing screening bilaterally as determined by a pure-tone audiometric hearing screening at 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz at 25 dB. Other standardized assessments that were utilized for descriptive data purposes included: the Word Identification (WI), the Word Attack (WA), Word Comprehension (WC), and Passage Comprehension (PC) subtests from the **Woodcock Reading Mastery Test-Revised (WRMT-R)** (Woodcock, 1998) and the Visual Modality (VM), Auditory Modality (AM), Delayed Recall (DR), Oral Fluency (OF), and Written Fluency (WF) subtests from the **Test of Information**

**Processing Skills (TIPS)** (Webster, 1998). A questionnaire to assist with collecting descriptive information was also given to the participants.

The **WRMT-R** assessed the participants' decoding skills and comprehension abilities. This test was also used to determine the nature and subtype of reading impairment (if present).

The **TIPS** assessed the participants' information processing skills in both the auditory and visual modalities. Within each of the auditory and visual modalities, this test gives the researcher an idea of how well the participant recalls information from long term memory, short term memory, and working memory in an ordered fashion and an unordered fashion. This test also assessed the participants' oral fluency and written fluency, which are needed in the process of taking notes.

***Stimuli***

The stimuli used were a series of three ten minute lecture samples taken from a video recorded lecture with information titled "Hurricanes" used during an orientation "Bootcamp" and presented by a faculty member from the Department of Geography. During the experimental phase of this project, the material covered in the lectures had been previously viewed by the students during "Bootcamp." Each sample was played for the students in both the visual and auditory modalities to mimic that of actually participating in an undergraduate classroom lecture.

The first section of the lecture sample was given solely to determine the participant's baseline note taking skills. The next two sections of the lecture sample (referred to as lecture one and lecture two) were given to assess the multiple baselines approach of the strategic note taking intervention. In the first ten minute sample, the lecturer predominately provided background information relative to weather, and then transitioned to information specifically relating to hurricanes. In this section, there were a total of 21 information units and four vocabulary terms.

For the middle ten minute sample (referred to as lecture one), specific vocabulary terms, hurricane classifications, causes, and meteorological information was presented. In this section, there were a total of 30 information units and five vocabulary terms. The last ten minute sample (referred to as lecture two) was comprised of information pertaining to air pressure, movement of air, the appearance of a hurricane, and the process through which a hurricane develops. In this section, there were 18 information units and three vocabulary terms.

To determine the number of information units in each of the three lecture samples, the researcher played the three sections of the lecture for two independent raters. These two independent raters were graduate students from the Department of Communication Sciences and Disorders. These raters listened to each lecture sample and wrote their own notes on the information provided. After each sample, the raters calculated the number of information units written down in their notes and compared them in a point by point comparison. After the original point by point comparison, the two raters exhibited a 77% agreement for information units. If a discrepancy existed between the two independent raters, then a third independent rater would listen to the same lecture sample and would compare his notes to the previous two raters. This third rater, too, was a graduate student in the Department of Communication Sciences and Disorders. If two of the three independent raters noted the same information, then that information was considered an information unit. After this process was completed, the percentage of agreement between the three raters resolved to 100%.

***Stimuli Development and Validation***

The questions for the quiz to assess information comprehension were created and validated prior to being used as an assessment tool in the experimental portion of this study. Twenty questions were written for each of the three sections of the video presented. Within these

20 questions were ten inferential questions and ten factual questions in a randomized order. Three individuals who were unfamiliar with the information presented in the stimulus lecture were asked to answer the 20 questions for each of the two sections in order to determine that the individuals would need to see each of the sections of the video in order to accurately answer the questions developed. After the individuals answered all of the forty questions total, then they were shown the two sections of the lecture. They were then asked to answer the same group of questions. If a question was answered accurately more than 50% of the time on the original question presentation, before the individuals watched the video, then these questions were dropped. Also if a previous question gave a hint to an answer of another question, then those questions too were eliminated. From lecture one, there were nine questions left and ten questions left from lecture two. From the questions remaining in lecture one, there were five inferential and four factual questions. From the questions remaining in lecture two, there were five inferential questions and five factually based questions. These 19 questions that were left were then given to a different groups of three individuals for the same process as mentioned above. After this stage was completed, then eight questions were selected from the remaining questions left in each section for this research. Refer to Appendix D for the comprehension quiz questions given following each section of the lecture.

***Instrumentation***

The stimuli were presented on an ECU computer provided in each classroom. The students used a LiveScribe© pen to take notes from the provided lecture. Following the lecture, the student had a one week period in which he or she was instructed to go back to listen to the lecture with the aid of the LiveScribe© pen, take additional notes, or re-organize the notes prior to being given a quiz. The LiveScribe© pen is an example of assistive technology that can help to

make students more effective note takers. The LiveScribe© pen is a ballpoint pen and voice recorder combination that preserves digital copies of notes and recordings, which can be replayed, saved to a computer, and shared with others ("Livescribe© apa-00007 echo," 2013).

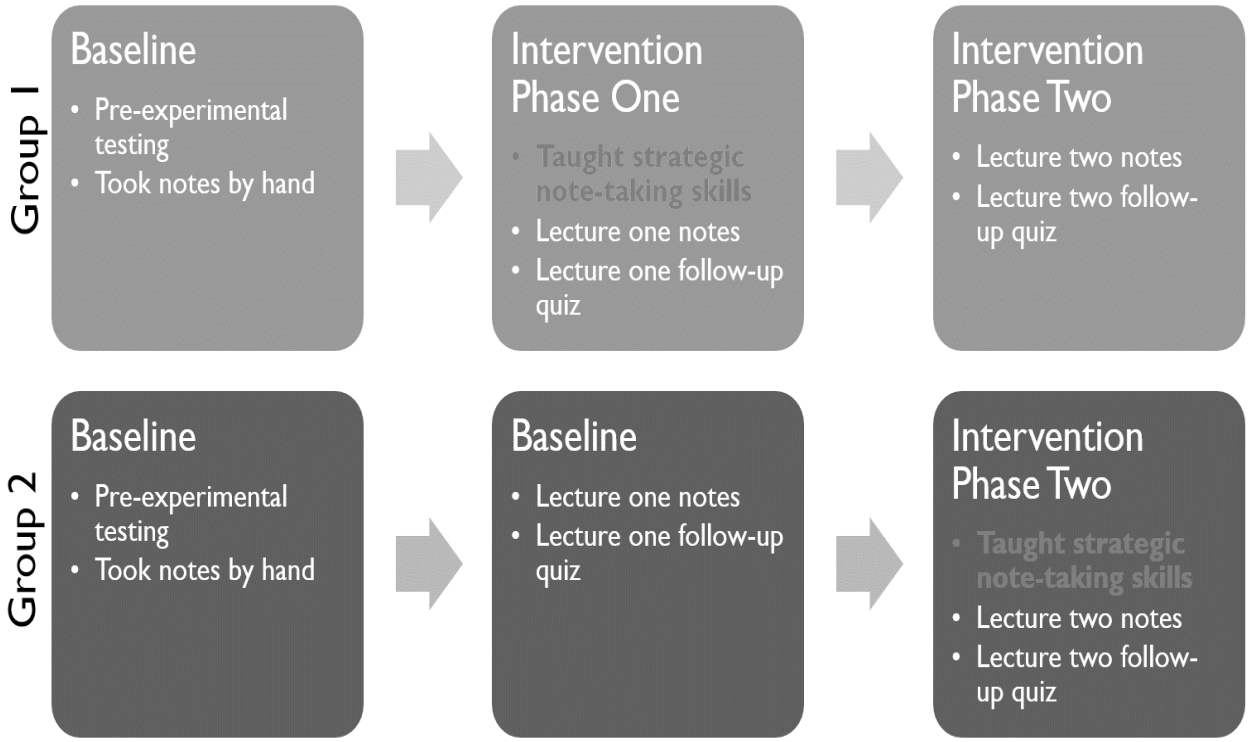
***Experimental Procedure***

During this experimental phase, the participants were seated in an ECU classroom in the Project STEPP area of Joyner Library. The lecture that was shown to the participants was the same lecture that they had viewed during the Project STEPP "Bootcamp." Prior to the participant's arrival, the researcher determined that both the video and audio were functioning, that the audio was loud enough to be heard at every seat at the table, and that the video was clear. The participants were given information regarding this research, signed the IRB, and then were given a questionnaire to assist with collecting descriptive information. After completion, these questionnaires were collected.

For baseline testing, the participants were seated at a long, rectangular conference table in a classroom in the Project STEPP area of Joyner Library. Each participant was given three sheets of blank, lined college ruled notebook paper and a black pen, and told to remove all items from their workspace at the table. They were told to "take notes as if you were in a college class." The researcher asked if any participants had further questions, and all indicated that they understood what they were to do. The researcher started the lecture, while simultaneously starting a stopwatch. She then stood outside of the door with the stopwatch, and only went back into the room to stop the video at the ten minute mark. The researcher then assigned each participant a random number between one and seven and had each participant write the number on the top right corner of the page(s) of notes. The notes were then collected from the participants to use as a baseline point. Refer to Figure 1.

Figure 1.

*Figure Depicting Each Step in the Experimental Method.*



Using a multiple baseline approach, three students were then taught the strategic note taking approach from the researcher in the same classroom, while the other participants were reminded to return in a week to begin the intervention phase. Before instructing the students on this approach, the researcher asked the students how they felt about note taking and if anyone had ever been taught a specific strategy prior to this time. Each of the three students reported that they had not been taught anything specific and found taking notes hard, especially at the undergraduate level. The researcher asked if there were any questions with using the LiveScribe© pen, and the basic procedures were reviewed with the group of students, as there were multiple questions. The procedures reviewed included: how to sync the audio with the handwritten notes, how to adjust volume, and to double check that there is ample charge to last for the duration of the lecture. The researcher then discussed what classes would be most appropriate for strategic note taking (e.g.: psychology, a course in the student's major, or a difficult science course).

This was followed by a description of strategic note taking during a lecture. The first three participants were instructed to:

- take notes in a bullet point format in the manner in which he or she is most comfortable. Some students preferred to take notes in complete sentences, while others preferred to take notes in simple phrases.
- leave one line of space between each bullet point when taking notes in class. This is to allow for room if the student desires to add additional information after the lecture.
- use common abbreviations (e.g.: w/ as an abbreviation for "with," w/o as an abbreviation for "without," or "def." for "definition").
- write a word followed by a colon and then its definition, when given an unfamiliar word.

- copy the graphic exactly if shown an important figure, graph, or chart, and not focus on ensuring that they write each word that the lecturer says, as they will be able to go back and listen again.
- put a small question mark on the far left of his or her page after the one space after the previous bullet point if the student misses an important piece of information. This will serve as an attention grabber for the student to go back and listen to that point in time during the lecture to add extra information.

The students were then given instruction on how to add notes that may have been missed during the lecture. They were told to review their notes the day of the lecture in order to ensure that there are no other areas that need clarification, other than where they had placed question marks during the class. This would serve to draw their attention to the additional areas requiring clarification. After the students had determined which additional information needed to be clarified or added, they were taught to place their LiveScribe© pen on the question marks which would sync the audio with that point in time during the lecture. That way they could go back and listen to the lecture, pause the recording, and write the information down. The participants were then taught to start the recording at the beginning and listen the lecture and read their notes as the lecture played. If anything needed to be added, then the space between each bullet point would be used to insert the additional information.

After they listened to the lecture from beginning to end, then the students were instructed to write a one-page list of the key points in the lecture. That way they could get the gist of each lecture by looking at the one-page review in order to assist with studying for a follow up information comprehension and retention measure (such as a quiz or a test). When studying for a

test, the students would have both handwritten formats to help with active processing of information and as study resources for quizzes or tests.

After a one week time period, the students returned to the same room in the Project STEPP section of Joyner Library. The students were told to get out the paper specifically designed for use with the LiveScribe pen as well as to get out their LiveScribe pen. They were told to remove all items from their workspace at the table. They were told to hit the "record" button on their pen. When the researcher ensured that each participant's pen was functioning, they were told to "take notes as if you were in a college class." The researcher asked if any participants had further questions, and all indicated that they understood what they were to do. The researcher did not give any instruction regarding using the strategy to determine whether the three students who had been given education would independently utilize this strategy. The researcher started the second ten minute section of the lecture, while simultaneously starting a stopwatch. She then stood outside of the door with the stopwatch, and only went back into the room to stop the video after ten minutes had passed. The participants each wrote their specific number on the top right hand corner of the page. The notes were then collected and photocopied to later analyze the quantity and the quality of the notes taken.

After the notes were photocopied, the participants were given back their original notes and told that there would be a quiz in exactly one week and the group members that had been given instruction on strategic note taking were reminded to use this strategy. A one-week time period was given in which the students could use their original notes and the LiveScribe© pen to employ strategic note-taking, any additional note taking strategies, reorganization, or add additional information. The second group of two students were given the same instruction for use of the LiveScribe© pen and strategic note taking as the other three participants.

After the seven day time period, the students returned to the same classroom. Each participant handed the researcher his or her notes to again photocopy. The researcher then handed out the quiz to the students that pertained to the information presented in the second ten minute section of the lecture. The quiz was comprised of eight questions (with four inferential and four factual questions in a random order). While the students took the quizzes, the researcher wrote an "A" or "B" on each of the photocopies (one from immediately following the lecture and the other from after the one week time period) in a randomized order. When each student was finished and the quizzes were collected, the researcher repeated the same experimental procedure with the third section of the lecture as with the second section of the lecture. The students were then reminded to return in one week to take the follow up quiz. After the seven day time period, the researcher repeated the same procedure with the quiz pertaining to the third section of information in the "Hurricanes" lecture.

# Chapter III

## Results

The act of taking notes has been widely researched in many student populations, especially students who have been diagnosed with learning disabilities. Researchers have demonstrated that students who have been diagnosed with learning disabilities do not take notes that are as comprehensive or complete as the notes of their non-disabled peers. However, limited research has investigated whether the use of technology can influence the note taking skills of post-secondary education students who have been diagnosed with learning disabilities. With the influx of technology and assistive technology now available to all students, such as laptop computers, recording devices, and the LiveScribe© pen, students are able to have access to a previously presented lecture. The student can go back and listen to grasp any information that he or she may have missed while listening in the classroom and taking notes.

The participants of this study included five college undergraduate freshmen who have been diagnosed with learning disabilities and part of the East Carolina University Project STEPP first-year student cohort. The pre-experimental tests that were administered prior to the study included: a hearing screening, the Word Identification (WI), the Word Attack (WA), Word Comprehension (WC), and Passage Comprehension (PC) subtests from the **Woodcock Reading Mastery Test-Revised (WRMT-R)**; and the Visual Modality (VM), Auditory Modality (AM), Delayed Recall (DR), Oral Fluency (OF), and Written Fluency (WF) subtests from the **Test of Information Processing Skills (TIPS)**. Each participant passed the hearing screening bilaterally as determined by a pure-tone audiometric hearing screening at 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz at 25 dB. The means of the results of each subtest for the **WRMT-R** and the **TIPS** are

shown in Table 1. Individual scores for each participant for each of these pre-experimental tests are shown in Appendix C.

In this experiment, participants took notes on three segments of the same lecture titled "Hurricanes," which was presented by a faculty member of the East Carolina University Department of Geography. A multiple baselines approach was used in which one group of students at a time was taught strategic note taking from the researcher. A recorded sample from the same lecture was played for all students, and using their LiveScribe© pens, the students took notes on the lecture. Subsequently the notes were photocopied to use for later analysis and comparison. Following a one-week time period, the notes were photocopied again and compared to the previously photocopied notes from immediately following the lecture to determine whether any additional information was added following the original lecture presentation. Also they were compared to analyze the quantity and the quality of the notes taken. A quiz was given on the material covered in the lecture segment to determine information retention. This procedure was repeated with the second group of students given instruction on strategic note taking.

Once the series of three lectures was completed and the participant's notes had been collected, two non-biased students analyzed the notes in a blind analysis. The researcher gave each investigator the photocopied notes from each participant. There were three sets of notes from each participant, one set from the first week (baseline testing), one set from the second week, and one set from the third week. Each of the sets consisted of the two copies of the notes taken - one from immediately following the lecture and the other from immediately preceding the quiz in a random order, with one labeled "A" and the other labeled "B." The investigators were given a two-question evaluation for each set of participant's notes from the lecture series.

Table 1.

*Means for the results of the **WRMT-R** (Word Identification, Word Attack, Word Comprehension, and Passage Comprehension Subtests with the Total Reading Cluster Score) and the **TIPS** (Visual Modality, Auditory Modality, Delayed Recall, Oral Fluency, and Written Fluency Subtests).*

| **Pre-Experimental Subtest** | **Standard Score Means** | **Standard Deviation** |
|---|---|---|
| ***WRMT-R:*** *Word Identification* | 90.2 | 2.62 |
| *Word Attack* | 92.2 | 2.67 |
| *Word Comprehension* | 97.2 | 2.69 |
| *Passage Comprehension* | 85.8 | 2.70 |
| *Total Reading Cluster Score* | 89.4 | 7.01 |
| ***TIPS:*** *Visual Modality* | 94.4 | 1.37 |
| *Auditory Modality* | 87.4 | 2.11 |
| *Delayed Recall* | 80.0 | 2.39 |
| *Oral Fluency* | 98.0 | 2.54 |
| *Written Fluency* | 98.0 | 2.54 |

*Note: The **WRMT-R** and the **TIPS** are reported in standard scores, which have a mean of 100 and a standard deviation of +/- 15; therefore, the average range is 85-115.*

The investigators were asked to decide which notes were better in both quantity and quality ("A" or "B"), and then told to explain why in their own words, which was used to measure the quality of the notes. To measure the quantity of the notes, the two investigators were told to count the number of accurate information units, the number of inaccurate information units, and the number of vocabulary words with definitions.

After the notes were judged by the two investigators (and data was collected related to the objective measurement of both quality and quantity), the researcher analyzed the data collected. The researcher compared each participant's results from the notes prior to the quiz to the notes immediately following the lecture. The researcher also analyzed the descriptive data collected. For example, the researcher determined if participants with a certain learning disability diagnosis benefited from the use of the strategy as compared to participants with a different learning disability diagnosis-if participants with comorbid ADHD benefited from the strategy as compared to participants without ADHD, and what characteristics were present in the participant's notes (such as: abbreviations, acronyms, or repetitiveness of the notes).

For each set of notes from the same lecture sample (immediately after lecture presentation and after a one-week time period), two non-biased investigators analyzed the notes taken. Each set consisted of the two copies of the notes taken in a random order with one labeled "A" and the other labeled "B." To measure the quality of the notes, the investigators determined which set of notes were better, "A" or "B," and explained their rationale. To measure the quantity of the notes, the two investigators calculated the number of accurate information units, the number of inaccurate information units, and number of vocabulary words with definitions.

The independent variables for this experimental intervention included: the lecture condition (baseline note taking skills, notes taken immediately following lecture presentation,

and notes taken after a one-week times period following lecture presentation) and the group (within an individual diagnosed with a learning disability or within a group of undergraduate freshmen who have been diagnosed with learning disabilities.

The dependent variables for this experimental intervention included: the quantity of the notes (the number of accurate information units, the number of inaccurate information units, and the number of vocabulary words with definitions); the quality of the notes (the structure of the notes taken, if the student changed the format of the notes between the two conditions, if information units were added in the second condition, and if notes were reformatted between conditions) to determine if an interaction existed between the independent variables. The dependent variables also included the participant's overall percentage of accuracy on the follow-up information retention measure, the percentage of accuracy for inferential questions, and the percentage of accuracy for the factual questions.

***Quantity of Information Units***

The first experimental question was to determine if using the strategy of strategic note-taking with the LiveScribe© pen increased the quantity of idea units (the number of accurate information units, the number of inaccurate information units, and the number of vocabulary words with definitions) written down immediately following a ten minute sample of a lecture and seven days following the lecture within an individual diagnosed with a learning disability and in a group of undergraduate students diagnosed with learning disabilities. The mean proportion of accurate information units, inaccurate information units, and vocabulary words with definitions for the entire participant pool in both conditions: immediately following a ten minute sample of a lecture and seven days following each lecture presentation can be found in Table 2.

Table 2.

*Mean proportion of accurate information units, inaccurate information units, and vocabulary words with definitions for both immediately following a ten minute sample of a lecture and seven days following the lecture presentation.*

| **Mean Quantity Measures** | **Immediately Following Lecture Presentation** | **Standard Deviation** | **7 Days Following Lecture Presentation** | **Standard Deviation** |
|---|---|---|---|---|
| Lecture one: Accurate Information Units | 0.250 | 0.17 | 0.297 | 0.15 |
| Lecture one: Inaccurate Information Units | 0.000 | 0.00 | 0.000 | 0.00 |
| Lecture one: Vocabulary Words with Definitions | 0.440 | 0.25 | 0.460 | 0.23 |
| Lecture two: Accurate Information Units | 0.317 | 0.12 | 0.478 | 0.11 |
| Lecture two: Inaccurate Information Units | 0.000 | 0.00 | 0.000 | 0.00 |
| Lecture two: Vocabulary Words with Definitions | 0.500 | 0.17 | 0.500 | 0.17 |
| Overall Accurate Information Units | 0.275 | 0.14 | 0.365 | 0.12 |
| Overall Inaccurate Information Units | 0.000 | 0.00 | 0.000 | 0.00 |
| Overall Vocabulary Words with Definitions | 0.463 | 0.19 | 0.475 | 0.18 |

The figure illustrating the proportion of accurate information units from the baseline lecture, lecture one, and lecture two immediately following lecture presentation and after a seven day time period can be found in Figure 2. The proportion of vocabulary words with definitions from lecture one and lecture two immediately following lecture presentation and after a seven day time period can be found in Figure 3.

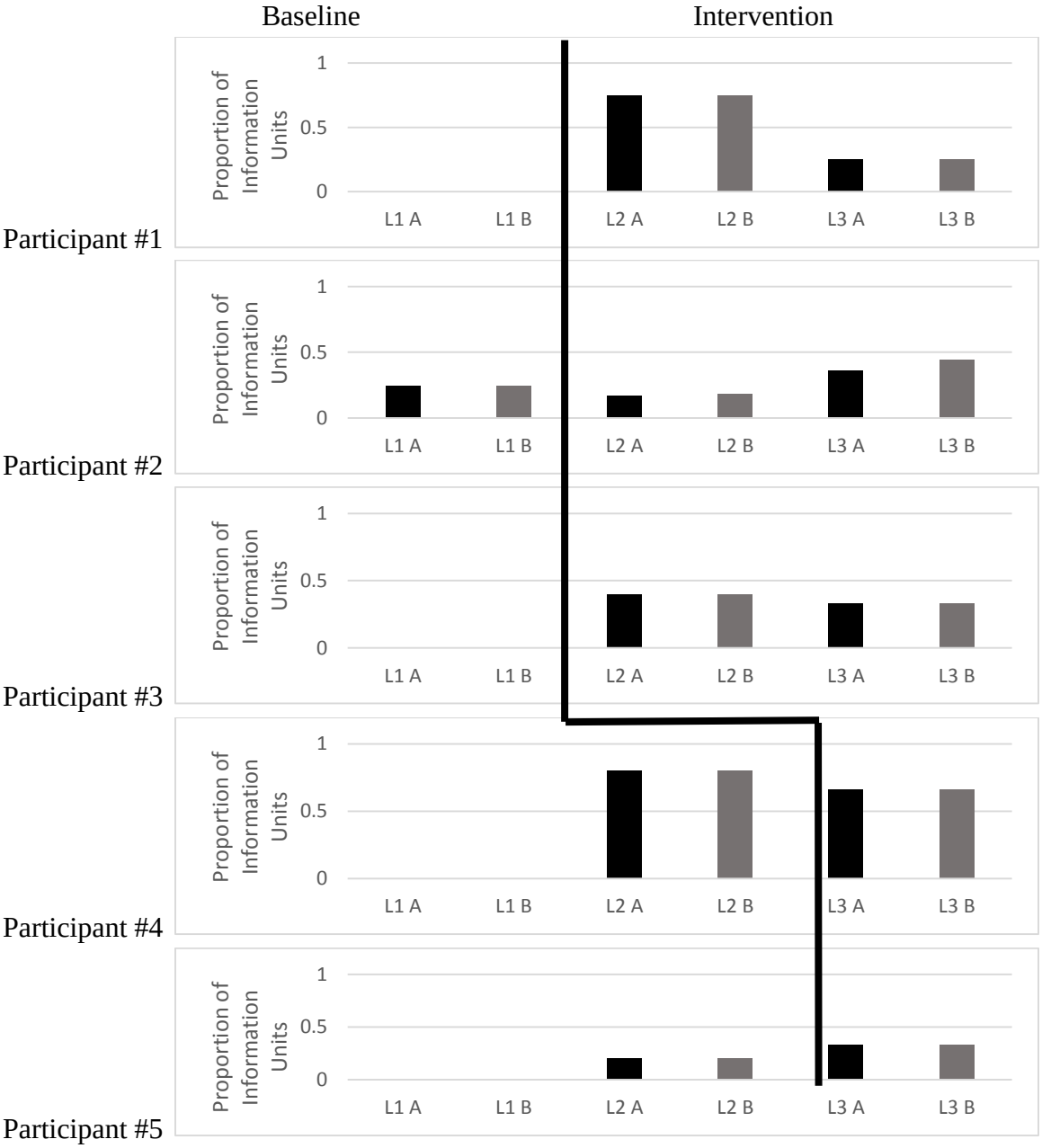
The results of this experiment indicate that, as a whole, the participants increased the number of correct information units from the condition immediately following the lecture presentation to the one-week period condition following lecture presentation. There was a sharper increase in the number of information units from immediately following the lecture presentation to a one-week period following lecture presentation on the second lecture. This is when the entire participant pool had been exposed to the strategic note-taking teachings provided by the researcher. There was a very slight increase in the number of citing of vocabulary with definitions from immediately following the lecture presentation to a one-week period following lecture presentation on the second lecture from an average of 1.85 vocabulary words to 1.90 vocabulary words. It can be noted that there was no change in the number of incorrect information units from one condition to the next, since no participant wrote down any incorrect information during the lecture presentation.

***Quality of Information Units***

The second experimental question asked whether using the strategy of strategic note-taking with the LiveScribe© pen increased the quality of idea units (the structure of the notes taken, if the student changed the format of the notes between the two conditions, if information units were added in the second condition, and how the student reformatted his notes between conditions) in two different conditions.

Figure 2.

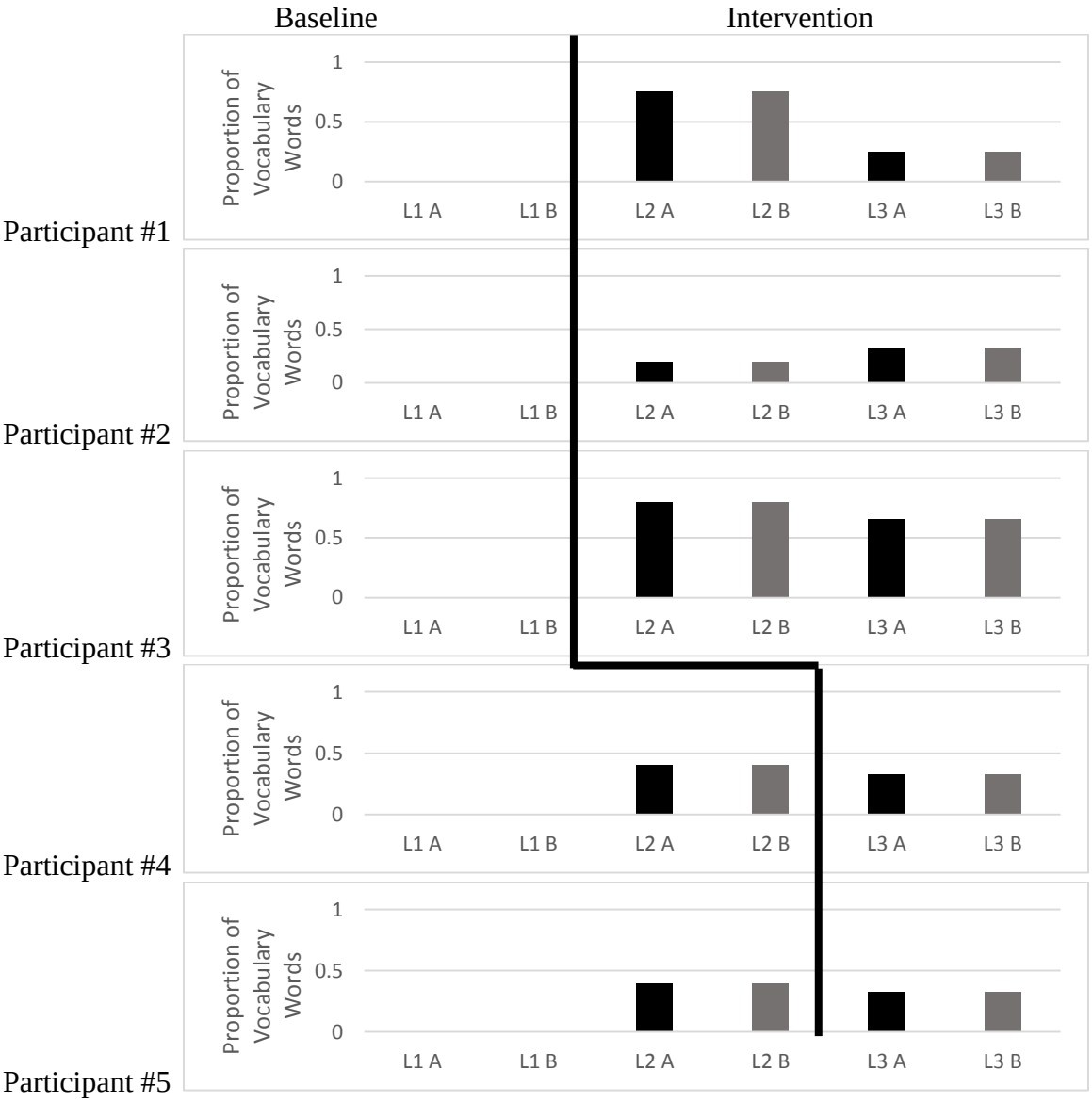
*Proportion of accurate information units for each participant for both immediately following a ten minute sample of a lecture and seven days following each lecture.*




*Note: L1 refers to baseline lecture, L2 refers to lecture one, L3 refers to lecture two, A refers to notes taken immediately following lecture presentation, and B refers to notes taken one week following lecture presentation.*

Figure 3.

*The proportion of vocabulary words with definitions for each participant for both immediately following a ten minute sample of a lecture and seven days following each lecture.*




*Note: L1 refers to baseline lecture, L2 refers to lecture one, L3 refers to lecture two, A refers to notes taken immediately following lecture presentation, and B refers to notes taken one week following lecture presentation.*

The first condition, immediately following a ten-minute sample of a lecture, and the second condition was seven days following the lecture within an individual diagnosed with a learning disability and in a group of undergraduate students diagnosed with learning disabilities. Table 3 reports the results of the structure of the notes taken, if the student changes the format of the notes between the two conditions, if information units are added in the second condition, and how the participant reformats his notes between conditions.

Some of the structures of the notes taken include: making a list of phrases, vocabulary with definitions, bullet points, question and answer format, indented outline format, abbreviations, or drawing pictures. A list of phrases means that the participant simply wrote phrases on each consecutive line of paper. If the participant formatted his or her notes with vocabulary and definitions, then he or she wrote a new term (vocabulary word) mentioned within the lecture, and then either a colon or a dash, and a definition of the term. This could be combined with several other formats, such as indented outline format or bullet points as well. The bullet point format means that the participant used bullet points to separate each individual note on subsequent lines of the paper. Bullet point format could be in either phrases or sentences. Question and answer format indicates that the participant wrote out a question either posed by the lecturer, verbatim, or summarized in his or her own words, ending in a question mark. To be in this format, the student then responded to the question posed. The indented outline format is an outline format in which each subsequent heading is indented farther to the right, instead of using a Roman numeral outline system. Abbreviations signify any abbreviation that the participant used- whether commonly used or personally designed for the student to understand his or her own notes.

Table 3.

*The structure of the notes taken, if the student changes the format of the notes between the two conditions, if information units are added in the second condition, and how the participant reformats his notes from immediately following lecture presentation to seven days following lecture presentation.*

| **Participant Number** | **Structure of Notes Taken Immediately Following Lecture** | **If Student Changed Note Format** | **If Information Units Added** | **How Participant Reformatted Notes** |
|---|---|---|---|---|
| 1 | list of phrases<br>definitions | No | Yes | Same as prior |
| 2 | bullets<br>list of phrases<br>definitions | No | Yes | Same as prior |
| 3 | list of question/answer<br>indented outline<br>abbreviations | Yes | Yes | list of question/answer<br>drew pictures<br>indented outline<br>abbreviations |
| 4 | list of phrases<br>definitions | No | Yes | Same as prior |
| 5 | slide number with heading bullet points<br>list of phrases | No | No | Same as prior |

The results of this experiment indicate that a majority of the participants (four out of five), did not change or alter the format of their notes in any way, regardless if they were adding additional information units. Only one participant changed his or her notes, and the only difference in the notes was that he or she added a graphic/picture that was on the slide during the original lecture presentation. This participant had been diagnosed with dyseidetic dyslexia; however, the other participant who had also been diagnosed with dyseidetic dyslexia did not change his notes between the original lecture presentation and the one-week period following the lecture. The commonly used format for taking notes included using bullet points, listing phrases, vocabulary with definitions, and/or a combination of the previous formats.

***Comprehension and Information Retention***

The third experimental question asked if using the strategy of strategic note-taking with the LiveScribe© pen aids lecture comprehension and information retention following a seven day period from presentation of the lecture as measured by the overall percentage accuracy on an eight question quiz comprised of four inferential questions and four factual questions in a random order, the percentage accuracy on the four inferential questions, and the percentage accuracy on the four factual questions within an individual diagnosed with a learning disability and in a group of undergraduate students diagnosed with learning disabilities. A table illustrating the percentage of accuracy for the quiz, the four inferential questions, and the four factual questions can be seen in Table 4 for each individual participant on lecture one and lecture two. A table illustrating the mean percentage of accuracy for the quiz, the four inferential questions, and the four factual questions can be seen in Table 5 for lecture one and lecture two.

Table 4.

*The percentage of accuracy for the quiz overall, the percentage of accuracy for the four inferential questions, and the percentage of accuracy for the four factual questions on lectures one and two.*

| | **Percent Accuracy on Quiz one Overall** | **Percent Accuracy on Quiz one Inference Questions** | **Percent Accuracy on Quiz one Factual Questions** | **Percent Accuracy on Quiz two Overall** | **Percent Accuracy on Quiz two Inference Questions** | **Percent Accuracy on Quiz two Factual Questions** |
|---|---|---|---|---|---|---|
| **Participant #1** | 75 | 75 | 75 | 63 | 50 | 75 |
| **Participant #2** | 38 | 50 | 25 | 38 | 25 | 50 |
| **Participant #3** | 63 | 75 | 50 | 38 | 0 | 75 |
| **Participant #4** | 50 | 25 | 75 | 75 | 50 | 100 |
| **Participant #5** | 75 | 75 | 75 | 75 | 100 | 50 |

Table 5.

*The mean percentage of accuracy for the quizzes overall, the percentage of accuracy for the four inferential questions, and the percentage of accuracy for the four factual questions.*

| | **Percent Accuracy** |
|---|---|
| **Quizzes Overall** | 59.00 |
| **Inferential Questions** | 52.50 |
| **Factual Questions** | 65.00 |

# Chapter IV

## Discussion

In disciplines related to education and learning, research is necessary to better understand and utilize the rapidly growing field of technology within an academic setting. For many years, researchers have focused on the note taking skills of students diagnosed with learning disabilities as compared to their peers who have not been diagnosed with a disability. It has been posited that students who have been diagnosed with learning disabilities do not take as comprehensive or complete notes as their classmates who do not have learning disabilities (Hughes & Suritsky, 1994).

As a result of these studies, it has been accepted that students with learning disabilities have difficulties taking notes in an undergraduate lecture setting. However, there has been a rapid change in technology and significant technological advances in the past decade, which have not been researched with note taking as thoroughly as taking notes by hand. Within the past ten years, there has been an influx of laptop computers for use in the classroom to take notes, the use of iPads© to take notes, the use of desktop computers with recording and spell-checking capabilities, multiple recording devices, and the LiveScribe© pen. The LiveScribe© pen can be used in the same manner as a typical ink pen, can be turned on to audio record information, or can use the audio recording and pen together. This is a very different educational and academic scenario than from what the previous research has explored. With all of this assistive technology, students can take notes on the computer by typing them, take photos of a graphic or important figure in class with their cellular phone, record a lecture and then go back and listen to it again to fill in any gaps in information that may exist from taking notes during the original lecture, or even have access to an outline of the lecturer's notes in the form of a PowerPoint or handout to

ease the burden of organizing the main points to be covered within the lecture. Students have access to an expansive amount of assistive technology at their fingertips, with which to use in the post-secondary academic setting. Due to this lack of research in this area, this current study was designed to explore whether using a specific note taking strategy in conjunction with the LiveScribe© pen can assist post-secondary freshman students diagnosed with learning disabilities in note taking skills during and following a lecture.

***Quantity of Information Units***

The first experimental question was to find out if using the strategy of strategic note-taking with the LiveScribe© pen increases the quantity of idea units (the number of accurate information units, the number of inaccurate information units, and the number of vocabulary words with definitions) written down immediately following a ten minute sample of a lecture and seven days following the lecture within an individual diagnosed with a learning disability and in a group of undergraduate students diagnosed with learning disabilities.

This study revealed that the mean quantity measures of accurate information units from a seven day time period following the lecture presentation were greater than the mean quantity measures collected immediately following the lecture presentation. This pattern was demonstrated across the two groups of participants (the group instructed on strategic note taking skills prior to lecture one and the group instructed on strategic note taking skills prior to lecture two) in the multiple baseline approach, and correlates to the research conducted by Bireley et al. (1986), Cowen (1988), and Suritsky (1992). These researchers have found that post-secondary students are unable to write as quickly as their non-disabled peers and have difficulty reading their handwriting following a lecture. These studies revealed that the students who went back and reviewed their notes after a lecture were able to add in the missing details and also clarify

any legibility issues. In this study, the participants demonstrated an increase in the number of accurate information units from immediately following lecture presentation to a one week period following the lecture presentation. The second lecture exhibited even a greater increase in the number of information units added, which could be attributed to the fact that the entire group of participants had been instructed on the use of strategic note taking, as opposed to just half of the participants who had received instruction with the first lecture.

A majority of the participants exhibited an increase in the number of information units from immediately following a lecture to the one-week period after the lecture was presented. In four out of five participants, the participants added information units. Of these four participants, two were diagnosed with dyseidetic dyslexia, one with reading comprehension deficits, and one with average reading abilities. This is interesting in that there was no pattern between these participants in that each of these participants performed in a similar manner, regardless of their reading profile. Participant #5, however, who had been diagnosed with mixed dysphonetic/dyseidetic dyslexia exhibited fewer additions to his notes than did the other participants.

The mean quantities of inaccurate information units (from the first to the second condition) used in the note taking remained steady at a 0.0 mean, indicating that the participants did not write down any inaccurate information units throughout the entire study. This is remarkable in that it indicates that the participants only wrote down information about they knew was accurate based upon the lecture presentation. This is interesting because it hints at the fact that the students are not taking risks by taking notes on information that they think that they heard, but instead, just do not write it down, to ensure accuracy when studying for a test or quiz.

This finding supports the research conducted by Joseph Boyle (2012), specifically that students who have been diagnosed with learning disabilities write down fewer notes.

This current study shows that if the students do not know if the information is important or that their perception of the information provided is accurate, they will not write down that information. That can be both a positive and negative finding from this study. It is positive in that the participants are not writing down inaccurate information. Research has shown that note taking aids with coding the information presented auditorily into long term memory to allow for better storage (Ruhl & Suritsky, 1995). If the students are not taking notes on inaccurate information, then the information that they are writing down with be accurately coded into long term memory to aid with memory retention and recall. On the other hand, this can be a drawback, because the participants are not writing a large quantity of information, and thus, might not catch all of the important points covered within a lecture. If information was written down, and then the participants went back to listen to the lecture and ensure accuracy, then any incorrect information could be amended.

Three of the participants (participants #1, 2, and 3) exhibited delayed recall skills that were below average for information presented auditorily as indicated by pre-experimental testing. Of these three participants, all three participants noticeably benefitted from being able to utilize the LiveScribe© pen in conjunction with the note taking strategy to assist with adding information units. This is important in that it demonstrates that students who exhibit difficulties with recalling auditory information in their episodic memory may benefit from multiple repetitions of the same information in order to comprehend and recall the information. Within this study, it should be noted that the LiveScribe© pen allowed these students to access the same information multiple times, which allowed them to add extra information crucial to

understanding the overall lecture. The other two participants (participants #4 and 5) presented with delayed recall skills for visual and auditory memory in the average range. Of these, only participant #4 truly benefited from using the LiveScribe© pen in terms of quantity of information units, and participant #5 did not add information units.

This study also shows a very slight increase in the number of vocabulary words with definitions written down after the first lecture, and then no change within the second lecture when the entire group of participants was taking notes. This finding is notable in that, as a whole, students diagnosed with learning disabilities who hear new vocabulary do not write down the unknown vocabulary word or its meaning, which could be related to an underlying language component. This can be detrimental to post-secondary students because these students are learning new vocabulary every day, especially very specific and detailed terms relating to their intended academic major, that are not commonly used vocabulary terms. If the students do not begin to use these terms or ensure accurate understanding of the meaning, their total understanding of a post-secondary course could be impacted. This is because college courses are designed so that each class builds upon the information and vocabulary presented the previous session. If the student exhibits difficulty with writing down vocabulary to ensure accurate understanding from the outset, then they will most likely demonstrate increasing difficulties with understanding and or using additional vocabulary presented later on in the course.

***Quality of Information Units***

The second experimental question asked is if using the strategy of strategic note-taking with the LiveScribe© pen increases the quality of idea units (the structure of the notes taken, if the student changes the format of the notes between the two conditions, if information units are added in the second condition, and how the student reformats his notes between conditions) from

immediately following a ten minute sample of a lecture to seven days following the lecture within an individual diagnosed with a learning disability and in a group of undergraduate students diagnosed with learning disabilities.

In this study, the participants did not demonstrate changes in the formats of their notes from the baseline session to the final lecture. The predominate form of notes taken by all of the participants were in a bullet point format. Prior to entering the post-secondary institution, these students had not formally been taught any specific note taking strategy. Some participants used bullet points in tandem with writing phrases of information. When asked, the participants stated that they had not been taught any specific note taking format or strategy in their previous schooling.

Possible explanations for this finding may relate to the influx of technology in the educational setting. If students in middle school or high school are being provided with multiple sources of what information will be covered within a class, then the students are not being forced to learn how to take notes, as a majority of the information is being provided them. If students are not being tasked with the responsibility of learning how to take appropriate and comprehensive notes, then their post-secondary education will be much more difficult because the professors and lecturers expect that their students have a functional manner in which to take notes.

Also, it is possible that the students did not have a need to reformat their notes between immediately hearing the lecture and the one-week period following. These participants had already heard the lecture during their “Bootcamp” prior to the beginning of the academic year. As they had already been exposed to this lecture, these participants may have already formed an idea of how to format their notes already, before this study even began. This possible explanation

allows for another avenue for further research in note taking skills in students diagnosed with learning disabilities in a post-secondary setting.

These findings could be used to teach strategies to students diagnosed with learning disabilities how to take notes that will be comprehensive and organized. However, every student is different, so one format will not work with each individual, but if given education on several formats, the student could choose what format best serves his or her needs. This process could be guided by a speech-language pathologist. This speech-language pathologist should perform a full battery of language tests in order to determine if there are any underlying oral language factors that could be impacting the note taking abilities of the student. This way, the speech-language pathologist can ensure that the student is using the most appropriate note taking strategy based upon his language profile. The particular format of choice for the student should be utilized multiple times in high school or prior to entering a post-secondary level of education to ensure functionality. Moving from secondary school to a post-secondary level is a change to begin with. This also compounds the difficulty with having to learn how to take notes while in college courses. To eliminate this exacerbating factor, students diagnosed with learning disabilities should be education regarding different note taking formats and given an opportunity to figure out which format works best for him or her.

***Comprehension and Information Retention***

The third experimental question asked if using the strategy of strategic note-taking with the LiveScribe© pen aids lecture comprehension and information retention following a seven day period from presentation of the lecture as measured by the overall percentage accuracy on an eight question quiz comprised of four inferential questions and four factual questions in a random order, the percentage accuracy on the four inferential questions, and the percentage

accuracy on the four factual questions within an individual diagnosed with a learning disability and in a group of undergraduate students diagnosed with learning disabilities.

These results demonstrate that even with the use of the LiveScribe© pen, the percentage of accuracy on the follow-up information retention measures (quizzes) of 59% was still very low. This means that the participants either did not comprehend, or did not retain the information presented during the lectures. It can also be shown in this study that the percentage of accuracy for the factual questions was higher than the percentage of accuracy for the inferential questions. This could be attributed to the fact that there are a number of processes that must take place when a student answers an inferential question. Some of these processes could be impacted by the student's language profile and underlying deficits.

As a whole, the group of participants exhibited lower information retention from information provided during a lecture. The design of this study was created to mimic that of an undergraduate classroom in which a freshman student is being exposed to information with which he or she is unfamiliar, and asked to take notes. This simulation is close to that of a typical college classroom, and allowed the researcher to evaluate how well the participants were comprehending information and retaining information with the aid of their notes and the assistive technology of a LiveScribe© pen.

It should be noted however, that this simulation may not have been truly representative of a typical college classroom. This study was conducted in the latter half of the academic semester, beginning during the week of mid-terms in the participant's academic classes. This is a stressful time in a college student's life, due to the large amount of information that a student must learn in order to succeed on an information retention measure in the academic setting. These participants were overwhelmed at the time of this study with their other academic classes. These

students may not have put forth their full effort into the strategic note taking process with the LiveScribe© pen upon which they had been educated. When the participants were asked if they had used this strategy with the notes taken from immediately following the lecture presentation, a majority of the participants (three out of five), stated that they did use the strategy. However, each student was quick to add that they did not follow every direction given, although they did listen to parts of the lecture. Their feelings of being overwhelmed with other academic coursework could have affected these students' willingness to do each step given to them in the original education provided regarding the strategy.

In the research study conducted by Peper and Mayer (1986), a positive correlation was found between the amount of notes taken during a lecture in a post-secondary classroom and follow-up test scores obtained specific to the information provided during the lecture. The findings of this study support the conclusions of this earlier study. In the current study, the participants took only a few notes (mean quantity of information units overall was 7.7) for a ten minute lecture segment. That means that the students took down an information unit about every 1.2 minutes. This could potentially be attributed to an underlying written language deficit as well. This is important because the lower number of information units written down means that there is less information written down with which to study for a follow up quiz or test. Relating this to a post-secondary course, a student may only have a midterm test in the middle of the semester and a final exam at the end of the semester. If the students are only taking two tests per fifteen weeks of material, and take a very limited number of notes, according to Peper and Mayer (1986), these students will not score well. This is reflected in the current study, as the overall percentage of accuracy from the quizzes is only 59%. In a post-secondary course, if this was a final grade, the students would have failed the course.

Based upon the pre-experimental testing, two participants were diagnosed with dyseidetic dyslexia, one with a reading comprehension impairment, one with no reading difficulties, and one with mixed dysphonetic/dyseidetic dyslexia. Of these participants, it could be hypothesized that the four participants with some form of reading impairment (whether dyslexia or reading comprehension deficits), would have difficulties in post-secondary education courses due to the high level of reading required in addition to the amount of writing required for the in-class lectures. As much of the information provided during the "Hurricanes" lecture was also visually provided in the forms of graphics and written definitions, the results of these low comprehension measures were to be expected. However, participant #4 also scored in the "failing" range of the follow-up information retention measures. Therefore, there was no pattern found within the group of participants relating to their learning disability, when only reading impairments are considered.

Likewise, it should be noted that there were differing abilities present relative to delayed recall skills for information presented both auditorily and visually. The participants who presented with difficulties with auditory recall (participants #1, 2, and 3) all scored below 75% on the follow-up comprehension measures. There were no individuals who presented with visual recall deficits within this group of participants. The participants (participants #4 and 5) who exhibited average skills in delayed recall for information presented verbally and auditorily, also obtained scores between 50%-75%. Due to the variance in profiles and low scores for all participants, no pattern can be distinguished between delayed recall measures and the outcome of a follow-up comprehension measure, such as a quiz or test.

This could be attributed to two different factors. First, that the participant did not take enough notes or comprehensive enough notes to truly comprehend the information. Or, that the

student did not review his or her notes prior to the quiz. It has been shown that if a student takes notes during a lecture, and then does not review them prior to a test or quiz, that he or she will score lower on the follow up assessment than someone who has reviewed his or her notes from class (Kiewra et al., 1991). This current study did not differentiate between the two factors, so it is unknown whether the students did not study or take comprehensive notes.

Another explanation for this finding from this study is that the timing when this study was conducted may have impacted the results. This study was started later in the semester than was expected prior to the beginning of the study. These participants were highly engaged and involved in their other academic classes, as the study was conducted in the second half of the semester around mid-term evaluation time. The student may have been focusing their efforts more on their academic classes instead of this study. They may not have gone back to review the notes taken in the study, as they were more concerned with their grades in their college level courses.

However, in this study, there were two formats of questions given to the students: inferential questions and factual questions. As a whole, the students answered more factual questions correctly than inferential questions. This could be attributed to the fact that a factual question comes from information presented straight from the lecturer's oral discourse. The response to a factual question is a concrete answer and there is no additional thinking or problem solving involved. An answer is either right or wrong, and comes explicitly from the presentation. Some research suggests that students diagnosed with learning disabilities perform better when given concrete images and facts than inferential or abstract ideas (Kiewra et al., 1991). This could potentially be attributed to verbal reasoning or inferential reasoning, due to an underlying oral language impairment.

The students scored lower on the inferential questions given in this study. As previously mentioned, this can be explained by the fact that students diagnosed with learning disabilities tend to perform better with concrete right or wrong answers. With an inferential question, a student must first understand what the question is asking, figure out what information he or she needs to know, figure out the answers to what he or she needs to know, and then process that information to come up with the correct answer. This involves many steps for one multiple choice problem, much less for a test full of inferential questions. An inferential test question is given to evaluate if the student understands a concept well enough to be able to apply it.

The findings of this study may show that lecture review alone is not enough for a student to pass a college-level course. This student must study the information and apply the information learned in order to demonstrate knowledge and understanding of the lecture concepts presented. The findings from this study support the research of Weishaar and Boyle (2010), which concludes that if students become more involved in the note-taking and use the metacognitive skills of organizing incoming aurally presented information and combining the new information presented with prior knowledge, students increase their comprehension of the information presented.

This finding could be used to assist post-secondary lecturers and educators to best design a comprehensive follow up comprehension measure, such as a test or quiz for students diagnosed with learning disabilities. This finding indicates that students diagnosed with learning disabilities have difficulties with the abstract information and less of a challenge with factual or concrete information. The ideal test design for students diagnosed with learning disabilities would be to have a more factual question based test design earlier in the course to ensure that the students are comprehending and retaining the basic concepts upon which the information from a course is

based. After the lecturer feels that the students understand the basic information and are able to build upon it, as like a building block, then the test formats should morph into more of an inferential question based test. This way, the professor can see whether the student has incorporated the information provided, processed it, and understands how to best apply it to a given situation.

***Limitations***

Findings of this research reflect the outcomes for these five participants and should not be generalized to the larger population of students with learning disabilities. There are many subtypes of learning disabilities, and this group of participants was not a complete representation of the population of students who have been diagnosed with language learning disabilities at the post-secondary educational level. Future studies should aim to address these preliminary findings with a larger number of participants that more accurately reflects the current breakdown of different subtypes of learning disabilities at the post-secondary educational level. Also, these future studies should give the participants a full battery of tests to identify underlying language deficiencies that could impact on learning in general.

The pre-experimental testing conducted in this study did not add information to the participants' existing diagnoses of specific learning disabilities. The pre-experimental testing conducted only focused on identifying if the participant had a primary reading disorder, and if so, the subtype. For this study, the diagnoses found as a result of the pre-experimental testing did not add to the previously existing diagnoses or affect the outcomes of this particular study. By being able to administer a full battery of language tests, a researcher can use the participant's full language profile and research whether certain aspects of a person's learning profile further impact their note taking skills.

Secondly, due to a delay in the start date of this research, students were well into their semester coursework before the intervention began. This shortened the timeline available for data collection resulting in an inability to collect multiple iterations of data prior to the intervention to ensure baseline stability. Additionally, only one lecture session occurred in each subsequent phase. More data points would have allowed a more thorough analysis of student outcomes before and after the intervention began. Also, starting well into the semester may have impacted the priority students placed on thoroughly following through with lecture review techniques and the motivation of student participants who may have selected instead to spend their time focusing on course assignments. By the time the project started, the student coursework load had increased from the early weeks of the semester. Students may have placed a priority on completing their coursework than spending as much time as they would have with this material in an actual classroom situations. Future researchers may want to incorporate the intervention into an actual course environment and begin at the very beginning of the semester.

A third limitation to this study was that the length of the lecture information presented at a time was not equivalent to that of a typical college classroom. Usually for a post-secondary level course, a lecture is given for a minimum of forty-five minutes, whereas in this study, only ten minutes of a lecture were given. The results may have been different if truly representative of a college course. Future studies should be conducted in an actual classroom environment or attempt to more closely simulate the length of a typical lecture session to evaluate these students' performances.

Finally, the length of the overall study was not representative of a true post-secondary course either. A typical college course lasts approximately fifteen weeks in length. This study was only for three weeks, so not as much information was presented as would typically be given.

A future study should research the information comprehension and retention and overall note taking in a longitudinal manner over the course of an undergraduate freshman's class to research note taking with a LiveScribe© pen over a more realistic representation of a college course.

### *Future Research*

Implications from this research suggest the need to further investigate the impact of note taking with specific diagnoses under the umbrella term of "learning disabilities." In this study, a group of student participants were used who were diagnosed with learning disabilities, but who were not categorized into specific diagnoses. Further research should also be conducted in a longitudinal manner to better see the note taking skills of students diagnosed with learning disabilities over a longer time period and also to more accurately evaluate information comprehension and retention over the course of a post-secondary length semester.

### *Summary*

The purpose of this study was to explore whether using a specific note taking strategy with the use of the LiveScribe© pen can aid college students diagnosed with learning disabilities in note-taking skills during and following a lecture. An analysis of the quality of notes taken, quantity of notes taken, and information retention revealed educationally relevant findings, which suggest both educational applications and additional studies to research this over a longer period of time.

An analysis of the quantity of notes taken revealed that while the participants did not write down inaccurate information units, they wrote down a small number of accurate information units. The overall findings indicated that the students only wrote a small number of information units given the length of the material. This small number of information units impacted the overall quiz scores following the lecture presentation. The quantity of notes taken

in this study was consistent with the research conducted by Locke (1977), Bretzing and Kulhavy (1981), Peck and Hannafin (1983), LeBauer (1984), Kiewra and Benton (1988), Smith and Tompkins (1988), Hughes and Suritsky (1994), and Bligh (2000).

An analysis of the quality of the notes taken revealed that the participants took notes in very similar formats, utilizing a bullet point format. It is important to note that only one participant changed the format of his or her notes and reorganized the information provided. In this case, the only change was that the participant added a graphic from the presentation. This raises the question whether it might be more difficult for the students to integrate all of the incoming additional information with what they already know and understand, which is a component of oral language.

Information comprehension and retention analysis of the notes by using a follow up quiz revealed that these college students diagnosed with learning disabilities found answering inferential questions more difficult than factual questions. Analysis also shows that these students either do not take comprehensive enough notes from the outset or do not study their notes as well as they should to ensure information retention over a period of time.

This study suggests that there is a pattern between the type and number of notes taken and score on a follow up assessment measure for students who have been diagnosed with learning disabilities. These findings suggest that students diagnosed with learning disabilities need to be provided with education and practice utilizing different note taking strategies, both with and without assistive technology, to figure out what works best for the individual student. The field of speech-language pathology should be involved in this process due to the substantial number of processes involved in taking notes that deal with cognition and language. Speech-language pathology, professionals specializing in education and academics, and professionals

specializing in working with students who have learning disabilities should work together to develop programs and approaches to support students diagnosed with language learning disabilities to develop note taking skills prior to entering the post-secondary institution and their undergraduate courses. Every student who has been diagnosed with a learning disability of any kind has the potential to succeed with academic supports in a post-secondary institution.

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Appendix A.

Informed Consent Form

*East Carolina University*

# Informed Consent to Participate in Research

Information to consider before taking part in research that has no more than minimal risk.

Title of Research Study: Note Taking Skills Using the LiveScribe Pen: College Students Diagnosed with Learning Disabilities
Principal Investigators: Dr. Marianna Walker (Faculty Supervisor) and Dr. Sarah Williams (Project STEPP)
Co-Investigators: Anne Martin, Graduate Student, Department of Communication Sciences and Disorders
Institution/Department or Division: Communication Sciences and Disorders/College of Allied Health Sciences
Address: East Carolina University; 3310Y Health Sciences Building Dept. of CSDI; Greenville, NC 27858
Telephone #: 252-744-6096

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Researchers at East Carolina University (ECU) study problems in society, health problems, environmental problems, behavior problems and the human condition. Our goal is to try to find ways to improve the lives of you and others. To do this, we need the help of volunteers who are willing to take part in research.

## Why is this research being done?

The purpose of this research is to evaluate the effectiveness of using strategic note-taking in conjunction with the LiveScribe pen during lectures at the college level. As you know, there are many adjustments to the first year of college, and language and note-taking skills are utilized in the university setting more than ever. Therefore, we would like to explore the impact of adding supports in the area of language to the first year of Project STEPP (Supporting Transition and Education through Planning and Partnerships) in collaboration with the Department of Communication Sciences and Disorders at ECU. The decision to take part in the research component of the program is yours to make. By doing this research, we hope to learn how to effectively support post-secondary learning and note-taking success for students with learning disabilities.

## Why am I being invited to take part in this research?

You are being invited to take part in this research because you have been selected as a participant of Project STEPP. If you volunteer to take part in this research, you will be one of about 10 people to do so.

## Are there reasons I should not take part in this research?

No, any participant in Project STEPP is invited to participate in the research component of the program.

**What other choices do I have if I do not take part in this research?**
You can choose not to participate. Remember that students are expected to take part in all data collection for Project STEPP for the purposes of program monitoring and improvement. This permission form applies to the *use* of collected data for *research* purposes.

**Where is the research going to take place and how long will it last?**
The research procedures will be conducted at the Project STEPP space in Joyner Library. The total amount of time you will be asked to volunteer for this study is approximately 8 hours during the upcoming semester.

**What will I be asked to do?**
You are being asked to do the following:
Early in the Fall 2013 semester, you will receive training on the purpose of the LiveScribe pen and how to use it. During this time, the researcher will also obtain your baseline note- taking skills during a lecture using only pen and paper with no LiveScribe pen. Afterward, you will receive instruction about a strategic note-taking model. Over a period of 3 weeks, you will listen to three short lectures, take notes during the lecture with the LiveScribe pen, and take a quiz on the lecture material after one week. The total time frame for the project will be approximately 5 weeks.

Data collected will be used for the purpose of improving the services offered to first year students diagnosed with learning disabilities. Your participation in the *research component* of this project will help the investigator share information learned about how to effectively support the transition process for note-taking for students from high school to college.

**What possible harms or discomforts might I experience if I take part in the research?**
It has been determined that the risks associated with this research are no more than what you would experience in everyday life. Your name will not be associated with research reports, and will be pooled anonymously with that from other students in the research pool. Your name will not be attached to specific pieces of information. Any disclosure of personal preferences, frustrations, and /or suggestions regarding this project and/or your ECU coursework will not negatively impact your success and/or grades.

**What are the possible benefits I may experience from taking part in this research?**
We do not know if you will get any benefits by taking part in this study. The design of the study is intended to provide you with an active-learning strategy that has the benefit to improve your understanding of class material and performance on class grades. There is, however, no guarantee this will occur. Additionally, this research has the potential to help us learn more about how to best support students with learning differences during their first year of college. Even if there is no personal benefit from your participation but the information gained by doing this research may help others in the future.

**Will I be paid for taking part in this research?**
We will not be able to pay you for the time you volunteer while being in this study.

**What will it cost me to take part in this research?**
It will not cost you any money to be part of the research.

**Who will know that I took part in this research and learn personal information about me?**
To do this research, ECU and the people and organizations listed below may know that you took part in this research and may see information about you that is normally kept private. With your permission, these people may use your private information to do this research:

- The sponsors of Project STEPP and Communication Sciences and Disorders faculty with an educational interest in the project.
- Any agency of the federal, state, or local government that regulates human research. This includes the Department of Health and Human Services (DHHS), the North Carolina Department of Health, and the Office for Human Research Protections.
- The University & Medical Center Institutional Review Board (UMCIRB) and its staff, who have responsibility for overseeing your welfare during this research, and other ECU staff who oversee this research.

**How will you keep the information you collect about me secure? How long will you keep it?**
Taking part in this research is voluntary. If you chose not to allow your information to be used for research purposes there will be no penalty or negative consequences. Participation in this research entails no more than minimal risk to you personally. Your identity will be protected. Your academic information, responses to surveys, etc. will remain confidential. The information used for research purposes will be coded and your name will be removed from that information. Any identifying information will be kept in a secure location on the campus of East Carolina University and destroyed when the study reaches its conclusion.

All information about students collected for research purposes will be kept private, and student names will be removed (and replaced with a code name) from any information shared beyond the ECU setting. Data will be kept in a locked location and on a password-protected computer for the duration of your time at ECU, with access provided only to those directly involved in this research. Once gathered, names on surveys and technology assessments will be removed and replaced with a code so that the surveys will be anonymous during data analysis.

**What if I decide I do not want to continue in this research?**
If you decide you no longer want to be in this research after it has already started, you may stop at any time. You will not be penalized or criticized for stopping. You will not lose any benefits that you should normally receive.

**Who should I contact if I have questions?**
The people conducting this study will be available to answer any questions concerning this research, now or in the future. You may contact the Principal Investigator at 804-221-0642 (weekdays, between 8:00 am and 4:00 pm).

If you have questions about your rights as someone taking part in research, you may call the Office for Human Research Integrity (OHRI) at phone number 252-744-2914 (days, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of the OHRI, at 252-744-1971.

**Is there anything else I should know?**
We have attempted to anticipate any questions or concerns you may have in the development of this consent form. It is important to understand that if you have any further questions (now or in the future) you are welcome to ask any of the Principal Investigator.

**I have decided I want to take part in this research. What should I do now?**
The person obtaining informed consent will ask you to read the following and if you agree, you should sign this form:

- I have read (or had read to me) all of the above information.
- I have had an opportunity to ask questions about things in this research I did not understand and have received satisfactory answers.
- I know that I can stop taking part in this study at any time.
- By signing this informed consent form, I am not giving up any of my rights.
- I have been given a copy of this consent document, and it is mine to keep.

_____ _____

**Participant's Name (PRINT)** **Signature** **Date**

**Person Obtaining Informed Consent**: I have conducted the initial informed consent process. I have orally reviewed the contents of the consent document with the person who has signed above, and answered all of the person's questions about the research.

_____

**Person Obtaining Consent (PRINT)** **Signature** **Date**

Appendix B.

Institutional Review Board Approval Form

**EAST CAROLINA UNIVERSITY**
**University & Medical Center Institutional Review Board Office**
4N-70 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** · **www.ecu.edu/irb**

## Notification of Amendment Approval

From: Biomedical IRB
To: Marianna Walker
CC:

Date: 10/16/2013
Re: Ame1 UMCIRB 12-002235
UMCIRB 12-002235
Language and Learning Disabilities

Your Amendment has been reviewed and approved using expedited review for the period of 10/16/2013 to1/20/2014. It was the determination of the UMCIRB Chairperson (or designee) that this revision does not impact the overall risk/benefit ratio of the study and is appropriate for the population and procedures proposed.

Please note that any further changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. A continuing or final review must be submitted to the UMCIRB prior to the date of study expiration. The investigator must adhere to all reporting requirements for this study.

Approved consent documents with the IRB approval date stamped on the document should be used to consent participants (consent documents with the IRB approval date stamp are found under the Documents tab in the study workspace).

The approval includes the following items:

| Document | Description |
|---|---|
| New Project Study (0.01) | Consent Forms |

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

Appendix C.

Pre-Experimental Standardized Test Scores (Average Range: 85-115) with Standard Deviations

| | Participant #1 | Participant #2 | Participant #3 | Participant #4 | Participant #5 | Standard Deviation |
|---|---|---|---|---|---|---|
| *Hearing Screening* | Pass | Pass | Pass | Pass | Pass | n/a |
| ***WRMT-R:*** *Word Identification* | 81 | 129 | 72 | 97 | 72 | 37.22 |
| ***WRMT-R:*** *Word Attack* | 92 | 101 | 90 | 98 | 80 | 36.11 |
| ***WRMT-R:*** *Word Comprehension* | 97 | 91 | 93 | 109 | 96 | 35.08 |
| ***WRMT-R:*** *Passage Comprehension* | 92 | 68 | 87 | 92 | 90 | 34.12 |
| ***WRMT-R:*** *Total Reading Cluster Score* | 92 | 87 | 85 | 99 | 84 | 36.42 |
| ***TIPS:*** *Visual Modality* | 92 | 94 | 85 | 104 | 97 | 1.37 |
| ***TIPS:*** *Auditory Modality* | 82 | 83 | 82 | 95 | 95 | 2.11 |
| ***TIPS:*** *Delayed Recall* | 80 | 55 | 70 | 105 | 90 | 2.39 |
| ***TIPS:*** *Oral Fluency* | 100 | 95 | 75 | 100 | 110 | 1.38 |
| ***TIPS:*** *Written Fluency* | 110 | 100 | 65 | 110 | 95 | 2.54 |

Appendix D.

Comprehension Quiz Lecture One Questions

1. What determines the magnitude of the push or pull of a force?
    A. Rotation of the air particles
    B. Energy
    C. Weight of the air
    D. Directionality of the airflow
2. The primary molecules in the air are:
    A. Hydrogen and Nitrogen
    B. Hydrogen and Oxygen
    C. Nitrogen and Oxygen
    D. Hydrogen, Nitrogen, and Oxygen
3. Atmospheric pressure is calculated using:
    A. The atomic weight of the gasses
    B. The atomic mass of the gasses
    C. The atomic number of the gasses
    D. The number of molecules of each gas
4. What determines the amount of air pressure at a given location?
    A. The type of air molecules
    B. The concentration of molecules in the air
    C. Mass
    D. Gravity
5. In an air column, most of the molecules of air are located in:
    A. The middle of the column
    B. The bottom of the column
    C. The top of column
    D. The top and middle of the column
6. Why are the air molecules concentrated in that area?
    A. The weight of the air molecules
    B. The mass of the air molecules
    C. Gravity
    D. The density of the air molecules
7. If you are standing at the top of Mount Everest (one of the tallest mountains in the world), what would you experience?
    A. Higher atmospheric pressure than at the base
    B. Lower atmospheric pressure than at the base
    C. Higher concentration of air molecules than at the base
    D. Increased concentration of air molecules than at the base
8. What is a force?
    A. Having magnitude and directionality
    B. A push or pull
    C. Gravity
    D. A push or pull having magnitude and directionality

Appendix E.

Comprehension Quiz Lecture Two Questions

1. The greater the difference in pressure, the _____ the air moves:
    A. slower
    B. faster
    C. higher
    D. lower
2. When do you experience low pressure?
    A. When air moves upwards
    B. When air moves downwards
    C. When air moves horizontally
    D. When air is moving in a circular pattern
3. What causes horizontal movement of air?
    A. Gravity
    B. Wind
    C. High pressure
    D. Air pressure differences
4. If you are looking at a weather map and can see a low pressure system and a high pressure system, where will the wind blow?
    A. The wind will not blow
    B. The wind will blow from the low pressure system to high pressure system
    C. The wind will blow from the high pressure system to the low pressure system
    D. The wind will blow in a circular pattern
5. What determines the directionality of the force of air pressure?
    A. Gravity
    B. Wind
    C. High Pressure System
    D. Low Pressure System
6. What will you see in the eye of a hurricane?
    A. Low atmospheric pressure
    B. Equal atmospheric pressure
    C. High atmospheric pressure
    D. Higher temperature
7. If you were to look at barometric reading in the eye of a hurricane, approximately what pressure would it read?
    A. 500-800 MB
    B. 800-900 MB
    C. 900-1000 MB
    D. 1000-2000 MB
8. Any air pressure above 1000 MB is considered to be:
    A. Average
    B. High
    C. Low
    D. Normal

Appendix F.

Participants' scores on the Lecture One Quiz

| | **Participant #1** | **Participant #2** | **Participant #3** | **Participant #4** | **Participant #5** |
|---|---|---|---|---|---|
| **Question 1** | C | C | C | C | C |
| **Question 2** | C | I | I | C | C |
| **Question 3** | C | I | C | C | C |
| **Question 4** | I | I | I | I | I |
| **Question 5** | C | I | C | I | C |
| **Question 6** | C | C | C | C | C |
| **Question 7** | C | C | C | I | C |
| **Question 8** | I | I | I | I | I |

*Note: "C" refers to a correct response and "I" refers to an incorrect response on the quiz question. Questions 1, 2, 3, and 8 were factual questions and questions 4, 5, 6, and 7 were inferential questions.*

Appendix G.

Participants' scores on the Lecture Two Quiz

| | **Participant #1** | **Participant #2** | **Participant #3** | **Participant #4** | **Participant #5** |
|---|---|---|---|---|---|
| **Question 1** | C | C | C | C | C |
| **Question 2** | C | C | C | C | C |
| **Question 3** | I | I | C | C | I |
| **Question 4** | I | I | I | C | C |
| **Question 5** | I | I | I | C | I |
| **Question 6** | C | C | I | I | C |
| **Question 7** | I | I | I | I | C |
| **Question 8** | C | I | I | C | C |

*Note: "C" refers to a correct response and "I" refers to an incorrect response on the quiz question. Questions 1, 2, 3, and 5 were factual questions and questions 4, 6, 7, and 8 were inferential questions.*