

Fall 2021

An Action Research Study Implementing a Livescribe™ Pen and Cornell Note-Taking Strategy in a Personal and Community Health Course to Support Note-Taking and Comprehension of College Student-Athletes With Learning Disabilities

Ivana Rich

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AN ACTION RESEARCH STUDY IMPLEMENTING A LIVESCRIBE™
PEN AND CORNELL NOTE-TAKING STRATEGY IN A PERSONAL
AND COMMUNITY HEALTH COURSE TO SUPPORT NOTE-TAKING
AND COMPREHENSION OF COLLEGE STUDENT-ATHLETES WITH
LEARNING DISABILITIES

by

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Submitted in Partial Fulfillment of the Requirements

For the Degree of Doctor of Education in

Curriculum and Instruction

College of Education

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2021

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DEDICATION

I would like to dedicate my dissertation work to my family, friends, and many of my students. A special feeling of gratitude to my fiancé Calvin Copeland, my parents, Michelle and Alfonso Belle, my aunt, Jane Washington, and my close friends Latrese Barker, Jenira Shufford, Porche Grant, Kristin Boyd, and Jasmine Waters, whose words of encouragement have kept me lifted during this process. To my daughter Melanie, you continue to inspire me to be the best version of myself each day. You have been a guiding light for me, helping me to remain focused and optimistic throughout this process. I also dedicate this work to the many students who have inspired me to pursue this research. Their desire to better themselves and pursue higher education despite personal challenges has been a constant inspiration. Finally, I would like to dedicate my research to my late grandmother, Jean Shaw, who raised me and instilled in me the foundation and desire to pursue higher education.

ACKNOWLEDGEMENTS

The culmination of this journey is a true testament to the saying “it takes a village.” The support team that surrounded me during this process was instrumental in assisting me in reaching my goal. I would like to acknowledge the members of the Student-Athlete Academic Support staff for their support and encouragement. Additionally, I would like to give special thanks to my learning specialist, Jenira Shufford, who dedicated countless hours assisting with my study. Her assistance was invaluable in making this study a success. I would also like to thank my mother, who read my manuscript and provided many valuable suggestions. I would be remiss if I did not acknowledge my student-athletes whose motivation, discipline, and integrity were essential to the success of the study.

I would also like to thank my dissertation committee members, Dr. Fatih Ari, Dr. Lucas Vasconcelos, and Dr. William Morris, for their continued encouragement, candid feedback, and enduring support over the course of this program. Finally, I want to thank my advisor and dissertation committee chairperson, Dr. Fatih Ari. Dr. Ari’s guidance, feedback, and encouragement willed me through this process.

ABSTRACT

The purpose of this study was to examine the impact of the Livescribe™ Symphony smartpen and the Cornell note-taking strategy on the lecture comprehension and quality of written notes of college student-athletes with learning disabilities. To explore educational tools and strategies that can assist students with learning disabilities in overcoming academic challenges, this study focused on three research questions: (1) how does the use of the Cornell note-taking strategy supported with a Livescribe™ pen affect the note-taking quality of student-athletes with learning disabilities (2) how does the use of the Cornell note-taking strategy supported with a Livescribe™ pen affect the comprehension of lecture content and vocabulary among student-athletes with learning disabilities? and (3) what are the experiences and perceptions of student-athletes with learning disabilities using Livescribe™ pens and their impact on note-taking and comprehension of lecture content?

The research was conducted with five student-athletes who had documented learning disabilities over a 10-week period in a personal and community health course at Norfolk State University. Data were collected using semi-structured interviews, immediate free recall exercises, comprehension tests, students' notes evaluated by a rubric, administered before and after the intervention, and a note-taking experience survey. An inductive approach was used to analyze qualitative data following the constant comparative method. Quantitative data were analyzed then organized and described using descriptive statistics. Five themes emerged from the data (a) perceptions

of note-taking, (b) note-taking strategies, challenges, and areas for improvement, (c) perceptions of the Livescribe™ pen, (d) perceptions of Cornell note-taking, and (e) combined use of Cornell note-taking and Livescribe™ pen.

Findings indicate that participants developed positive perceptions of the Livescribe™ pen and Cornell note-taking strategy. Specifically, students found that the intervention assisted them in improving multiple aspects of note-taking, such as organization, quality, and efficiency. Additionally, students indicated that the resources assisted them in remembering lecture content, summarizing and consolidating information, and generating study questions. Implications for student-athlete support services and future research are discussed. Limitations of the study included aspects of the study's design, sample, and measures used.

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LIST OF ABBREVIATIONS

AT	Assistive Technology
IFR	Immediate Free Recall
LP	Lecture Point
NSU.....	Norfolk State University
OASIS	Office of Accessibility Services and International Students
SAAS	Student-Athlete Academic Support
SLD	Specific Learning Disability
TLP	Total Lecture Points

CHAPTER 1

INTRODUCTION

National Context

An increased number of students with learning disabilities are entering postsecondary educational institutions (DaDeppo 2009; Heiman and Precel 2003; Madaus, Banerjee, & Merchant, 2011; Sparks & Lovett, 2014). Seventeen percent of students attending postsecondary institutions in the United States identify as having a learning disability (National Council on Disability, 2000; Stodden & Whelley, 2001). The number of students with LD enrolling in postsecondary institutions has continued to trend upward. According to the National Council for Higher Education (2012), students with learning disabilities account for 30% of students with disabilities enrolling at institutions of higher education. Federal mandates such as the Americans with Disabilities Act and the Disabilities Education Act (IDEA) Amendments have had a notable impact on the number of students with learning disabilities entering postsecondary institutions (Gregg, 2012; Weis, Dean & Osborne, 2016; Stodden & Whelley, 2001). These mandates have increased access for students with disabilities by requiring colleges and universities to provide students with disabilities with a full range of services (Gregg, 2012; Stodden & Whelley, 2001). The Cooperative Institutional Research Program (CIRP) conducted by The University of California, Los Angeles, found that the most commonly identified disability among first-year college students is learning disabilities. The data from the recent report

also expressed a relative increase in students with learning disabilities attending four-year colleges and universities since 1994 (Abreu-Ellis & Hayes, 2009; Henderson, 2001).

A learning disability can be described by multiple characteristics but is defined as a “lifelong and neurologically based involving significant difficulties in acquiring and using skills in listening, speaking, reading, writing, reasoning or mathematics” (National Joint Committee on Learning Disabilities, 2011). Students with learning disabilities experience considerable challenges that hinder academic performance. In addition to difficulties with decoding and reading comprehension, college students with learning disabilities have trouble with language and information processing (Gajria, Jitendra, Sood, & Sacks, 2007), evaluation and organization of written content (Martínez-Marderero & Estrada-Hernández, 2008), taking accurate notes (Wook & Rao, 2017), writing (Scott, 1997), and mathematics (Learning Disabilities Association of America, 2005). Compared to students without learning disabilities, students with learning disabilities are more likely to receive lower grades or fail courses (Cortiella & Horowitz, 2014; Wook & Rao, 2017). These students also persist, graduate, and are retained at a lower rate than their peers (Reiff, 2007).

Note-taking is an essential strategy that is positively correlated with academic achievement among college students (Lee, Wang, Hamman, Hsiao, & Huang, 2013). Note-taking helps students learn course material by increasing their understanding of lecture content and improving the likelihood of recollection later (Chang & Ku, 2015; Piolet, Olive & Kellog, 2005). “It increases class attention, active engagement in classes, clarification, and paraphrasing of confusing points and their performance” (Seid & Tekley, 2018, p. 2). Approximately 30-50% of postsecondary level classes are lecture-

based and require extensive note-taking (Boyle & Forchelli, 2014; Johnson, 2008). It is the expectation that students can differentiate important information from unimportant information to use notes as a primary method of learning (Badger, White, Sutherland, & Haggis, 2001; Bakunas & Holley, 2001; Boyle & Forchelli, 2014). Instructors often use the information presented in their lecture to construct exams; therefore, note-taking accuracy correlates directly with performance on exams (Putnam et al., 1993).

College students with learning disabilities have difficulty utilizing learning strategies such as note-taking (Evers & Spencer, 2007; Mortimore & Crozier, 2006; Seid & Teklay, 2018). According to Mortimore and Crozier (2006), 78% of students with learning disabilities attending higher education institutions reported having problems recording notes during lectures. Students with learning disabilities have trouble maintaining attention during lectures and therefore miss essential points (Seid & Teklay, 2018). These students encounter difficulty inferring which material is important to record (Suritsky, 1992). After the lecture, students with learning disabilities often cannot understand the notes recorded due to poor legibility (Suritsky, 1992). Students with learning disabilities frequently lose track of the lecture and cannot write down content fast enough to keep up with the speed of the lecture (Suritsky, 1992). Past research asserts that students with learning disabilities produce incomplete lecture notes lacking important lecture points (Seid & Tekley, 2018). Hughes and Suritsky (1994) found that students with learning disabilities recorded fewer lecture points than students without learning disabilities. Finding evidence-based tools that can assist students with learning disabilities to deploy note-taking strategies effectively is vital to providing these students with the ability to improve their academic performance and academic success.

In addition to managing the daunting task of taking notes, postsecondary students with learning disabilities struggle to comprehend content covered by instructors during lectures. Students with learning disabilities often have difficulty acquiring knowledge from written and oral content and understanding information that has been presented (Jitenra, Burgess & Gajria, 2011). Studies suggest that comprehension problems result from deficiencies in decoding language and word recognition (Torgesen, 2000). As a result, slow word processing impedes a student's ability to comprehend connected ideas by placing an increased demand on other processes such as working memory (Cutting et al., 2009; Shankweiler, 1999; Wolf & Katzir-Cohen, 2001). Therefore, finding useful tools that can help students with learning disabilities overcome comprehension challenges is imperative in bridging the achievement gap between college students with learning disabilities and their peers.

Assistive technology (AT) is a useful instructional tool to assist college students with learning disabilities in overcoming their academic challenges (Dell, Newton, & Petroff, 2012; Shaffer & Schwebach, 2015; Wook & Rao, 2017). Specifically, smart pens, such as the Livescribe™ pen, have been found to improve student outcomes with this population. Livescribe™ pens are handheld smartpens that promote learning among students with learning disabilities (Wook & Rao, 2017). Livescribe™ pens encompass a built-in camera that digitizes handwritten text, which produces digitized notes (Wook & Rao, 2017). The device also captures audio simultaneously as the student is taking notes and synchronizes the audio recording with the handwritten notes (Wook & Rao, 2017). Past research has found digital pens to be effective in assisting students in improving comprehension, organization, and note-taking skills in addition to increasing engagement

(Doughty et al., 2013; Higgins & Raskind, 2005; Johnson, 2008). Institutions need to provide students with learning disabilities with assistive technology that will increase their ability to overcome their deficiencies, increase their academic performance, and improve their likelihood of graduating.

Local Context

Over the past three years, the Norfolk State University Athletics Department has seen increased student-athletes being recruited, signed, and admitted who have documented and undocumented learning disabilities. The department currently comprises 246 student-athletes. The Student-Athlete Academic Support (SAAS) staff, which is devoted explicitly to student-athlete academic advising and monitoring, consists of three full-time athletic academic coordinators, and one full-time learning specialist. Forty-six (19%) student-athletes in the department had documented learning disabilities, a four percent increase from the 2017-2018 academic year when there were 38 (15%) student-athletes with documented learning disabilities. During the 2015 – 2016 academic year, the SAAS staff determined that the department needed additional staffing to provide educational support for this group of student-athletes.

To respond to the increase in student-athletes enrolling in the university with learning disabilities, the athletic department applied for the National Collegiate Athletic Association (NCAA) Accelerating Academic Success Program (AASP) grant, which provided the department with the funding needed to hire a full-time learning specialist. A learning specialist serves as a member of the SAAS staff specializing in working with students with learning disabilities. This individual's responsibilities include serving as an advocate for student-athletes with learning disabilities, assisting them in obtaining

resources (e.g., accommodations, assistive technology, etc.), and providing them with skill development in areas of deficiency to promote self-regulated learning.

The first learning specialist hired at NSU was during the spring 2016 semester. In the summer before the 2016 – 2017 academic year, the learning specialist conducted an academic evaluation of the incoming freshman class of student-athletes. During this evaluation, the metrics used included high school grade point average (GPA), SAT scores, and ACT scores. The goal of this evaluation was to assist with the early identification of student-athletes with learning disabilities. The student-athletes were also required to complete an educational questionnaire that collected information on past educational experiences, academic difficulty, utilization of an IEP or 504 Plan at the secondary level, and history of learning disability. When the freshman class arrived on campus, each student was required to take the LASSI (Learning and Study Skills Inventory) Assessment. The LASSI is “ a 10-scale, 80-item assessment of learners’ awareness about and use of learning and study strategies related to skill, will and self-regulation components of strategic learning.” (H&H Publishing, 2018). The LASSI results enabled the learning specialist to determine which students experienced academic difficulty and which interventions would be most effective for each student. The skill component of the LASSI scores depicted that most of the student-athletes with a learning disability had substantial challenges related to the skill component of strategic learning. Therefore, the students encompassed deficits in information processing, identification and acquisition of new information, and comprehension of new information on assessments. The learning specialist conducts the academic evaluation during the summer preceding each academic year.

The learning specialist also worked with the Office of Accessibility Services and International Students (OASIS) to acquire resources for student-athletes with learning disabilities. However, the resources and staffing in the OASIS remain very limited. Additionally, the learning specialist also experienced difficulty integrating student-athletes into the campus assistive technology lab. The lab is only open during specific times that usually conflicted with the student-athletes' academic and athletic obligations. Therefore, the SAAS staff decided to explore portable assistive technology to assist students in multiple skill areas. Based on research conducted by the learning specialist, the department purchased 15 Livescribe™ pens. Providing practical and affordable assistive technology that can assist student-athletes with learning disabilities in achieving academic success is a top priority for the SAAS department.

Statement of the Problem

Students with learning disabilities experience significant challenges with academic skills such as reading, writing, note-taking, and reading comprehension (McGregor et al., 2016; Perelmutter, McGregor, & Gordon, 2017; Shaffer & Schwebach, 2015). Existing research suggests that assistive technology and academic strategies can help students improve their academic skills, persistence toward graduation, and overall academic achievement (DaDeppo, 2009; Ok & Rao, 2017). Effective assistive technology resources and academic strategies must be evaluated as supports for students with learning disabilities in postsecondary education.

Purpose Statement

This research aims to explore the impact of the Livescribe™ pen on the quality of notes and comprehension abilities of student-athletes with learning disabilities. Secondly,

the study seeks to examine the Cornell note-taking strategy's impact on note-taking quality and comprehension of student-athletes with learning disabilities. Finally, the study aims to explore student-athletes' perceptions and experiences using the Livescribe™ pen and Cornell note-taking strategy.

Research Questions

The following research questions were developed to explore the impact of the Livescribe™ pen and Cornell note-taking strategy on the academic skills of college student-athletes with learning disabilities.

1. How does the use of the Cornell note-taking strategy supported with a Livescribe™ pen affect the note-taking quality of student-athletes with learning disabilities?
2. How does the use of the Cornell note-taking strategy supported with a Livescribe™ pen affect the comprehension of lecture content and vocabulary among student-athletes with learning disabilities?
3. What are the experiences and perceptions of student-athletes with learning disabilities using Livescribe™ pens and their impact on note-taking and comprehension of lecture content?

Researcher Subjectivities & Positionality Statement

The purpose of this research subjectivities and positionality statement is to provide insight into my experiences related to this research. Because I will research within my professional setting, it is important to identify my subjectivity within this research. Identifying my subjectivities will ensure that I transparently present the research findings and allow only the data to communicate with the reader (Mertler, 2016). I have

many life experiences that have shaped my view of education and educational access. The importance of education was ingrained into my existence since the day I was born. I grew up in a family where both of my parents were educators in the local school system. Therefore, throughout my professional career, I have developed a passion for using my position to leverage educational opportunities for others and ensure access to education for the disenfranchised. I currently serve as Associate Athletic Director for Academic Services at Norfolk State University, a Historically Black College and University (HBCU) located in Norfolk, Virginia. In my role, I monitor the academic and athletic eligibility of all NSU student-athletes, and I am responsible for providing them with resources to support their academic progress.

I first began my career at NSU as the SAAS department's learning specialist with the primary responsibility of working with student-athletes with learning disabilities. In this position, I worked with student-athletes to help them overcome academic deficits by utilizing various interventions to include assistive technology. I secured a grant which provided the funding for assistive technology to help student-athletes with learning disabilities. I worked with various campus and community stakeholders to identify an affordable intervention that could effectively assist this group of student-athletes.

My professional experiences, coupled with my niche for technology, have motivated me to employ a technology intervention that can improve the lives of students with learning disabilities. I believe educational technology has the potential to close educational gaps. Therefore, I will conduct transformative action research to improve the academic outcomes of students with learning disabilities and increase their likelihood of leading successful lives. According to Creswell (2012), transformative research aims to

improve and empower the participants' lives. The transformative worldview focuses "on the needs of groups and individuals in our society that may be marginalized or disenfranchised" (Creswell, 2014, p. 39). My research will focus primarily on African American students attending a four-year HBCU, many of whom will be first-generation college students. Transformative research will offer valuable insight to assist practitioners in providing educational support for students with learning disabilities.

My research will investigate the implementation of Livescribe™ pens, coupled with the Cornell note-taking strategy and their impact on the note-taking and comprehension skills of student-athletes with learning disabilities attending Norfolk State University. In reference to the continuum of positionality, I am an insider within my research context. I will employ a combination of qualitative and quantitative methods to evaluate the impact of an assistive technology intervention and academic strategy within my professional setting. I recognize that the implicit knowledge I encompass about Norfolk State University could foster epistemological dilemmas such as biases and preconceived assumptions about the students' experiences, perceptions, and values (Herr & Anderson, 2005). I believe being aware of these biases is critical. I am also mindful of the potential for power dilemmas to occur since I am researching with student-athletes that I oversee in an advising capacity. To ensure the validity of my findings, I will employ researched-based mechanisms for managing bias that may arise during my research. I will participate in personal reflection throughout the study. Personal reflection will be an ongoing process that will assist me in constructing and critiquing my positionality (Holmes, 2014). I will also use standardized protocols for interview

interactions with my participants and data collection methods (Pannucci & Wilkins, 2010).

Researching as an insider will serve as an advantage for me. I believe the student-athletes that will participate in the study will yield genuine results due to their relationship with the researcher. As the students' advisor, it is my role to assist them in achieving educational success by providing them with academic and career advising and personal development opportunities. Due to this dynamic, my students have developed a sense of trust and respect for me and the relationship I have with each of them. Therefore, as an insider, I will have the ability to ask meaningful questions during the interview process. I will also have an enhanced understanding of the language, emotional, and psychological precepts, and non-verbal cues used by the students (Holmes, 2014; Chavez, 2008). As an educational technology researcher, I will call on my value system to guide my actions. I have always held integrity at the center of my value system. Therefore, I will uphold ethical standards throughout my research. I will put on my white hat and employ an ethically sound methodology to produce findings.

Definition of Terms

Assistive Technology. Assistive technology includes “items, devices, equipment, or products which may be commercially available, customized, or adapted to help a person with a disability to function or to improve, maintain or increase their capacity to function” (IDEA) (U.S.C § 2201, 2202). The Livescribe™ pen is a form of assistive technology in this study.

Cornell Note-taking. The Cornell note-taking strategy is a specialized note-taking strategy in which students must divide their paper into three sections (Paulk, 1962). The

left section is used for questions and keywords, the right section is used for main points, and the bottom section of the paper is used for writing a summary (Belson, Hartman, & Sherman, 2103).

Immediate Free Recall. Immediate free recall (IFR) involves writing down all the information one can remember from a lecture (Kobayashi, 2005). Immediate free recall is a measure of working memory capacity (WMC) that can help understand reading comprehension ability (Unsworth, Spillers, & Brewer, 2010).

Lecture Point. A lecture point (LP) is an idea or block of information covered during a lecture. A short phrase or clause representing the lecture material is the minimum requirement to be considered a lecture point (Boyle, 2010; Boyle & Joyce, 2019).

Livescribe™ Pen. A smartpen handheld device that encompasses a variety of functions that can provide assistive learning supports for secondary students with learning disabilities. The pen has character recognition features that allow the user to scan words or phrases with the pen and produce definitions, speech synthesis, translations, and syllabification. Livescribe pens can create pencasts (audio-recordings of a lecture) that can serve as supplementary learning tools that can assist students with note-taking and reading comprehension.

Note-taking. Note-taking is the process of utilizing the critical thinking skills to organize and highlight information presented in a lecture using symbolization and summarizing.

Note-taking skill. Note-taking skill refers to the measurement of a student's note-taking skill or ability to process and relate the material to real-life experience for easy memorization.

Notes. Notes are “short condensations of a source material that are generated by writing them down while simultaneously listening, studying, or observing” (Piolet, Olive, & Kellogg, 2005, p. 294). The function of notes is to gather the information presented in a lecture that should be remembered.

Comprehension. Comprehension is the complex process of understanding the meaning of one or a series of words presented in oral or printed form through the use of decoding. Comprehension involves interpreting the meaning of a text by integrating its various components and constructing integrative and constructive inferences to produce meaning from the information presented during a lecture.

CHAPTER 2

LITERATURE REVIEW

The purpose of this action research was to explore the impact of a specific assistive technology, the Livescribe™ pen combined with the Cornell note-taking strategy and its impact on the note-taking and comprehension skills of students with learning disabilities enrolled in a personal and community health course at Norfolk State University. The review of literature was guided by three research questions, “How does the use of the Cornell note-taking strategy supported with a Livescribe™ pen affect the note-taking quality of student-athletes with learning disabilities?,” “How does the use of the Cornell note-taking strategy supported with a Livescribe™ pen affect the comprehension of lecture content and vocabulary among student-athletes with learning disabilities?,” and “What are the experiences and perceptions of student-athletes with learning disabilities using Livescribe™ pens and their impact on note-taking and comprehension of lecture content?” The variables used to conduct the literature search were derived from these research questions.

The literature review was conducted using a systematic process. The variables associated with each research question were searched independently and simultaneously utilizing keywords. The inclusion criteria for the literature review include studies that (a) used qualitative, quantitative, or mixed methods, (b) included participants with learning disabilities who were attending or attended a secondary or post-secondary school, college or university, and (c) that were conducted in the United States. Studies that were excluded from the literature review were those that (a) were conducted with general disabilities, not including learning disabilities, and (a) written in a language other than

English. The databases Academic Search Complete, ERIC, and Google Scholar were used to search for literature on note-taking and reading comprehension. The process for each search is outlined below.

Note-taking and learning disability. The keywords that were used in the searches are as follows: note-taking [and] learning disability, note-taking, learning disability [and] postsecondary education, note-taking [and] attention deficit disorder, note-taking [and] dyslexia, note-taking [and] academic performance, note-taking [and] higher education, note-taking [and] academic success. Additional sources were located utilizing the reference lists of relevant studies.

Reading comprehension and learning disability. The keywords that were used in the searches are as follows: reading comprehension [and] learning disability, reading comprehension [and] dyslexia, reading comprehension [and] attention deficit disorder, comprehension [and] learning disability, reading comprehension, learning disabilities [and] postsecondary education, reading comprehension, learning disabilities [and] higher education, reading comprehension [and] academic success.

Assistive technology and reading comprehension. The keywords that were used in the searches are as follows: assistive technology [and] learning disabilities, assistive technology, reading comprehension [and] learning disabilities, assistive technology, reading comprehension [and] higher education, assistive technology, reading comprehension [and] postsecondary education, smartpen [and] reading comprehension, Livescribe™ pen, Livescribe™ pen [and] reading comprehension.

Assistive technology and note-taking. In the final search, Academic Search Complete, ERIC, and Google Scholar were used to search for literature on assistive

technology and note-taking. The keywords that were used in the searches are as follows: assistive technology [and] note-taking, assistive technology, note-taking [and] learning disabilities, assistive technology, note-taking [and] higher education, assistive technology, note-taking [and] postsecondary education, smartpen [and] note-taking, Livescribe™ pen [and] note-taking, Livescribe™ pen, note-taking [and] higher education.

The review of literature is organized into two primary sections, (a) learning disabilities in postsecondary education and (b) assistive technology in postsecondary education. The first section provides a comprehensive review of learning disabilities in postsecondary education. The second section focuses on assistive technology and provides an overview of the evolution of assistive technology in postsecondary education and its use among students with learning disabilities. The constructs of note-taking and reading comprehension are discussed in relation to learning disabilities and assistive technology, respectively.

Learning Disabilities in Higher Education

There has been a notable increase in the number of students with learning disabilities entering postsecondary institutions. An estimated 23% of all students enrolling in a two-year college program identified as having a learning disability, with 11% percent of students enrolling in four-year institutions having a learning disability (Wagner, Newman, Cameto, Garza, & Levine, 2005). In a more recent survey of 1,000 higher education institutions in the United States, approximately 195,870 students were identified as having a specific learning disability with an estimated enrollment of 16.1% (Lewis & Farris, 1999; Horn & Berkold, 1999). This group of students experiences

significant challenges as a consequence of their learning disability. These challenges have profound implications for the academic success, persistence, and educational outcomes of students with learning disabilities. This section (a) defines learning disabilities, (b) provides an overview of types of learning disabilities prevalent in higher education, and (c) discusses the challenges and outcomes of students with learning disabilities attending postsecondary institutions.

Defining Learning Disabilities

Learning disabilities are characterized by deficiencies across many domains that impact an individual's learning potential, academic success, and overall outcomes. The National Institutes of Health (NIH) defines learning disabilities as disorders that may affect an individual's ability "to understand or use spoken or written language, do mathematical calculations, coordinate movements, or direct attention (NIH, 2019, para 1). Their definition supports the Individuals with Disabilities Education Act's (IDEA) definition, which defines a specific learning disability as:

a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations, including conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia."

(P.L. 108-466, Sec. 602[30]) (IDEA, 2004)

Specific learning disabilities do not include disorders that impact learning as a result of motor, visual, or hearing impairment or resulting from emotional disturbance or intellectual disability (IDEA, 2004). The IDEA applies to public primary and secondary

institutions but does not directly apply to higher education institutions. This definition is widely used in learning disabilities research conducted in secondary education settings (Boyle, 2011; Kavale, Spaulding, & Beam, 2009; Martínez-Marrero & Noel Estrada-Hernández, 2008).

The American Psychiatric Association (APA) (2013) provides another definition of a specific learning disability, as defined in Cortiella and Harowitz (2014) and Fletcher, Lyon, and Fuchs (2018). The APA definition of specific learning disability asserts that individuals with learning disabilities exhibit persistent difficulty in the areas of writing, reading, arithmetic, or mathematic reasoning skills during the years in which they are receiving formal schooling (American Psychiatric Association, 2013). The APA defines specific learning disability as:

a persistent difficulties in reading, writing, arithmetic, or mathematical reasoning skills during formal years of schooling. Symptoms may include inaccurate or slow and effortful reading, poor written expression that lacks clarity, difficulties remembering number facts, or inaccurate mathematical reasoning (p.2).

To redefine specific learning disability, Kavale et al. (2009) proposed an operationalized definition that reflects new knowledge and an increased understanding of the construct of learning disabilities. Their goal was to provide a “richer” explanation of specific learning disabilities that could be applied to all settings. Kavale et al. (2009) assert that specific learning disabilities are defined as:

heterogeneous clusters of disorders that significantly impede the normal progress of academic achievement in 2%- 3% of the school population. The lack of progress is exhibited in school performance that remains below expectation for

chronological and mental ages, even when provided with high-quality instruction.

The primary manifestation of the failure to progress is significant underachievement in a basic skill area (i.e., reading, math, writing) that is not associated with insufficient educational, interpersonal, cultural/familial, and/or sociolinguistic experiences. (p.45)

This definition includes information about the percentage of students impacted by learning disabilities while distinguishing between challenges resulting from learning disabilities, educational difficulties, and other factors such as quality of education.

The IDEA definition includes skill areas directly related to note-taking and reading comprehension, such as listening, reading, writing, thinking, and spelling. Thereby, for this research, the IDEA definition of specific learning disability will be used.

Types of Learning Disabilities

Students with learning disabilities encompass unique characteristics that are influenced by the type of learning disability they have. There are multiple disabilities classified under learning disability or specific learning disability. This research focused on three specific categories of learning disabilities which include dyslexia, learning disability in mathematics, and attention deficit disorders. In the following paragraphs, specific learning disabilities such as (a) dyslexia, (b) specific learning disability in mathematics, and (c) attention deficit disorders are discussed.

Dyslexia. Dyslexia is the most common form of reading disability, one which poses significant challenges for learners, challenges that extend from childhood through adulthood. Dyslexia accounts for more than 80% of all learning disabilities (Kohli,

Sharma, & Padhy, 2018). Also referred to as a lifelong disorder, dyslexia is a disorder that is exhibited by difficulties in learning how to read (Critchley, 1999), difficulties impacting the learning process in reading, writing, and spelling (Draffan, Evans, & Blenkhorn, 2007), challenges with information processing, working memory, and motor skills (Mortimore & Crozier, 2006), difficulties remembering sequences and names, rote memory tasks, word retrieval (Klein, 1993), and significant impairment affecting the development of reading and spelling skills (Schuchardt, Maehler, & Hasselhorn, 2008). Critchley (1999) suggests that these deficiencies are not significantly influenced by sufficient intelligence, instruction, and sociocultural opportunity (p. 361). Lyon, Saywitz, and Shaywitz (2003) adapted a definition of dyslexia from the National Institute of Child Health and Human Development (NICHD) and the International Dyslexia Association. Lyon et al. (2003) define dyslexia as:

a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge. (p. 1)

Dyslexia, characterized by a specific issue with the processing of speech sounds, which can impact an individual's ability to make connections between letters and their

associated sounds, all of which pose significant challenges with academic tasks (Kohli et al., 2018).

The deficiencies in spelling, word recognition, reading, and writing present dyslexic students challenges with the demanding tasks of higher education, which often include essay writing (Simmons & Singleton, 2000), note-taking during lectures (Riddock, Farmer, & Sterling, 1997), comprehending large texts, and synthesizing course content (Kirby, Silvestri, Allingham, Parrila, & La Fave, 2008). Therefore, students with dyslexia require educational supports to assist them in overcoming these challenges.

Specific math disability. Specific math disability (MD) contributes to poor performance in a variety of academic tasks such as math fact retrieval and calculation skills, math phonological memory, and verbal short-term memory (Mazzocco & Thompson, 2005). Individuals with MD have a fundamental weakness in mathematical cognition not resulting from environmental or sociocultural factors (Soares, Evan, & Patel, 2018). The World Health Organization (2012) defines MD as “a specific impairment in arithmetical skills not solely explicable on the basis of general mental retardation or of inadequate schooling, which involves mastery of basic computational skills rather than more abstract mathematical skills” (p. F81.2). MD is included in the DSM’s definition of specific learning disability. For the purpose of this study, MD and dyscalculia are synonymous.

Previous research indicates that difficulties in math can lead to failure, poor attrition, and even dropout among college students (McGlaughlin, Knoop, & Holliday, 2005). Although students with learning disabilities spend a significant amount of time working on their math skills, deficits in math achievement tend to persist over time

resulting in negative academic outcomes (Jones, Wilson, & Bhojwani, 1997). However, limited research has investigated educational supports for postsecondary students with MD.

Attention deficit disorders. Attention deficit disorders such as attention deficit disorder (ADD) and attention deficit hyperactivity disorder (ADHD) hinder the academic outcomes of postsecondary students. The effects of attention deficit disorders impact multiple domains, including occupational, psychological, social, and academic (Fleming & McMahon, 2012). Indications of attention disorders include difficulty staying focused, paying attention, and controlling behavior (NIH, 2019). Students with attention disorders also experience challenges with time management, procrastination, memory retrieval (Nadeau, 1995), impairments in behaviors that are essential for adaptive functions (Fleming & McMahon, 2012), difficulty following instructions on tasks, and trouble staying organized (APA, 1994). In addition to these challenges, students with ADHD experience varying levels of hyperactivity (NIH, 2019). Students with attention disorders tend to avoid activities or tasks that require an extended amount of mental focus and attention to detail (APA, 1994).

Students with attention disorders entering postsecondary education are at a heightened risk due to a unique set of transitional challenges that impact the academic performance and college adjustment accompanied by early adulthood coupled with the demands of the college environment (Nugent & Smart, 2014; Advokat, Lane, & Lou, 2014). In addition to adjusting to the developmental changes that occur during the college years, students with ADD/ADHD must also adapt to a change in their environment and the loss of parental structure (Nugent & Smart, 2014). These students require additional

mentoring and assistance with organization, prioritization, time management, and follow-through compared to their counterparts (Nadeau, 1995). These constructs are often substantially reduced in the higher education environment where students' daily schedules differ, the environment is less structured, and there are increased opportunities for distractions.

Educational Outcomes for Students with Learning Disabilities

Students with learning disabilities face an array of challenges that put them at a disadvantage in the higher education environment. The educational outcomes for postsecondary students with learning disabilities are quite different from those of postsecondary students without learning disabilities. Differences between these populations are apparent in (a) postsecondary completion rates and (b) academic success.

Postsecondary completion rates of students with learning disabilities. College students with learning disabilities encounter challenges that have implications for academic success. Compared to students without learning disabilities, students with learning disabilities have a higher likelihood of encompassing attributes correlated with low persistence and completion rates (Horn & Berkold, 1999). According to Cortiella and Harowitz (2014), postsecondary students with learning disabilities complete their college degrees at a lower rate than the general population. The completion rates for students with learning disabilities is 41% compared to 52% among students without learning disabilities (Cortiella and Harowitz, 2014; Newman et al., 2011). Other research suggests that students with learning disabilities are less likely to remain enrolled in college and earn their degrees when compared to students without learning disabilities (Horn, 1999).

Data from the Beginning Postsecondary Students Longitudinal Study (BPS) reported that only 53% of students with learning disabilities persisted in their degree program compared to the 64% of students without learning disabilities (Horn, 1999). This study followed students who first enrolled in a postsecondary institution during the 1989-1990 academic year and collected data on progress, persistence, and attainment of approximately 8,000 students. According to this study, students with learning disabilities fared worse than students with other types of disabilities, such as visual impairment, hearing impairment, etc. Approximately 50% of students with disabilities drop out of college compared to about 30% of students without learning disabilities (Horn & Berkold, 1999; Wolf, 2001). These numbers rise to nearly 60% of students with learning disabilities (Wolf, 2001). The completion rates of college students with learning disabilities have remained consistent, lagging behind their counterparts (Newman et al., 2011).

Very few studies suggest positive overall outcomes for students with learning disabilities. Adleman (1992) indicates that postsecondary students with learning disabilities graduate at similar rates as their peers without learning disabilities, despite enrolling in lighter course loads and extended time to graduate. A report from Gavilan College (2002) indicated that students with learning disabilities fared well in math and English courses at a rate comparable to students without learning disabilities.

Academic success of students with learning disabilities. Limited research has focused on examining the academic performance of students with learning disabilities in postsecondary settings. Vogel and Adelman (1992) compared the academic performance of students with and without learning disabilities who were matched by American

College Testing (ACT) Assessment scores. Their research found that students with learning disabilities scored lower on standardized measures of sentence structure and reading ability (Vogel & Adelman, 1992). Deschler et al. (2004) studied the academic performance of secondary students with learning disabilities in core courses. Through an evaluation of the students' grades, the researchers found that 51% of the students had grade point averages in the D or F range. It could be assumed that these challenges would persist into postsecondary education. Despite being conducted in the secondary setting, this research provides valuable insight on the academic performance and success of students with learning disabilities.

There are a few studies that have focused on the factors that influence the academic success of postsecondary students with learning disabilities (DaDeppo, 2009; Raskind, Goldberg, Higgins, & Herman, 1999; Skinner & Lindstrom, 2003). According to Skinner and Lindstrom (2003), students' understanding of the nature and extent of their disability may influence their success in the postsecondary environment. Students with learning disabilities in higher education must proactively advocate for themselves and seek out available resources and support services available to them (Asselin, 2014). In high school, students are entitled to support services under the IDEA, and these services are implemented in coordination with school personnel and parents. Teacher-to-student interaction is also more frequent in the secondary setting, allowing less opportunity for a student with a learning disability to be overlooked (DaDeppo, 2009). Raskind et al. (1999) conducted the second phase of a 10-year longitudinal study examining the predictors of academic success of students with learning disabilities enrolled at the Frostig Center from 1958 to 1965. Their findings suggest that emotional

stability, goal setting, perseverance, proactivity, self-awareness, and use of support systems are the most powerful predictors of future success (Raskind et al., 1999).

Challenges for Students with Learning Disabilities

The higher education environment requires students to fully engage in their courses, study independently, and employ various skills and strategies to be successful. The educational outcomes of students with learning disabilities are highly influenced by the challenges they encounter due in part to intrinsic factors (self-esteem, anxiety, depression, etc.) and extrinsic factors (characteristics of the college environment) (Greg, Hoy, King, Moreland, & Jagota, 1992). Students with learning disabilities are more likely only to meet the minimum requirements required for admission, require remedial courses (Horn & Berkold, 1999), and experience transitional challenges in the first two years of enrollment (Wolf, 2001). The areas in which students with learning disabilities experience challenges or shortcomings include (a) academic skills, (b) metacognitive ability and cognitive processes, (c) executive function, working memory, and cognitive load, (d) note-taking, and (e) reading and comprehension (Boyle, 2012).

Academic skill deficiencies. Students entering postsecondary institutions arrive with a myriad of academic and skill deficiencies that greatly influence their academic success (Foley, 2006; Skinner & Lindstrom, 2003; Wolf, 2001). The presence of a learning disability intensifies these challenges. According to Foley (2006), students with learning disabilities attend college equipped with “varying levels of skills and degrees of preparation, and they have experienced varying degrees of success as undergraduates” (p.642). These students often have difficulty with spoken language in addition to deficiencies in executive functioning, resulting in problems organizing and managing

assignments and deadlines (Skinner & Linstrom, 2003). Students with learning disabilities enrolling in postsecondary institutions also have a higher likelihood of demonstrating deficiencies in time management, organization, listening comprehension, and note-taking (Wolf, 2011). These challenges are in addition to the increased likelihood of students with learning disabilities entering college with cognitive deficits and poor study skills (Wolf, 2011). These skill deficiencies, coupled with difficulties with written language, low self-esteem, and poor social skills, pose a significant challenge for college students with learning disabilities (DaDeppo, 2009).

Differences in academic skill development and preparation among students with and without learning disabilities have been examined by a few studies (Abreu-Ellis, Ellis & Hayes, 2009; Kovach & Wilgosh, 1999; Reaser, Prevatt, Petscher & Proctor, 2007). Abreu-Ellis et al. (2009) found disparities between postsecondary students with and without learning disabilities according to the six constructs of the Learning and Study Strategies Inventory (LASSI) (Weinstein, Schulte, & Palmer, 1987). Their findings suggest that students with learning disabilities are more likely to have higher levels of anxiety and lower levels of motivation. Also, students with learning disabilities scored lower on the test strategies scale, indicating a lack of test-taking skills. Their research did not find differences in learning and study strategies. Similar research examining differences among undergraduate students with and without learning disabilities found that students with learning disabilities performed lower on each of the ten scales of the LASSI (Reaser et al., 2007). These scales include time management, attitude, motivation, anxiety, concentration, information processing, study aids, selecting main ideas, self-testing, and test strategies. Kovach and Wilgosh (1999) found students with learning

disabilities to have a deficient repertoire of strategies required for learning and studying. The researchers examined the academic skills of first-year college students using the LASSI. They found that students with learning disabilities perform lower on measures of self-testing, motivation, test-taking strategies, and study aids. However, their findings indicate that students with learning disabilities show higher levels of attitudes toward success. These findings indicate that college students with learning disabilities need educational support to assist in managing and overcoming these challenges.

Metacognitive ability & cognitive processes. The metacognition of students with learning disabilities impacts their ability to perform essential academic tasks such as reading, comprehension, and coordinating the cognitive processes required for note-taking (Brown, 1980; Butler, 1998). Metacognition is an individual's ability to respond to changes by adjusting their behavioral and environmental functioning (Zimmerman, 1986). Metacognition is defined by an individual's ability to combine knowledge of his/her information processing ability, tasks, and strategies in addition to his/her ability to self-regulate learning (Butler, 1998; Noushad, 2008). Flavell (1976) identified two primary constructs of metacognition: (1) control over learning behaviors, (2) the self-regulation component of metacognition: awareness and self-regulation. These constructs were expanded by Pintrich (1994), who focused on academic metacognition. Academic metacognition comprises of (1) control over learning-related behaviors, (2) the self-regulation component of motivation, and (3) control over the cognitive strategies used for learning (Pintrich, 1994). Metacognitive skills are responsible for regulating the cognitive processes required for good academic performance. These cognitive processes deal with the regulation of the cognitive processes necessary for good performance, including

planning, progress checking, effort allocation, and time allocation (Tops et al., 2014).

Deficient metacognitive abilities of students with learning disabilities pose a challenge for these students in academic settings.

There is conflicting research on the metacognitive abilities of students with learning disabilities. Some research suggests that students with learning disabilities use their metacognition to compensate for their learning disabilities (Kirby et al., 2008). Other research found that the metacognitive abilities in students with learning disabilities are deficient, negatively impacting their academic performance (Klassen, 2006; Job & Klassen, 2012). Mason and Mason (2005) studied the metacognitive abilities of postsecondary students with learning disabilities. Their findings suggest that college students with dyslexia displayed deficiencies in metacognitive skills that impact students' ability to select and utilize effective cognitive skills (Mason & Mason, 2005).

Note-taking is one of the most challenging tasks a student may have to perform during their school day (Gathercole, Durling, Evans, Jeffcock, & Stone, 2008). According to Peverly (2006), students must perform three major cognitive tasks when recording notes during a lecture; (1) holding and rehearsing incoming verbal lecture content, (2) rapidly constructing representations of the content during a lecture and, (3) transcribing the information before the information temporarily located in the verbal store is lost and new information arrives for processing (Peverly, 2006). Difficulty performing the task of note-taking can be attributed to deficiencies in metacognitive functions required for note-taking, such as storing and processing information simultaneously (Gathercole et al., 2008).

Research suggests that students with learning disabilities lack the appropriate strategies to approach various academic tasks. Students with learning disabilities find it difficult to regulate and activate strategic behavior (Gersten, Fuchs, Williams & Baker, 2001; Graham & Harris, 2003). The allocation and deployment of resources during learning tasks require metacognitive processes (Cutting & Denckla, 2003).

Executive function, working memory, and cognitive load. Deficits in executive functioning, including impairments of working memory, are also associated with poorer academic achievement (Nugent & Smart, 2014). Working memory influences the cognitive processes of an individual, processes that are necessary for employing academic tasks (Schuchardt et al., 2008). Working memory is “the ability to temporarily store, manipulate, and transform incoming auditory and visual information (Boyle, Forchelli, & Cariss, 2015, p. 188). Working memory plays a significant role in each cognitive activity that requires the storing and manipulation of temporary information such as learning new words (Gathercole & Baddeley, 1990), producing sentences (Adams & Gathercole, 1996), reading comprehension, note-taking, and essay writing (Piolat, Olive, & Kellogg, 2005). Research asserts that problems with working memory impact the efficient processing of lecture points and note-taking (Boyle, 2012; Archibald & Gathercole, 2006). Students with learning disabilities have poor working memory function, and academic tasks, such as note-taking, places a heavy demand on working memory which can be detrimental to academic success (Gathercole, 2004).

Baddeley’s (2003) working memory (WM) model contains multiple components that may explain the note-taking process of students with learning disabilities. The WM model specifies four major components of working memory, which include “central

executive, phonological loop, the visuo-spatial sketchpad, and an episodic buffer” (Baddeley et al., 2009 as cited in Boyle, 2012). Impairments of executive function, working memory, and cognitive load are common among students with learning disabilities (Boyle, 2012). Ruhl, Hughes, and Gajar (1990) studied the impact of pauses on the free recall and long-term recall of students with and without learning disabilities on tests. Their findings indicate that interventions such as a pause procedure can assist students with learning disabilities in overcoming working memory deficiencies and increasing recall and comprehension. Goff, Pratt, and Ong (2005) examined predictors of reading comprehension among students in grades 3 – 5. Their findings concluded that orthographic processing, which controls for variance in language skills, verbal working memory, word reading, and language skills, was the strongest predictor of reading comprehension (Goff et al., 2005). These findings indicate that working memory, executive function, and cognitive load impact the ability of students with learning disabilities to perform multiple academic tasks such as comprehension and note-taking.

Also, cognitive load can impact academic tasks such as note-taking and reading comprehension. According to the Cognitive Load Theory (CLT), individuals have limited working memory, and when the limited cognitive resources are overwhelmed, it prevents new learning from occurring (Baddeley, 2003; Chandler & Sweller, 1991). CLT holds that working memory comprises three systems: visual/spatial, auditory/phonological, and executive function (Baddeley, 2003). Therefore, strategies to reduce cognitive load and the effort required to focus and complete learning tasks should be explored, especially for students with learning disabilities (Belson, Hartman, & Sherman, 2013; Paas, Tuovinen, Tabbers & Van Gerven, 2003). Reductions in cognitive load can assist with the

facilitation of learning by redirecting cognitive effort toward activities that are relevant to learning (Belson et al., 2013). Educational supports, such as assistive technology, that can assist students with learning disabilities in reducing cognitive load can positively impact their academic success (Harper, Kurtzworth-Keen, & Marable, 2017).

Reading challenges. Reading is another area where students with learning disabilities have difficulty (Abreu-Ellis et al., 2009). Given the extensive amount of reading required in higher education settings, postsecondary students with learning disabilities are disadvantaged (Smith, 1990 as cited in. Abreu-Ellis et al., 2009). Reading comprises two major components, which include comprehension and decoding (Gough & Tunmer, 1986). Reading disabilities, such as dyslexia, cause phonological deficits that impair an individual's ability to link letters to corresponding sounds in addition to segmenting spoken word (Scarborough, 1984). Therefore, the reader has difficulty decoding and identifying words (Goff et al., 2005). Difficulties in reading are also impacted by deficits in higher-order processes that prevent the interpretation of meaning from text (Lyon et al., 2001).

Data from the National Longitudinal Transitional Study-2 suggest that more than 50% of secondary students with learning disabilities performed below the 16th percentile on measures of reading comprehension. The study's sample comprised 11,000 youth ages 13 to 16 in seventh grade or above who were receiving special education services from 2000 – 2010. (Wagner et al., 2005). Research supports that these difficulties persist throughout life, therefore accompanying secondary students into the higher education environment (Gerber et al., 1990; Floyd & Judge, 2012). The reading comprehension

challenges students face at the secondary level mirror the challenges faced by college students with learning disabilities (Floyd, 2012; Floyd & Judge, 2012).

Note-taking challenges. With the overwhelming number of lecture-based courses in the higher education environment, note-taking skill is a key predictor of academic success (Ruhl et al., 1990). Evidence from previous research examining the note-taking skills of college students found common challenges faced by students with learning disabilities. Evers and Spencer (2007) found that students with learning disabilities have a difficult time deploying strategies required for successful note-taking. In their study, students with learning disabilities recorded fewer lecture points after taking notes from a video-recorded lecture. In examining note-taking skills of students with learning disabilities, Suritsky and Hughes (1991) found that the notes of students with learning disabilities were of poorer quality than students without learning disabilities. Students with learning disabilities' notes contained only 36% of lecture information points compared to 56% of lecture information points recorded by students without learning disabilities (p.22).

Later research conducted by Suritsky (1992) examined the note-taking of college students with and without learning disabilities. Their findings showed that students with learning disabilities recorded fewer lecture points during lectures when compared to students without learning disabilities. Their research also discovered that students with learning disabilities experience difficulties with written expression, maintaining concentration during lectures, and recording notes quickly enough to keep up with the lecture. The students were surveyed and asked to report areas of difficulty in note-taking during lectures. The top-rated responses by students included writing fast enough,

making sense of notes, deciding which information is most important, and understanding what the professor is saying (Suritsky, 1992). Students with learning disabilities have difficulty distinguishing between important and unimportant information during the lecture and making sense of written notes after the lecture (Suritsky, 1992; Suritsky & Hughes, 1991).

Other research investigating the note-taking abilities of students with learning disabilities focused on the secondary setting. Although Boyle (2010a) conducted his research in the middle school setting, his findings provide valuable insight into the note-taking challenges encountered by students with learning disabilities. This research found significant differences in the quality of notes recorded by students with learning disabilities compared to students without learning disabilities. Boyle (2010a) found that students with learning disabilities only recorded 18% of cued lecture points compared to 42% recorded by students without learning disabilities. Therefore, the notes of students with learning disabilities contained less than half of the total lecture points of their counterparts. Differences were also found in the number of notes recorded. Students with learning disabilities lagged behind students without learning disabilities in terms of words per note. Students with learning disabilities recorded an average of 57 words per note, while students without learning disabilities recorded 130 words per note (Boyle, 2010a). In addition to recording fewer lecture points, students with learning disabilities recorded fewer vocabulary words than students without learning disabilities (Boyle & Baharev, 2010).

Boyle et al. (2015) studied note-taking among eighth-grade students with high incidence disabilities. They asked students to rate ten difficulty areas relating to note-

taking. The top five difficulty areas rated by the students included (1) studying notes, (2) the ability to write fast enough, (3) the ability to determine what information is important to record, (4) being able to make sense of the notes after the lecture, and (5) understanding the teacher during the lecture. Their research agrees with earlier research conducted by Suritsky (1992).

Note-taking interventions for students with learning disabilities. Note-taking is one of the many challenges that students with learning disabilities face in educational settings. Research examining the difficulties of students with learning disabilities has focused on identifying strategies that can assist students in overcoming the challenges associated with note-taking (Boyle, 2012; Baharev, 2016). Strategies that can help students with learning disabilities in improving their note-taking include (a) guided notes (Lazarus, 1991), (b) strategic note-taking (Weishaar & Boyle, 1999), (c) Cornell note-taking (Baharev, 2016), and (c) technology (Belson et al., 2013).

Guided notes. Much research has examined the benefits of guided notes on the note-taking of students with learning disabilities. Guided notes are teacher-prepared notes in the form of an outline containing blanks where key lecture concepts are to be recorded. This strategy aims to guide students through the lecture (Heward, 1994; Boyle & Rivera, 2012). Lazarus (1991;1993) examined the impact of guided notes on the note-taking accuracy and test scores of secondary students with learning disabilities in a regular-curriculum science class. The authors used a traditional form of guided notes, which used cued note-paper accompanied by roman numerals, letters, words, questions directly related to the lecture content. The student's scores on chapter tests and baseline levels improved following the guided note-taking intervention.

In a similar study, Sweeney et al. (1999) examined the effectiveness of guided notes with high school students in a remedial social studies class. Their research studied two forms of guided notes, short-form, and long-form guided notes. Short-form guided notes were defined as “responses written by the student containing one to three words and reflecting essential information from the presented sentences that were necessary to understand the concepts in the lesson” (Sweeney et al., 1999, p. 310). Long-form notes were classified as “responses written by the student containing four to eight words and reflecting essential information from sentences presented that were necessary to understand the concepts in the lesson” (Sweeney et al., 1999, p. 310). The findings of both studies provide support for guided notes as an effective way of improving the accuracy of notes by improving the recording of concepts.

Other research examined the impact of guided notes on note-taking accuracy. Hamilton, Seibert, Gardner, and Talbert-Johnson (2000) and Patterson (2005) examined the impact of guided notes on the note-taking accuracy and quiz scores of students with learning disabilities in a classroom setting. Seibert et al. (2000) investigated the effectiveness of guided notes in improving the academic performance of incarcerated male students with and without learning disabilities ages 13 to 18 years old in a social studies class. Their findings showed improved academic performance with the use of guided notes. In a similar study, Patterson (2005) examined the impact of guided notes on the academic performance of African American males with learning disabilities and behavioral disorders in two fourth-grade inclusion classrooms. She also found a positive relationship between the use of guided notes and students' academic performance with learning disabilities. Both studies support the findings of Sweeney et al. (1999), which

asserted that guided notes are an effective intervention to support improvements in students' note-taking and academic performance. Each of the studies found that the accuracy of students' notes improved after implementing the guided note-taking intervention.

Strategic note-taking. Strategic note-taking is another research-based strategy used with students with learning disabilities. Strategic note-taking is a strategy based on the assumption that students are passive learners (Jiang, Clarke-Midura, Keller, Baker, Paquette, & Ocumpaugh, 2018; Weishaar & Boyle, 1999). To encourage note-taking, students are given notepaper containing cues to prompt students to utilize their metacognitive abilities during a lecture (Weishaar & Boyle, 1999). Boyle and Weishaar (2001) evaluated the effectiveness of strategic note-taking of high school students in a special education class by measuring the immediate long-term recall, free recall, quiz performance, and total comprehension of video-recorded lectures. Students who utilized the strategic note-taking intervention outperformed students who used conventional note-taking strategies on the immediate free recall and long-term free recall exercises and the total number of recorded vocabulary words (Boyle & Weishaar, 2001). Their findings support the use of strategic note-taking to improve the note-taking skills of students with learning disabilities.

The usefulness of strategic note-taking for students with learning disabilities is also supported by Boyle (2011). Boyle (2011) investigated the impact of strategic note-taking on the note-taking of middle school students with and without learning disabilities. He found that strategic note-taking improves students' academic outcomes with learning disabilities by increasing the number of cued lecture points, words recorded, vocabulary

words, and total lecture points recorded in their notes. Research on strategic note-taking and learning disabilities is optimistic. However, additional research on the impact of strategic note-taking on the note-taking abilities of postsecondary students with learning disabilities is warranted (Boyle, 2011; Boyle & Weishaar, 2001).

Cornell note-taking. Existing research shows support for the use of Cornell note-taking to improve comprehension and recall for students with and without learning disabilities (Baharev, 2016; Faber, Morris, & Lieberman, 2000; Tsai-Fu & Wu, 2010). Cornell note-taking prompts students to become independent note-takers by employing cognitive strategies such as main idea identification, questioning, and summarizing (Baharev, 2000). The Cornell method has a specific template that is used to record notes. This template includes three main sections: (1) the left column is for keywords/questions, the right column is for main ideas, and the bottom section is for the summary (Baharev, 2000; Tsai-Fu & Wu, 2010). This strategy requires both explicit instruction and modeling on how to compose paragraphs from discrete words to develop a summary from the main ideas (Tsai-Fu & Wu, 2010).

Few studies have investigated the impact of Cornell note-taking on comprehension (Baharev, 2000; Faber et al., 2000, Tsai-Fu & Wu, 2010). Baharev (2000) examined the impact of the Cornell note-taking strategy on the comprehension and recall of eighth-grade students with and without learning disabilities. The research did not find the number of notes recorded to predict success on comprehension measures. However, the findings indicate that students trained to use the Cornell note-taking strategy perform better on comprehension tests. Baharev (2000) concluded that the differences in the performance of the students who used the Cornell method and students who did not were

not significant (Baharev, 2000). Tsai-Fu & Wu (2010) studied Taiwanese freshman English majors in an English listening comprehension course to determine the impact of the Cornell note-taking method and note-taking language on the listening comprehension of long conversations and short texts. They found that the students who received training on the Cornell method scored significantly higher on comprehension measures of long conversations and short text. The findings of their study support the use of Cornell note-taking to improve comprehension among postsecondary students.

Other research has evaluated the Cornell method's impact on students' performance on objective tests (Faber et al., 2000). Faber et al. (2000) explored the effectiveness of Cornell note-taking strategy training on ninth-grade students' performance on content area tests in world cultures, English, and science classes. Their findings indicate that students of higher and lower abilities have higher comprehension outcomes when provided with note-taking instruction. Their findings also offered support for Cornell note-taking to enhance the encoding process of secondary students across multiple subject areas.

Technology to enhance note-taking. Research supports using technology to help students with learning disabilities with reading comprehension, note-taking, and organization (Belson et al., 2013; Boyle, 2012; Hannon, 2008). Technology that can enhance students' note-taking includes assistive technology such as digital pens, tablets, personal computers, and guided notes through electronic lectures using Microsoft PowerPoint (Boyle, 2012). Belson et al. (2013) examined the impact of digital pens with the Cornell note-taking strategy with high school students with language-based learning disabilities in a reading strategies class. They found that students with learning

disabilities improved the quality of their notes using a combination of the digital pen and Cornell note-taking strategy. These improvements included the increased recording of main points and the student's ability to summarize important ideas or words. Their research did not find a significant difference in note organization.

Other research examined the use of smartpen in postsecondary education (Boyle & Joyce, 2019a; Boyle & Joyce, 2019b; Hannon, 2008; Stachowiak, 2010). Hannon (2008) discussed the “coming wave of recording devices and other classroom technologies” (p.15), suggesting that new forms of technology would be student-centered, forcing conversations about the best ways to support student success. Stachowiak (2010) presented information on the trial of the Livescribe™ smartpen at the University of Iowa. The author noted the positive benefits of UDL implementation in postsecondary classroom settings.

Joyce and Boyle (2019a) performed a case study to evaluate the impact of using a Livescribe™ smartpen on the note-taking ability of a ninth-grade language arts student. Following the Livescribe™ pen intervention, the student experienced improvements in lecture test scores, total word count, and vocabulary. In a second study, Joyce and Boyle (2019b) examined the impact of smartpen use combined with the TARGET strategy on note-taking skills of students with learning disabilities in a ninth-grade English language arts class. They found that students who used the smartpen strategy recorded more lecture points than students who did not use the smartpen. The intervention group recorded an average of 21.6 lecture points, while the control group only recorded an average of 16.4 lecture points. The students in the experimental group also recorded a higher number of words in their notes (average of 188) compared to the control group (average of 141

words). These studies suggest that smartpens can be effective in supporting students with learning disabilities. Despite the insight provided by these studies, there is limited research investigating the impact of smartpens on the note-taking skills of students with learning disabilities at the postsecondary level. Additional research in this area can provide valuable insight into practical educational supports for students with learning disabilities.

Comprehension challenges for students with learning disabilities. Students with learning disabilities experience significant challenges with comprehension. These challenges are often displayed in their performance on measures of comprehension and recall (Boyle, 2010a; Lonergan, Lilies, and Anderson (1999). Boyle (2010a) found that middle school students with learning disabilities recorded lower scores on comprehension measures in science lectures. In their study, students with learning disabilities scored an average of 47% compared to an average of 67% among students without learning disabilities. Ward-Lonergan et al. (1999) examined the comprehension and recall skills of seventh-grade students with and without learning disabilities in social studies classes. They found that students with learning disabilities performed poorer on comprehension questions compared to students without learning disabilities. Their findings suggest that students with learning disabilities encompass inadequate listening comprehension abilities compared to their counterparts.

Decoding. Research suggests that comprehension and decoding skills develop concurrently (Nation & Snowling, 1998). Therefore, individuals with poor reading skills usually have deficiencies in both areas (Gajria et al., 2007; Nation & Snowling, 1998). Decoding requires integrating knowledge acquired from text and the real world

(Simmons & Singleton, 2000). However, there is competing research on the subject. Some studies indicate that students can have poor decoding skills but adequate reading comprehension skills. Other research suggests that students have reading comprehension difficulties with sufficient decoding and word recognition skills (Stothard & Hulme, 1995; Yuill & Oakhill, 1991).

Yuill and Oakhill (1991) studied children, ages 7-8 years old, with similar vocabulary and word recognition skills and varying comprehension ability. They did not find any difference in the reading speed of low and high-frequency words among students considered to have good and poor comprehension skills, who were also matched on reading accuracy and vocabulary knowledge. Their findings suggest that reading accuracy significantly impacts reading comprehension, but reading speed is not as critical (Yuill & Oakhill, 1991). They noted that poor decoding skills were not an indicator of a student's comprehension skills (Yuill & Oakhill, 1991). Stothard and Hulme (1995) studied two distinctive groups; children with comprehension problems and children with decoding problems. Their findings suggest that children with poor decoding skills also have impaired phonological skills, while children with poor comprehension skills have phonological skills within the normal range (Stothard & Hulme, 1995). The findings of both studies indicate that students with poor decoding skills can have good comprehension skills and vice versa. Additional research on this relationship is necessary.

Comprehension interventions for students with learning disabilities. Some strategies are effective in helping students with learning disabilities in overcoming reading comprehension difficulties. These strategies include (a) text-structure-based

training (Bakken & Mastropieri, 1997; Meyer et al., 2010; Wijekumar, Meyer, & Lei, 2012; Wijekumar Meyer, & Lei, 2017), (b) strategic reading, (Klingner & Vaughn, 1996;1998; Vaughn & Klingner, 1999), and (c) paragraph restatement (Doctorow, Wittrock & Marks, 1978; Jenkins et al., 1986; Jenkins et al., 1987).

Text-structure based training. Text structure-based training as a solution for reading comprehension difficulties is supported by several studies (Bakken & Mastropieri, 1997; Meyer et al., 2010; Wijekumar et al., 2017). Text structure strategy involves the identification, signaling, and linking of words, the summarization of text-structure-based scaffolds (Wijekumar et al., 2012), and the encoding or strategic memory structures (Wijekumar et al., 2012). This strategy teaches students how to follow text structures by strategically using knowledge to organize their writing better and improve their comprehension (Wijekumar et al., 2012). Bakken and Mastropieri (1997) evaluated the impact of text structure-based training on the reading comprehension of eight grade students with learning disabilities. They found text structure-based training to increase the performance levels in the recall of idea units on immediate and delayed recall measures. Similar work has been pursued by Meyer et al. (2010) and Wijekumar et al. (2017). Meyer et al. (2010) investigated the effectiveness of different web-based tutoring systems to teach text-structure strategy on the reading comprehension of fifth and seventh-grade students. They found that students' reading comprehension improved using the web-based system with elaborated feedback. Less improvement was shown on reading comprehension measures of students who used the web-based system with simple feedback (Meyer et al., 2010). Wijekumar et al. (2017) investigated the impact of web-based text structure instruction on the reading comprehension of seventh-grade students

in multiple language arts classes. Students who used the web-based text structure strategy scored higher on all reading comprehension measured compared to the control group. Both studies found that students who received the intervention improved standardized reading comprehension scores. Students improved in the areas of competence, knowledge, and summarization (Wijekumar et al., 2017). Although these two studies were not conducted with students with learning disabilities, the findings support the use of text structure-based instruction to improve reading comprehension in students.

Meyer and Poon (2001) evaluated the use of the text structure strategy on adult learners. Their findings indicate that structure strategy can increase the amount of information recalled for both young and older adult learners. This study also found that the intervention increased the students' ability to recall the most important information. Their findings suggest that text structure strategy can be an effective intervention for college-aged learners.

Strategic reading. Collaborative strategic reading (CSR) is a strategy that has been used to improve the reading comprehension of elementary students. This strategy emphasizes explicit instruction, scaffolding, and peer-mediated instruction (Klingner & Vaughn, 1999; Klingner et al., 2012). Vaughn and Klingner (1999) proposed a model of strategic reading that would assist students with learning disabilities with reading comprehension. The model included the following process taught through collaborative strategic reading (CSR): previewing and predicting (Preview), monitoring for understanding and vocabulary knowledge (Click and Clunk), main idea (Get the Gist), and self-questioning and passage understanding (Wrap-Up) (Vaughn & Klingner, 1999). Early research conducted by Klingner and Vaughn (1996;1998) studied CSR with

elementary and middle school students. In their first study evaluating the impact of CSR on middle school ESL students with learning disabilities, the researchers discovered that students improved their reading comprehension after the CSR intervention. Significant improvements were also observed in students who began the study with higher-level decoding skills (Klingner and Vaughn, 1996). In a subsequent study, Klingner and Vaughn (1998) found similar positive results in their study examining CSR as a strategy to improve the reading comprehension of fourth-grade students. A large body of research supports the use of collaborative strategic reading as a tool to enhance students' ability to understand the text and improve reading comprehension for students with learning disabilities, low achievers, and students who are not native English language speakers (Boardman et al., 2016; Vaughn & Klinger, 1999).

Paragraph reinstatement. Paragraph reinstatement or summarizing is a strategy used to assist students in facilitating the construction of meaning from texts (Jenkins et al., 1987). Early research supports the use of paragraph reinstatement to improve reading comprehension (Doctorow, Wittrock & Marks, 1978; Jenkins et al., 1986; Jenkins et al., 1987). Doctorow et al. (1978) examined the effectiveness of paragraph reinstatement on the comprehension of sixth-grade students. Their findings indicated that teaching students how to write original sentences while reading each paragraph of a story improved students' recall and comprehension (Doctorow et al., 1978). In a similar study, Jenkins et al. (1986) researched the impact of paragraph reinstatement among elementary students with learning disabilities. Their findings indicated that students who were trained to use the paragraph reinstatement strategy performed higher on reading comprehension measures compared to students who were not trained to use the strategy. The findings of

Doctorow et al. (1978) and Jenkins et al. (1986) are supported by the research of Jenkins et al. (1987). Jenkins et al. (1987) investigated elementary school learning disabled students' ability to apply the paragraph reinstatement strategy under different conditions while examining how the strategy would impact students' reading comprehension. They found that students improved reading comprehension using the paragraph reinstatement strategy under multiple conditions (Jenkins et al., 1987).

Assistive Technology in Higher Education

Advances in technology and increasing numbers of students with learning disabilities entering higher education institutions have resulted in research investigating the role of assistive technology in supporting the educational endeavors of this population of students. The Individuals with Disabilities Education Act (IDEA) defines assistive technology as "items, devices, equipment, or products which may be commercially available, customized or adapted to help a person with a disability to function or to improve, maintain or increase their capacity to function" (IDEA) (U.S.C § 2201, 2202). This definition is the most commonly accepted definition across institutions. Hersh and Johnson (2008a) provided an additional definition of assistive technology, which specifies that assistive technology includes:

technologies, equipment, devices, apparatus, services, systems, processes and environmental modifications used by disabled and/or elderly people to overcome the social, infrastructural and other barriers to independence, full participation in society and carrying out activities safely and easily (p. 196).

There are seven assistive technology categories, including positioning, mobility, augmentative communication, computer access, adaptive toys and games, adaptive

environments, and instructional aids (Bryant & Bryant, 2003). This section will provide an overview of (a) the benefits of assistive technology, (b) smartpen technology, and (c) the benefits of smartpens on digital note-taking and reading comprehension.

Benefits of Assistive Technology for Students with Learning Disabilities

Assistive technology has positive benefits for individuals with learning disabilities, including fostering independence (Carlson, Ehrlich, Berland, & Bailey, 2001), increasing productivity, and improving learning (Estrada-Hernandez, Wheaton, Dawson, & Krispinsky, 2007). The positive benefits of assistive technology in higher education have been examined by many researchers (Earman-Stetter & Tajero-Hughes, 2010; Malcolm & Roll, 2017; Meyer & Bouck, 2014). According to the National Center for Education Statistics (2013), approximately 70% of higher education degree-granting institutions reported assistive technology as the essential support needed to meet the educational needs of students with learning disabilities. Assistive technology can enhance communication, reading, writing, and note-taking.

Impact of assistive technology use on reading. Reading is a skill consistently noted as being a challenge for students with learning disabilities. Research suggests that assistive technology could be a helpful tool in mediating these challenges. Few studies have researched the impact of assistive technology on the reading skills of postsecondary students with learning disabilities (Malcolm & Roll, 2017; Meyer and Bouck, 2014; Earman-Stetter and Tajero-Hughes, 2010). One study found that postsecondary students with learning disabilities used assistive technology for studying and reading (Malcolm & Roll, 2017). In their survey investigating the impact of assistive technology use, 84% of students responded that assistive technology positively impacted their grades, and 80% of

students responded that the AT assisted them with keeping up in their courses. Malcolm and Roll's (2017) research supports the findings of Earman-Stetter and Tajero-Hughes (2010; 2011), indicating that assistive technology has a positive impact on student's reading comprehension skills.

Other research has examined the impact of specific assistive technology on the reading skills of students with learning disabilities. Meyer and Bouck (2014) evaluated the impact of text-to-speech software on the reading skills of middle school students with specific learning disabilities in fluency, comprehension, and task completion time using expository texts. Their research found that assistive technology did not impact students' fluency, comprehension, and task completion rates. However, it is noteworthy to mention that through interviews, the students indicated that they believed their fluency, comprehension, independence, and task completion were positively impacted by the text-to-speech software (Meyer & Bouck, 2014). This research disagrees with the findings of Earman-Stetter and Tajero-Hughes (2010; 2011) and Malcolm and Roll (2017).

Another notable study conducted by Armstrong and Hughes (2012) investigated the impact of evidence-based computer interventions on the reading comprehension of children with autism. Their results indicated a positive correlation between assistive technology use and reading comprehension (Armstrong and Hughes, 2012). The mix of findings in this area calls for additional research.

Impact of assistive technology use on writing. In general, work to date in this area support the use of assistive technology to improve writing skills. In a study examining the impact of speech recognition software on the writing of postsecondary students with learning disabilities, Higgins and Raskind (2005) found that the use of

assistive technology helped students to improve their writing in the areas of vocabulary, syntax, and fluency. Bouck, Doughty, Flanagan, Szwed, and Bassette (2010) examined the use of a FLY pentop computer and its impact on the writing skills of students with learning disabilities in a sixth-grade self-contained mathematics class. Their research also found positive support for the use of assistive technology to support writing skills. The findings of their study indicate that assistive technology can improve the quality and quantity of students with learning disabilities' writing and can also assist with facilitating planning and independent task completion (Bouck et al., 2010).

Other technologies that have proved to assist students with learning disabilities in improving their writing abilities include “word processing, spell checkers, word prediction, speech recognition, and text-to-speech screen review” (Peterson-Karlan, Hourcade, & Parette, 2008, p.16). Scaffolding with technology assists students with learning disabilities to compensate for their deficiencies, allowing them to perform at higher levels (Peterson et al., 2008). Hertzroni and Shrieber (2004) found that junior high students with learning disabilities were able to improve aspects of their writing using a word processor. Students improved the structure and organization in their writing and decreased spelling errors (Hertzroni & Shrieber, 2004). Overall, research has found positive correlations between technology use and writing improvement.

Smartpen Technology

Recent studies on the use of assistive technology assert that smartpens can assist students with learning disabilities in overcoming various academic skill deficiencies (Boyle et al., 2015; Boyle & Joyce, 2019; Ellis, 2016; Patti & Garland, 2015). A smartpen is “an electronic pen that contains a micro-camera that records information”

(Boyle et al., 2015, p. 192). There are two primary types of smartpens, a freeform pen and a pen that uses specialized dot paper (Boyle et al., 2015; VanSchaack, 2012). A freeform pen contains wireless positioning technology that allows the pen to track note-taking on any type of paper. The notes recorded using a freeform pen are uploaded as digital images (VanSchaack, 2012). Other pens require special dot paper that contains microdots, which allows the pen's built-in camera to monitor the movement of the pen on the paper. The microdots communicate the location of the pen on the paper utilizing the pen's microcamera, facilitating coordination between the written and audio material during lectures (Boyle et al., 2015; VanSchaack, 2012). Smartpens encompass multiple features that can assist with a variety of academic tasks. The portability and low cost (average \$150) of smartpens make them an excellent option for students (Boyle & Joyce, 2019).

Livescribe™ pen. The Livescribe™ pen (Echo, 3 and Symphony) function like traditional pens, allowing students to record written notes utilizing ink and notebook paper. The features of a smartpen, such as a high-speed infrared camera, a built-in microphone, and a speaker allow students to simultaneously record the verbal component of the lecture while writing their notes (Livescribe, n.d.). The Livescribe™ pen operates by recording the information on a page utilizing a unique set of x, y coordinates ingrained in the invisible dot codes printed on the paper. The content on the page is synced with the audio recording. This feature allows a student to place the tip of their pen on any portion of the lecture to generate the audio recording associated with that exact point in the lecture. The audio recording is also referred to as a pencast. This feature allows the student to amend their notes after the lecture. The ability to amend notes using a pencast

can be advantageous for students with learning disabilities who often have a difficult time keeping up with lectures and writing fast enough to capture important lecture points (Boyle et al., 2015; Boyle & Joyce, 2019).

The Livescribe™ pen can be connected to mobile computing devices such as computers, smartphones, and tablets via Bluetooth and is compatible with both (Director, 2015). The capability allows the information written on the dot paper to be transcribed electronically to any of those devices in multiple formats. Notes can also be converted to PDF and Flash Movies (Bokhari, Ahmad, Alam, & Masoodi, 2011).

Benefits of Smartpens on Digital Note-taking and Reading Comprehension

Limited research has examined the impact of the smartpens on the notetaking and reading comprehension skills of students at all levels. Few studies have investigated the effects of smartpen interventions in secondary education (Belson et al., 2013; Ok & Rao, 2017). In an examination of high school students with learning disabilities, Ok and Rao (2017) found Livescribe™ pens to be a valuable tool to support students with learning disabilities in language arts and mathematics classes. Their findings suggest that smartpens are “an effective tool for helping with note-taking, providing supplementary learning supports (e.g., reviewing lessons, preparing for exams), creating read-aloud class materials, creating assessments, and helping with mathematics computations” (p. 41).

Other research found smartpens to be effective in assisting with mathematics and improving the quality of students’ notes (Belson et al., 2013; Boyle & Joyce, 2019a), assessment, study skills, and working independently (Patti & Garland, 2015). Belson et al. (2013) researched the use of a Livescribe™ pen along with the Cornell note-taking strategy and found that high school students with language-based learning disabilities

were able to improve the quality of their notes in the categories of selectivity and content using the Livescribe™ pen in a reading strategies class. Their findings also suggest that the Livescribe™ pen can positively impact students' ability to improve the conciseness of their notes and produce refined notes using audio playback options. The benefits of smartpens are also visible in terms of lecture points recorded. Boyle and Joyce (2019a) conducted the first empirical study evaluating the use of a smartpen on the note-taking of students with and without learning disabilities in a ninth-grade English language arts class. They discovered that students who utilized a smartpen during a lecture were able to record more lecture points than the control group. Their research also captured the benefits of the smartpen's playback features. By utilizing the playback feature, students could revise their notes, adding an average of 27 new words (Boyle & Joyce, 2019a). In a similar study, Boyle and Joyce (2019b) investigated the effectiveness of smartpen use, coupled with the TARGET strategy. The researchers found that ninth-grade students with specific learning disabilities and attention deficit hyperactivity disorder (ADHD) who used the Livescribe™ Echo smartpen in their English language arts class recorded more lecture points and more words in their notes. They also performed better on lecture assessments than students who utilized traditional note-taking methods (Boyle & Joyce, 2019b).

Shaffer and Schwebach (2015) evaluated the use of Livescribe™ pen web recordings in a postsecondary cell biology course. Although they did not find a significant correlation between the use of pencasts and student achievement, their findings suggest that pencasts can be useful in enhancing students' learning experiences and increasing student engagement (Shaffer & Schwebach, 2015). Their findings are

supported by Tucker and Zamfir (2021), who explored the perceived impact of the Livescribe™ pen among students with disabilities in higher education. They found that overall, students had positive experiences using the Livescribe™ pen. The perceived benefits included greater academic outcomes, recording more complete notes, improved focus, and increased independence (Tucker & Zamfir, 2021).

The use of a smartpen may lessen the cognitive activity required for effective note-taking (Boyle & Joyce, 2019b). Employing a note-taking procedure, such as a smartpen, can allow students to process and store information on a deeper level by freeing up space in the verbal working memory for the processing of new information (Boyle, 2012). Therefore, smartpens can provide increased learning opportunities for students in reading comprehension and pronunciation (Knox, Herrington, & Quin, 2011; Johnson, 2008). Few studies have investigated the usefulness of a smartpen in mediating the reading comprehension challenges faced by students with learning disabilities. Johnson (2008) studied the impact of the Oxford Reading Pen (ORP) on the comprehension and reading accuracy of students with reading difficulties enrolled in a reading remediation program. Reading accuracy and comprehension were improved by the use of the ORP. This research provides support for the use of smartpens with students who have reading disabilities such as dyslexia. Further investigation is required to explore the impact of smartpens on the note-taking and reading comprehension skills of students with learning disabilities in postsecondary education.

In sum, students with learning disabilities encompass a variety of cognitive and academic skill deficiencies that impact their academic success at all levels. This group of students encounters difficulty with multiple academic tasks to include comprehension and

note-taking. Research supports the use of note-taking interventions (i.e., Cornell note-taking, guided notes, etc.), reading comprehension interventions (i.e., strategic reading, paragraph reinstatement, etc.), and assistive technology (i.e., Livescribe™ smartpen) to assist students with learning disabilities in overcoming these challenges. These resources, along with training, should be made accessible to postsecondary students with learning disabilities.

CHAPTER 3

METHOD

The present action research study used a systematic form of inquiry to identify effective educational support for students with learning disabilities. First, this research aimed to explore the impact of the Livescribe™ pen on the quality of notes and comprehension abilities of student-athletes with learning disabilities. Secondly, the study sought to examine the Cornell note-taking strategy's impact on note-taking quality and comprehension of student-athletes with learning disabilities. Finally, the study explored student-athletes' perceptions and experiences using the Livescribe™ pen and Cornell note-taking strategy. The research was guided by the following research questions.

1. How does the use of the Cornell note-taking strategy supported with a Livescribe™ pen affect the note-taking quality of student-athletes with learning disabilities?
2. How does the use of the Cornell note-taking strategy supported with a Livescribe™ pen affect the comprehension of lecture content and vocabulary among student-athletes with learning disabilities?
3. What are the experiences and perceptions of student-athletes with learning disabilities using Livescribe™ pens and their impact on note-taking and comprehension of lecture content?

Research Design

The present study investigated how using a Livescribe™ pen influenced self-perceptions and improved the comprehension and note-taking skills of students with learning disabilities in a higher education setting. I utilized action research as the form of inquiry to explore the experiences of students with learning disabilities at Norfolk State University.

Action research can be defined as a type of systematic inquiry by individuals who encompass a vested interest in the setting in which the research is being conducted (Mills, 2011). This type of research places emphasis on the unique characteristics of the population and setting being studied with the goal of obtaining data that will lead to improvements in the area of focus (Mertler, 2016). Action research was an appropriate form of inquiry because it allowed me as a practitioner to conduct research using a collaborative and participative approach to produce findings that could directly impact the students that I serve. The action research process is both explorative and cyclical, involving multiple systematic phases (Mertler, 2016). Because of my role as a practitioner at Norfolk State University, I was able to identify potential issues that could hinder student success, develop questions for inquiry and conduct timely research (Mertler, 2016). The advantages of action research served as a solid foundation for me to conduct research that could lead to improvements within my professional context.

In order to provide a complete understanding of the participants, their perceptions, and their experiences, it was appropriate to utilize a mixed-methods approach that incorporated both quantitative and qualitative methods to explore the research questions

comprehensively. This study utilized a mixed-methods approach designed to employ theoretical frameworks and philosophical assumptions for a level of inquiry that integrated multiple forms of data (Creswell & Creswell, 2017). Mixed methods are beneficial when the goal is to evaluate the processes or outcomes of an experimental intervention (Creswell & Creswell, 2017). According to Mertler (2016), utilizing a convergent or triangulation mixed methods approach allowed me to “combine the strengths of each form of data” by gathering both qualitative and quantitative data at the same time, then analyzing the data to uncover similarities and differences (p. 107). The converging of the two sets of data aimed to strengthen the credibility of the findings (Mertler, 2016).

There are a few characteristics unique to qualitative research which served as my reasoning for incorporating this method. A qualitative approach is appropriate to gauge the participants’ perspectives while keeping the researcher focused on capturing the meaning behind the participants’ attitudes (Creswell & Creswell, 2017; LeCompte & Schensul, 1999; Hatch, 2002). Qualitative research provides an understanding of an individual’s lived experiences and how each individual makes meaning out of their experience (Seidman, 2013). To analyze the perceptions of each participant and their experiences using the Livescribe™ pen, this study employed a qualitative approach to gather data. A qualitative design was appropriate because it allowed for data to be collected in the field while relying on the researcher as a key instrument in the data collection process (Creswell, Hanson, Clark-Plano & Morales, 2007). I employed qualitative data collection methods, such as participant interviews.

Quantitative methods were employed to evaluate the outcome of the Livescribe™ pen and Cornell note-taking intervention. The goal of utilizing quantitative methods such as an immediate free recall exercise, comprehension test, rubric evaluation of students' notes, and a note-taking experience survey was to provide a well-rounded understanding of the impact of the Livescribe™ pen and Cornell note-taking intervention on the student's notetaking and comprehension skills.

Setting and Participants

Setting

This action research was conducted at Norfolk State University (NSU), which is an urban public historically black college and university (HBCU) located in Norfolk, Virginia, in the Southeast region of the United States. Its current undergraduate enrollment is 4,689, with a population of 84% Black or African American students, 3.8% white students, and 12% of students identified as other (Norfolk State University, 2018). The gender distribution of the NSU population is 65% female and 35% male. Seventy-five percent of the undergraduate population receives some form of need-based financial aid.

This study took place in a Personal and Community Health (HED 100) course. This course is designed to teach students about community and personal health problems to assist them in making informed decisions and practice a lifestyle of healthy living. The average enrollment of HED 100 courses is between 25 and 30 students. The class is held twice a week in 50-minute sessions. Students enrolled in this course are usually in their first or second year of undergraduate enrollment. HED 100 courses are held in classrooms located on the first floor of Gill Gymnasium. Gill Gymnasium is dually used as an academic building and athletic facility. The classrooms are arranged in a stadium

format with five rows of desks facing the whiteboard. Each classroom is equipped with a computer, projector, desk, and podium. Students have no assigned seats.

HED 100 is usually taught in a lecture format in which the instructor uses a teacher-centered approach. Lectures are delivered using a PowerPoint presentation, and students take notes in this course using traditional note-taking with pen and paper. The course content is very dense, featuring many health concepts, diseases, disorders, and health-related vocabulary. Due to the volume of content covered in each lecture, it is important for students to take sufficient notes to capture major points, keywords, and vocabulary to ensure that information can be comprehended and recalled at a later time.

Participants

Participants in this study were five undergraduate student-athletes who received support through the Student-Athlete Academic Support Center's Learning Services program and were enrolled in a personal and community health (HED 100) course. I used purposeful sampling to select the participants for the study. Purposeful sampling enabled me to choose students who were "information rich," which allowed me to learn about the issues of central importance to the study (Patton, 1990, p. 169). This sampling method helped me maximize my understanding of the phenomenon being studied (Onwuegbuzie & Leech, 2007). The participants in this study were student-athletes that I advise and work with daily in my professional setting. I had an existing rapport with these student-athletes, which promoted honest and authentic interactions (Bonner and Tolhurst, 2002). It was required that all participants be enrolled in the learning services program and have a documented learning disability. Learning disabilities may include ADD, ADHD, language disability, math disability, or reading disability. Hence, there were three criteria

for participation in the study; (1) the student must have a diagnosed learning disability with documentation filed in OASIS, (2) the student must be a varsity student-athlete and, (3) the student must be enrolled in an introductory personal and community health course.

Five students completed their consent forms and agreed to participate in the study. Table 3.1 provides an overview of the five participants, followed by a detailed description of each participant.

Table 3.1 *Participants*

Participant Pseudonym	Description
Kendall	<ul style="list-style-type: none"> • Junior student-athlete • Specific Learning Disability in math calculation and math problem solving • Receives accommodations such as extended time, calculator, and small group test environment
Jay	<ul style="list-style-type: none"> • Freshman student-athlete • Attention Deficit Hyperactivity Disorder (ADHD) • Receives accommodations such as preferential seating, extended time, and small group test environment
Caleb	<ul style="list-style-type: none"> • Sophomore student-athlete • Attention Deficit Hyperactivity Disorder (ADHD) • Adjustment Disorder with Anxiety • such as extended time, note-taker, and small group test environment
Damien	<ul style="list-style-type: none"> • Sophomore student-athlete • Attention Deficit Hyperactivity Disorder (ADHD) • Received accommodations such as extended time, note-taker, and small group test environment
Marcus	<ul style="list-style-type: none"> • Freshman student-athlete • Attention Deficit Hyperactivity Disorder (ADHD) • Receives accommodations such as extended time, note-taker, and small group test environment

Kendall was a junior varsity student-athlete who was well-liked by his peers and a respectful student. His strengths included memory and processing speed. Kendall had an individualized education plan (IEP) during high school, which addressed his weaknesses in math problem solving and math calculation. As a high school student, Kendall required specially designed instruction to address his math deficiencies and worked with an intervention specialist. He received accommodations that included access to a calculator for math and science courses, the use of student-created math referenced/formula sheet, visual models and examples, extended time up to 50%, and class notes and study guides provided in a hard copy format. He also benefited from chunking material and math content, pre-teaching, and a review of vocabulary for math. He received extended time for tests across all courses and was permitted to use a calculator for all math and science courses. In college, Kendall received identical accommodations through OASIS with the addition of access to a note-taker. During his pre-intervention interview, Kendall stated that he was not the best note-taker and had difficulty comprehending the material that he wrote in his notes. He shared that he felt like he could do better in terms of taking notes in class.

Jay was a freshman student in the second semester of his freshman year and first year as a varsity student-athlete. His strengths included having a respectful attitude and being productive in structured settings. Jay was diagnosed with ADHD, and his academic struggles were influenced by distractibility, tendency to fidget, and poor organization skills. In high school, his accommodations included extended time for assessments, access to lecture notes and study guides, preferential seating, frequent movement breaks, and small group settings for testing. Other accommodations provided to Jay included

reminders, the use of an agenda, and positive reinforcement. The challenges experienced by Jay included staying organized, planning ahead for academic tasks, and taking detailed lecture notes. Jay experienced difficulties staying motivated to complete various academic tasks. In the learning services program at NSU, the learning specialist implemented similar strategies to assist Jay in fostering academic success. When asked to describe how he takes notes, he did not have a solid process for taking notes. He also discussed the challenge of keeping up with the professor in his lecture courses, stating how this discouraged him.

Caleb was a sophomore student-athlete in his fourth semester of college, finishing up his second year as a varsity student-athlete. Caleb was diagnosed with ADHD and Adjustment Disorder with Anxiety and experienced difficulties staying focused, on task, and organized. He also experienced challenges with reading comprehension and phonics. In high school, Caleb required additional support in reading and writing. He had significant challenges with encoding and decoding. He was provided with accommodations that included testing in a small group setting, frequent breaks, guided questions for note-taking, extra time up to 50%, reading tests aloud by an instructor or assistive technology. Caleb enrolled in the learning services program and worked with the learning specialist on courses requiring considerable writing. He also received accommodation through OASIS that included testing in a small group or private setting, extra time up to 50%, and extended time on assignments. When asked to describe his ability to take notes, Caleb described himself to be an average note-taker. In his pre-intervention interview, he made positive comments about the importance of notes to

academic success and how notes became even more important to him due to the pandemic.

Damien was a sophomore student in his third semester, competing in his first year as a varsity student-athlete. Damien was diagnosed with ADHD and struggled to stay focused and on task. Damien also had difficulties with reading comprehension, written expression, and completing assignments. Additional weaknesses included math and overall effort to maintain satisfactory grades. In high school, Damien had an individualized education plan (IEP) that provided him with accommodations in his courses. His accommodations included extended time to complete assignments up to two days, extra time for responses, guided notes or graphic organizers, chunking materials, cue to task, note exchange with a peer, writing assignments in agenda daily, and checking for understanding of directions and instructions. In his first semester, Damien enrolled in the learning services program. Each week he met with the learning specialist four times and was provided with an academic action plan outlining all objectives for the week while prioritizing daily task goals. Damien also was required to complete eight hours of student-athlete study hall. When asked about the role of notes in his classes, Damien stated that notes were important to do well. He shared during his pre-intervention interview that keeping up with the lecture was a challenge for him. Overall, he agreed that his note-taking could improve.

Marcus was a first-year student entering his second semester of college. He was competing in his first year as a varsity student-athlete. Marcus received accommodations in high school in all subject areas. His academic strengths included math, verbal comprehension, and organization. He experienced challenges with working memory and

processing material. As a high school student, he worked with a learning specialist who provided individualized study and coaching sessions. He received testing accommodations such as extended time up to 50%, testing in a small group setting, and frequent breaks. In addition, he was provided with class notes for each of his courses. During his first year of college, Marcus worked with the learning specialist as a student enrolled in the learning services program. The learning specialist provided him with individualized strategies to help him succeed in each of his courses. Strategies implemented included an academic action plan to prioritize and track assignments, frequent check-ins and reminders, and regularly scheduled appointments. Marcus was also provided with assistance on writing assignments such as pre-writing activities and review. Based on his pre-intervention interview, Marcus had some form of previous note-taking training. His comments reflected a belief that notes were essential to academic success.

Innovation

The focus of my action research was to evaluate the use of a Livescribe™ pen and the Cornell note-taking strategy and its impact on the academic skills of students enrolled in a personal and community health course. The Livescribe™ pen is a smartpen that can serve as effective learning support for students with learning disabilities. The pen can transcribe handwriting, audio record simultaneously while note-taking, replay notes and audio pencasts, and record audio utilizing sound stickers (Ok & Rao, 2017). The Cornell note-taking is a specialized note-taking strategy that prompts students to become independent note-takers using cognitive strategies. Research supports the use of the Livescribe™ pen coupled with the Cornell note-taking strategy to support students with

learning disabilities in overcoming various academic skill deficiencies. The alignment between the academic skill deficiencies of students with learning disabilities and research-based strategies is depicted in Table 3.2.

Table 3.2 *Academic Skill Deficiencies and Research-based Strategies*

Academic Skill Deficiencies	Research-Based Strategies
Students with LD produce incomplete notes	<ul style="list-style-type: none"> • The audio-recording feature of digital pens can help students increase the quality of their notes in the areas of selectivity and content (Belson et al., 2013). • The Livescribe™ pencast feature can help students review content taught during their classes (Ok & Rao, 2017) and support student comprehension, retention, and content acquisition (Higgins & Raskind, 1995). • Note-taking strategies (i.e., Cornell note-taking) effectively improve the quality and quantity of notes among students with learning disabilities (Boyle & Rivera, 2012).
Students with LD have difficulty comprehending and recalling lecture content	<ul style="list-style-type: none"> • The synchronous text and audio features of the Livescribe™ pen can assist students in facilitating the retention of knowledge (Belson et al., 2013). • The Cornell note-taking strategy has been found to increase students' comprehension, retention, and ability to synthesize and apply information (Faber et al., 2000; Baharev, 2016).
Students with LD have difficulty organizing notes	<ul style="list-style-type: none"> • Amending notes using the audio recording feature (pencast) of the Livescribe™ pen can help students overcome weak writing and organization skills, assisting them in capturing key ideas from the lecture (Lindstrom, 2007). • The structure of Cornell notes is designed to help students improve the organization of their notes (Pauk & Owens, 2011).
Pre-intervention	

During the pre-intervention, students' comprehension skills were assessed using baseline measures: an immediate free recall exercise and a comprehension pretest. Students took notes using pen and paper while watching a video-recorded lecture. Immediately following the lecture, students participated in an immediate free recall (IFR)

exercise. Students were given the IFR sheet (see Appendix D) and five minutes to write as many vocabulary words and main ideas from the lecture. Upon completion, students' IFR exercises were collected, and each student was given a comprehension pretest based on the lecture content. After the students completed the pretest, the pretests were collected.

Training

Students were taught how to use the Livescribe™ pen in conjunction with the Cornell note-taking strategy with a PowerPoint presentation and Livescribe™ pen video tutorial during the training phase. At this time, the students were provided with an overview of the Cornell note-taking strategy and taught how to set up their paper using the strategy. The students were trained to pay attention to visual and verbal cues and instructed on the process of reviewing their notes by writing summaries. The training followed the steps of strategy instruction, which included describing the strategy, modeling the strategy, providing guided practice and feedback, and independent practice (Baharev, 2016). The students were taught to follow these steps when taking notes using the Cornell strategy; (1) write the topic/title of the lecture and date in the top quadrant, (2) write the main notes in the right quadrant, (3) review the main notes and write the keywords and ideas in the left quadrant, (4) write a summary of the lecture in the bottom quadrant.

After the PowerPoint and video tutorial, the students were provided with their Livescribe™ pen, notebook, and black and red ink cartridges. The students were then provided with a tutorial on the features of the smartpen. First, the instructor modeled how to use the pen. The students were asked to mimic each process along with the instructor.

Students were taught how to turn the pen on and off, activate the pencast (audio-recording feature), start, stop, rewind, and fast forward through their notes, and adjust the playback volume. Students were taught how to amend their notes after the lecture by switching their ink to red and playing back the pencast using headphones. Next, the instructor explained the process of amending notes using the smartpen by changing the pen tip to red and listening to the audio recorded (pencast) during a lecture.

Practice

During these sessions, students practiced using the Livescribe™ and Cornell note-taking strategy during class sessions. During the class sessions, students took notes using the Livescribe™ pen and Cornell note-taking strategy. The day after each class session, students attended an amendment session during which they listened to the pencast of the lecture recorded during the previous class session and made amendments to their notes. In this session, students practiced switching the pen ink from black to red, amending their notes, and writing summaries.

Post-Intervention

Students took notes using the Livescribe™ pen and Cornell note-taking strategy while watching a video-recorded lecture. Immediately following the lecture, students participated in an IFR. Students were given the immediate free recall sheet (see Appendix D) and given five minutes to write as many vocabulary words and main points from the lecture. Students' IFR exercises were collected, and each student was given a comprehension posttest based on the lecture content. The comprehension tests were collected once completed.

Data Collection

A variety of data collection sources were used in the present study to investigate the proposed research questions. These data collection methods included a rubric, comprehension tests (pretest/posttest), IFR) exercises, semi-structured interviews, and a note-taking experience survey. Each of the data collection methods is described in the following paragraphs. The alignment between the research questions and data sources is depicted in Table 3.3.

Rubric and Student Notes

The quality of students' notes was evaluated using a rubric adapted from Englert et al. (2009). The four categories used by Englert et al. (2009) in the original rubric included (a) organization, (b) content, (c) reduction or selectivity, and (d) potential to be a useful tool. The original categories were adapted to align with the components of the Cornell note-taking strategy. For example, "organization" in the original rubric assessed students' representation of major ideas and related details, organizational patterns, and hierarchy within their notes. In the adapted rubric, "organization" evaluated students' notes on the representation of Cornell note-taking's format and organizational pattern, including the topic, date, and page number. In addition, the category "potential to be a useful tool" was changed to "summarization" to better assess students' ability to compose a summary of the notes taken.

Students' notes were collected during each phase of the intervention (pre-intervention and post-intervention) and were evaluated using a rubric (see Appendix A). The rubric evaluated the students' notes based on four traits: (1) organization, (2) content, (3) reduction, and (4) summarization. For each component in the rubric, students received

a score ranging from 0 -10. Two independent raters scored the students' notes using the rubric. The use of two raters helped determine interrater reliability (Belson et al., 2013). The percentage of agreement between the two raters was used as a measure of interrater reliability (LaBreton & Senter, 2008; Bliese, 2000).

Comprehension Test

A comprehension test was used to gather data on students' comprehension by assessing the vocabulary and knowledge remembered from the lecture. After viewing the lecture, the students were given a comprehension test based on the video-recorded lecture. During the pre-intervention phase, students were given a comprehension test on the video-recorded lecture topic, psychological health (see appendix B).

Table 3.3 *Research Questions and Data Sources*

Research Questions	Data Sources
RQ1: How does the use of the Cornell note-taking strategy supported with a Livescribe™ pen affect the note-taking quality of student-athletes with learning disabilities?	<ul style="list-style-type: none"> • Rubric and Student Notes • Note-taking Experience Questionnaire
RQ2: How does the use of the Cornell note-taking strategy supported with a Livescribe™ pen affect the comprehension of lecture content and vocabulary among student-athletes with learning disabilities?	<ul style="list-style-type: none"> • Comprehension Test • Immediate Free Recall Exercise (IFR)
RQ3: What are the experiences and perceptions of student-athletes with learning disabilities using Livescribe™ pens and their impact on note-taking and comprehension of lecture content?	<ul style="list-style-type: none"> • Interviews • Note-taking Experience Questionnaire

The process was repeated during the post-intervention phase, during which students were given a comprehension pre-test on the video-recorded lecture topic, obesity and eating

disorder (see Appendix C). These topics were chosen from the curriculum due to similarities in terms of vocabulary, lectures points, and main ideas. The tests consisted of 15 questions, and each question was comprised of a stem with four options. One of the four options was the correct answer. The test was scored using an answer key. Kobayashi (2005) and Boyle and Joyce (2019) found that using both a multiple-choice test and an immediate free recall measure can provide an assessment of learning differences that result from a note-taking intervention (p. 7). Multiple-choice tests provide retrieval cues and a recall test condition that promotes the autonomous retrieval of cues among learners (Kobayashi, 2005).

Immediate Free Recall Exercise

A five-minute immediate free recall (IFR) exercise was used as a measure of comprehension. This strategy, suggested by Ruhl and Suritsky (1995) and Kobayashi (2005), is useful in evaluating the retention of factual information from lectures. The exercise was used to gather data on the number of total lecture points (TLP) and vocabulary (VOCAB) remembered by the students from the lecture (Kobayashi, 2005). The IFR exercise was conducted twice, once during the pre-intervention phase and once during the post-intervention phase. Immediately following the Livescribe™ pen intervention, students were required to write down as many vocabulary words and main points from the lecture on the immediate free recall sheet (see Appendix D) provided to them. The exercise was collected and analyzed to determine the number of lecture points and vocabulary remembered from the lecture.

Interviews

One goal of this study was to explore the perceptions and experiences of student-athletes with learning disabilities before and after implementing a Livescribe™ pen and Cornell note-taking intervention. Therefore, it was important to employ a data source that provided a deeper understanding of the student-athletes' experiences. Interviewing provides the opportunity for “individuals to think and to talk about their predicaments, needs, expectations, experiences, and understandings” (Anyan, 2013, p.1). Interviews also allow the researcher to explore the beliefs, views, and experiences of individuals (Gill, Stewart & Chadwick, 2008). Therefore, interviews were selected as the data source to explore student-athletes' perceptions and experiences on the Livescribe™ pen and Cornell note-taking strategy.

Interviews were conducted twice during the study, before and after the Livescribe™ pen and Cornell note-taking strategy intervention. I conducted each interview in a one-on-one setting in the academic support center conference room. Each interview took between 30 – 45 minutes, following a semi-structured interview protocol. The interview protocol was used to guide the discussion, allowing for the flexibility offered by semi-structured interviews (Creswell & Creswell, 2017).

The pre-intervention interview protocol (see Appendix E) consisted of eight questions, and the post-intervention interview protocol (see Appendix F) consisted of 23 questions. I asked the students the questions according to the interview protocol and asked follow-up questions when necessary. The post-intervention interview began with questions about the students' experience using the Livescribe™ pen and then transitioned into questions about their experience using the Cornell note-taking strategy. Each

question in the interview was aligned with the research questions, as presented in Appendix J. The interviews were audio-recorded and transcribed for data analysis. During the interviews, I took notes and used them to enhance the data from the transcriptions. All audio recordings and transcriptions were saved on my computer and backed up in my cloud drive.

The validity of the interview questions was verified through a pre-screening with student-athletes that were not participating in the study. During the pre-screening, I asked the questions to a select group of student-athletes. I then asked the students for feedback about the questions. Specific attention was given to the clarity of the language used in the questions. I used the insight gained during this process to make adjustments to the questions before the interview.

Note-taking Experience Survey

A note-taking experience survey was adapted from Joyce (2016) to gather quantitative data on the students' experiences and perceptions after using the Livescribe™ pen and Cornell note-taking strategy. For example, the item "I plan on continuing to use this note-taking strategy and the pen in the future." was revised as "I will continue to use the Cornell note-taking strategy and Livescribe™ pen in the future." A full list of items that were adapted is presented in Table 3.4. The survey consisted of two sections with a total of 10 Likert-type items (see Appendix G) ranging from (strongly disagree) to (strongly agree). Students were required to circle their responses. Each question in the survey was aligned with research question three, as presented in Table 3.5. The reliability of this instrument was reported after data collection. An expert reviewed the content of the items to ensure the content validity of this instrument.

Table 3.4 *Original and Adapted Survey Items*

Original Items	Adapted Items
Using the smartpen technology was quick to learn and easy to use.	It was easy to learn how to use the Livescribe™ pen with training and instructions.
I plan on continuing to use this note-taking strategy and the pen in the future.	I will continue to use the Cornell note-taking strategy and Livescribe™ pen in the future.
This note-taking strategy helped me remember lectures more clearly.	Summarizing lecture points helped me better remember information.
I felt more relaxed while using the note-taking strategy and smartpen technology.	The Livescribe Pen™ made me feel more comfortable taking notes during lectures.

Data Analysis

This study used a mixed-methods approach, combining both quantitative and qualitative data analysis methods. The data sources included semi-structured interviews, a note-taking experience survey, a rubric, comprehension tests, and IFR exercise. To ensure the credibility and quality of the data, the quantitative and qualitative data were analyzed using rigorous methods and then integrated using a convergent design (Creswell & Creswell, 2017; Patton, 1999). The data were triangulated to provide a comprehensive understanding of the research questions (Mertler, 2016). The research questions, data sources, and corresponding data analysis procedures are displayed in Table 3.6.

Quantitative Data

The comprehension tests and IFR exercise were used in a one-group pretest-posttest design to evaluate the impact of the Livescribe™ pen and Cornell note-taking strategy on students' comprehension (Creswell & Creswell, 2017; Stroud & Reynolds, 2006).

Table 3.5 *Research Questions and Survey Questions Alignment*

Research Question	Survey Items
RQ3: What are the experiences and perceptions of student-athletes with learning disabilities using Livescribe™ pens and their impact on note-taking and comprehension of lecture content?	<ol style="list-style-type: none"> 1. The Livescribe™ pen made it easier to take notes. 2. Using the Livescribe™ pen helped me to revise my notes. 3. Using the Livescribe™ pen helped me to review my notes. 4. The audio recording features were helpful in organizing my notes. 5. The audio pencast was useful in revising my notes. 6. It was easy to learn how to use the Livescribe™ pen with training and instructions. 7. It was easy to organize my notes using the Livescribe™ pen. 8. It was easy to keep with the Livescribe™ pen. 9. The Cornell note-taking strategy helped me to improve the quality of my notes. 10. Summarizing lecture points helped me better remember information. 11. Generating and answering questions help me better understand and remember information. 12. The Cornell note-taking strategy helped me to organize the main ideas of the lecture better. 13. I will use the Cornell note-taking strategy in other courses. 14. I will use the Livescribe™ pen in other courses. 15. I prefer using the Cornell note-taking strategy over my old note-taking method. 16. The Cornell note-taking strategy was easy to learn with training. 17. The Cornell note-taking strategy was harder to use than my previous strategy. 18. Using the Livescribe™ pen was time-consuming. 19. The notes I recorded with my Livescribe™ pen did not sync with the audio recordings. 20. It was difficult to amend my notes using the pencasts.

The IFR exercise and comprehension tests were scored and analyzed separately. I used descriptive statistics to organize and describe the data. The IFR exercise and comprehension test data from the pre-intervention and post-intervention phases were analyzed independently using the JASP statistical software. Descriptive statistics, including measures of central tendency such as mean, median, mode, and standard deviation, were compared to examine students' scores before and after the intervention (Creswell & Creswell, 2017; Mertler, 2016). The quantitative data analysis results were coupled with the qualitative data to provide a well-rounded picture of the Cornell note-taking strategy and Livescribe™ pen's impact on students' comprehension skills and note-taking.

The students' notes from the pre-intervention and post-intervention lectures were be evaluated and scored by a rubric based on four categories: organization, content, reduction, and summarization. The data from this analysis was organized using descriptive statistics. Descriptive statistics for each category are displayed in Table 4.1 and Table 4.2. The note-taking experience survey was analyzed and described using descriptive statistics (See Table 4.5 – 4.9).

Qualitative Data

Qualitative data were used to supplement the quantitative data to explore the research questions further. Student interviews conducted during the pre-intervention and post-intervention phases were used to collect qualitative data. The qualitative data were triangulated with the quantitative data to provide a comprehensive overview of the research questions.

Table 3.6 *Research Questions, Data Sources & Data Analysis Procedures*

Research Questions	Data Sources	Data Analysis
RQ1: How does the use of Cornell note-taking strategy supported with a Livescribe™ pen affect the note-taking quality of student-athletes with learning disabilities?	Student Notes & Rubric	Descriptive statistics
RQ2: How does the use of Cornell note-taking strategy supported with a Livescribe™ pen affect the comprehension of lecture content and vocabulary among student-athletes with learning disabilities?	Comprehension Test Immediate Free Recall (IFR) Exercise	Descriptive statistics Descriptive statistics
RQ3: What are the experiences and perceptions of student-athletes with learning disabilities using Livescribe™ pens and their impact on note-taking and comprehension of lecture content?	Interviews Note-taking Experience Questionnaire	Inductive Analysis Descriptive Statistics

The data from the student interviews were analyzed using an inductive approach to generate conclusions from patterns found in the data. Using a constant comparative method, the qualitative data were analyzed to determine if patterns or themes existed in the data (Strauss & Corbin, 2008; Bogdan & Biklen, 2007). The interviews were recorded, transcribed, and analyzed using open coding, In Vivo coding, process coding, and pattern coding. In the first cycle, open coding will be used to generate codes from the interview data. In Vivo coding was used to capture students' own words about their perceptions and experiences using the Cornell note-taking strategy and the Livescribe™ pen. Process coding was employed to capture specific actions performed by the students while using the Cornell note-taking strategy and Livescribe™ pen (Charmaz, 2002;

Saldana, 2013). In the second cycle, pattern coding was used to establish categories and themes and attribute meaning to the data (Creswell & Creswell, 2017).

The results of the data analysis were interpreted using an inductive and reflective process with the goal of developing an objective understanding of the data (Mertler, 2017). The results of the quantitative and qualitative data analysis were compared to determine similarities and differences. Member checking was used to enhance credibility by confirming the accuracy of the qualitative findings (Creswell, 2016). The results of the data analysis are presented in narrative passages using “rich thick descriptions” (Creswell, 2016, p. 251) to provide sufficient details to make the results both realistic and valid. The results of the data analysis with assertions are presented in Table 4.11.

Procedures

This research study occurred during the Spring 2021 semester and took place in five phases: (1) pre-intervention, (2) training, (3) practice, (4) post-intervention, and (5) interviews. A detailed description of each phase is provided in the following sections, and the timeline is depicted in Table 3.7.

Phase 1: Pre-intervention

Phase 1 of the study took place over a three-week period. Each week contained two class sessions. During the first week, the study participants were solidified. In week two, session one, students received information about the study’s purpose and procedures. Informed consent forms were distributed to participants. Participants reviewed and signed the forms. After completion of the forms, they were collected and filed appropriately. During week two, students were asked to participate in interviews about their note-taking experience. In week three, session one, students watched a video-

recorded lecture and participated in the pre-test measures: an IFR exercise and comprehension pretest.

Phase 2: Training Phase

The training phase of the study occurred over two 50-minute class sessions in Week 4: session seven and session eight. During these sessions, students received training on the Cornell note-taking strategy and Livescribe™ pen.

Phase 3: Practice Phase

The practice phase took place over four weeks (eight class sessions). During sessions 7 – 14, students practiced using the Cornell note-taking strategy in conjunction with their Livescribe™ pen. During the practice sessions, students will record notes using the Livescribe™ pen and Cornell note-taking strategy. The day after each lecture, all students attended amendment sessions in the Student-Athlete Academic Support center. The amendment sessions ranged from 30 – 45 minutes and during the session, the students listened to their pencasts and made amendments to the notes taken during the previous class meeting. When they were finished with their amendments, the students were permitted to leave.

Phase 4: Post-intervention

The post-treatment phase occurred over one class session. During session 15, students completed all post-test measures. Students watched a video-recorded lecture and took notes using the Cornell note-taking strategy and the Livescribe™ pen, after which students amended their notes and wrote their summary. Students participated in the post-test measures: IFR and comprehension posttest. After the comprehension posttest, the note-taking questionnaire was administered.

Table 3.7 *Timeline for Procedures*

Phase	Activities	Timeframe
1. Pre-intervention	<ul style="list-style-type: none"> • Recruitment and selection of participants • Review study purpose and process • Interviews • Video-Recorded Lecture • Obtain Informed Consent • Immediate Free Recall (IFR) • Multiple Choice Assessment (MC) 	3 - weeks (6 sessions)
2. Training	<ul style="list-style-type: none"> • Training on Cornell note-taking • Livescribe™ Pen training 	1 - week (2 sessions)
3. Practice	<ul style="list-style-type: none"> • Video-Recorded Lectures • Amendments 	4 - weeks (8 sessions)
4. Post-intervention	<ul style="list-style-type: none"> • Video-Recorded Lecture • Amendments • Immediate Free Recall (IFR) • Multiple Choice Assessment (MC) • Note-taking Questionnaire 	1 - week (1 session)
5. Interviews	<ul style="list-style-type: none"> • Interviews • Transcription • Member Checking 	2 - weeks

Phase 5: Interviews

The final phase of the study occurred over two weeks. Participants were interviewed during week ten of the study. All interviews were recorded and transcribed. During the second week of phase five, member checking was conducted by meeting with each student individually in the SAAS conference room to review the transcription of their interviews.

Rigor & Trustworthiness

In order to produce credible findings, it is imperative to deploy methods that ensure the reliability and credibility of findings (Amankwaa, 2016). This study used both qualitative and quantitative data to answer the research questions (Creswell, 2017). Therefore, four methods were utilized for rigor and trustworthiness to strengthen the outcome of the study: (a) rich thick descriptions, (b) triangulation, and (c) member checking, and (d) peer debriefing.

Rich Thick Descriptions

One strategy used to ensure internal validity is rich thick descriptions (Merriam, 1988). Rich thick descriptions are detailed descriptions that provide the reader with the ability to produce a solid framework for comparison and transferability of the findings (Creswell & Creswell, 2017; Merriam, 1988). The use of rich thick descriptions “creates verisimilitude, statements that produce for the readers the feeling that they have experienced, or could experience, the events being described in a study” (Creswell & Miller, 2000, p. 128).

To produce trust in the veracity of my data, I provided detailed information about the purpose of the study and the role of the researcher (Creswell & Creswell, 2017). Additionally, I provided a comprehensive description of the research setting and context in which the data will be collected (Geotz & LeCompte, 1984). The qualitative narrative includes a vivid account of the data collected through student interviews. I have utilized direct quotes when needed to provide a descriptive depiction of the participants’ views. Therefore, qualitative findings include “deep, dense, detailed accounts” of the qualitative data (Denzin, 1989, p. 83).

Triangulation

Another qualitative method for rigor and trustworthiness used was triangulation. Triangulation involves the “process of relating multiple sources of data in order to establish their trustworthiness or verification of the consistency of the facts while trying to account for their inherent biases” (Mertler, 2016, p. 11). Triangulation provides the opportunity to improve the accuracy of the data by evaluating the findings produced by various data collection methods (Amankwaa, 2016). This method allows for a well-rounded evaluation of the research questions and the strengthening of the reliability and internal validity of the findings (Merriam, 1988). Overall, triangulation allows for a comprehensive understanding of a phenomenon (Patton, 1999).

I used methodological triangulation, combining both qualitative and quantitative data collection methods (Bekhet & Zauszniewski, 2012). Each of the data collection methods was triangulated. The student interviews were conducted using a semi-structured interview protocol during which I asked open-ended questions and allowed the participants to provide their views openly. Data from each source were analyzed individually and then together to identify similarities and differences in the data.

Member Checking

Member checking involves the discussion of the data and the findings with the participants in the study. The purpose of member checking is to ensure that the findings are both accurate and reflective of the participants (Creswell & Creswell, 2017). I provided an opportunity for my participants to review the study’s findings and provide feedback during a follow-up interview. To do this, I presented the participants with the

major findings/themes during follow-up meetings, and the students had an opportunity to give feedback on their experiences.

Peer Debriefing

Peer debriefing involves exploring aspects of the research with someone who is not an immediate stakeholder in the study's outcome (Schwandt, 2007). During this process, the researcher confides in a knowledgeable colleague for an external perspective (Lincoln & Guba, 1985). Peer debriefing was conducted periodically with my dissertation chair. Engaging in this process allowed me to obtain an objective perspective, recall new information or additional facts, and “ rethink findings or explore varied conclusions (Hail, Hurst, & Camp, 2011, p. 74).

Plan for Sharing & Communicating Findings

The purpose of this action research is to improve the comprehension and note-taking skills of student-athletes with learning disabilities in a personal and community health course. Therefore, the findings of this research were shared with the participants, athletic administrators, specifically the SAAS staff, faculty in the health, physical education, and exercise science department, and the staff in OASIS. The research findings can have implications for campus leaders and provide them with valuable insight into effective assistive technology supports for students with learning disabilities. The findings can also be specifically useful to student-athlete support professionals who offer support services for student-athletes with learning disabilities, such as athletic academic advisors and learning specialists. Understanding how critical it is to design innovative and effective accommodations for students attending postsecondary institutions with learning disabilities, it was important to disseminate the findings to individuals who are

directly involved in the decision-making process and can leverage funding to acquire effective assistive technology supports (Floyd & Judge, 2012).

At the conclusion of the study, the findings were shared with the participants through in-person meetings. During these meetings, the participants had an opportunity to reflect on their experiences using the Livescribe™ pen and provide recommendations for future research. I also organized a meeting consisting of the stakeholders of interest listed previously. I sent a calendar request utilizing the Outlook scheduling assistant to determine what meeting time worked best for the identified individuals. Once a meeting time was selected, I sent out a calendar request with the day, time, and meeting location. The findings were disseminated verbally using a multimedia PowerPoint presentation. Stakeholders also received a handout detailing the findings of the action research. The participants' names were not used during the presentation or handout to protect the participants' rights and identities. The participants' names must remain anonymous to stay in compliance with The Family Educational Rights and Privacy Act (FERPA), Americans with Disabilities Act (ADA), and 504 of the Rehabilitation Act (Section 504), laws that were implemented to protect the rights of students with disabilities attending federally-funded institutions of higher education (The Family Educational Rights and Privacy Act of 1974; 504 of the Rehabilitation Act, 1973; Americans with Disabilities Act, 1990).

CHAPTER 4

ANALYSIS AND FINDINGS

The purpose of this research was to explore the impact of the Livescribe™ and Cornell note-taking strategy on note-taking quality and comprehension of student-athletes with learning disabilities. The study took place over a twelve-week period with five students who had been diagnosed with a learning disability. Students' comprehension skills were measured using IFR exercises and comprehension tests. The quality of the students' notes was evaluated using a rubric. Perceptions of the students were assessed quantitatively and qualitatively using a note-taking experience survey and pre-intervention and post-intervention interviews, respectively. This chapter presents the findings from the research investigating the impact of the Livescribe™ pen and Cornell note-taking strategy on the quality of notes and comprehension abilities of college student-athletes with learning disabilities.

Quantitative Findings

Multiple quantitative data collection sources were used to provide a well-rounded understanding of the impact of the Livescribe™ pen and Cornell note-taking intervention on the students' note-taking and comprehension. Data collections methods included an IFR exercise, comprehension test, rubric evaluation of students' notes, and a note-taking experience survey. The following section will provide an overview of the findings of the

student notes and rubric, IFR exercises, comprehension tests, and note-taking experience survey.

Student Notes and Rubric

The students' notes were collected during the pre-intervention and post-intervention phases and were assessed using a rubric adapted from Englert et al. (2009). The rubric evaluated the students' notes on four specific traits: (a) organization, (b) content, (c) reduction, and (d) summarization (see Appendix A). The maximum score in each category was 10, and the total score each student could earn was 40. Two independent raters scored the students' notes using the rubric. The size of the agreement between two raters was measured using Cohen's kappa coefficient. The interrater reliability was determined to be $\kappa = 0.75$. An agreement between 0.61 and 0.80 is substantial (McHugh, 2012).

The students' organization scores increased from pre-intervention ($M=1.40$, $SD=0.89$) to post-intervention ($M=7.60$, $SD=2.51$) by 6 points. An increase of 0.20 points was observed in the students' content scores from pre-intervention ($M=7.20$, $SD=2.77$) to post-intervention ($M=7.40$, $SD=3.05$). Similarly, there was a 0.20-point increase in the students' reduction scores from pre-intervention ($M=8.20$, $SD=2.49$) to post-intervention ($M=8.40$, $SD=2.51$). There was also a noteworthy increase in the students' summarization scores before ($M=0.60$, $SD=1.34$) and after ($M=4.60$, $SD=2.19$) the intervention. Total scores for each student are presented in Table 4.1.

Caleb and Damien showed the largest increase in their organization score, with their scores increasing from one to ten from pre-intervention to post-intervention. Marcus showed the most improvement in his content score which increased from three to nine.

Table 4.1 *Individual Scores for Students' Notes (n=5)*

<u>Student</u>	Organization		Content		Reduction		Summarization	
	<u>Pre</u>	<u>Post</u>	<u>Pre</u>	<u>Post</u>	<u>Pre</u>	<u>Post</u>	<u>Pre</u>	<u>Post</u>
Kendall	1	5	9	2	10	4	0	1
Jay	1	5	8	8	10	10	0	5
Caleb	1	10	6	9	6	10	3	5
Damien	3	8	10	9	10	9	0	5
Marcus	1	10	3	9	5	9	0	7

Kendall's content score decreased from pre-intervention (9) to post-intervention (2). Caleb earned the highest reduction score (10), which was an increase from his pre-intervention content score (6). Kendall's score also decreased from pre-intervention (10) to post-intervention (4), while Jay and Damien's scores changed minimally. The summarization scores increased for each student. Scores in the summarization category increased for each student from pre-intervention to post-intervention. Individual scores for each student are presented in Table 4.2.

Immediate Free Recall

The students' comprehension skills were assessed using an IFR exercise during the pre-intervention and post-intervention phases. The students used their traditional note-taking method to record notes during the pre-intervention phase, and the students recorded notes using the Cornell note-taking strategy during the post-intervention phase. The students were evaluated on total vocabulary (TV), and total main points (TMP) remembered from the lecture. The number of TV recorded increased from the pre-intervention phase ($M=5.60$, $SD=3.51$)

Table 4.2 *Total Scores for Student Notes (n=5)*

Student	Pre	Post
Kendall	20	12
Jay	19	28
Caleb	16	34
Damien	23	31
Marcus	9	35

to the post-intervention phase ($M=7.80$, $SD=2.39$) phase. The students' TMP scores also increased from the pre-intervention ($M=6.00$, $SD=1.58$) to the post-intervention ($M=7.60$, $SD=4.04$) phase. Individual TV and TMP scores for each student are displayed in Table 4.3.

Table 4.3 *Individual Scores for IFR (n=5)*

Student	Total Vocabulary		Total Main Points	
	<u>Pre</u>	<u>Post</u>	<u>Pre</u>	<u>Post-</u>
Kendall	3	6	4	4
Jay	6	8	6	3
Caleb	2	5	7	12
Damien	6	9	8	8
Marcus	11	11	5	11
Average	5.60	7.80	6.00	7.60

Comprehension Test

Students were given a comprehension test during the pre-intervention and post-interventions phases to gather data on their comprehension of vocabulary and knowledge remembered from the lecture (see Appendix B and Appendix C). The tests consisted of 15 questions, each comprising of a stem with four options. The maximum potential score of each test was 15. Four of the five students' comprehension test scores increased from the pre-intervention ($M=7.60$, $SD=2.61$) to the post-intervention phase ($M=10.40$,

$SD=3.65$). Kendall's scores remained the same for both the pre-intervention (4) and post-intervention (4) phases. Individual student comprehension test scores are displayed in Table 4.4.

Table 4.4 *Individual Scores for Comprehension Tests (n=5)*

Student	Comprehension Pretest	Comprehension Posttest
Kendall	4	4
Jay	7	13
Caleb	9	12
Damien	7	11
Marcus	9	12

Note-Taking Experience Survey

At the end of the post-intervention phase, a note-taking experience survey was used to gauge students' experiences and perceptions of using the Livescribe™ pen and Cornell note-taking strategy. The survey consisted of two sections with a total of 10 Likert-type items (see Appendix G) ranging from (1=strongly disagree) to (5=strongly agree). Students were required to circle only one response for each survey statement with either pen or pencil and were given approximately 5 minutes to complete the survey. Negative-worded statements were reverse coded before calculating the subscale scores (See Appendix G for a sample survey). The survey questions were organized into five subscales (1) usefulness of the Livescribe™ pen, (2) usefulness of the Cornell note-taking strategy, (3) ease of use, (4) future use of the Livescribe™ pen, and (5) anticipated benefits.

Usefulness of the Livescribe™ Pen

Responses for survey items one, two, three, and four captured the students' perceptions on the usefulness of the Livescribe™ pen were positive ($M=4.45$, $SD=0.59$).

The questionnaire data indicated that all the students agreed that the Livescribe™ pen made it easier to take notes during the lecture ($M=4.20$, $SD=0.84$). In addition, all the students indicated that using the Livescribe™ pen helped them review notes after the lecture. It was a consensus among all the students that the Livescribe™ pen made them feel more comfortable taking notes during lectures and the audio pencast helped them amend their notes and add missing points from the lecture ($M=4.40$, $SD=0.55$). The descriptive statistics for the questions relating to "usefulness of the Livescribe™ pen" are displayed in Table 4.5.

Table 4.5 *Descriptive Statistics for Usefulness of the Livescribe™ Pen Survey Items*

Survey Item	<i>M</i>	<i>SD</i>
The Livescribe™ pen made it easier to take notes during the lecture.	4.20	0.84
Using the Livescribe™ pen helped me to review my notes after the lecture.	4.80	0.45
The Livescribe Pen™ made me feel more comfortable taking notes during lectures.	4.40	0.55
The audio pencast helped me to amend my notes and add missing points from the lecture.	4.40	0.55

Usefulness of the Cornell Note-taking Strategy

Items five, six, seven, and eight related to the usefulness of the Cornell note-taking strategy ($M=4.40$, $SD=0.67$). All students indicated that the Cornell note-taking strategy helped them to organize the main ideas of the lecture better. Furthermore, most of the students ($n=4$) found that summarizing lecture points helped them remember information better and generating and answering questions helped them better understand and remember information. Also, most of the students ($n=4$) agreed that reviewing the

summaries in their notes helped them recall important lecture points ($M=4.40$, $SD=0.55$).

The descriptive statistics for the questions relating to "usefulness of the Cornell note-taking strategy" are presented in Table 4.6.

Table 4.6 *Descriptive Statistics for Usefulness of the Cornell Note-taking Strategy Survey*

Items

Survey Item	<i>M</i>	<i>SD</i>
The Cornell note-taking strategy helped me to organize the main ideas of the lecture better	4.80	0.45
Summarizing lecture points helped me better remember information.	4.20	0.84
Generating and answering questions help me better understand and remember information.	4.20	0.84
Reviewing the summaries in my notes helped me to recall important lecture points.	4.40	0.55

Ease of use

Questions nine, ten, eleven, and twelve provided insight into the students' perceptions of the ease of use of the Livescribe pen and Cornell note-taking strategy ($M=4.20$, $SD=0.61$). After being provided with training and instruction, all students found that it was easy to learn how to use the Livescribe pen. Also, all of the students indicated that it was easy to set up their notebook using the Cornell note-taking strategy ($M=4.20$, $SD=0.61$). Most of the students ($n= 4$) disagreed that the Cornell note-taking strategy was harder to use than their previous note-taking method. However, one student agreed that the Cornell note-taking strategy was harder to use than their previous note-taking method. All of the students responded positively to using the Livescribe™ pen with the Cornell note-taking strategy, indicating that it was easy to use both resources together to take

notes ($M=4.20$, $SD=0.61$). The descriptive statistics for the questions relating to the subscale "ease of use" are displayed in Table 4.7.

Table 4.7 *Descriptive Statistics for Ease of Use Survey Items*

Survey Item	<i>M</i>	<i>SD</i>
It was easy to learn how to use the Livescribe™ pen with training and instructions.	3.60	0.55
It was easy to set up my notebook using the Cornell note-taking strategy.	4.60	0.55
The Cornell note-taking strategy was harder to use than my previous note-taking method.	3.60	0.89
It was easy to use the Livescribe™ pen with the Cornell note-taking strategy to take notes.	4.20	0.45

Future Intention to Use Livescribe™ Pen

The students' future intention to use the Livescribe™ pen was assessed by item 14 ($M=3.60$, $SD=0.24$). There was positive support for future use of the Livescribe™ pen and Cornell note-taking strategy. All of the students indicated that they would continue to use the Cornell note-taking strategy and Livescribe™ pen in the future. Descriptive statistics for this subscale are displayed in Table 4.8.

Table 4.8 *Future Intention to Use Livescribe™ Pen*

Survey Item	<i>M</i>	<i>SD</i>
I will continue to use the Cornell note-taking strategy and Livescribe™ pen in the future.	3.60	0.55

Anticipated Benefits of Cornell note-taking Strategy and the Livescribe™ pen Together

The perceived benefits of the Cornell note-taking strategy coupled with the Livescribe™ pen were assessed by items 13, 15, and 16 ($M=4.60$, $SD=0.45$). All of the

students indicated that the Cornell note-taking strategy and Livescribe™ pen could help them in other courses. In addition, every student agreed that it was beneficial to use the Cornell note-taking method with the Livescribe™ pen ($M=4.20$, $SD=0.45$). Each student also agreed that the Cornell note-taking method could be useful without the Livescribe™ pen ($M=4.80$, $SD=0.45$). The descriptive statistics for the anticipated benefits subscale are displayed in Table 4.9.

Table 4.9 *Descriptive Statistics for Anticipated Benefits Survey Items*

Survey Item	<i>M</i>	<i>SD</i>
Using Cornell note-taking with the Livescribe™ pen can help me in other courses.	4.80	0.45
It is beneficial to use the Cornell note-taking method with the Livescribe™ pen.	4.20	0.45
The Cornell note-taking method can be useful without the Livescribe™ pen.	4.80	0.45

Qualitative Findings

Qualitative data were collected to explore the students' experiences and perceptions of the Livescribe™ pen and Cornell note-taking intervention. Interviews were used as the sole qualitative data collection method. Each participant completed two semi-structured interviews during the study, one before and one after the Livescribe pen and Cornell note-taking intervention. Each interview was conducted in the student-athlete academic support center conference room and last approximately thirty minutes. The pre-intervention interview asked students questions about their ability to take notes and the strategies they use while taking notes. The post-intervention interviews asked students questions to elicit responses about their experiences using the Livescribe pen and Cornell

note-taking strategy and how each tool impacted their note-taking or comprehension. During the post-intervention interview, students were also asked about their intended future use of the two resources.

Qualitative Data Analysis

As described by Mertler (2017), an inductive approach was used to analyze the interview data. During this process, data were organized, described, and interpreted (Mertler, 2017). During the first step of the qualitative data analysis process, audio recordings from each interview were transcribed using an online audio transcription software. Each transcription file was reviewed and compared to the audio recordings to confirm the accuracy of the interview. In this transcription, several inaccuracies were missed by the software. Therefore, the inaccuracies caused by the software were corrected manually. For example, when Damien discussed the importance of notes in his classes, the transcription software used to transcribe his interview converted the audio recording as:

"You have to take notes for you're not going to do well in the Tasman."

After reviewing the transcript while listening to the audio recording, the transcription was revised to accurately reflect Damien's voice. The revised transcript read as follows:

"You have to take notes or you're not going to do well in the classes."

After each transcript was reviewed and revised for accuracy, each student sat down with the researcher and reviewed the transcripts to confirm accuracy. This served as a form of member checking.

Once verbatim transcripts of the data were revised, the transcripts were uploaded into Delve (2019), a web-based tool used for qualitative analysis. Delve (2019) was used

to complete the coding process. During the first cycle of coding, individual statements from the students were coded using a combination of affective and elemental methods. Elemental methods used during initial coding included In Vivo coding, process coding, and emotion coding. In Vivo coding was an appropriate method to capture the participant's voices about their perceptions and experiences using the Cornell note-taking strategy and Livescribe pen. Process coding was used to depict observable actions reflecting the students' note-taking processes (Saldaña, 2013; Charmaz, 2006). Emotion coding assisted in uncovering the feelings the participants had about their experience taking notes before the intervention and their experiences using the Livescribe pen and Cornell note-taking strategy. During the first cycle of open coding, the students' individual statements were highlighted and labeled with one or more codes that captured a general meaning of each statement. The unit of analysis was sentenced by sentence. Process coding and In Vivo coding were used simultaneously during the initial coding process. An example of this process is visible in the excerpt from Kendall's post-intervention interview in which process and In Vivo codes were assigned to highlighted statements within a passage (see Figure 4.1).

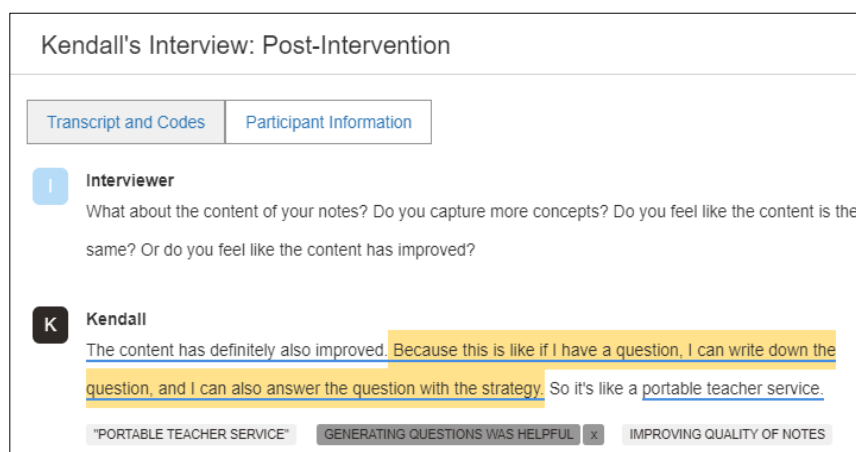


Figure 4.1. Initial coding in Delve.

In subsequent cycles of coding, the qualitative data were reread, and emotion codes were applied to students' statements that identified emotions experienced by the students before, during, and after the intervention. Employing emotion codes provided deeper insight into the students' perspectives and experiences (Saldaña, 2013). This cycle of coding produced codes such as "discouragement," "frustration," and "hope." Figure 4.2 provides an example of emotion codes that were assigned to statements from Jay's pre-intervention interview.

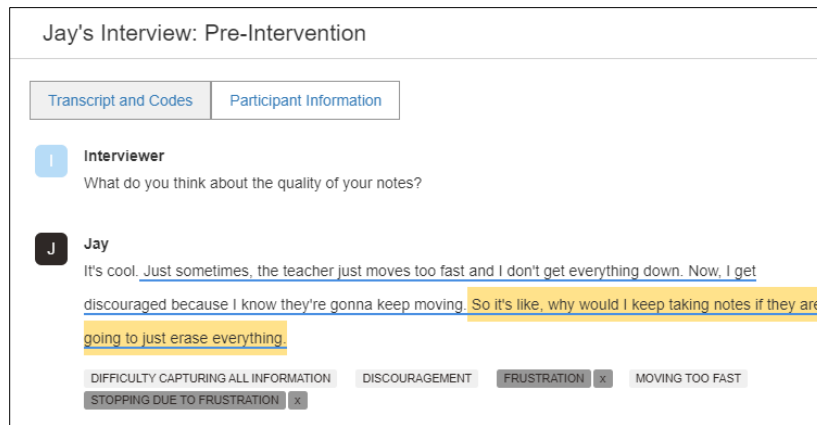


Figure 4.2. Emotion coding in Delve.

The first cycle of coding of the pre-intervention and post-intervention interviews resulted in 291 codes (see Table 4.10). Code mapping was then employed to organize codes into categories. All 291 codes were printed, and each code was cut into an individual strip of paper. Pre-intervention codes were printed in black ink, and post-intervention codes were printed in blue ink. The codes were then arranged on a table and organized using broad categories (see Figure 4.3).

Table 4.10 *Summary of Qualitative Data Sources*

Survey Item	Number	Total Number of Codes Applied
Pre-intervention interviews	5	111
Post-intervention interview	5	180
Totals	10	291

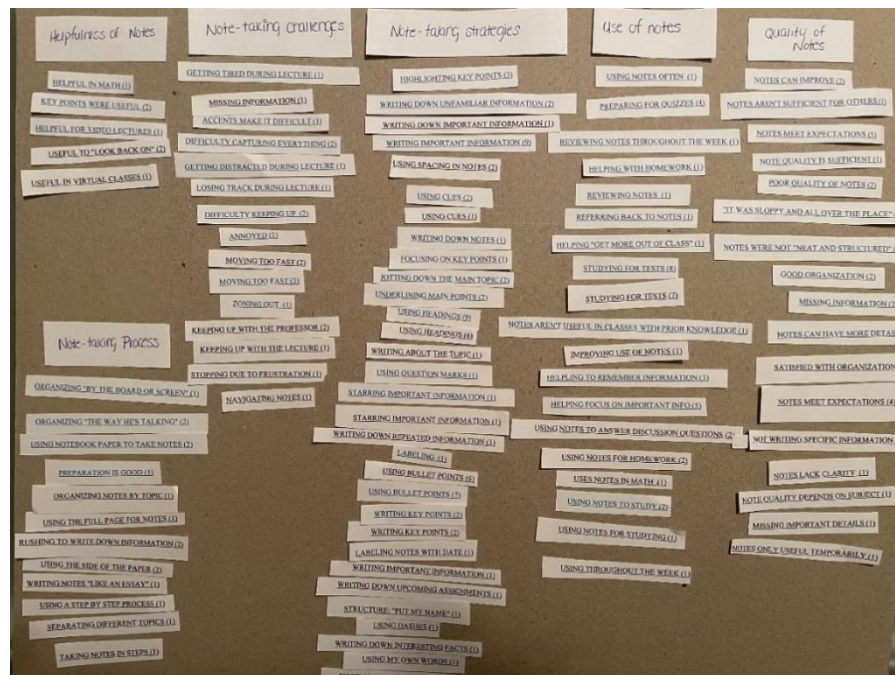


Figure 4.3. Codes grouped by category.

In the second cycle, pattern coding was used to condense codes established during the first cycle of coding and organize data into more meaningful units of analysis (Miles & Huberman, 1994; Saldaña, 2013). After the completion of the first cycle of coding, 13 categories were established. These categories include *using Cornell note-taking*, *using Livescribe pen*, *supporting academic success*, *ability to take notes*, *quality of notes*, *use of notes*, *note-taking strategies*, *note-taking challenges*, *note-taking process*, and *importance*

of note-taking. The categories were refined and recategorized during a third iteration. During this process, codes were moved around and combined in some instances. For example, "note-taking strategies" and "note-taking process" were combined because the codes under both categories represented the ways in which the participants took notes. Some of the participants' statements initially coded under certain categories were discarded during this process because they no longer related to the refined category. For example, the initial category "perceptions of note-taking" was refined into more specific categories such as "positive perceptions of note-taking," "helpfulness of notes," and "negative perceptions of note-taking."

Analytic memos were used to track the process of making connections between the codes and the developing more specific codes and make initial assertions about the categories and codes. A definition of each category was also recorded in the analytic memo. Peer debriefing was conducted with my dissertation advisor. During this process, the initial groupings were discussed and refined. An example of a category that was refined is "positive perceptions of the Livescribe pen." Initially, codes relating to positive perceptions of the Livescribe pen were grouped under the general category. After the debriefing session, this category was refined into subcategories such as "engagement," "perceived impact," "helpfulness," and "ease of use." The subcategories established better reflected the areas in which students' held perceptions about their experiences using the Livescribe pen. After the categories were refined and necessary subcategories were created, the codes were reviewed to ensure alignment. During this review, duplicated codes were discarded, and codes that needed realignment were reorganized under the appropriate category.

During this process, assertions were made about the relationships between the categories. These relationships were used to connect similar categories and derive major themes. Each of the themes related to the participant's experiences with note-taking and comprehension. The relationship between themes, categories, and codes is represented in Appendix K.

Qualitative Themes and Interpretations

Five major themes emerged from the data. A summary of qualitative themes, assertions, and categories is presented in Table 4.11. Through the semi-structured interviews, participants shared insight into their (a) perceptions of note-taking, (b) perceptions of the Livescribe pen, (c) perceptions of Cornell Note-taking, (d) perceptions of combined use of Cornell Note-taking and Livescribe Pen, and (e) note-taking strategies, challenges, and areas for improvement. Explanations of each theme are provided in the following sections. The students are identified using pseudonyms for confidentiality purposes. Quotations are used to represent students' verbatim statements captured during the interviews.

Theme 1: Perceptions of note-taking. Perceptions of note-taking reflects students' beliefs and experiences with note-taking. This theme provides insight into students' negative and positive experiences taking notes and their viewpoints on the importance of notes. Existing research indicates that note-taking is an essential skill in higher education as well as a predictor of academic success (Ruhl et al., 1990). Overall, participants held positive perceptions of note-taking before and after the intervention. During the interview process, students discussed their (a) positive perceptions of note-taking, including the (b) helpfulness of notes, the (c) strategies they use to take notes, (d)

challenges they experience during the note-taking process, and (d) areas they believe their notes can improve.

Positive perceptions of note-taking. Positive perceptions of note-taking represent the students' optimistic beliefs about note-taking. Students' perceptions about the importance of note-taking to academic success are highlighted in this section. During the interviews, students were asked how important notes are to their academic success.

The students' responses reflect the belief that notes are important to their academic progress and preparation. For example, Caleb commented on the importance of note-taking stating, "I don't think you can really be successful in the class the way you want to be without taking good notes. You might be able to get by without taking notes, but to really reach your maximum potential, then you need to take notes." In addition, Marcus emphasized another positive benefit of notes, indicating that "they [notes] like keep me on track sometimes." Enthusiasm for note-taking was also shared by Jay who stated that "they're [notes] essential." In addition, Jay discussed the importance of notes in a virtual environment, saying that "They are important like nowadays, you can go back and review your lecture." Jay's comments emphasize the benefits of note-taking in online courses. The students' responses promote the importance of note-taking to reaching their academic potential and managing online courses.

In their responses, students also noted how the importance of note-taking varies by course and academic task. Students agreed that note-taking plays an instrumental role in preparing for academic tasks such as tests and quizzes. Damien expressed, "I think they're really important especially. They help you do better on your tests or quizzes."

And they also help you with certain homework assignments and certain classes. In addition to assisting with tests, quizzes, and homework, Kendall highlighted the impact of note-taking on remembering information. Kendall noted that “notes can help you to memorize what you know. If you study your notes, you can pretty much know the answers to the test.” In Marcus’ assessment of note-taking, he stated, “I feel like when you do have good notes, it can like make the test like so much easier.” Marcus suggested that “taking the good notes just makes it [studying] easier for you,” indicating that note-taking supports test preparation. Jay’s response to the question indicated that the importance of notes “depends on what class it is.” He added that note-taking is essential in courses in which there are pop quizzes but may not be as important in courses where there is time to prepare for tests. Overall, students’ responses suggest that note-taking plays a positive role in finding success in various academic tasks such as taking assessments, completing homework assignments, and studying.

Helpfulness of note-taking. Previous literature on note-taking suggests that notes are an essential ingredient to academic success, especially in the higher education setting where there are a significant number of lecture courses (Suritsky, 1992; Boyle, 2010; Boyle & Joyce, 2019). Helpfulness of note-taking describes students’ general perceptions about how note-taking helps them to complete various academic tasks. During the interview, students were not asked how they felt notes helped them specifically. Instead, the students were asked to describe the role of notes in their classes. In response to this question, students indicated that note-taking helped them in multiple areas, such as

Table 4.11 *Themes, Assertions, and Categories from Qualitative Data*

Themes	Assertions	Categories
1. Perceptions of note-taking	Note-taking is important to students' academic success, and notes help students complete multiple academic tasks.	<ul style="list-style-type: none"> • Positive Perceptions (essential to academic success, provide structure, and keep you on track) • Helpfulness of notes (studying, homework, answering discussions, remembering information, and in online classes)
2. Note-taking strategies, challenges, and areas for improvement	Students use various strategies to organize and structure their notes, experience multiple challenges during the note-taking process, and feel they can improve their note-taking.	<ul style="list-style-type: none"> • Strategies (Organization, structure, and process) • Challenges (Keeping up, fatigue, distractions, and organization) • Areas for improvement (organization, content)
3. Perceptions of the Livescribe™ pen	The Livescribe™ pen helped students to increase engagement, generate excitement, and improve note-taking efficiency and ability.	<ul style="list-style-type: none"> • Engagement (increase engagement and generate excitement) • Perceived Impact (improved efficiency and improved note-taking ability) • Ease of use (portables, easy to use and easy to keep up with) • Helpfulness (lecture courses, when there are no cues, relieve stress, and reach maximum potential) • Livescribe™+ App (convenience of notes)
4. Perceptions of Cornell Note-taking	The Cornell note-taking strategy helped students to improve the quality of notes by organizing, consolidating, and capturing more information in their notes.	<ul style="list-style-type: none"> • Positive Perceptions (changed attitude, independent thinking, and making note-taking fun) • Helpfulness (organization, overcoming writing challenges, summarizing and consolidating information, remembering information, and generating study questions) • Challenges (less effective with a pencil, does not work for all learning styles, and has less space on the page)
5. Combined use of Cornell Note-taking and Livescribe™ Pen	Using the Cornell note-taking strategy and Livescribe™ pen together helps students to record better notes.	<ul style="list-style-type: none"> • Perceptions of combined use of Cornell Note-taking and Livescribe™ pen (tools complement each other, can help in the future, and all schools should use them)

remembering and focusing on important information, reviewing lecture material, and answering discussion questions.

Damien commented on how note-taking assisted him in “remembering and learning” information presented during a lecture. In addition, three students found that notes helped them prepare for tests. Kendall asserted that taking notes helps him “do well on tests.” Jay expressed that he uses his notes to study by reviewing “notes before a test,” while Caleb stated, “I just go back to my notes for my test answers and discussions.” Kendall expanded on this by explaining how he uses his notes to prepare for tests. He stated, “If I am studying, I just reread until I can have somebody ask me a question based off the notes and see if I can answer the question based off of what I wrote.” Kendall’s comments suggest that note-taking plays a role in facilitating studying. Caleb elaborated on the helpfulness of note-taking during COVID-19, suggesting that with an increase in “recorded lectures and zoom classes,” note-taking has become even more useful than before. The students’ assertions support previous literature citing note-taking as a vital resource to support test preparation, studying, and student success (Suritsky, 1992; Boyle & Joyce, 2019).

The students also noted specific courses in which note-taking is helpful. Kendall stated that notes are most useful in physical science. He added, “I feel like all my science classes have a lot of notes,” suggesting that he takes more notes in his physical science class than in his other classes. Jay stated that note-taking is especially useful in courses such as math and human anatomy and physiology. He indicated that his notes function as “something to look back on” after class. Each of the courses mentioned by the students is delivered in a lecture format. The students’ comments suggest that note-taking is an

academic skill that can assist students in accomplishing multiple academic tasks while supporting students in specific lecture courses (Boyle, 2010; Belson et al., 2013).

Theme 2: Note-taking strategies, challenges, and areas for improvement.

Students with learning disabilities experience significant challenges identifying and using appropriate strategies and skills to take notes during lectures (Kiewra, 2002; Boyle, 2010; Peverly et al., 2003). Note-taking strategies describe the strategies that students used before the Livescribe™ pen and Cornell note-taking intervention. Challenges refer to the difficulties students experience during the note-taking process. Areas for improvement reflect the students' beliefs about areas of their notes or note-taking process they believe can improve. During the pre-intervention interview, students discussed (a) strategies they used to take notes, (b) challenges experienced with note-taking, and (c) perceived areas for improvement. The following sections provide an overview of the students' comments in each of these areas.

Note-taking strategies. The students employed a variety of strategies to take notes before the intervention. Note-taking strategies describe the techniques, organizational patterns, and structure students used to take notes before the intervention. When asked what strategies you use to take notes, students indicated that they use bullet points, headings, highlighting, starring, spacing, dashes, capitalization, and underlining to take notes. These techniques are consistent with note-taking strategies used by students in previous studies (Baharev, 2016; Harper, Kurtsworth-Keen, & Marable, 2016). Multiple students commented that they used bullet points in to organize their notes. For example, Kendall stated, "I have one line of bullets under the header," and Damien stated he writes "descriptions with bullet points or dashes underneath it." He added, "Then I write

whatever notes on that bullet, and then if we switch the topic, another bullet.” Damien’s comments reflect students use of a combination of strategies to take notes. Multiple students also indicated that they used headings to structure and organize their notes. In regard to the use of headings, Caleb described how he used heading in his notes stating, “I will use heading to separate the different topics.” In addition, Damien and Kendall reflected on how they identified important information in their notes. Damien stated, “for the most important stuff, I’ll always put a star next to it.” He added that he would use a “more descriptive word... just to remember” the information. Kendall shared, “if the professor gives us a key point, I’ll make sure that I try to highlight that key point of writing in all uppercase. He describes this method as his way of distinguishing key points in his notes. Highlighting key points and main ideas is another commonly used note-taking strategy (Joyce, 2016; Baharev, 2016).

The students also described what type of information they record in their notes. Jay commented, “I try to write whatever he keeps repeating,” indicating that he did not have a process for writing notes. He added that he just tries to “write what they have on the board.” Jay’s comments are consistent with a significant challenge experienced by students with learning disabilities, discerning important information from unimportant information (Boyle, 2016; Baharev, 2016; Belson et al., 2013). Marcus’ comments also reflect an inability to determine what information should be recorded during notes. He stated, “I was never really taught a note-taking strategy. I was just writing down what’s important to me.” Marcus added that he writes “interesting facts” and upcoming assignments. These comments also suggest that students are often not taught note-taking

strategies before entering the postsecondary setting, placing them at a significant disadvantage in lecture courses (Tsai and Wu, 2010; Deshler & Schumaker, 2009).

Multiple students also explained how they approach the note-taking process. Caleb described the step-by-step process of taking notes on the topic of carnivores. He described this process as follows.

Say my teacher gives us a topic like carnivores and then she tells us what animals are carnivores. So, I will have carnivores be at the top of my paper as the heading and then a section for animals. The animals will be listed as bullet points. I'll list the animals step by step.

Jay outlined a less detailed note-taking process, using his physiology class as an example. He stated, "she's been talking about like, how the body works and stuff like the brain. So, I write about the process routine and stuff like that." His comments suggest that he does not have a specific process that he uses to take notes. In describing his note-taking process, Marcus stated, "First off, I would just try to write about whatever the section or topic we are learning about and then I'll use bullet points and list the most important facts about that and then branch out the three topics. Each of the students described a unique process for taking notes. This is consistent with research suggesting that most students do not receive formal note-taking training (Kiewra, 1987).

Students also discussed the methods they used to structure their notes. When asked to describe how you organize your notes, each student described a unique process. For example, Kendall responded, "I write my notes like an essay. I don't break them down into different parts of the paper. I just continue to write." Caleb and Marcus discussed how they used the section of the paper to assist in structuring their notes. For

example, Caleb stated, “I write down the things the professor says down the side of my paper” and Marcus added that he writes “the main topic at the top of the page... and random things she’s talking about in the lecture on the sides of the paper, and then just the main points in the middle.” Marcus’ description of how he organizes his notes reflects previous note-taking training. The students’ comments reflect the variety of strategies used to structure and organize notes among students with and without formal note-taking training.

Note-taking challenges. Previous literature identifies multiple challenges faced by students with learning disabilities when taking notes. These challenges include not being able to pay attention, writing fast enough to keep up with the lecture, deciding what information is important to write down, and making sense of their notes after the lecture (Suritsky, 1992). Hence, note-taking challenges illustrate the difficulties students experience while taking notes. Jay’s comments centered around difficulties maintaining focus. For example, he stated that he sometimes struggles with “zoning out “ during the lecture. Therefore, his notes are often missing important information. Other comments made by the students during the pre-intervention interviews also support existing literature. Jay and Damien reflected on having trouble keeping up with the lecture. Jay commented, “Just sometimes, the teacher just moves too fast, and I don’t get everything down.” He added that the pace of the lecture impacts the quality of his notes. Otherwise, when the professor moves too fast, he cannot record all the information covered. Reflecting on how this impacts his motivation to take notes, Jay stated, “Now, I get discouraged because I know they’re gonna keep moving.” Damien also noted that he sometimes has trouble keeping up with the professor, but “it depends on the teacher.” He

commented, “If I am going a little bit behind, I’ll start to rush and miss some other points for notes.” These comments affirm previous literature indicating that students with learning disabilities struggle with keeping up with the lecture (Belson et al., 2013; Joyce, 2016; Baharev, 2016). Caleb’s reflection about his ability to keep up with the lecture was positive. He stated, “I feel like I am able to keep up.” Caleb’s comment reflects how keeping up with the lecture influences students’ confidence to take quality notes.

When discussing the transition from high school to college, Damien reflected on the challenge of taking notes in college compared to high school. He commented, “in high school, it was a lot easier because sometimes they had notes for you. But now, I have to really try to change,” indicating that college requires more effort, prompting him to adjust his note-taking approach. Marcus also commented on his experience in high school, suggesting that his peers assisted in his note-taking development. He stated, “Well, like in high school, when I had looked at other people’s notes and compared them to mine, like seeing theirs is what helped me.” Damian added that he did not learn how to take notes in high school, stating, “I was never really taught like a note-taking strategy. I was just writing down what’s important to me, that’s usually what they told me in high school.” These experiences suggest that there may be a gap in note-taking expectations from high school to college.

Areas for improvement. Each of the students indicated that their notes could improve in one way or another. Therefore, areas for improvement depict specific areas in which students believe their notes can improve. When discussing the quality of his notes, Kendall stated that his notes “could be better.” He added that he does not “take notes to comprehend them in the future” or “review them later,” indicating that he can improve by

using his notes once he has written them. Marcus stated, “when I take notes, it’s never very detailed. I just do the topic and then some main points.” He also stated, “there are still main points I usually just don’t write down.” Marcus’ comments indicate that the overall quality of his notes can improve. Caleb described himself as being an “average note-taker,” suggesting that he could improve his note-taking ability. Similarly, Damien rated his note-taking ability as a five, attributing this rating to his difficulties keeping up with professors and missing information during lectures.

When asked what features of your notes need improvement, students discussed multiple aspects of their notes they felt required the most development. Areas for improvement noted by students include organization, handwriting, and meaning. For example, Damien responded that he could improve his “organization” in addition to “being more descriptive.” Caleb also stated that his notes to be “more organized” and “neater.” He added that his “handwriting is not that good.” Kendall’s comments focused on improvements to the meaning of his notes. He shared that he needed to make sure his notes “make sense,” and that he is “not copying whatever” he sees. He added he could improve on “just making sure that my notes have some of meaning and structure to them.” Marcus’ stated that he needed to improve his notes to make them sufficient for long-term use. He shared, “my notes are good for now. But like, when I go back to the study for my exams last semester is like, I really don’t know what I was writing down.... It’s like the information is not good long term.” Although Jay did not cite any specific areas where he felt like he could improve, he stated, “there is still stuff I need to improve on.” Therefore, each of the students shared that they could improve their notes in some way. The students’ comments support previous literature suggesting that students with

learning disabilities have difficulty discerning which important is important to write down and making sense out of their notes after they have recorded them (Suritsky, 1992; Hughes & Suritsky, 1994).

Theme 2: Perceptions of the Livescribe™ pen. Existing literature on Livescribe™ pens found positive support for their use in helping students with note-taking (Belson et al., 2013; Boyle & Joyce, 2019a; Hartman & Sherman, 2013). Perceptions of the Livescribe™ pen relates to students' positive and negative beliefs and experiences using the Livescribe™ pen. The post-intervention interview asked students questions about their experiences using the Livescribe™ pen to take notes. Overall, the students shared positive perceptions about the Livescribe™ pen. Kendall commented on his overall experience using the pen, stating, “My experience with it was a great experience.” Damien added, “It was pretty cool,” and Caleb stated that “I feel like it helped a lot. I love it.” Marcus shared about specific features of the pen that he liked. For example, he stated, “I like it. I like the audio, and I like having when you hear it and write it,” Marcus' feedback centered on the potential benefit of the Livescribe™ for secondary students, “I think at least every high school should have one [Livescribe™ pen] because it would have actually helped me take notes in high school.” Jay's comments about his experience were less enthusiastic. He stated that his experience using the Livescribe pen was “good,” but he added that “it could be time-consuming little bit.” The remainder of the students' comments related to the areas of (a) engagement, (b) perceived impact, (c) ease of use, and (d) helpfulness.

Engagement. Existing literature asserts that note-taking is important for students to be engaged in lectures, regardless of disability status (Boyle et al., 2015; Boyle &

Joyce, 2019). Engagement refers to the time and effort invested by students intended to enhance learning outcomes and optimize the student experience (Trowler, 2010).

Students shared that using the Livescribe™ pen can have a positive impact on student engagement. For example, when discussing his intentions to use the Livescribe pen in the future, Caleb expressed, “I love it. I feel like just using the pen will just make you more engaged as a whole.” Damien shared similar enthusiasm. He commented, “I think the pen can actually make some people get a little excited about taking notes.” The students’ statements suggest that the Livescribe™ pen can increase student engagement and motivation to take notes.

Helpfulness. During the post-intervention interviews, the students commented on the helpfulness of the Livescribe™ pen. Helpfulness describes how students feel the Livescribe™ pen assisted them during the note-taking process. All students expressed that the Livescribe™ pen was helpful in their lecture courses. Caleb stated that the Livescribe pen is helpful in “lecture courses, especially if you’re not a good note-taker.” In addition, Damien commented, “I feel like it definitely helped me to just stay focused, like in a long lecture class,” also noting that at times he loses track, gets distracted, or sometimes falls asleep during the lecture. He added, “I think it [Livescribe™ pen] helped me to capture more things from my notes from the lecture because it didn’t stress me out because I couldn’t keep up. Jay shared similar sentiments regarding the helpfulness of the Livescribe™ pen. For example, Jay stated, “It helped me write down more information and focus on what was important.” The student’s assertions suggest that the features of the Livescribe™ pen help students improve focus and capture more information during the lecture (Lindstrom, 2007; Ok & Rao, 2017). This affirms the findings of previous

studies that found the Livescribe pen to be effective in increasing students' focus during note-taking and assisting students in taking more notes during lectures (Boyle and Joyce, 2019).

Jay and Caleb also suggested that the Livescribe™ pen would be helpful in lectures courses. Caleb added that the Livescribe pen would be helpful in your general education courses, which are usually taught in a lecture format. In reference to specific courses, Damien expressed, "I think, I definitely think it will be helpful in my history course and my psychology course because those two professors talk the entire time." He discussed the challenge of listening and taking notes in his lecture courses, adding that the Livescribe™ pen is also helpful when the professor "doesn't even use a PowerPoint presentation" to guide students. When asked what other courses you feel like the Livescribe™ pen would be useful, Marcus responded, "definitely history." The students' feedback suggests that the Livescribe™ pen can assist students in enhancing their learning in multiple subject areas (Ok & Rao, 2017).

Livescribe™+ App. In addition to the helpfulness of the Livescribe™ pen in general, multiple students shared comments on the usefulness of the Livescribe™ + app, the app used in coordination with the Livescribe™ pen. The discussion on the app centered primarily on the ability to amend notes and conveniently access notes at any time. For example, Kendall asserted that the app "was the best feature" because if he forgot his notebook, he could always "have a backup" on the app. Marcus's feedback showed his appreciation for being able to save his notes to his phone using the app while Jay commented on the convenience of being able to have notes in a notebook and electronically through the app. Jay stated, "sometimes you forget your notebook, and you

can just look on your phone instead of going back to your room.” Caleb shared similar thoughts on the app’s convenience, commenting that the app allows you to “pull the app up on your phone and press playback. You may not feel like getting up to get your notebook.” Damien added, “I could access my notes anywhere. I can read them on the go.” The students’ statements show a positive perception of the Livescribe + app and its impact on convenience and efficiency. Damien also discussed his experience using the app to amend his notes. He stated, “I was able to go back and fill in my notes when I needed to. The pencast was the most useful part of having the pen.” Jay added, “If I missed something, I could go back and rewrite it.” The ability for students to review and amend notes efficiently and save digitized copies of their notes serve as advantages of the Livescribe™ pen (Ok & Rao, 2017; Boyle & Joyce, 2019).

Perceived impact. Perceived impact describes how students feel the Livescribe™ impacted their note-taking experience. Students noted that the Livescribe™ pen assisted them in improving various aspects of their notes to include understanding, meaning, and quality. For example, Kendall stated, “now I feel like my notes have meaning.” He added, “Now, I feel like I can take notes and actually understand my notes. “Now” represents his perception of his notes taking-ability after the intervention, suggesting that he feels the Livescribe™ pen has helped him improve his notes. Marcus noted that he experienced the greatest effect in his note-taking efficiency. He commented, “it made me be like more efficient with note-taking.” When asked about positive experiences with the Livescribe™ pen, Marcus stated, “I can see the improvement in myself notes, even with the like the things I remember.” The insight shared by the students portray an overall

positive perception of the Livescribe™ pen and its impact multiple aspects of note-taking.

Ease of Use. During the post-intervention interview, students shared insight into positive and negative experiences using the pen. Ease of use describes students' perceptions of the Livescribe™ pen's usability and user-friendliness. The students' experiences support Belson et al., (2013) findings that students felt that the Livescribe™ pen was easy to use. When asked to share any obstacles encountered with the pen, overall, the students shared positive responses about their experiences. According to Kendall, The Livescribe™ pen "was actually fairly easy to use." Damien stated, "I had to get used to using it, but I got the hang of it pretty fast." The other three students answered "No" when asked if they experienced any challenges, suggesting that students were able to successfully use the pen and its features after receiving training. In addition to the pen being easy to use, three students also commented on the pen's portability. Damien stated, "The pen is really portable like it's very similar to a regular pen..... It is easy to keep up with, and it's not heavy. Caleb shared similar comments regarding the pen's portability, suggesting that he did not think the pen "was too much different" and that you "can carry it almost the same way." He added that "you can put it in your pocket, you can put it in your bookbag and put it in a pencil pouch. I think it's just as mobile as any other pencil or pen." Although most students commented positively about the pen's usability, Damien stated that he had difficulties keeping the pen aligned with the dot paper while taking notes which caused the pen to beep. The students' assertions about the Livescribe™ pen's portability, ease of use, and physical similarities to a regular pen

support the findings of existing research citing these factors as advantages of smartpens (Dell, Newton, & Petroff, 2012; Ok & Rao, 2017; Olabisi & David, 2013).

Theme 3: Perceptions of the Cornell note-taking. Students held positive feelings about their experience using the Cornell note-taking strategy. Perceptions describe students' positive and negatives beliefs and experiences using the Cornell note-taking strategy. In the post-intervention interview, Kendall stated that the Cornell method "made it [note-taking] fun." He also commented on how using the Cornell note-taking strategy changed his attitude toward note-taking. Kendall stated, "at first, I really didn't like taking notes, but now I look forward to it." Marcus' assertions about the Cornell method centered on engagement. He shared how the Cornell method made him "randomly think about the lecture." The Cornell note-taking strategy assisted Marcus in visualizing his notes days after the lecture. When describing his experience with the Cornell note-taking method, Kendall stated it was like a "portable teacher service." Students also shared comments on their experiences using the Cornell note-taking strategy centered on (a) helpfulness, (b) perceived impact, and (c) challenges.

Helpfulness. The Cornell note-taking method helps students with aspects of note-taking and comprehension (Baharev, 2016; Maulidia, Ys, & Silviyanti, 2021). Helpfulness describes students' perceptions of how the Cornell note-taking strategy assists them with various aspects of note-taking. All students expressed that the Cornell method helped them with various aspects, including (a) organization, (b) overcoming writing challenges, (c) summarizing and consolidating information, (d) remembering information, and (e) generating study questions.

Organization. Four students reflected on the impact of the Cornell note-taking method on the organization of their notes. For example, Caleb stated, “The Cornell strategy took my organization to a better level.” He added that the strategy helped him to “have the right things together instead of being all over the place.” Similar sentiments were shared by Damien about the effect of the Cornell note-taking strategy the organization of his notes. Damien commented, “Cornell note-taking helped to improve the structure and organization of my notes.” He reflected on his previous way of organizing his notes which involved using bullet points, suggesting that having the “specific structure” of the Cornell note-taking strategy improved the organization of his notes. When asked about their experience with Cornell note-taking, Jay stated, “my notes became very organized,” and Marcus commented, “it helped me a lot. I like it [notes] being organized.” Marcus added, “It made everything just clear and like it made me be able to go into more detail on what I was writing. I can clearly see what I’m writing about more.” The students’ comments support previous literature indicating that Cornell note-taking can improve the organization of students’ notes (Pauk, 1974).

Overcoming writing challenges. Writing was cited by multiple students as an obstacle encountered during note-taking. Writing can be defined as a mental and physical act aimed at developing ideas into sentences and paragraphs (Alzu’bi, 2019). Writing challenges represent the obstacles students experience with writing during the note-taking process. Caleb expressed that the Cornell note-taking strategy can be very helpful in courses that require a significant amount of note-taking, especially for students who do not like to write. According to Caleb, these types of classes “might just discourage” students. He stated, “the Cornell strategy is helping people, making it easier for them to

actually get through those classes.” The comments made by Caleb support existing research suggesting that using Cornell note-taking can improve writing (Bouguesba, 2020; Alzu’bi, 2019).

Summarizing and consolidating information. A major component of Cornell note-taking is the summary section, which is located at the bottom of the Cornell page (Baharev, 2016; Pauk, 2000). Summarizing and consolidating information describes how Cornell note-taking assisted students in consolidating and summarizing lecture content. Students shared positive experiences using the summary. When asked what aspects of Cornell note-taking were most useful, Marcus, Kendall, and Damien commented on the summary. Marcus stated, “I like it [summary] because it helped wrap things up, tie it all together in my head, “ and Kendall commented, “I like that you can give a brief summary at end to break down what you learned.” Damien expressed that the summary helped him to remember the content covered during the lecture. Based on these students’ comments about the summary, it can be concluded that the summary is a valuable component of the Cornell method that can assist students in consolidating and remembering information during lectures.

Remembering information. Previous research found the Cornell note-taking strategy to be effective in helping students remember information taught during a lecture (Maulidia, Ys, & Silvianti, 2021; Baharev, 2016; Faber et al., 2000). Therefore, remembering information describes the impact of the Cornell note-taking strategy on students’ ability to remember information taught during a lecture. Three students mentioned that the Cornell method helped them to remember information that was learned in class. Damien expressed, “it helped me to remember what I actually wrote

about, and I can visualize what I wrote.” Jay added, “It helped me remember information while I was writing it.” Damien’s comments specifically focused on the Cornell note-taking strategy’s impact on remembering lecture content. Damien stated that he would start “randomly remembering the lecture” after taking notes using the Cornell note-taking strategy. These statements support previous literature suggesting that the components of the Cornell method, such as the summary and questions, help students better understand and remember information from the lecture (Baharev, 2016).

Generating study questions. The questions section serves as one of the three primary components of the Cornell note-taking strategy. The questions/keywords section is located in the upper left-hand column (Donohoo, 2010; Pauk, 2000). Generating study questions highlights the usefulness of the Cornell method in assisting students in generating study questions from the lecture content. Generating questions can be useful in assisting students in making external and internal connections between lecture content (Baharev, 2016). When asked what component of the Cornell method was most helpful, Kendall responded that “the questions in the body” were most useful. He further explained how the questions section was something new for him. However, it helped him by prompting him to develop questions and locate the answers in the notes. Kendall commented, “Because this is like if I have a question, I can write down the question, and I can also answer the question with the strategy.” Damien also responded to the latter question, stating that “the main points and the questions” were the most useful components of the Cornell strategy. The questions section helped students engage in the lecture material while promoting autonomous learning (Susanti, 2020).

Challenges. Students also discussed the challenges they encountered while using the Cornell note-taking strategy. When asked to share about negative experiences using the Cornell method, Marcus commented on the time associated with setting up his paper. He stated, “it takes longer to do than my regular note-taking.” Jay’s comments also suggested that components of the Cornell method required additional effort. Jay expressed, “I am kind of lazy, so I would say the only part I didn’t like was the summary part.” Other students commented on issues with the summary. Damien stated, “I’m not that type of learner that can just write paragraphs and remember, so I remember more like words or phrases.” He added that he felt “like the summary probably was the least useful.” Damien’s sentiments suggest that the Cornell method may not be helpful for all learning styles. Marcus and Damien also discussed challenges with the space allocated for writing on the Cornell page. Marcus stated that “the size of the sections” was not helpful, and Damien commented, “I had less space on the paper to write stuff down, so I had to use more pages.” These comments indicate that structure of Cornell may provide less flexibility for students to write freely by limiting the writing space allocated for each section.

Theme 4: Perceptions of Cornell Note-taking and Livescribe Pen Together.

Perceptions of the Cornell note-taking and Livescribe pen together represent students’ experiences and beliefs about using both tools together. Students had an overall positive experience using the Cornell note-taking strategy and Livescribe™ pen together. The comments made by the students suggest that the combination is valuable for students at the secondary and postsecondary levels. When asked about the experience using both tools together, Kendall responded, “It’s a great invention, and they need to make it a

public thing where all schools use it.” Marcus stated, “I think they’re like good together because having both features of the pen and like the organizational skills of the Cornell note-taking is what I feel like helped me the most.” Marcus’ remarks suggest that the tool complement each other well. Marcus followed by stating that he believes the Cornell method “would be less effective with like a pencil.” Jay’s statements were centered on the future use of both tools. He commented, “I feel like both will help you in the future, especially if you have a hard time remembering things. In class, this can help you like write down better notes.” Caleb described his experience with Cornell note-taking and the Livescribe™ as “using a cool pair.” The positive nature of each of the students’ comments suggests that the Cornell note-taking strategy and Livescribe™ pen can support students with note-taking and comprehension.

Summary

This chapter explored students’ experiences and perceptions using the Livescribe™ pen and Cornell note-taking strategy. The quantitative analysis examined the impact of Cornell note-taking and the Livescribe™ pen on students’ lecture comprehension and quality of notes. Immediate free call exercises, comprehension tests, and student notes were used to gather data on the impact of Cornell note-taking and the Livescribe™ pen students’ notes. The qualitative analysis examined students’ perceptions of note-taking, strategies, challenges, and areas for improvement, perceptions of the Livescribe™ pen, perceptions of the Cornell note-taking strategy, and perceptions of Livescribe™ pen and Cornell note-taking strategy together. The pre-and post-intervention interviews helped develop an understanding of students’ perceptions of note-taking, using the Livescribe™ pen and using the Cornell note-taking strategy. The

findings presented support the use of the Cornell note-taking strategy and the Livescribe™ pen to assist students with disabilities in engaging in lectures and recording better quality notes

CHAPTER 5

DISCUSSION, IMPLICATIONS, AND LIMITATIONS

The purpose of this action research was to identify effective educational supports for students with learning disabilities by evaluating the impact of the Livescribe™ pen and Cornell note-taking strategy on the note-taking and comprehension of college student-athletes with learning disabilities at a Historically Black College and University (HBCU). This study evaluated how the Livescribe™ pen and Cornell note-taking strategy impacts students' experiences and perceptions of note-taking. This chapter provides a discussion of the findings in relation to each of the three research questions while situating the findings within the literature. The (a) discussion, (b) implications, and (c) limitations of the present study will be presented in the following section.

Discussion

The qualitative and quantitative data were combined and analyzed to answer the research questions. The discussion is organized into three sections, correlating with each research question: (a) Research Question 1: How does the use of the Cornell note-taking strategy supported with a Livescribe™ pen affect the note-taking quality of student-athletes with learning disabilities? (b) Research Question 2: How does the use of the Cornell note-taking strategy supported with a Livescribe™ pen affect the comprehension of lecture content and vocabulary among student-athletes with learning disabilities? (c) Research Question 3: What are the experiences and perceptions of student-athletes with learning disabilities using Livescribe™ pens and their impact on note-taking and

comprehension of lecture content? The following sections aim to provide a comprehensive understanding of the findings integrated into existing literature.

Research Question 1: How does the use of the Cornell note-taking strategy supported with a Livescribe™ pen affect the note-taking quality of student-athletes with learning disabilities?

This research question explored the impact of the Cornell note-taking method and the Livescribe™ pen on the note-taking quality of college student-athletes with learning disabilities. The findings revealed that the Cornell note-taking strategy and Livescribe™ pen impacted students' note-taking in multiple areas. These areas include organization, reduction, and overall content. The Cornell note-taking strategy and the Livescribe™ pen assisted students in improving the overall organization of their notes by helping them to add structure and integrate the format and organization pattern of the Cornell method into their notes. The content recorded in the students' notes showed that the tools impacted the students' reduction or representation of keywords and questions aligned with the main ideas of the lectures. Previous research indicates that the Livescribe™ pen and the Cornell note-taking strategy help increase the quality of students' notes in multiple areas to include selectivity, organization, and the total number of vocabulary and main points recorded (Belson et al., 2013; Ok & Rao, 2017; Joyce & Boyle, 2019; Boyle & Joyce, 2019). The findings support previous research, revealing two major themes relating to the impact of the Livescribe™ pen and Cornell note-taking strategy on the quality of students' notes: (a) content and (b) organization.

Content. This study revealed that the Livescribe™ pen and Cornell note-taking strategy help students with learning disabilities to increase the representation of

keywords/questions and improve the number of lecture points and vocabulary words captured in their notes. In a previous pilot study, Belson et al. (2013) found that the Livescribe™ pen and Cornell note-taking strategy assisted students in increasing the number of main ideas recorded in their notes in addition to enhancing the depth and breadth of each topic recorded (p. 20). In addition, Joyce and Boyle (2019) investigated the impact of a Livescribe™ pen and note-taking intervention on students with and without learning disabilities. They found that students with learning disabilities, who used the smartpen, increased their notes by an average of 53 words, and students in the intervention group recorded more lecture points. This study corroborates these findings, suggesting that the Livescribe™ pen and Cornell note-taking may effectively close the gap between students with and without learning disabilities.

Previous research suggests that students with learning disabilities can use a smartpen intervention to record more lecture points and vocabulary in their notes (Joyce & Boyle, 2019). Findings from the rubric illuminated the impact of the Livescribe™ pen and Cornell note-taking strategy in helping students improve the overall content of their notes. After using the Livescribe™ pen and Cornell note-taking strategy to take notes, students improved their notes in the areas of content and reduction. Three students increased the number of lecture points and supporting details in their notes after using the Livescribe™ pen and Cornell note-taking strategy. However, two students recorded fewer main points and supporting details from the lecture after using both tools. This decrease can be attributed to a lack of engagement and effort on the post-intervention measures. In addition, although Kendall recorded a reasonable number of words in his post-intervention notes, he recorded multiple unnecessary words and incorrect lecture

points for which he could not receive credit, contributing to a lower post-intervention content score.

While the increase in the students' rubric scores was small in most cases, the findings support the use of the Livescribe™ pen and Cornell note-taking strategy to assist students with learning disabilities in enhancing the breadth and depth of their notes (Belson et al., 2013). The insight from the post-intervention interviews provides more direct support of this finding. For example, when discussing the helpfulness of the Livescribe pen, Jay shared, "it helped me write down more information and focus on what was important," and Damien stated that intervention helped him to "to capture more things" from the lecture in his notes. The comments made by the students reflecting the perceived impact of the Livescribe pen and Cornell note-taking strategy are also confirmed by their responses to the note-taking experience survey. All participants agreed with the statement, "The audio pencast helped me to amend my notes and add missing points from the lecture," suggesting that the students felt that the pencast feature of the Livescribe pen helped them to add lecture points to their notes that may have been missed during the lecture. Using the pencast to amend notes after the lecture can assist students in increasing the number of vocabulary and total words in their notes (Boyle, 2010b; Boyle & Weishaar, 2001; Joyce & Boyle, 2019).

In addition to aiding students in enhancing the content of their notes, the Livescribe™ pen and Cornell note-taking strategy can also support students in generating questions and recording keywords in their notes (Faber et al., 2000; Boyle & Weishaar, 2001). The students' reduction scores did not provide overwhelming support for this finding. There was a wide variety in students' ability to record keywords and generate

questions during pre-intervention and post-intervention. After using the Livescribe™ pen and Cornell note-taking strategy, Caleb and Marcus improved their ability to recognize and write down keywords/ questions in their notes. Jay's reduction abilities remained consistent before and after the use of the Livescribe™ pen and Cornell method. However, Kendall and Damien wrote fewer keywords/questions in their notes after the intervention. Variety in the student's performance in this area could be influenced by a few factors such as student engagement, effort, and familiarity with the lecture content. Overall, the students' rubric scores did not provide strong support for using the Livescribe™ pen and Cornell note-taking to improve students' ability to capture keywords and generate questions from the lecture content.

However, insight shared during the post-intervention interviews depicts a positive impact of the Cornell note-taking strategy in supporting students with their reduction skills. Previous research suggests that generating questions can help students make external and internal connections between content taught during lectures (Baharev, 2016). Multiple students shared positive comments regarding the impact of the Cornell method on their note-taking. For instance, Kendall shared that the "questions in the body" were the most beneficial component of the Cornell note-taking strategy, adding, "Because this is like if I have a question, I can write down the question, and I can also answer the question with the strategy." Damien's comments also indicated that "the main points and the questions" were the most useful components of the Cornell strategy. These findings support previous literature highlighting the usefulness of the Cornell note-taking strategy in helping students to derive questions from the lecture content during the note-taking process while promoting self-questioning and comprehension (Faber et al., 2000).

Organization. The quality of notes is often evaluated by completeness, accuracy, and organization (Baharev, 2016). The findings of this study indicate that the Cornell note-taking strategy and Livescribe™ pen can assist students in improving the organization of their notes. Belson et al. (2013) evaluated the impact of the Livescribe pen and Cornell note-taking method on various aspects of students' notes, including organization. Although they did not find that the Cornell note-taking strategy and Livescribe™ significantly impacted the organization of students' notes, they indicated that the tools did not have a negative effect on the organization of the students' notes. The findings of this study expand on the previous studies, confirming that the Cornell note-taking strategy can assist students in improving organization while taking notes.

Cornell note-taking is a strategy that can assist students in producing well-organized notes, allowing learners to identify key concepts quickly (Pauk, 1962, Belson et al., 2013). Previous research suggests that the strategic organization of the lecture content can promote problem-solving when lecture material is recalled later (Pauk, 1962). The results of the note-taking experience survey support previous research indicating that the Cornell note-taking strategy can assist students in organizing their notes. All students agreed with the statement, "The Cornell note-taking strategy helped me to organize the main ideas of the lecture better." The impact of the Cornell note-taking strategy on students' ability to organize content presented during lectures was also illustrated by the students' rubric scores. The rubric scores highlighted the effect of the Cornell note-taking strategy and Livescribe™ pen on the organization of students' notes. The organization category of the rubric assessed students' notes on the presence of the Cornell format and organizational pattern. Students were awarded points if the Cornell note-taking format

was followed, and the features (lecture topic, date, and page number) were present on the note page. Because none of the students were previously taught how to use the Cornell strategy, students were awarded a baseline score of one for reflecting some form of structure within their notes. However, Damien was awarded a baseline score of three because he presented elements of the organizational pattern of the Cornell strategy in his pre-intervention notes.

After using the Cornell note-taking strategy and Livescribe™ pen, all students improved their ability to follow the organizational pattern of Cornell and reflect each component in their notes, including the lecture topic, date, and page number. Upon evaluation of their notes after using the Cornell note-taking strategy and Livescribe™ pen, two students earned a perfect organizational score (10), and two students earned a score of eight. However, Damien showed the smallest improvement in organization even though he was the only student to demonstrate previous note-taking training in his notes recorded using his traditional note-taking method. This could be explained by a lack of buy-in into the Cornell note-taking method due to having confidence in his previous note-taking strategy. The inability of all students to successfully implement the Cornell features and format could also result from insufficient training, indicating that students may need training over a more extended period of time and practice to fully grasp the Cornell note-taking strategy.

Although the organization of the students' notes improved considerably, it is important to note that most of the students did not have previous training on the Cornell note-taking strategy, hindering their ability to reflect components on Cornell in their traditional notes. Therefore, receiving formal training on the Cornell note-taking strategy

could have impacted the student's improvement in this area. Hence, the post-intervention organization scores should be reviewed with caution.

In addition to the rubric scores, feedback shared during the post-intervention interviews provides more explicit support of the positive effect of the Cornell note-taking strategy on the organization of students' notes. The comments shared during the post-intervention interviews illustrate how the Cornell note-taking strategy helps students record well-organized notes. Multiple students communicated how the Cornell note-taking strategy positively impacted the organization of their notes. For example, Damien remarked, "Cornell note-taking helped to improve the structure and organization of my notes." He discussed how the Cornell note-taking strategy prompted him to implement a "specific structure," which enhanced the development of his notes from his previous method of only using bullet points. Caleb shared similar sentiments, stating, "The Cornell strategy took my organization to a better level." He also commented on how the Cornell method helped him to "have the right things together instead of being all over the place." Jay and Marcus also shared positive perceptions of the Cornell note-taking method and its effect on the organizational component of their notes. Jay stated, "my notes became very organized," and Marcus noted, "it helped me a lot. I like it [notes] being organized." Marcus expanded on his comments stating that "It made everything just clear and like it made me be able to go into more detail on what I was writing. I can clearly see what I'm writing about more." These findings support previous literature indicating that Cornell note-taking can assist students in recording notes that are well-organized to allow for the quick identification of key concepts (Pauk, 1974; Belson et al., 2013).

How does the use of the Cornell note-taking strategy supported with a Livescribe™ pen affect the comprehension of lecture content and vocabulary among student-athletes with learning disabilities?

The goal of this research question was to investigate the impact of the Cornell note-taking strategy, supported by the Livescribe™ pen on the comprehension of college student-athletes with learning disabilities. The findings of this study indicate the Cornell note-taking strategy and the Livescribe™ pen can assist students in comprehending, summarizing, and consolidating lecture content. Students with learning disabilities have difficulties comprehending and recalling information taught during lecture courses (Wolf, 2001; Boyle, 2010A; Suritsky, 1994). Faber et al. (2000) found that the Cornell note-taking method increases comprehension among high school students. In addition, Baharev's (2016) findings suggest that components of the Cornell note-taking strategy can assist middle school students in understanding and remembering information. The impact of the Cornell method has also been found at the postsecondary level. In their research, Tsai-Fu and Wu (2010) studied the Cornell note-taking strategy with first-year college students. The students in their study performed better on comprehension measures after receiving training on the Cornell note-taking strategy. In this study, the data from the IFR exercises, comprehension tests, note-taking experience questionnaire, and pre-and post-intervention interviews were triangulated to provide a comprehensive overview of the impact of the Livescribe™ pen and Cornell note-taking strategy on the comprehension of lecture content and vocabulary. The findings support previous research suggesting that the Livescribe™ pen and Cornell note-taking strategy positively impacted students' ability to carry out multiple tasks such as (a)

comprehending and recalling lecture content and (b) summarizing and consolidating information.

Comprehending lecture content. Students with learning disabilities experience significant challenges employing academic strategies such as comprehension and recall (Schuchardt et al., 2008; Wolf, 2011). These challenges directly reflect deficiencies in executive functioning, which impact students' ability to coordinate cognitive processes such as consolidating information into long-term memory (Foley, 2006; Lindstrom & Skinner, 2003). Poor metacognitive abilities also contribute to ineffective regulation of cognitive processes necessary for satisfactory academic performance (Pintrich, 1994). This study revealed that the Cornell note-taking strategy can assist students comprehending information learned during lectures. The findings are supported by previous research suggesting that features of the Livescribe™ pen, such as the pencast playback, can assist students in compensating for poor comprehension skills (Belson et al., 2013; Wise 2010). Belson et al. (2013) found that the audio playback feature helps students with note-taking challenges to learn essential content from lectures to be used on future exams and assignments. Jacobs (2008) studied the impact of the Cornell method among ninth-grade English students. His findings suggest that the Cornell note-taking method can help students synthesize and apply information and perform at a higher level.

Previous research proposes that a systematic note-taking strategy such as the Cornell method can assist students in enhancing understanding and remembering lecture content (Boyle, 2010; Akintunde, 2013). This finding is exemplified by the results of the IFR exercise which show that students' comprehension improved with the usage of the Cornell note-taking strategy and Livescribe™ pen. After using the Cornell note-taking

strategy and Livescribe™ pen, students recalled more total vocabulary words and more main points on the IFR exercise. These findings show that the students' short-term mastery of the lecture content improved after using the Cornell method and the Livescribe™ pen. The findings from the IFR are consistent with findings of previous research (Joyce, 2016; Boyle, 2010). Similar improvements were noted in students' comprehension test scores. Four of the five students performed better on the comprehension posttest which was administered after students received training on the Cornell note-taking strategy and Livescribe™ pen. These findings corroborate Boyle's (2010) findings which reflected increases in students' performance on comprehension measures after implementation of a note-taking intervention. After using the Cornell note-taking strategy and Livescribe™ pen over the eight-week period, the students performed better on both comprehension measures. Together, these findings provide support for the use of the Livescribe™ pen and Cornell note-taking strategy to help students improve comprehension of lecture content.

Summarizing and consolidating information. Summarization leads to a deeper understanding of information, resulting in better performance on conceptual and integrative assessments (Baharev, 2017). In addition to summarizing information, the process of consolidating information is also important in transitioning information from short-term to long-term memory (Peverly, 2006). The findings of this research suggest that the Cornell note-taking method can assist students in summarizing, remembering, and recalling lecture content. Existing note-taking literature indicates that consolidating information recorded in notes helps to reduce the natural process of forgetting information (Kiewra, 1989). This impact is illuminated by the results of the note-taking

experience questionnaire and the feedback shared by student during the post-intervention interview. Most of the students ($n=4$) agreed that summarizing lecture points assisted them in remembering information taught during the lecture ($M=4.40$, $SD=0.55$). One student put their thoughts into words stating, "I like it [the summary] because it helped wrap things up, tie it all together in my head." The students' feedback suggests that the summary can impact one's ability to make connections between the lecture content. The students also responded positively to the statement, "reviewing the summaries in my notes helped me to recall important lecture points," confirming that writing and reviewing the summaries contributed to remembering and recalling lecture points. The findings support previous research indicating that a note-taking intervention can assist students in synthesizing and reorganizing information presented in the lecture (Baharev, 2016; Boyle, 2010; Boyle & Weishaar, 200; Joyce & Boyle, 2019b). Together, these findings provide support for the use of the Livescribe™ pen and Cornell note-taking strategy to help students improve comprehension of lecture content.

What are the experiences and perceptions of student-athletes with learning disabilities using Livescribe™ pens and their impact on note-taking and comprehension of lecture content?

This research question explored the students' experiences using the Livescribe™ pen and Cornell note-taking strategy, while gaining insight into their perceptions of the two resources and their impact on note-taking and comprehension. Limited research has explored the perceptions and experiences students with learning disabilities' using digital pens and systematic note-taking strategies (Baharev, 2016; Joyce, 2016; Belson et al., 2013; Patti & Garland, 2015). The results of the note-taking experience survey and the

pre-and post-intervention interviews were combined to develop a comprehensive understanding of the students' experiences and perceptions using the Cornell note-taking strategy and Livescribe™ pen. Analysis of these measures revealed that students had (a) positive perceptions of the Cornell note-taking strategy, (b) positive perceptions of the Livescribe™ pen and had positive perceptions of (c) combined use of the Livescribe™ pen and Cornell note-taking strategy.

Positive perceptions of Cornell note-taking. Baharev (2016) studied the impact of the Cornell note-taking strategy among middle school students and found that students felt that the Cornell method helped them to take better notes and generating and answering questions helped students to remember and understand information from the lecture better (p. 114). Faber et al. (2000) found similar results, indicating that students who were taught the Cornell note-taking strategy scored significantly higher on comprehension measures than students who were not taught the Cornell method. The findings of this research affirm those of the previous studies, suggesting that the Cornell note-taking strategy can assist students with various aspects of note-taking and comprehension. The analysis revealed two major themes relating to students' perceptions of the Cornell note-taking strategy: (a) helpfulness and (b) challenges.

Helpfulness. Previous studies have highlighted the potential of the Cornell note-taking strategy as an effective tool to assist students in various aspects of their academics (Baharev, 2016; Belson et al., 2013; Tucker & Zamfir, 2021). Baharev (2016) evaluated students' perceptions of the effectiveness of the Cornell method in helping them to take better notes and remembering and understanding information presented during lectures. He found that students felt that the Cornell note-taking method helped them to take better

notes, the summary helped them to remember information and the process of generating and answering questions helped them to better remember and understand information. This study affirms these findings, adding additional areas in which the students feel their note-taking is positively impacted by the Cornell note-taking method. The findings are organized into the following sections: (a) organization, (b) writing, (c) summarizing and consolidating information, (d) remembering lecture content, and (e) generating study questions.

Organization. Findings of this study show that students felt the Cornell method positively impacted the organization of their notes. For example, Caleb stated in his post-intervention interview, "The Cornell strategy took my organization to a better level" while helping him to "have the right things together instead of being all over the place." Damien also reflected the improvements in his notes after using the Cornell note-taking strategy, stating, "Cornell note-taking helped to improve the structure and organization of my notes." Marcus' comments reveal how the improved organization enhanced his ability to use his notes after the lecture. He shared, "It made everything just clear," providing him with quality notes that he could use for studying. In addition, Jay commented that after using the Cornell note-taking strategy, his notes became very organized. These findings provide support for previous literature highlighting the impact of the Cornell note-taking method on the structure and organization of students' notes (Baharev, 2016).

Writing. Writing has been cited in previous studies as challenge for many students during the note-taking process (Boyle, 2016; Hughes & Suritsky, 1993). This obstacle is more significant for students with learning disabilities who have difficulty holding lecture information while writing and encoding information (Kellogg et al., 2007). This study

found that the Cornell note-taking strategy was effective in assisting students in overcoming writing challenges encountered during the note-taking process. Hughes and Suritsky (1993) interviewed college students with learning disabilities and found that these students experiences difficulties writing fast enough and deciding what information to write when taking notes. The feedback shared during the post-intervention interviews suggest that the Cornell note-taking strategy can assist students who are poor writers in overcoming writing challenges. In his post-intervention interview, Caleb commented that he felt the Cornell note-taking strategy would be useful in courses that require students to take a significant number of notes. According to Caleb, these courses "might just discourage" students. His comments suggest that the Cornell note-taking strategy can help students find success in these types of courses by providing the organization and structure needed to take quality notes. These findings support previous research suggesting that using Cornell note-taking can help students to improve writing and overcome writing deficiencies (Boyle, 2016; Hughes & Suritsky, 1993).

Summarizing and consolidating. The findings of this study suggest that the Cornell note-taking strategy can assist students in summarizing and consolidating information recorded during a lecture. This finding confirms Baharev's (2016) study which indicated that summarizing information facilitate comprehension, synthesis, and analysis of lecture content, assisting students to make internal and external connections. In the post-intervention interviews, multiple students reflected positively on the summary section of the Cornell method. Marcus expressed how he felt about the summary section and its impact on his learning by commenting, "I like it [summary] because it helped wrap things up, tie it all together in my head." Kendall expanded on these feelings by

stating, "I like that you can give a brief summary at end to break down what you learned."

Damien also expressed that he felt that the summary helped him to remember the information that was taught during the lectures. Previous studies have concluded that summarization can assist students in identifying key points, organizing information, and making connections between ideas and their existing knowledge (Kiewra, 2002; King, 1992). The students' comments affirm the findings of previous literature suggesting that the Cornell note-taking strategy can be an effective method to assist students in synthesizing essential information presented during lectures (Kiewra, 2002; King, 1992; Baharev, 2016).

Remembering information. In addition to summarizing and consolidating information, this study also discovered that the Cornell note-taking strategy can help students to remember information taught during a lecture. Baharev (2016) found that the Cornell note-taking strategy helped students to remember information presented during a lecture. The post-intervention interviews and note-taking experience surveys were combined to provide a comprehensive overview of this finding. During the pre-intervention interviews, multiple students expressed how the Cornell method impacted their ability to remember information presented during a lecture. Damien commented, "it helped me to remember what I actually wrote about, and I can visualize what I wrote." Jay shared similar feelings, stating, "It helped me remember information while I was writing it." Damien also commented on how the Cornell note-taking strategy impacted his connection to the lecture, even after class was over. He shared that he would periodically start "randomly remembering the lecture" outside of the class. The insight shared during the pre-intervention interviews was supported by the results of the note-

taking experience questionnaire. For example, all students agreed to statements about the impact of the Cornell note-taking method on their ability to remember information. All four participants responded positively to the statements “Generating and answering questions help me better understand and remember information,” “Summarizing lecture points helped me better remember information,” and “Reviewing the summaries in my notes helped me to recall important lecture points.” These findings support previous research in which students found the Cornell method to be helpful in remembering information from the lecture (Baharev, 2016; Boyle & Weishaar, 2001).

Generating study questions. This study also found that the Cornell note-taking strategy can assist students in generating study questions from their notes. The questions/keywords section of the Cornell method prompts students to generate questions that can help students in making internal and external connections between ideas and information presented during a lecture (Baharev, 2016). According to King (1992), self-questioning is an exercise that facilitates comprehension of lecture content by prompting various cognitive activities such as organizing new material, focusing, and integrating new material with existing material. The comments shared during the post-intervention interviews provided insight into the students’ experiences using the Cornell method to generate study questions while making their notes into a valuable study resource. For instance, Kendall stated that “the questions in the body” were the most useful components of the Cornell note-taking strategy. He expanded on his response, explaining how the questions section helped him study by prompting him to generate questions about the lecture content while locating the answer in the notes. Kendall’s feelings about the questions/keywords section also provided support for its use as a study aid. He stated,

because "if I have a question, I can write down the question, and I can also answer the question with the strategy." This finding corroborates previous literature indicating the Cornell method can assist in facilitating the studying process, helping students engage in lecture content while promoting autonomous learning (King, 1992; Baharev, 2016).

Challenges. Although the majority of this study's findings centered around the positive effects of the Cornell note-taking strategy, this study also revealed challenges experiences by students while using the Cornell method. Limited research has specifically explored the challenges students experience using the Cornell note-taking strategy, therefore, the insight shared during the pre-intervention interviews add to the literature by describing students' negative experiences using the Cornell note-taking strategy. For example, Marcus commented on the time and effort required by the strategy. Marcus stated during his pre-intervention interview, "it takes longer to do than my regular note-taking," suggesting that the Cornell method required additional effort than his traditional note-taking method. Kendall and Damien's comments suggested that for some students, the Cornell note-taking strategy may be more challenging due to the additional time commitment it requires to set up the page and to write the summary. Other students' comments reflected dissatisfaction with the amount of effort required to complete the summary. For instance, Jay stated, "I am kind of lazy, so I would say the only part I didn't like was the summary part." Damien's provided an evaluation of the summary component. He said, "I'm not that type of learner that can just write paragraphs and remember, so I remember more like words or phrases," while also commenting that he felt the summary was the least useful. Another challenge expressed by students was the limited space on the Cornell page. Damien commented, "I had less space on the paper

to write stuff down, so I had to use more pages," while Marcus stated that "the size of the sections" was a challenge. Despite the advantages of using the Cornell note-taking strategy, these findings suggest that the Cornell note-taking strategy (a) may require more effort than traditional note-taking methods, (b) may not be helpful for students with different learning styles, and (c) provides less flexibility for students due to the limited space provided in each section.

Positive perceptions of the Livescribe™ pen. Few studies have investigated students' use of the Livescribe™ pen, explicitly focusing on their experiences and perceptions (Belson et al., 2013; Joyce, 2016; Ellis, 2016). The findings of this study suggest that students have positive overall perceptions of the Livescribe™ pen. This study supports previous research indicating that students with learning disabilities view the Livescribe™ pen as being a positive contributor to their note-taking experience, especially in courses that rely on note-taking as a primary means of actively engaging in the course content (Ellis, 2016). Data from the note-taking experience survey and semi-structured interviews were triangulated to gather a comprehensive understanding of students' perceptions of the Livescribe™ pen. The findings indicate that the Livescribe™ pen can increase (a) student engagement and improve (b) note quality and (c) note-taking efficiency. In addition, the data analysis uncovered students' perceptions of the Livescribe™ pen's overall (d) helpfulness and (e) ease of use.

Student engagement. Student engagement impacts students' ability to recall and comprehend information presented during a lecture (Baharev, 2016). Students who engage in a particular lecture also perform better on assessments (Higgins & Raskind, 1995). This study found that the Livescribe™ pen is effective in increasing student

engagement. Although limited research has investigated the impact of assistive technology, such as digital pens, on student engagement, Joyce (2016) found positive support for the use of the Livescribe™ pen to increase student engagement. According to Joyce (2016), students were more focused and engaged in the lecture when using the Livescribe™ pen. The comments shared during the post-intervention interviews provide support for this finding. Multiple students made comments about the Livescribe™ pen's impact on their engagement. Caleb commented on his experience with the Livescribe™ pen stating that "using the pen will just make you more engaged as a whole." Damien added by sharing how the Livescribe™ pen can increase excitement to take notes. Damien said, "I think the pen can actually make some people get a little excited about taking notes." These findings validate previous research suggesting that the Livescribe™ pen can foster engagement, focus, and motivation in students as they approach the note-taking process.

Note quality. Previous research found the Livescribe™ pen to be helpful in improving the quality of the students' notes in multiple areas, including total word count, vocabulary, and lecture points (Boyle & Joyce, 2019b; Joyce, 2016). The findings of this study indicate that the Livescribe™ is effective in improving the overall quality of students' notes. This study also found that the pencast feature of the Livescribe™ pen can assist students in adding information to their notes that was missed during a lecture. The results of the rubric did not provide strong support for this finding. Improvement in students' ability to represent lecture points, supporting details, keywords, and vocabulary in their notes did not improve after using the Livescribe™ pen. Although Caleb and Marcus improved in the categories of content and reduction after using the Livescribe™

pen, the rubric data did not provide overwhelming support for the use of the Livescribe™ pen to assist students in improving the quality of their notes in terms of content and reduction. The comments shared during the students' post-intervention interview provide more direct support of this finding. Jay's reflection emphasized the Livescribe™ pen's effect on the amount of information recorded in his notes. Jay stated, "It helped me write down more information and focus on what was important." His comments depict a significant benefit of the Livescribe™ pen, specifically for students with learning disabilities who often have difficulties discerning important information from unimportant information (Joyce, 2016). Kendall stated, "now I feel like my notes have meaning." He added, "now, I feel like I can take notes and actually understand my notes," suggesting that using the Livescribe pen gave his notes more meaning while helping to improve his ability to understand them. These findings are supported by the data from the note-taking experience survey. For example, all students responded positively ($M=4.40$) to the statement "The audio pencast helped me to amend my notes and add missing points from the lecture." The improvements in the students' notes can be attributed to the features of the Livescribe™ pen, specifically the pencast, which allows students to amend their notes using an audio recording of the lecture.

Note-taking efficiency. Previous note-taking research identifies note-taking efficiency as a challenge for students, with most students only recording between 20 to 40% of the main concepts presented during a lecture (Kiewra, 1985). The findings of this study indicate that the Livescribe™ pen can help students to be more efficient while taking notes. Results of the note-taking experience survey revealed that students felt that the Livescribe™ pen made it easier to take notes during lectures. In response to the

statement, "The Livescribe™ pen made me feel more comfortable taking notes during lectures," students responded positively ($M=4.40$). Belson et al. (2013) reported that 90% of students surveyed in their research agreed that they were less anxious about capturing all the information presented in the lecture and were more focused when using the Livescribe™ pen. Their findings were affirmed by the insight shared during the post-intervention interview. For example, Kendall expressed how the Livescribe™ pen helped him relieve stress during the lecture by stating, "I think it [Livescribe™ pen] helped me to capture more things in my notes from the lecture because it didn't stress me out because I couldn't keep up." This suggests that the features of the Livescribe™ pen, such as the pencast, provide students with security, allowing them to focus on what the instructor is saying instead of worrying about keeping up the lecture (Belson et al., 2013).

Helpfulness. Previous literature suggests that the Livescribe™ pen can help students take better notes in lecture courses (Boyle & Joyce, 2019b; Belson et al., 2013, Ok & Rao, 2017). This research found that the Livescribe™ pen can help students in multiple facets of the note-taking process. In addition, the findings show that the Livescribe™ pen can help students in various subject areas. Lastly, the Livescribe™ + app was found to assist students in amending their notes, adding missed information from the lecture, and accessing their notes through multiple mediums. There are a few notable findings relating to the overall helpfulness of the Livescribe™ pen. Feedback provided during the post-intervention interviews provided insight into the impact of the Livescribe™ pen on students' confidence and focus levels. Reflecting on his ability to take notes, Caleb stated that the Livescribe™ pen was helpful in lecture courses, especially for students who are not good note-takers. This suggests that students who do

not consider themselves to be good note-takers are empowered by the Livescribe™ pen to better note-takers. Other findings portray the impact of the Livescribe™ pen on students' ability to focus during lecture courses. Students with learning disabilities often struggle to maintain the level of focus necessary to record notes that encompass important lecture points and vocabulary (Boyle & Joyce, 2017; Piolat, Olive, & Kellogg, 2005). One student commented that the Livescribe™ pen helped him "to stay focused... in a long lecture" and "focus on what was important." This student also shared his experiences of losing track and getting distracted during the lecture while providing support for the Livescribe™ pen as a tool that could assist him in overcoming these challenges. These findings support the use of the Livescribe™ pen to increase students' focus and enhance the students' ability to capture more information during the lecture, affirming the findings of previous research (Ellis, 2016; Ok & Rao, 2017; Boyle & Joyce, 2019).

Another theme derived from the data regarding the helpfulness of the Livescribe™ pen was the potential benefits of the pen across various subjects. The findings support the research of Ok and Rao (2017), Baharev (2017), and Joyce and Boyle (2019b), which found that the Livescribe™ pen can be useful in a variety of subject areas to include English language arts, math, and social studies. In addition to providing support for the use of the Livescribe™ pen in a personal and community health course, the students also commented on the usefulness of the Livescribe™ pen in other courses. For example, Damien shared, "I definitely think it will be helpful in my history course and my psychology course because those two professors talk the entire time," suggesting that the Livescribe™ pen could be impactful in courses where instructors'

primary mode of instruction is lecturing. Marcus responded, "definitely history," when asked which courses you feel the Livescribe™ pen would be most useful. This finding supports previous literature while also providing a recommendation for future research exploring the impact of the Livescribe™ pen in different courses or subject areas.

The Livescribe™ + app was identified by students as a significant resource while using the Livescribe™ pen. The Livescribe™ + app is a mobile application that pairs with the Livescribe™ pen to sync, store, transcribe, search, and share audio pencasts and digitized notes (Livescribe, 2021). The app permitted students to amend their notes after the lecture using the pencast while reviewing notes and filling in information missed during the lecture. The ability for students to amend their notes using the audio pencast to identify missing information is a significant advantage of using the Livescribe™ pen and Livescribe™ + app. During the post-intervention interviews, two students made positive comments about their experience using the Livescribe™ + app to amend their notes.

Damien stated, "I was able to go back and fill in my notes when I needed to. The pencast was the most useful part of having the pen." Similar sentiments were shared by Jay. Jay commented, "If I missed something, I could go back and rewrite it." Multiple students identified the app as being the best aspect of using the Livescribe™ pen. Ok and Rao (2017) also cited students' ability to save and share digitized versions of their notes as a major advantage of the Livescribe™ pen. Students identified the ability to access notes conveniently using the Livescribe™ + app as a significant advantage of the Livescribe™ pen. Multiple students shared positive remarks about their ability to access their notes electronically utilizing the app. Data from the post-intervention interviews highlighted the students' admiration for the Livescribe™ + app and its ability to provide convenient

access when they did not have their physical notebooks. For example, Jay shared, "sometimes you forget your notebook, and you can just look on your phone instead of going back to your room," while Damien stated that "I could access my notes anywhere. I can read them on the go." The students' experiences using the Livescribe™ pen and Livescribe™ + app are consistent with previous research, providing strong support for using the tools to enhance note-taking efficiency and quality.

Ease of use. Several factors can challenge technology integration, including perceptions and a lack of training and support (Ok & Rao, 2017). Previous research indicates that the Livescribe™ pen is easy to use with adequate training (Belson et al., 2013; Joyce, 2016). This study found that students felt that the Livescribe™ pen was easy to use with training and support. This finding was illuminated by the responses gathered from the note-taking experience survey. Students were asked to respond to the statement, "It was easy to learn how to use the Livescribe™ pen with training and instructions." Overall, students responded positively ($M=3.60$), suggesting that students felt that the Livescribe™ pen was easy to use with training. Two students responded *neutrally* to this statement. One reason for these responses is that the students could have felt that additional training was needed to acclimate to using the pen fully as the students only received training over two 50-minutes sessions. Students also responded positively ($M=4.20$) to the statement, "It was easy to use the Livescribe™ pen with the Cornell note-taking strategy to take notes," suggesting that students felt that it was easy to integrate the Livescribe™ pen with Cornell note-taking strategy during the note-taking process.

Combined use of the Livescribe™ pen and Cornell note-taking strategy. An aim of this research was to investigate students' perceptions and experiences using the Livescribe™ pen and Cornell note-taking strategy together. The findings suggest that students had an overall positive experience using both tools collectively. Students responded enthusiastically during the interviews when asked about their experience using both tools together. For example, Kendall commented, "It's a great invention, and they need to make it a public thing where all schools use it." His comments not only reflect the impact of the tools on his note-taking but also suggest that the tools could be helpful to other students. Caleb described the Cornell note-taking strategy and Livescribe™ pen as a "cool pair." At the same time, Marcus also responded positively in his post-intervention interview by stating, "I think they're like good together because having both features of the pen and like the organizational skills of the Cornell note-taking is what I feel like helped me the most." Jay expanded on these feelings by commenting, "I feel like both will help you in the future, especially if you have a hard time remembering things. In class, this can help you like write down better notes." The students' comments provide evidence for the use of both tools in supporting multiple aspects of note-taking and comprehension to include organization and remembering information. The students' comments support the findings of Baharev (2016) and Belson et al. (2013), in which students felt that the Cornell note-taking strategy and Livescribe™ pen were helpful when used together.

Implications

Due to the evolving role of technology in the educational setting and the lives of students, this research has several implications. Three types of implications are considered in this research, (a) personal implications, (b) practice implications, and (c) implications for future research.

Personal Implications

Conducting this research has helped me gain valuable insights that will help me grow in my role as a practitioner in the field of student-athlete support services. Reflecting on what I have learned during this process has allowed me to identify specific areas where I have endured the most growth. I have gained knowledge on (a) research methodologies, (b) the value of positionality, and (c) the needs of students with learning disabilities.

Research Methodologies. The initial aim of this research was to identify resources that could help student-athletes with learning disabilities overcome academic challenges. As the research developed, so did the focus on two specific research-based interventions. As the researcher, I was challenged with approaching the problem as an action researcher, requiring the development of a systemic approach to investigate the problem of practice identified in my professional setting (Mertler, 2019). Refining my research focus was guided by a critical evaluation of the issue and a review of relevant literature (Mertler, 2019). During the action research process, my knowledge of the quantitative and qualitative approaches increased significantly. The process of identifying the most appropriate data collection methods to gather data on each of the research questions required personal reflection and critical thinking to create a refined plan of

action to address the problem (Mills, 2011; Mertler, 2019). The research problem and related research questions required the use of both quantitative and qualitative methods to provide a comprehensive understanding of the problem. Although qualitative data sources are very common in research conducted by educators, it was critical that quantitative sources were also used to answer the research questions (Mills, 2000). To answer the research questions, I combined qualitative and quantitative data sources. This process emphasized the importance of implementing sound data collection measures, ensuring the validity and reliability of the data collection tools, and employing triangulation, peer debriefing, and member checking to ensure rigor and trustworthiness of the data (Creswell & Miller, 2000). The action research process has equipped me with the knowledge and skills to evaluate problems of practice and conduct scholarly inquiry using qualitative and quantitative data sources. Using the knowledge gained during this process, I feel prepared to approach future problems of practice by reviewing previous literature, implementing and evaluating interventions using qualitative and quantitative inquiry, and analyzing findings to provide insights for other practitioners.

Value of positionality. When approaching this research, I reflected on my role as an insider within my research context to ensure I was aware of inherent biases and preconceived assumptions that may exist. I assumed that my positionality would serve as an advantage for me because the participants in the study were student-athletes that I work with daily. During the research process, my assumption was confirmed. My role as an insider within my research context allowed me to ask students meaningful questions during the pre-and post-intervention interviews and capture open and honest responses. My knowledge of the students and educational context provided me with an enhanced

understanding of their language, psychological and emotional perceptions, and non-verbal cues (Holmes, 2014; Chavez, 2008). It appeared that students felt comfortable answering questions and were able to be themselves during the interviews. They used authentic language and answered the questions based on their individual experiences. I believe the relationship between the students and me helped to facilitate authentic interactions. This relationship also enhanced my ability to dive into the qualitative research process, assisting me through multiple iteration cycles. Working in a student-athlete academic support center, practitioners develop close relationships with their students. This served as an advantage for me as a researcher, allowing me to better understand the experiences and perceptions of the students. With this knowledge, I am now confident in approaching the research process as an insider. This research has equipped me with the knowledge to understand the influence of positionality on various aspects of the research process.

Needs of students with learning disabilities. This research spawned from my professional experiences working with student-athletes with learning disabilities. My work with this group of student-athletes provided me with insight into their experiences as students in a higher education setting, bringing attention to their attitudes, behaviors, and beliefs related to learning. This research has broadened my knowledge about the challenges students with learning disabilities experience as well as the conditions and resources that support their learning and engagement. A significant insight gained during this research is that each student experiences unique challenges regardless of similarities of their diagnosed disability. In addition, individual characteristics such as self-discipline, motivation, anxiety, and overall attitude influence how students respond to learning

interventions and assistive technology. In addition, students with learning disabilities have individual needs in regard to training. This research indicated that some students with learning disabilities adapt to assistive technology quicker than others. Therefore, students require varying levels of intervention training. Students' ability to learning a new technology is also highly influenced by their motivation and the attitude toward technology and its perceived benefit. Therefore, when attempting to implement learning strategies and assistive technology in the future with students with learning disabilities, I will focus on gathering additional information about each student to determine which approach is best to facilitate an intervention.

Implications for Student-Athlete Support Services

The field of student-athlete support services has expanded significantly over the last decade. The shift in focus of intercollegiate athletic departments to provide student-athletes with a holistic student-athlete experience has resulted in student-athlete academic support professionals continuing to explore ways to increase support and resources for college student-athletes to assist them in achieving success academically (Clark & Parette, 2002; Gaston-Gayles, 2003). Although the findings of this study are not considered to be generalizable, like most action research studies, there are three major implications for student-athlete academic support services professionals: (a) benefits of smartpen technology and (b) benefits of systematic note-taking strategies for student-athletes with learning disabilities.

Benefits of smartpen technology. Smartpen technology can effectively support students with learning disabilities (Wook & Rao, 2017; Boyle & Joyce, 2019; Joyce, 2016; Olabisi & David, 2013). Similar to previous research, the findings of this study

show support for the use of smartpens, such as the Livescribe pen, to assist students with learning disabilities with note-taking. The students' experiences and perceptions of the Livescribe pen provide evidence supporting its use among populations of student-athletes with learning disabilities. Students' feedback suggests that the Livescribe pen can assist them in recording more complete notes and improving their note-taking efficiency. Consistent with the findings of Joyce (2016), the findings also indicate that the Livescribe pen can assist students in recording better quality notes with more words, vocabulary, and main points from the lecture. The students also noted that the features of the pen and the Livescribe+ app allowed them to conveniently access their notes using their phones or smart device and amend their notes to add information that may have been missed during the lecture. The Livescribe pen also helped reduce the stress and anxiety experienced by some students when they approach the note-taking process. These findings can benefit student-athlete support services professionals who work directly with student-athletes with learning disabilities, such as learning specialists. The Livescribe pen is one of the assistive technology offerings that learning specialists can provide to assist students in improving note-taking.

Benefits of systematic note-taking. A systematic note-taking strategy, such as the Cornell note-taking method, can assist students with learning disabilities in improving the quality of their notes (Belson et al., 2013) and their ability to remember, comprehend, and recall lecture content (Tsai-Fu & Wu, 2010; Faber et al., 2000; Boyle, 2010), while helping them to organize information recorded during the lecture (Pauk, 1974; Baharev, 2016). This research found similar results regarding the benefits of the Cornell note-taking strategy. The Cornell note-taking strategy can assist students in producing notes

that are more organized (Pauk, 1974; Baharev, 2016). Students commented that the Cornell note-taking strategy helped to improve the overall structure and organization of their notes while assisting them in writing more in detail. In addition, previous note-taking studies have found a positive relationship between using a systematic note-taking system such as strategic note-taking, Cornell note-taking, or guided notes and the improved comprehension and recall of lecture content (Tsai-Fu & Wu, 2010; Faber et al., 2000; Boyle, 2010). The results of this research support the findings of Tsai-Fu and Wu (2010), Faber et al. (2000), and Boyle (2010), suggesting that the Cornell note-taking strategy can help students to improve comprehension and recall of lecture content. The students' feedback indicates that the Cornell note-taking strategy is helpful in remembering information from the lecture. Another benefit of the Cornell note-taking strategy is its potential to assist students with studying. The students identified the questions/keywords section as a significant component of the Cornell note-taking strategy, assisting them in developing questions and making connections between the lecture content (Baharev, 2016). The findings of this study suggest that Cornell note-taking can help student-athletes with learning disabilities in improving their ability to summarize, remember, comprehend, and recall information presented during lectures while assisting them to produce more organized notes. Student-athlete academic support professionals should invest time in teaching students a systematic note-taking strategy as an early intervention to equip them with the skills to be successful in lecture courses (Weishaar & Boyle, 1999).

Implications for Future Research

The findings of the research provide several implications for future research. Implications for future research include (a) implementing a note-taking intervention with student-athletes without learning disabilities, (b) implementing a note-taking intervention over a longer duration of time, (c) employing delayed free recall measures and comprehension tests, and (d) evaluating the intervention with a more diverse sample of students with learning disabilities.

Implementing a note-taking intervention with student-athletes without learning disabilities. Previous research has focused on evaluating the impact of note-taking interventions on non-student-athletes with learning disabilities (Boyle, 2010; Baharev, 2016; Joyce & Boyle, 2019a; Joyce & Boyle, 2019b; Boyle, 2011; Joyce, 2016). Limited research has focused on investigating educational supports for student-athletes with and without learning disabilities (Clark & Parette, 2002; Weiss, 2011; Stokowski, 2013). Future research should investigate the impact of the Cornell note-taking method and Livescribe™ pen among student-athletes who have not been diagnosed with a learning disability. Research in this area would add to the literature on academic supports for student-athletes and provide results that can be used to compare the impact of the Cornell note-taking strategy and Livescribe™ pen on student-athletes with and without learning disabilities.

Employing delayed free recall measures and comprehension tests. Previous research used IFR and comprehension tests as primary comprehension measures (Boyle, 2010; Baharev, 2016; Joyce & Boyle, 2019; Boyle, 2011). In this research, students' comprehension and recall were measured using IFR and comprehension tests that were

administered right after the lecture. However, students usually take tests and exams days to weeks after a lecture. Therefore, future research should examine the impact of the note-taking intervention on the delayed recall of students, employing a delayed recall measure and comprehension tests at a later time during the study. This would allow for a more authentic replication of what occurs in the classroom setting in which students take notes over several classes before taking an exam.

Implementing a note-taking intervention over a longer duration of time. This research occurred over a 10-week period during which students received training, practice, instruction, and assessments. Feedback from the students suggested that they could have benefited from more training on the Livescribe™ pen. Giving students additional training and practice time would allow them to become more proficient with the process of setting up their Cornell note-taking page, writing their notes using the intervention, and amending their notes after the lecture. Therefore, future studies should consider examining the impact of the Cornell note-taking strategy and Livescribe™ pen over a longer period of time.

Evaluating the intervention with a more diverse sample of students with learning disabilities. The study's sample consisted of five students with learning disabilities, which also serves as a limitation. In addition, the sample comprised only male student-athletes with learning disabilities. Therefore, future research should consider investigating the impact of the Cornell note-taking strategy and Livescribe™ pen intervention with a larger group of student-athletes with learning disabilities. Future research should also consider implementing the intervention with a sample that has diverse characteristics (i.e., gender, race/ethnicity, type of disability).

Limitations

While interpreting the results of the current study, it is important to consider several limitations. The limitations of this research include the (a) sample, (b) the research design, and (c) measures.

Sample. The research sample included only five students who were diagnosed with a learning disability. A smaller sample size can lower the reliability of a study's findings (Hackshaw, 2008). Because of the small sample size, the data collected may not be representative of the University's population of student-athletes with learning disabilities. It would have been beneficial to have a larger sample size to gain a more comprehensive understanding of students' experiences with learning disabilities and the impact of the intervention. Also, the sample included only African American male students, therefore, lacking diversity in terms of gender and race. A more diverse sample could provide a broader representation of the experiences and perceptions of student-athletes with learning disabilities. In addition, convenience and purposive sampling were used in this research. A convenience sample was used for this research as the sample comprised of students on the researcher's advising caseload, and purposeful sampling was used to select students based on three qualities; (1) being a varsity student-athlete, (2) having a learning disability, and (3) being enrolled in a personal and community health course. Both sampling techniques can potentially result in a biased sample and, therefore, should not be representative of a population (Etikan, Musa, & Alkassim, 2016).

Research Design. The research design serves as another limitation of the study. The study was conducted over a ten-week period, which could have impacted evidence showing the effect of the intervention. The students received training, practice,

instruction, and assessments over the ten weeks. Conducting the research over a more extended period could have resulted in more data and improved the reliability of the findings. The research design could have benefited from having a comparison group comprised of student-athletes without learning disabilities. This design would have produced results that could have been compared to the results of the intervention group. Utilizing a control group would have also provided an opportunity to compare the results of students who used the intervention and students who used their traditional note-taking method. The lack of a control group could have influenced the evidence of the impact of the intervention. Another limitation of this study is that students only used the Livescribe pen in the personal and community health course and therefore did not use it in their other lecture courses. Allowing students to use the intervention in other courses would have given the students additional time to practice using the intervention, amending their notes, and using their notes to study. The use of video-recorded lectures is another limitation of the research. Although the video-recorded lectures controlled for extraneous variables, the students took notes under contrived circumstances that did not reflect the interactions found in a typical college lecture course.

Measures. A comprehension test was chosen as a primary measure for this research to be consistent with commonly used test formats in college courses. However, Katayama and Robinson's (2000) findings suggest that there are differences between note-taking conditions on measures that require deeper processing of information and not just the processing of basic facts. Therefore, the instruments used may not have provided a comprehensive depiction of students' comprehension and processing of lecture content. In addition, the rubric used to evaluate the students' notes related directly to the

components of the Cornell note-taking strategy. Therefore, if students did not have previous Cornell note-taking training before the study, they would have scored lower in the pre-intervention evaluation of their notes.

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APPENDIX A

RUBRIC

Traits	Satisfactory (10)	Partial (5)	Underdeveloped (1)
Organization Cornell note-taking components and format are present	<ul style="list-style-type: none"> Format and organizational pattern are represented Cornell note-taking format is followed with no variation The lecture topic, date, and page number are recorded. 	<ul style="list-style-type: none"> The format is followed with few variations Cornell note-taking format is partially followed; one component is missing The lecture topic and date are recorded. 	<ul style="list-style-type: none"> The format is not followed Cornell note-taking format is not followed; two or more components are missing. The lecture topic, date, and page number are missing.
Content (Note Column) Breadth: Representation of lecture points Depth: Representation of supporting details for main ideas	<ul style="list-style-type: none"> Between 20 – 30 lecture points are recorded in notes Main ideas and supporting details recorded are $\geq 80\%$ 	<ul style="list-style-type: none"> Between 15 – 20 lecture points are recorded in notes Main ideas, lecture points, and supporting details recorded are between 50% - 79% 	<ul style="list-style-type: none"> Less than 15 lecture points are recorded in notes Main ideas, lecture points, and supporting details recorded are $\leq 49\%$
Reduction (Cue Column) Representation of keywords and questions.	<ul style="list-style-type: none"> Between 8 - 10 keywords and/or questions are recorded. The keywords/questions are aligned with the main ideas. 	<ul style="list-style-type: none"> Between 4 - 7 keywords and/or questions are recorded. Half of the keywords/questions are aligned with the main ideas. 	<ul style="list-style-type: none"> Between 0 - 3 keywords and/or questions are recorded. The keywords/questions are not aligned with the main ideas.
Summarization (Summary Column) Evidence of summarization and reduction; includes a topic sentence and main ideas.	<ul style="list-style-type: none"> The summary contains a topic sentence and 4 - 5 main ideas. The summary is in complete sentences in paragraph form 	<ul style="list-style-type: none"> The summary contains a topic sentence and 2 - 3 main ideas. The summary is in complete sentences in paragraph form. 	<ul style="list-style-type: none"> The summary contains a topic sentence and 0 -1 main ideas. The summary contains a few complete sentences and is in paragraph form.

APPENDIX B

COMPREHENSION PRETEST

Chapter 4: Psychological Health

Name: _____ Date: _____

Please circle the correct response for each question from the options provided.

1. The best definition of health is _____ .
 - a. the absence of sickness or disease
 - b. the state of the physical, mental, and social well-being
 - c. the absence of disease or infirmity
 - d. the state of physical and emotional well-being
2. The dimensions of psychological health include
 - a. mental, emotional, spiritual, and cultural
 - b. mental, physical, spiritual, and cultural
 - c. physiological, mental, emotional, and spiritual
 - d. physiological, emotional, spiritual, and cultural
3. Which is not a characteristic of self-esteem?
 - a. Belief and pride in ourselves.
 - b. Ability to overcome failures and try new things
 - c. Ability to maintain a positive view of one's self
 - d. Allowing external factors dictate the view of one's self
4. According to Maslow's five levels of basic needs, physiological needs are defined as _____.
 - a. a person's need to be and do that which the person was born to do
 - b. a person's need for self-esteem
 - c. a person's biological needs
 - d. a person's need to overcome feelings of loneliness
5. Which is not a characteristic of self-esteem?
 - a. Belief and pride in ourselves.
 - b. Ability to overcome failures and try new things
 - c. Ability to maintain a positive view of one's self
 - d. Allowing external factors dictate the view of one's self

6. A mental disorder is a _____ .
- a. repeated or unexpected episodes of intense fear
 - b. diagnosable mental, behavioral, or emotional disorders that interfere with major activities
 - c. chronic exaggerated worry and tension
 - d. persistent sadness and anxiety
7. A panic attack is defined as _____ .
- a. persistent sadness and anxiety
 - b. diagnosable mental, behavioral, or emotional disorders that interfere with major activities
 - c. chronic exaggerated worry and tension
 - d. repeated or unexpected episodes of intense fear
8. Each of the following are characteristics of an anxiety disorder _____ .
- a. repeated or unexpected episodes of intense fear
 - b. fatigue, trembling, muscle tension and headaches
 - c. chronic exaggerated worry and tension
 - d. inability to relax
9. Individuals with obsessive-compulsive disorder (OCD) suffer from recurrent _____ and _____ .
- a. fear, anxiety
 - b. depression, anxiety
 - c. obsessions, compulsions
 - d. tension, irritability
10. The most common mental disorder in the world is _____ .
- a. depression
 - b. anxiety
 - c. stress
 - d. panic attacks
11. Bipolar disorder is known as _____ .
- a. anxiety
 - b. depression
 - c. panic disorder
 - d. manic depression
12. _____ is a consequence of a psychological disorder .
- a. verbal threats
 - b. depression
 - c. suicide
 - d. provocative behavior
13. Seasonal affective disorder (SAD) is characterized by all the following except _____ .

- a. regularly occurring symptoms of depression
 - b. depression that occurs in the winter months and subside in the spring and summer months
 - c. changes in an individual's biological clock
 - d. disordered thinking and speech
14. _____ is defined as an anxiety disorder that can develop after exposure to a terrifying event.
- a. Post-traumatic stress disorder (PTSD)
 - b. Seasonal affective disorder (SAD)
 - c. Bi-polar disorder
 - d. Attention Deficit/Hyperactivity Disorder (ADHD)
15. Schizophrenia is defined as a disorder in which _____ .
- a. a person suffers from depression during the winter months
 - b. a person may have difficulty distinguishing between reality and imagination
 - c. a person mood changes often from excessively high to low
 - d. a person may suffer from recurrent unwanted thoughts

APPENDIX C

COMPREHENSION POSTEST

Chapter 9: Obesity and Eating Disorder

Name: _____

Date: _____

Please circle the correct response for each question from the options provided.

1. _____ affects one-third of the adult American population.
 - a. hunger
 - b. obesity
 - c. allergies
 - d. eczema

2. The leading sources of calories in the U.S. Diet include all of the following except _____.
 - a. pasta
 - b. sugared beverages
 - c. cake and sweet rolls
 - d. potato chips and corn chips

3. Which is not one of the effects of modernization?
 - a. increase in buffet style restaurants
 - b. increase in ready-made foods and ingredients for cooking
 - c. increase in sedentary occupational lifestyles due to technology
 - d. increase in the purchase of whole foods

4. The _____ is a mathematical calculation used to determine whether a patient is overweight.
 - a. Mass
 - b. Body Mass Index (BMI)
 - c. Body Fat Percentage
 - d. Weight

5. Obesity in children is caused by all the following except _____.
 - a. poor eating habits
 - b. reduction in school physical education programs

- c. family history of obesity
 - d. well balanced meals
6. Dietary therapy is _____ .
- a. the teaching of behaviors at a young age
 - b. instruction on how to adjust a diet to reduce the number of calories eaten
 - c. the strategies of physical activity
 - d. a discussion on weight loss
7. Each of the following are treatment for obesity except _____ .
- a. dietary therapy
 - b. drug therapy
 - c. behavior modification
 - d. plastic surgery
8. Behavior therapy involves _____ .
- a. changing diet and physical activity patterns and habits to new behavior
 - b. reducing the number of calories in the diet
 - c. utilizing weight loss drugs and calorie suppressants
 - d. modifying the stomach or intestines through a surgical procedure
9. The weight loss drugs that are approved through the Federal Drug Administration (FDA) are:
- a. Orlistat, Percocet, and Salazopyrin
 - b. Ibuprofen, Phentermine, and Tylenol
 - c. Orlistat, Phentermine, and Sibutramine
 - d. Naproxen, Phentermine, and Sibutramine
10. _____ is recommended as a treatment for persons with obesity that have a BMI ≥ 40 with a serious medical condition .
- a. surgery
 - b. drug therapy
 - c. behavior modification
 - d. dietary therapy
11. The risks of obesity surgery include all of the following except _____ .
- a. gallstones
 - b. anemia
 - c. wound infections
 - d. rapid recovery
12. _____ is when a person's attitudes about food, weight, and body size lead to very rigid eating and exercise habits that jeopardize one's health.
- a. anxiety

- b. depression
 - c. disordered eating
 - d. provocative behavior
13. Characteristics of anorexia nervosa include each of the following except _____ .
- a. low body weight
 - b. disgust with body size or shape
 - c. intense fear of weight gain
 - d. high-level of self-esteem
14. _____ is defined as a serious, potentially life-threatening eating disorder characterized by a cycle of bingeing and purging.
- a. bulimia nervosa
 - b. anorexia nervosa
 - c. bi-polar disorder
 - d. laxative abuse
15. Binge-eating disorder (BED) is a type of disorder _____ .
- a. when a person suffers from extreme disappointment in their physical appearance
 - b. characterized by binge eating without regular use of compensatory measures
 - c. when a person attempts to get rid of unwanted calories through the excessive use of laxatives
 - d. characterized by a cycle bingeing and purging

APPENDIX D

IMMEDIATE FREE RECALL SHEET

Immediate Free Recall Exercise	
Name:	Date:
Directions: In the space provided, write down as many vocabulary words and main points you remember from the lecture.	
Vocabulary	Main Points

APPENDIX E

INTERVIEW QUESTIONS – PRE-INTERVENTION

1. How would you describe your ability to take notes?
2. What strategies do you use to take notes?
 - a. Can you describe how you take notes in your lecture courses?
 - b. Can you give me an example?
3. What do you think about the quality of your notes?
 - a. What features of your notes do you feel need improvement?
 - b. What features of your notes do you feel do not need improvement?
4. What information do you record in your notes?
5. Can you describe how you organize your notes?
6. How do you use your notes once you have written them?
7. How do you feel notes are important to your academic success?
8. How would you describe the role of notes in your classes?

APPENDIX F

INTERVIEW QUESTIONS – POST- INTERVENTION

1. How would you describe your ability to take notes?
2. What strategies do you use to take notes?
 - a. Can you describe how you take notes in your lecture courses?
 - b. Can you give me an example?
3. What do you think about the quality of your notes?
 - a. What features of your notes do you feel need improvement?
 - b. What features of your notes do you feel do not need improvement?
4. What information do you record in your notes?
5. Can you describe how you organize your notes?
6. How do you use your notes once you have written them?
7. How do you feel notes are important to your academic success?
8. How would you describe the role of notes in your classes?
9. What do you think about your experience with the Livescribe™ pen?
10. How do you feel the Livescribe™ pen impacted your note-taking?
 - a. How did the quality of your notes change?
11. Can you share examples of positive experiences using the Livescribe™ pen?
12. Did you experience any problems or obstacles using the Livescribe™ pen?
 - a. Can you share examples of negative experiences using the Livescribe™ pen?
13. What features of the Livescribe™ pen did you use most often?
 - a. What features were most useful, and why?
 - b. What features were least useful, and why?
14. What did you like/dislike about the Livescribe™ pen?
15. Are there any features you would change on the Livescribe™ pen? If so, what are they?
16. In what other courses do you feel the Livescribe™ pen would be helpful?

17. How do you feel the Cornell note-taking strategy impacted the quality of your notes?
18. What impact do you feel the Cornell note-taking strategy had on your ability to remember lecture content?
19. Can you share examples of positive and negative experiences using the Cornell note-taking strategy?
 - a. Did you experience any problems or obstacles using the Cornell note-taking strategy?
20. What components of the Cornell note-taking strategy were most useful, and why?
21. What components of the Cornell note-taking strategy were least useful, and why?
22. In what other courses do you feel the Cornell note-taking strategy would be helpful?
23. What other information would you like to share about the Livescribe™ pen and/or Cornell note-taking strategy?

APPENDIX G

NOTE-TAKING EXPERIENCE SURVEY

Name:	Date:
Age:	Gender:
Classification:	Major:
Have you used the Livescribe™ Pen before this study? Yes No <input type="checkbox"/> <input type="checkbox"/>	
Have you used the Cornell note-taking strategy before this study? Yes No <input checked="" type="checkbox"/> <input type="checkbox"/>	

Part I: Please read the following statements and indicate how strongly you agree or disagree with each statement by circling your response.

Helpfulness/Usefulness of the Livescribe pen

1. The Livescribe™ pen made it easier to take notes during the lecture.
a. strongly disagree b. disagree c. neutral d. agree e. strongly agree
2. Using the Livescribe™ pen helped me to review my notes after the lecture.
a. strongly disagree b. disagree c. neutral d. agree e. strongly agree
3. The Livescribe Pen™ made me feel more comfortable taking notes during lectures.
a. strongly disagree b. disagree c. neutral d. agree e. strongly agree
4. The audio pencast helped me to amend my notes and add missing points from the lecture.
a. strongly disagree b. disagree c. neutral d. agree e. strongly agree

Helpfulness/Usefulness of the Cornell Note-taking Strategy

5. The Cornell note-taking strategy helped me to organize the main ideas of the lecture better.
a. strongly disagree b. disagree c. neutral d. agree e. strongly agree
6. Summarizing lecture points helped me better remember information.
a. strongly disagree b. disagree c. neutral d. agree e. strongly agree
7. Generating and answering questions help me better understand and remember information.

a. strongly disagree b. disagree c. neutral d. agree e. strongly agree

8. Reviewing the summaries in my notes helped me to recall important lecture points.

a. strongly disagree b. disagree c. neutral d. agree e. strongly agree

Ease of Use

9. It was easy to learn how to use the Livescribe™ pen with training and instructions.

a. strongly disagree b. disagree c. neutral d. agree e. strongly agree

10. It was easy to set up my notebook using the Cornell note-taking strategy.

a. strongly disagree b. disagree c. neutral d. agree e. strongly agree

11. The Cornell note-taking strategy was harder to use than my previous note-taking method.

a. strongly disagree b. disagree c. neutral d. agree e. strongly agree

12. It was easy to use the Livescribe™ pen with the Cornell note-taking strategy to take notes.

a. strongly disagree b. disagree c. neutral d. agree e. strongly agree

Future Use/Intentions

13. Using Cornell note-taking with the Livescribe™ pen can help me in other courses.

a. strongly disagree b. disagree c. neutral d. agree e. strongly agree

14. I will continue to use the Cornell note-taking strategy and Livescribe™ pen in the future.

a. strongly disagree b. disagree c. neutral d. agree e. strongly agree

15. It is beneficial to use the Cornell note-taking method with the Livescribe™ pen.

a. strongly disagree b. disagree c. neutral d. agree e. strongly agree

16. The Cornell note-taking method can be useful without the Livescribe™ pen.

a. strongly disagree b. disagree c. neutral d. agree e. strongly agree

APPENDIX H

IRB APPROVAL



**NORFOLK STATE
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February 4, 2021

Ms. Ivana Rich
Associate Athletic Director for Academic Services
Athletic Department
Campus

Dear Ms. Rich,

Re: NSU IRB #20-15 – Approval

The Norfolk State University Human Subjects Institutional Review Board received your request for approval to conduct your *"An Action Research Study Implementing a Livescribe™ Pen and Cornell Note-Taking Strategy in a Personal and Community Health Course to Support Note-Taking and Comprehension of College Student-Athletes with Learning Disabilities"* research.

The IRB Committee conducted a review and approved your study; the effective date is February 3, 2021.

This approval will expire in one year on February 2, 2022. This is an official notification that any required extensions must be processed through the IRB Committee, at least 45 days prior to this expiration. A copy of the approval and the Annual Reporting form, (due no later than one year from the date of this approval, or within two weeks of the completion of this research, whichever occurs first) is provided for your use. Additionally, any proposed changes to the protocol must be submitted to the IRB for review and consideration prior to implementation of the intended change(s), unless such a change is necessary to avoid immediate harm to subjects.

On behalf of the Institutional Review Board, I wish you the very best as you conduct this research and continued success in all your future endeavors.

Sincerely,

Paula R. D. Shaw
Director

C Dr. Rowena Wilson, Chair, IRB

Attachments: Human Subject Institutional Review Board Form
Copy of Submitted Documents
Institutional Review Board Annual Report Form

An Equal Opportunity Employer

APPENDIX I

INFORMED CONSENT FORM

UNIVERSITY OF SOUTH CAROLINA CONSENT TO BE A RESEARCH SUBJECT

AN ACTION RESEARCH STUDY IMPLEMENTING A LIVESCRIBE™ PEN AND CORNELL NOTE-TAKING STRATEGY IN A PERSONAL AND COMMUNITY HEALTH COURSE TO SUPPORT NOTE-TAKING AND COMPREHENSION OF COLLEGE STUDENT-ATHLETES WITH LEARNING DISABILITIES

KEY INFORMATION ABOUT THIS RESEARCH STUDY:

You are invited to volunteer for a research study conducted by Ivana Rich. I am a doctoral candidate in the Department of Education at the University of South Carolina. The University of South Carolina, Department of Education, is sponsoring this research study. The purpose of this study is to examine the impact of the Livescribe™ Symphony smartpen assistive technology and the Cornell note-taking strategy on the lecture comprehension and quality of written notes of college student-athletes with learning disabilities. You are being asked to participate in this study because you are a student-athlete at Norfolk State University, receiving services through the Student-Athlete Academic Support Learning Services program and enrolled in Personal and Community Health (HED 100). This study is being done at Norfolk State University and will involve approximately six to eight volunteers.

The following is a short summary of this study to help you decide whether to be a part of this study. More detailed information is listed later in this form.

PROCEDURES:

If you agree to participate in this study, you will do the following:

1. Complete an interview about your note-taking experience.
2. Have your interview recorded in order to ensure the details that you provide are accurately captured.
3. View a video-recorded lecture and take notes using pen and paper.
4. Participate in an immediate free recall exercise and comprehension test on the lecture content.
5. Complete training on the Livescribe™ pen and Cornell note-taking strategy.
6. Practice using the Cornell note-taking strategy and Livescribe™ pen during class sessions.

7. View a video-recorded lecture and take notes using the Livescribe™ pen and Cornell note-taking strategy.
8. Participate in an immediate free recall exercise and comprehension test on the lecture content.
9. Complete a questionnaire about your perceptions and experiences using the Cornell note-taking strategy and Livescribe™ pen.
10. Complete an interview about your perceptions and experiences using the Cornell note-taking strategy and Livescribe™ pen.
11. Have your interview recorded in order to ensure the details that you provide are accurately captured.

DURATION:

Participation in the study involves attendance in 20 class sessions over a period of 10 weeks. Each class session will last about 50 minutes.

RISKS/DISCOMFORTS:

Loss of Confidentiality:

There is the risk of a breach of confidentiality, despite the steps that will be taken to protect your identity. Specific safeguards to protect confidentiality are described in a separate section of this document.

BENEFITS:

You may benefit from participating in this study by learning strategies that may assist you in your academic endeavors. This study may also help researchers understand students' perceptions and experiences using the Cornell note-taking strategy and Livescribe™ pen. The study has the potential to provide knowledge on strategies and tools to assist students with note-taking and comprehension.

COSTS:

There will be no costs to you for participating in this study.

COLLECTION OF IDENTIFIABLE PRIVATE INFORMATION:

Your psychoeducation evaluation and LD diagnosis will be collected as part of the research study will not be used or distributed for future research studies.

CONFIDENTIALITY OF RECORDS:

Information obtained about you during this research study will remain confidential and released only with your written permission. Study information will be securely stored in locked files and on password-protected computer. Results of this research study may be published or presented at seminars; however, the report(s) or presentation(s) will not include your name or other identifying information about you.

VOLUNTARY PARTICIPATION:

Participation in this research study is voluntary. You are free not to participate, or to stop participating at any time, for any reason without negative consequences. In the event that you do withdraw from this study, the information you have already provided will be kept in a confidential manner. Ending participation in the study (withdrawal) will not affect your grade in HED-100, services received for disability or tutoring in general, or status as student. If you wish to withdraw from the study, please call or email the principal investigator listed on this form.

I have been given a chance to ask questions about this research study. These questions have been answered to my satisfaction. If I have any more questions about my participation in this study, or a study-related injury, I am to contact Ivana Rich at [REDACTED] or email [REDACTED]

Concerns about your rights as a research subject are to be directed to:

Lisa Johnson, Assistant Director, Office of Research Compliance, University of South Carolina, 1600 Hampton Street, Suite 414D, Columbia, SC 29208, phone: (803) 777-6670 or email: LisaJ@mailbox.sc.edu.

Or

Dr. Rowena Wilson, Chair, Norfolk State University IRB Committee, Office of Sponsored Programs, phone: (757) 823 - 9053 or email: rgwilson@nsu.edu

I agree to participate in this study. I have been given a copy of this form for my own records.

If you wish to participate, you should sign below.

Signature of Subject / Participant

Date

Signature of Qualified Person Obtaining Consent

Date

APPENDIX J

RESEARCH QUESTIONS AND INTERVIEW QUESTIONS ALIGNMENT

Research Question	Interview Questions
RQ3: What are the experiences and perceptions of student-athletes with learning disabilities using Livescribe™ pens and their impact on note-taking and comprehension of lecture content?	<ol style="list-style-type: none"> 1. How would you describe your ability to take notes? 2. What strategies do you use to take notes? <ol style="list-style-type: none"> a. Can you describe how you take notes in your lecture courses? b. Can you give me an example? 3. What do you think about the quality of your notes? <ol style="list-style-type: none"> a. What features of your notes do you feel need improvement? b. What features of your notes do you feel do not need improvement? 4. What information do you record in your notes? 5. Can you describe how you organize your notes? 6. How do you use your notes once you have written them? 7. How do you feel notes are important to your academic success? 8. How would you describe the role of notes in your classes? 9. What do you think about your experience with the Livescribe™ pen? 10. How do you feel the Livescribe™ pen impacted your note-taking? <ol style="list-style-type: none"> a. How did the quality of your notes change? 11. Can you share examples of positive experiences using the Livescribe™ pen?

12. Did you experience any problems or obstacles using the Livescribe™ pen?
 - a. Can you share examples of negative experiences using the Livescribe™ pen?
 13. What features of the Livescribe™ pen did you use most often?
 - a. What features were most useful, and why?
 - b. What features were least useful, and why?
 14. What did you like/dislike about the Livescribe™ pen?
 15. Are there any features you would change on the Livescribe™ pen? If so, what are they?
 16. In what other courses do you feel the Livescribe™ pen would be helpful?
 17. How do you feel the Cornell note-taking strategy impacted the quality of your notes?
 18. What impact do you feel the Cornell note-taking strategy had on your ability to remember lecture content?
 19. Can you share examples of positive and negative experiences using the Cornell note-taking strategy?
 - a. Did you experience any problems or obstacles using the Cornell note-taking strategy?
 20. What components of the Cornell note-taking strategy were most useful, and why?
 21. What components of the Cornell note-taking strategy were least useful, and why?
 22. In what other courses do you feel the Cornell note-taking strategy would be helpful?
 23. What other information would you like to share about the Livescribe™ pen and/or Cornell note-taking strategy?
-

APPENDIX K

SUMMARY OF QUALITATIVE THEMES, CATEGORIES, AND CODES

Themes	Categories	Codes
Perceptions of the Livescribe pen	Positive perceptions	<ul style="list-style-type: none"> • Livescribe pen is very useful • Livescribe pen provides security • "Portable teacher service" • "It's a great invention."
	Subcategory: Engagement	<ul style="list-style-type: none"> • Livescribe pen can increase engagement • Making "you more engaged as a whole" • Generating excitement "about taking notes"
	Subcategory: Perceived impact	<ul style="list-style-type: none"> • Improved note-taking ability • Improved efficiency
	Subcategory: Ease of use	<ul style="list-style-type: none"> • Ink levels are good • LS pen is portable • Easy to use • "It's easy to keep up with and not heavy"

Subcategory: Helpfulness

- Helpful for poor note-takers
- Helpful in lecture courses
- Helpful in history
- Helpful when there are no cues
- Helping “reach our maximum potential”
- Helping to relieve stress

Subcategory: Helpfulness of the
Livescribe+ App

- App is helpful (2)
- Viewing notes on phone (2)
- Printed notes useful for study groups
- App provides convenient access (6)
- Using the app is useful (1)
- Sending notes to smart device (1)

Challenges

- Making pen more comfortable
- Issues with pen alignment (experience)
- Beeping (experience)
- LS pen is time consuming
- Battery life is a challenge
- Forgetting to charge the pen (experience)

Positive Perceptions of Cornell notes

- Changed attitude about note-taking
- Visualizing notes on paper

Perceptions of the Cornell Note-taking strategy	<ul style="list-style-type: none"> • Making note taking “fun” • Cornell is easy to understand • “Tie it together all in my head”
Perceived impact	<ul style="list-style-type: none"> • Notes are better now • “Clearly see what I’m writing about more” • Consolidating Information • Improving organization • Setting up Cornell in advance is helpful
Subcategory: Helpfulness of Cornell note-taking	<ul style="list-style-type: none"> • Cornell “is helping me” • All parts equally useful • Writing down main points
Subcategory: Organization	<ul style="list-style-type: none"> • Helping to organize notes
Subcategory: Overcoming writing challenges	<ul style="list-style-type: none"> • Helping students overcome writing challenges • Helping students succeed in classes
Subcategory: Summarizing and consolidating information	<ul style="list-style-type: none"> • “Break down what you learned” • Summary was useful • Summary helped “wrap things up”
Subcategory: Remembering information and generating study questions	<ul style="list-style-type: none"> • Generating questions was helpful • Helping to navigate notes

	Challenges	<ul style="list-style-type: none"> • Cornell has “less space on the paper” • Setting Cornell up takes more time • Summary was least useful feature • Summary doesn’t work for all learning styles • Summary required more effort
Combined Use of Cornell Note-taking and Livescribe Pen	Perceptions of Cornell Note-taking and Livescribe Pen Together	<ul style="list-style-type: none"> • Can help in the future • All schools should use it • Positive overall experience • Using a “cool pair” • Both tools complement each other • Helpful for high school students • Helping “write down better notes” • Cornell is less effective with a pencil
Note-taking strategies, challenges, and areas for improvement	Note-taking strategies	<ul style="list-style-type: none"> • Highlighting key points • Focusing on key points • Underlining main points • Writing down unfamiliar information • Writing down important information • Starring important information • Writing down repeated information • Writing down interesting facts • Using spacing in notes

Note-taking challenges

- Using cues
 - Jotting down the main topic
 - Writing about the topic
 - Using question marks
 - Using headings
 - Separating different topics
 - Labeling
 - Using bullet points
 - Using dashes
 - “Using my own words”
 - Writing about processes
 - Using descriptions
 - Organizing “by the board or screen”
 - Organizing “by the way he’s talking”
 - Organizing notes by topic
 - Preparation is good
 - Using the full page for notes
 - Using the side of the paper
 - Using notebook paper
 - Writing notes “like an essay”
 - Using a step-by-step process
 - Taking notes in steps
-
- Keeping up with the lecture
 - Keeping up with the professor
 - Zoning out
 - Moving too fast
 - Difficulty keeping up
 - Losing track during the lecture
-

Areas for improvement

- Getting tired during the lecture
- Rushing to write down information
- Getting distracted during the lecture
- Navigating notes
- Taking notes in college is harder
- Never taught a note-taking strategy

- Notes can improve
- “It was sloppy and all over the place”
- Notes were not neat and structured
- Missing information
- Notes can have more details
- Not writing specific information
- Notes lack clarity
- Notes only useful temporarily
- Improving use of notes

Perceptions of Note-taking

Positive perceptions

- Taking notes makes studying easier
- Notes are essential
- Notes are good for visual learners
- Notes “give your academics structure”
- Notes are important to academic success
- Keep me on track

Subcategory: Helpfulness of notes

- Helpful in math
 - Helpful in online classes
 - Helpful for video recorded lectures
 - Helpful to look back on
 - Using throughout the week
-

-
- Studying for tests
 - Helping “get more out of class”
 - Helping to remember important information
 - Helping focus on important information
 - Helping with homework
 - Using notes to answer discussion questions
 - Preparing for tests and quizzes
 - Using notes for studying
-