Assistive Technology and Note-Taking Strategies to Foster Achievement Motivation and Self-Sufficient Learning in Students with Learning Disabilities

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Abstract

This pilot study examined the impact of the Livescribe™ Symphony smartpen assistive technology and the Cornell note-taking strategy on lecture comprehension and note quality for college student-athletes with learning disabilities. The study involved 5 undergraduate student-athletes who used the Livescribe™ pen and Cornell note-taking during health lectures. Findings showed that the combination of the Livescribe™ pen and Cornell notes increased lecture engagement, optimized note organization, improved critical content capture, assisted with information review, and enhanced recall abilities. Students reported that the assistive technology and structured note-taking techniques aided comprehension while reducing anxiety, and they desired broader implementation in fast-paced college courses to become more self-sufficient learners. Overall, the study demonstrated the effectiveness of the Livescribe™ pen and Cornell notes in overcoming note-taking barriers and boosting achievement motivation among university students with disabilities.

1. Introduction

An increased number of students with learning disabilities are entering postsecondary educational institutions [25, 30, 39]. Seventeen percent of students attending postsecondary institutions in the United States identify as having a learning disability [29, 40]. This percentage reflects an upward trend in the enrollment of students with learning disabilities (LD) in higher education over the past few decades.

Learning disabilities are characterized by deficiencies across many areas that impact an individual's ability to learn, achieve academic success, and experience positive life outcomes. The National Institutes of Health (NIH) defines learning disabilities as disorders that may affect someone's ability "to understand or use spoken or written language, do mathematical calculations, coordinate movements, or direct attention" [31]. This definition aligns with the Individuals with Disabilities Education Act's (IDEA) characterization of 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]) [19].

Learning disabilities can have a significant impact on various aspects of an individual's life, including academic performance, social interactions, and overall well-being. Students with LD may face challenges in areas such as reading comprehension, written expression, mathematical reasoning, and information processing. These difficulties can hinder their ability to acquire and apply knowledge effectively, leading to potential academic struggles and hindrances in achieving their full potential.

Despite the challenges posed by learning disabilities, many students with LD possess unique strengths, talents, and resilience. With appropriate accommodations, assistive technologies, and supportive services, these students can overcome barriers and thrive in postsecondary educational settings. Institutions of higher education play a crucial role in providing an inclusive and supportive environment that fosters the academic and personal growth of students with learning disabilities.

2. Related Literature

Federal mandates such as the Americans with Disabilities Act and the Individuals with Disabilities Education Act (IDEA) Amendments have significantly impacted the increasing number of students with learning disabilities entering postsecondary institutions [30]. These mandates have broadened access for students with disabilities by requiring colleges and universities to provide a comprehensive range of services and accommodations [30]. The Cooperative Institutional Research Program (CIRP) conducted by the University of California, Los Angeles, has identified

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learning disabilities as the most commonly reported disability among first-year college students. Additionally, the data from recent reports indicates a relative increase in the enrollment of students with learning disabilities at four-year colleges and universities since 1994 [1, 40].

For college students with learning disabilities, the challenges extend beyond gaining admission to higher education institutions. These students often face significant difficulties in employing effective learning strategies, such as note-taking [3, 7, 15, 24, 28,]. According to Mortimore and Crozier [28], a staggering 78% of students with learning disabilities attending higher education institutions reported having problems recording notes during lectures. Maintaining attention during lectures can be a daunting task, leading to missed crucial points and information [24, 37]. Furthermore, these students encounter challenges in discerning which material is important to record [24], and after the lecture, they often cannot understand their notes due to poor legibility [24]. The fast pace of lectures can also be overwhelming, causing students with learning disabilities to lose track and fail to write down content quickly enough [24].

Past research has consistently demonstrated that students with learning disabilities tend to produce incomplete lecture notes lacking important key points [24, 37]. Consequently, finding evidence-based tools and strategies that can assist these students in effectively deploying note-taking techniques is vital to providing them with the ability to improve their academic performance and overall success in higher education [24].

In addition to the daunting task of taking comprehensive notes, postsecondary students with learning disabilities often struggle to comprehend the content covered by instructors during lectures. These students frequently face challenges in acquiring knowledge from written and oral sources, as well as understanding the presented information [16, 21]. One study suggested that comprehension problems may stem from deficiencies in decoding language and word recognition [16, 41]. As a result, slow word processing can impede a student's ability to comprehend connected ideas by placing an increased demand on other cognitive processes, such as working memory [12, 16]. Therefore, identifying useful tools and strategies that can help students with learning disabilities overcome comprehension challenges is imperative in bridging the achievement gap between these students and their peers in higher education [24].

Furthermore, the transition to postsecondary education can be particularly challenging for students with learning disabilities, as they may encounter a significant shift in the level of support and accommodations provided compared to their previous educational experiences. While institutions are required to offer reasonable accommodations, the responsibility often falls on the students to self-advocate and navigate the system to access the necessary resources. Effective support systems, including disability services offices, peer mentoring programs, and inclusive instructional practices, can play a crucial role in promoting the academic success and overall well-being of students with learning disabilities in higher education settings.

2.1. Assistive Technology (AT)

Assistive technology (AT) is a useful instructional tool to assist college students with learning disabilities in overcoming their academic challenges [1, 32]. Specifically, smart pens, such as the Livescribe™ pen, have been found to improve student outcomes within this population. Livescribe™ pens are handheld smart pens that promote learning among students with learning disabilities [32]. These pens encompass a built-in camera that digitizes handwritten text, producing digitized notes. The device also captures audio simultaneously as the student is taking notes and synchronizes the audio recording with the handwritten notes [32].

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 [14, 22]. Institutions should provide students with learning disabilities with assistive technology that will increase their ability to overcome their deficiencies, enhance their academic performance, and improve their likelihood of graduating. Digital pens will be further discussed in this literature review.

The Livescribe™ pen is one of the more popular and widely used digital note-taking pens. It features a built-in audio recorder and a camera that captures handwritten notes on special dotted paper. The pen transfers the written notes to a mobile device or computer, syncing them with the recorded audio. This allows students to tap on any part of their notes and hear the corresponding audio playback, making it easier to review lectures and fill in any missing information.

Other digital note-taking pens, such as the Neo smartpen and the Equil Smartpen, offer similar functionality. These pens can be particularly beneficial for students with learning disabilities, as they provide a multisensory approach to note-taking and information retention. By combining written notes with recorded audio, students can engage multiple modalities, which can aid in comprehension and memory recall.

Many digital note-taking pens allow users to organize and search their notes, making it easier to locate specific topics or keywords. This organizational feature can be especially helpful for students with learning disabilities who may struggle

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with keeping their notes structured and easily accessible.

While digital note-taking pens can be an invaluable tool, it is essential to provide proper training and support to ensure that students with learning disabilities can fully utilize their features and maximize their benefits. Additionally, it is crucial to recognize that assistive technology should be tailored to individual needs and preferences, as different students may respond better to different tools or approaches.

2.2. Note Taking

Note-taking is widely recognized as a critical strategy that exhibits a positive correlation with academic achievement among college students [18, 23, 35]. The process of taking notes aids students in learning course material by enhancing their understanding of lecture content and improving their ability to recall information later [7, 8, 20]. As Kobayashi [37] aptly states, "It increases class attention, active engagement in classes, clarification, and paraphrasing of confusing points and their performance."

A significant portion of postsecondary level courses, approximately 30-50%, are lecture-based and require extensive note-taking [5, 18, 36]. Students are expected to differentiate between important and unimportant information, utilizing their notes as a primary method of learning [5, 20, 35]. Instructors often construct exams based on the information presented during lectures, which means that the accuracy of students' notes directly correlates with their performance on exams [34, 46].

For students with learning disabilities, academic skills such as reading, writing, note-taking, and reading comprehension can pose considerable challenges [18, 26]. Prior research indicates that assistive technology and academic strategies may support these students in enhancing their academic skills, persisting toward graduation, and achieving overall academic success [24, 32]. Therefore, it is crucial to assess and identify assistive technology tools and educational strategies that can effectively support college students with learning disabilities in the note-taking process.

Effective note-taking requires a complex set of skills, including active listening, information processing, distinguishing between main ideas and supporting details, and organizing information coherently. Students must simultaneously listen to the lecture, process the information, and transcribe the relevant points – a demanding task that can be particularly challenging for those with learning disabilities. Without proper support and strategies, these students may struggle to capture complete and accurate notes, leading to gaps in their understanding and retention of course material.

Equally important, note-taking transcends mere transcription, serving as an active learning process that cultivates critical thinking, synthesis, and richer subject immersion. By condensing and reorganizing information in their own words, students reinforce their understanding and create a personalized record of the material that can aid in review and preparation for assessments.

2.3. Students with Disabilities and College Completion Rates

College students with learning disabilities face a myriad of challenges that can significantly impact their academic success and persistence towards degree completion. Compared to their peers without learning disabilities, these students are more likely to exhibit attributes associated with lower rates of retention and graduation. According to Cortiella and Harowitz [9], the completion rate for postsecondary students with learning disabilities is alarmingly lower than the general student population, at 41% versus 52% for those without learning disabilities [9, 30]. Additional research findings reinforce this concerning trend, indicating that students with learning disabilities are less likely than their non-disabled peers to remain enrolled in college and ultimately earn their degrees. While the statistics paint a sobering picture, it is important to acknowledge that there are exceptions and instances of positive outcomes for students with learning disabilities. As early as 1992, Adleman's study [2] found that these students can graduate at rates comparable to their peers without learning disabilities, albeit with lighter course loads and requiring more time to complete their degrees. Furthermore, a report from Gavilan College [17] demonstrated that even two decades ago, students with and without learning disabilities achieved comparable levels of success in math and English courses. However, these isolated examples of positive outcomes should not overshadow the significant challenges and barriers that many college students with learning disabilities face on a daily basis. Academic tasks such as note-taking, reading comprehension, written expression, and information processing can be particularly demanding for these students, often requiring specialized accommodations and support services. Without appropriate interventions and resources, the cumulative impact of these challenges can lead to poor academic performance, increased risk of dropping out, and ultimately, lower graduation rates.

It is crucial to recognize that students with learning disabilities are a diverse group, each with unique strengths, weaknesses, and learning needs. While some may thrive in traditional academic settings with minimal accommodations, others may require more comprehensive support systems and assistive technologies to navigate the rigors of higher education

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successfully. Institutions must adopt a student-centered approach, tailoring their services and resources to address the specific needs of each individual while fostering an inclusive and supportive learning environment.

By addressing the systemic barriers and providing targeted interventions, colleges and universities can empower students with learning disabilities to overcome their challenges, unleash their full potential, and achieve academic success on par with their non-disabled peers. Investing in evidence-based strategies, assistive technologies, and inclusive instructional practices not only benefits these students but also enriches the overall learning experience for the entire campus community.

2.4. Benefits of Smartpens on Digital Note-taking and Reading Comprehension

Despite the growing popularity and potential benefits of smartpens, there is a limited body of research that has examined their effectiveness for note-taking and reading comprehension across K-12 and higher education settings. Initial studies at the secondary level have established smartpens as a valuable support tool in language arts and math for high school students with learning disabilities [32]. Livescribe™ pens have demonstrated their usefulness in aiding note-taking, content review, read-alouds, assessment creation, and math calculations. Similarly, Boyle and Joyce [6] found that 9th graders utilizing smartpens recorded more lecture points and added an average of 27 words after replaying their notes.

Additional studies have revealed benefits of smartpens for improving note quality, enhancing selection conciseness, enabling audio-enabled refinement [3], supporting math skills, facilitating assessments, promoting independence [34], and increasing engagement [38]. Although the research is still limited, findings suggest that smartpens can increase opportunities for pronunciation practice, vocabulary retention, and reading comprehension.

While these preliminary studies indicate promising potential, significant research gaps remain involving smartpen technology. Very few robust trials have been conducted to evaluate the efficacy of smartpens, explore implementation factors, examine teacher preparation needs, investigate usage barriers, or determine effectiveness differences by disability type or academic content area. Considerable opportunities exist to build a comprehensive knowledge base guiding universal design applications that can benefit diverse learners at both the secondary and postsecondary levels.

As smartpens continue to gain traction as an assistive tool, it is crucial to address these research gaps through rigorous and well-designed studies. Investigating the factors that influence the successful implementation and adoption of smartpens in educational settings is essential for maximizing their impact on student learning outcomes. Additionally, research is needed to understand the specific needs and preferences of different student populations, including those with various types of learning disabilities and across different academic disciplines.

Further studies should delve into the perspectives and experiences of both students and educators, exploring potential barriers to adoption, professional development needs, and best practices for integrating smartpens into classroom instruction and assessment. By gaining a deeper understanding of these factors, institutions can develop comprehensive strategies and support systems that foster the effective use of smartpens and other assistive technologies.

3. Methods

This study employed a phenomenological approach, utilizing in-depth semi-structured interviews to capture the lived experiences of undergraduate students with learning disabilities related to the challenges they face with traditional note-taking practices. Purposeful criterion sampling was used to identify information-rich cases of 5 student-athletes receiving disability services at an eastern university [10]. Participants meeting the criteria of a documented learning disability, varsity athletic involvement, and enrollment in a lecture-based health course were recruited for the study.

In-depth interviews lasting approximately 30-45 minutes were conducted to elicit the participants' perspectives on academic skill difficulties, attitudes towards assistive technology, and desires for enhanced educational supports. The interview questions probed the note-taking barriers faced by these students, the usefulness of note-taking tools they had tried, comprehension issues arising from their learning disabilities, and their interactions with the university's accommodation services.

The data analysis process adhered to established phenomenological techniques, ensuring a rigorous and systematic approach. Researchers bracketed out their presuppositions and biases to avoid influencing the analysis. Horizontalization was employed to extract non-repetitive and non-overlapping statements of significance from the interview transcripts. These significant statements were then clustered into broader themes, capturing the essence of the participants' experiences.

To further enhance the depth and richness of the analysis, textural and structural descriptions of the phenomenon were synthesized, providing a comprehensive understanding of the note-taking challenges faced by students with learning disabilities. The researchers derived the overall essence of the experience, distilling the core meanings and underlying structures that shaped the participants' lived realities.

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Multiple validation strategies were employed to ensure the trustworthiness and credibility of the findings. Member-checking techniques involved sharing the interview transcripts with participants to verify the accuracy of their responses and interpretations. Additionally, the researchers engaged in debriefing sessions with a peer expert in qualitative analysis, allowing for external scrutiny and feedback on the analytical process.

Triangulation of findings across multiple data sources, such as interviews, observations, and relevant documents, further strengthened the credibility and achieved a saturating understanding of the phenomenon under investigation. Rich, thick descriptions were provided, conveying explicit details and contextual information to allow readers to make informed judgments about the transferability of the findings to other settings or populations.

Through this phenomenological approach, the study aimed to shed light on the lived experiences and unique perspectives of students with learning disabilities, illuminating the note-taking challenges they encounter and their perceptions of assistive technologies and educational supports. By amplifying the voices of these students, the research contributes valuable insights that can inform the development of inclusive and supportive learning environments, as well as the design and implementation of assistive tools tailored to their specific needs.

3.1. Setting and Participants

This pilot study took place at a Historically Black University in eastern Virginia, USA, within the context of a Personal and Community Health course. The course met twice weekly for 50-minute lecture sessions, focusing on health concepts, diseases, disorders, and related vocabulary [33]. During these content-dense lectures, students were expected to take traditional pen-and-paper notes. Sufficient note-taking was crucial, as major points and keywords covered during the lectures were later used for exams [4].

To gain a comprehensive understanding of the phenomenon under investigation, five undergraduate student-athlete participants were purposefully sampled [11]. The selection criteria ensured that the participants had a documented learning disability, were receiving academic support services from the university, maintained varsity athletic status, and were enrolled in the health education course. This purposeful sampling approach maximized the richness of information and insights obtained, as the participants represented information-rich cases directly relevant to the study's objectives.

The existing advisor relationship between the researchers and the participants facilitated authentic interactions and rapport-building, creating an environment conducive to open and honest dialogue [27]. This rapport was essential for gaining a deeper understanding of the participants' lived experiences, perspectives, and challenges related to note-taking and learning disabilities.

To ensure a comprehensive exploration of the phenomenon, the study employed a multi-method approach. In addition to in-depth semi-structured interviews, which allowed participants to share their experiences and insights in their own words, the researchers also conducted classroom observations and analyzed relevant documents and artifacts, such as course materials, syllabi, and samples of the participants' notes.

The classroom observations provided valuable contextual information, enabling the researchers to witness first-hand the note-taking processes employed by the participants and the challenges they faced during the lectures. These observations complemented the interview data, offering a more holistic understanding of the phenomenon and facilitating triangulation of the findings.

Furthermore, the analysis of relevant documents and artifacts allowed the researchers to gain insights into the expectations and requirements set by the course, as well as the participants' actual note-taking practices and outputs. By examining samples of their notes, the researchers could assess the quality, completeness, and organization of the information captured, further illuminating the note-taking challenges faced by students with learning disabilities. Through this multi-method approach, the pilot study aimed to generate rich, contextualized data and insights, contributing to a deeper understanding of the note-taking experiences and challenges encountered by undergraduate student-athletes with learning disabilities in a lecture-based health education course. The findings from this pilot study can inform the development of interventions and support strategies tailored to the unique needs of this population, ultimately enhancing their academic success and overall learning experiences.

3.2 Data Collection

To comprehensively address the research questions of the study, a multi-faceted data collection approach was employed, utilizing both quantitative and qualitative methods. Pre and post lecture comprehension tests were administered to evaluate the potential differences in content retention with and without the intervention of the Livescribe™ pen. These tests aimed to assess the impact of the assistive technology on the participants' ability to understand and recall the lecture material effectively.

Immediate free recall exercises were conducted, requiring participants to record as much information as possible from the lecture they had just attended. This method quantified the amount of lecture content the participants could remember, providing insights

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into the effectiveness of their note-taking strategies and the potential benefits of the Livescribe™ pen in enhancing information retention.

To analyze the quality and completeness of the notes taken during the lectures, standardized note rubrics were employed. These rubrics enabled the researchers to detect variations in the quality and inclusion of main ideas across different note-taking conditions (with and without the Livescribe™ pen). By evaluating the notes against established criteria, the researchers could gain a deeper understanding of how the assistive technology influenced the participants' ability to capture essential information and organize their notes effectively.

A note-taking experience survey was then administered to gather the participants' perspectives and subjective experiences related to using the Livescribe™ pen during the lectures. This survey provided valuable insights into the participants' attitudes, perceptions, and potential challenges or benefits associated with the assistive technology. By capturing their first-hand accounts, the researchers could gain a more comprehensive understanding of the note-taking experience from the users' perspectives.

Qualitative data was collected through in-depth interviews with the participants. These interviews allowed for a rich exploration of the participants' lived experiences, enabling them to share their thoughts, feelings, and reflections on the note-taking process and the use of the Livescribe™ pen. The open-ended nature of the interviews provided opportunities for the participants to express themselves freely and offer insights that may not have been captured through the quantitative measures alone.

By triangulating data from multiple sources, including comprehension tests, free recall exercises, note rubrics, surveys, and interviews, the researchers aimed to achieve a comprehensive understanding of the phenomenon under investigation. This multi-method approach enhanced the validity and reliability of the findings, while also allowing for a holistic exploration of the note-taking experiences and challenges faced by students with learning disabilities, as well as the potential benefits and limitations of assistive technologies like the Livescribe™ pen.

4. Results

Analysis of the semi-structured interview transcripts uncovered five major qualitative themes related to the participants' attitudes and experiences with note-taking and assistive technology:

Theme 1: Perceptions of Note-Taking

For this theme, we saw comments revealing challenges many students with learning disabilities face when it comes to note-taking in lectures. For example, one student said "I have a hard time knowing what is important to write down and what I should skip over." Another stated, "My notes end up being a huge mess during class." This highlights how traditional note-taking methods are often inadequate to meet their needs.

Theme 2: Perceptions of the Livescribe™ Smartpen

Participants recognized the potential for assistive technology like the Livescribe pen to be helpful, with comments like "Tools like this give me a better shot at actually being able to take decent notes." However, some noted frustrations too, like "I'm definitely going to need some training on how to use it properly."

Theme 3: Note-Taking Strategies Needed

Some participants noted they lacked effective strategies for knowing what information should be included in lecture notes, as evidenced by the comment, "I never know what notes are important enough to write down in class."

Theme 4: Training Challenges

Others commented on training difficulties, pointing to the need to provide comprehensive information on how to effectively utilize the Livescribe and other assistive note-taking technologies.

Theme 5: Ongoing Support Requirements

Participants made clear that access to consistent assistance and support would be required in order to maximize the benefit of assistive technologies in the classroom.

These themes provided insight into the participants' attitudes and experiences with traditional note-taking methods, use of the Livescribe™ smartpen technology, implementation of the Cornell structured note-taking strategy, and the effectiveness of using the tools in tandem. Direct anonymous quotations from the interviews were utilized within each thematic section to capture the authentic voices of the student-athlete participants. Pseudonyms were used to maintain confidentiality. Explanations of the central ideas illuminated in each theme are elaborated in the corresponding sections below.

Table 1. Qualitative Themes and Interpretations

Theme	Assertions	Categories
1	Note-taking is	• Positive Perceptions

 | DOI: 10.20533/ijds.2040.2570.2024.0239

	important to students' academic success, and notes help students complete multiple academic tasks.	(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	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.	● Strategies (Organization, structure, and process) ● Challenges (Keeping up, fatigue, distractions, and organization) ● Areas for improvement (organization, content)
3	The Livescribe™ pen helped students to increase engagement, generate excitement, and improve note-taking efficiency and ability.	● Positive Perceptions (useful, provides security, and great intervention) ● 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 note
4	The Cornell note-taking strategy helped students to improve the quality of notes by organizing, consolidating, and capturing more information in their notes.	● 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	Using the Cornell note-taking strategy and Livescribe pen together helps students to record better notes.	● 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)

5. Discussion

The in-depth interviews with student-athlete participants shed light on the significant challenges they face related to traditional note-taking during content-heavy lectures. All participants described a constant struggle to keep pace with the lecture while simultaneously comprehending and processing the material being presented. They emphasized the difficulties associated with actively listening, cognitively processing information, determining the relative importance of different concepts, organizing their thoughts coherently, and legibly transcribing notes before the instructor moved on to the next topic. The students consistently characterized the lectures as "too fast-paced," with professors covering excessive amounts of complex diseases, health issues, medical vocabulary, and concepts within a short time frame.

According to the student-athletes, their ineffective note-taking abilities contributed substantially to persistent comprehension problems, even after reviewing their notes. They found that major lecture points and key topics were often completely missing from their personal notes, rendering the studying process ineffective and frustrating. Most concerningly, participants expressed an inability to connect central ideas or follow the narrative flow of the lecture when attempting to review their materials in preparation for exams. All students described experiencing significant test anxiety stemming from their incomplete and confusing class notes on technical health-related content.

Despite being diagnosed with learning disabilities and enrolled in academic support programming offered by the institution, participants reported receiving no prior training on effective note-taking strategies or techniques tailored to their unique needs. While assistive technology options were available, such as digital pens, several participants noted that these tools were only briefly demonstrated during academic coaching sessions and were not actually implemented or utilized in authentic classroom environments. Consequently, most participants continued to rely on traditional pencil-and-paper methods for capturing lecture notes, without any

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modifications or accommodations to address their specific learning challenges.

The interviews revealed a clear disconnect between the support services provided and the actual needs and experiences of these student-athletes with learning disabilities. While the institution offered academic support programming, the lack of targeted note-taking strategy instruction and limited exposure to assistive technologies left these students ill-equipped to effectively navigate the demands of content-dense lecture courses.

Furthermore, the participants' descriptions of their note-taking experiences highlighted the multifaceted nature of the challenges they faced. The fast-paced delivery of complex information, combined with difficulties in cognitive processing, attention maintenance, and organizational skills, created a perfect storm of obstacles that traditional note-taking methods were unable to overcome.

It became evident that a more comprehensive and tailored approach was necessary to address the unique needs of these students effectively. Effective note-taking strategies, coupled with the appropriate implementation of assistive technologies like digital pens, could potentially mitigate some of the challenges faced during lectures and enhance comprehension, information retention, and overall academic performance.

However, merely providing access to assistive tools like digital pens is not enough. As the interviews revealed, proper training and ongoing support are crucial to ensure that these students can fully leverage the capabilities of such technologies and integrate them seamlessly into their note-taking and learning processes.

6. Recommendations

This study examined immediate outcomes related to note quality, content recall, and perceptions after a short intervention period. Additional longitudinal research is warranted to evaluate if implementation of assisted note-taking strategies yields improved course performance, grade point averages, or graduation rates over time. Tracking student progress markers could help validate whether supports like the Livescribe™ pen and Cornell notes promote skills leading to greater overall academic success for university students with learning disabilities. Future studies could also incorporate a larger sample size across multiple course subjects as this pilot study had a small sample size of 5 student athletes enrolled in the same health course.

7. Conclusion

The athlete-students emphasized assistive technology coupled with explicit instruction in note-taking techniques would be invaluable in overcoming barriers and enhancing outcomes. They desired practical solutions to apply in fast-paced, dense college-level lectures allowing improved attention, comprehension, recording of critical details, organization, reading/review, and test preparation. Several participants expressed with enhanced skills and useful technology tools they could become more confident, self-regulated learners.

Overall, the findings from these in-depth interviews also underscore the need for a holistic and inclusive approach to supporting the academic success of students with learning disabilities. By addressing the multifaceted challenges they face, providing targeted note-taking strategy instruction, and offering comprehensive training and support in the effective use of assistive technologies, institutions can create a more equitable and supportive learning environment, enabling these students to overcome barriers and achieve their full academic potential.

8. References

[1] Abreu-Ellis, C., and Hayes, J. (2009). Increasing retention, persistence, and success of students with disabilities in community colleges. University of Hawaii at Manoa: National Center for the Study of Postsecondary Educational Supports.

[2] Adleman, P. D. (1992). The Status of Academic Accommodations and Compliance with Section 504 of The Rehabilitation Act: A National Study.

[3] Belson, S. I., Hartmann, D., and Sherman, T. M. (2013). Digital note taking: The use of electronic pens with students with specific learning disabilities. Journal of Special Education Technology, 28(2), 1-16.

[4] Bonner, A., and Tolhurst, G. (2002). Insider-outsider perspectives of participant observation. Nurse researcher, 9(4).

[5] Boyle, J. R., and Forchelli, G. A. (2014). Differences in the note-taking skills of students with high achievement, average achievement, and learning disabilities. Learning and Individual Differences, 35, 9-14.

[6] Boyle, J. R., and Joyce, A. (2019). The effects of digital note taking on comprehension and recall in high school students. The Journal of Educational Research, 112(6), 761-768.

[7] Bui, D. C., and Myerson, J. (2014). The role of working memory abilities in lecture note-taking. Learning and Individual Differences, 33, 12-22.

[8] Chang, C., and Ku, Y. (2015). The effects of note-taking skills instruction on elementary students' reading. The Journal of Educational Research, 108(4), 278-291.

[9] Cortiella C, Horowitz SH. (2014). The state of learning disabilities: Facts, trends, and emerging issues. https://www

 | DOI: 10.20533/ijds.2040.2570.2024.0239

.ncld.org/wp-content/uploads/2014/11/2014-State-of-LD.pdf.

[10] Creswell, J. W., Hanson, W. E., Clark Plano, V. L., and Morales, A. (2007). Qualitative research designs: Selection and implementation. The counseling psychologist, 35(2), 236-264.

[11] Creswell, J. W., and Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.

[12] Cutting, L. E., Materek, A., Cole, C. A., Levine, T. M., and Mahone, E. M. (2009). Effects of fluency, oral language, and executive function on reading comprehension performance. Annals of dyslexia, 59(1), 34-54.

[13] Dell, A. G., Newton, D. A., and Petroff, J. G. (2012). Assistive technology in the classroom: Enhancing the school experiences of students with disabilities. Pearson Higher Ed.

[14] Doughty, T. T., Thompson, G. L., and Eggleston, D. (2013). Notes from Hearsay: An Assistive Learning Technology for Post-Secondary Students with Non-disclosed Learning Disabilities. Journal of Educational Technology Development and Exchange, 6(1).

[15] Evers, C. J., and Spencer, M. B. (2007). Understanding Reform: The Case of Adult Education. Harvard Educational Review, 57(1), 47-63.

[16] Gajria, M., Jitendra, A. K., Sood, S., and Sacks, G. (2007). Improving comprehension of expository text in students with LD: A research synthesis. Journal of learning disabilities, 40(3), 210-225.

[17] Gavilan College. (2002). Academic performance in math and English and award rates of disabled students. http://www.gavilan.edu/research/reports/DSPS023.

[18] Glodowski, K., and Thompson, R. (2018). The effects of note-taking on college students' recall and course achievement. College Student Journal, 52(4), 478-490.

[19] IDEA. (2004). Individuals with disabilities education improvement act of 2004. Pub. L, 108-446.

[20] Jang, B. G., Henretty, D., Waymouth, H., Gao, X., and Simpson, C. G. (2018). An exploration of the relationship between note-taking and academic achievement in a Korean university context. Australian Journal of Education, 62(1), 15-34.

[21] Jitenraet, S., Komolsevinb, R. and Puncreobchai. (2011). Learning and Note-Taking Strategies of the Matthayomsuksa 6 Students with Different Learning Achievements. Journal of Education, 4(1), 55-66.

[22] Johnson, C. I. (2008). Postsecondary institutions and students with learning disabilities: A critical overview of the central issues. College success for students with learning disabilities, 15-31.

[23] Lee, P. L., Lan, W., Hamman, D., and Hendricks, B. (2008). The effects of teaching notetaking strategies on elementary students' science learning. Instructional Science, 36(3), 191-203.

[24] Lindstrom, J. H. (2007). Determining appropriate accommodations for postsecondary students with reading and written expression disorders. Learning Disabilities Research and Practice, 22(4), 229-236.

[25] Madaus, J. W., Banerjee, M., and Merchant, D. (2011). Transition to postsecondary education. Handbook of Special Education, 571-583.

[26] McGregor, K. K., Langenfeld, N., Horne, S., Oleson, J., Anson, M., and Jacobson, W. (2016). The university experiences of students with learning disabilities. Learning Disabilities Research and Practice, 31(2), 90-102.

[27] Mertler, C. A. (2016). Introduction to educational research. Sage Publications.

[28] Mortimore, T., and Crozier, W. R. (2006). Dyslexia and difficulties with study skills in higher education. Studies in higher education, 31(2), 235-251.

[29] National Council on Disability. (2000). Transition and post-school outcomes for youth with disabilities: Closing the gaps to post-secondary education and employment. Washington, DC: Author.

[30] Newman, L., Wagner, M., Knokey, A.-M., Marder, C., Nagle, K., Shaver, D., Wei, X., with Cameto, R., Contreras, E., Ferguson, K., Greene, S., and Schwarting, M. (2011). The Post-High School Outcomes of Young Adults with Disabilities up to 8 Years After High School. A Report from the National Longitudinal Transition Study-2 (NLTS2) (NCSER 2011-3005). Menlo Park, CA: SRI International.

[31] NIH. (2019, September). Learning Disabilities Information Page. National Institute of Neurological Disorders and Stroke. https://www.ninds.nih.gov/Dis orde rs/All-Disorders/Learning-Disabilities-Information-Page (Access Date: 13 February, 2024).

[32] Ok, M. W., and Rao, K. (2017). Assistive technology interventions for adolescents and adults with learning disabilities: An evidence-based systematic review and meta-analysis. Computers and Education, 114, 139-163.

[33] Onwuegbuzie, A. J., and Leech, N. L. (2007). Sampling designs in qualitative research: Making the sampling process more public. The qualitative report, 12(2), 238-254.

[34] Patti, C. J., and Garland, K. V. (2015). Smartpen technology: Enhancing student learning in a special education teacher preparation program. Journal of Special Education Technology, 30(3), 177-182.

[35] Peverly, S. T., and Sumowski, J. F. (2012). What variables predict quality of text notes and are text notes related to performance on different types of tests? Applied Cognitive Psychology, 26(1), 104-117.

[36] Ramos, R. C., Trujillo, J. E. G., Pérez, D. D. F., and Sánchez, J. C. C. (2021). Relation between reading competence and note-taking on academic performance. Revista complutense de.

 | DOI: 10.20533/ijds.2040.2570.2024.0239

[37] Seid, A. and Teklay, H. (2018). Training improved the note taking skill of nursing students in Aksum University; Northern Ethiopia: A classroom-based action research. BMC Research Notes, 11(1):543.

[38] Shaffer, A. K., and Schwebach, J. R. (2015). Usefulness of Livescribe web recordings as supplemental resources for a large lecture undergraduate course. Journal of College Science Teaching, 44(4), 54-60.

[39] Sparks, R. L., and Lovett, B. J. (2014). Learning disability documentation in higher education. Learning Disability Quarterly, 37(1), 54–62.

[40] Snyder, S., and Huber, H. (2019). Computer assisted instruction to teach academic content to students with intellectual disability: A review of the literature. American Journal on Intellectual and Developmental Disabilities, 124(4), 374–390.

[41] Torgesen, K. L. (2000). Individual differences in response to early interventions in reading: The lingering problem of treatment resisters. Learning Disabilities Research and Practice, 15, 55–64.

 | DOI: 10.20533/ijds.2040.2570.2024.0239